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Geography of Environment, Hazard and Disaster Management

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For a purpose to cascade and transfer knowledge through the academic learning to the readers, I have here liberally used and compiled different published and unpublished ideas, concepts, statements and knowledge with due citations and shouldering the knowledge levels as led foundation by them without any willful interest. I extend my sincere acknowledgements to all of them with due respect.

I apologize and also beg pardon if I unwittingly left someone for sincere citation and credited them on due placement.

Author

Preface

The geographical location of Nepal is in environmentally very sensitive zone of the world. Nepal is in between the foreheads of two different Precambrian Landmasses i.e.Angara in the north and Gondwana in the south. The Earth's history tells us, for last nearly 500 million years ago or since Ordovician Period, the present-day location of Nepal was under the geosynclinals trough and covered by water. In the course of time, gradually the geosynclinals trough filled by materials as well as sandwiched in between two rigid masses. Several endocentric processes and forces began after the Mesozoic Era for last 252 million years ago, upward thrown the geosynclinals trough and formed the elevated mountain. The Himalayas is the new folded mountain system with active and dynamic endogenetic forces and created highest mountain systems of the world. Because of that nearly 2400 kilometers from west to the east extension with an arc-shaped Himalayas is known as active, unstable and highest mountain systems of the world. Nepal has its location along the Himalayan systems elongated from west to the east around 1100 kilometers in length and nearly 200 kilometers in average width. Due to its location attributes, Nepal has various environmental issues and also the people living in this country frequently faced the problem of natural hazard, disaster, vulnerability and risk. It seems very relevant to understand the geo-environmental dynamism of Nepal for any domain disciplines of university degrees. Within this contextual ground this book on 'geography of environment, hazard and disaster management' has been prepared. The general thematic contents have been organized with reference to Nepal. The book has intended for the university fresher of geography education supposed to be future geography school teachers but not limited to them. This would be the reference handbook to all those who are related with the Disaster Risk Reduction and Management (DRRM) assignment with any domain disciplines adopting holistic approach.

The objectives of writing this book were on seeking answer of the following questions.

- What is environment geography, hazard and disaster management?
- What are the relationships of environmental geography with other branches of geography as well as biological sciences?

- What are the environmental issues and their linkages with environmental geography
- What are hazard, disaster, vulnerability and risk?
- How to account hazard and disaster within the school safety contexts?
- What are the initiations and measures for Disaster Risk Reduction and Management (DRRM) taken in Nepal?
- How to incorporate the teaching learning strategies of environment geography, hazard and disaster management at school and beyond social framework?

The content of environment, hazard and disaster management is widely used by the several disciplines. But there is a need to write a book with establishing direct linkages with geography and environment. Several environmental elements and factors originate from the geographical contextual ground and result hazard, disaster, vulnerability and risk. The sub-surface events like earthquake, volcano and gravity flow and wasting; surface and above surface events like climate change, water pollution, air pollution, landslide, flood, Landslide Lake Outburst Flood (LLOF), Glacial Lake Outburst Flood (GLOF), unnatural cloudburst, El Nino, black carbon, biodiversity loss and so on environmental issues are closely associated with the geography of the earth surface. The human death-toll and property loss by several such events are directly linking with the geography of the space. There are several geographical properties like spaces and their dimensions, structures, linkages, human and their activities and coverage. In the course of understanding environmental issues along with hazard, vulnerability and risk; proper scrutiny through geographical perspective is highly essential. Therefore, study of environment through the geographical lens provides a holistic completion.

The scope of this book is, thus, limiting to basic understanding of environment, hazard and disaster management within the geographical perspective. However, the supporting data, information, materials and methods have been compiled wherever available within the interdisciplinary sources without limiting to geography. The questions anticipated to cover throughout the assignment are the output in the form of a book.

Most of the data and information were collected from the desk-top review of the materials from the secondary sources like books, report, statistical records and monographs either from open sources or libraries and personal basis. The available data and information were scrutinized based on the requirements and compiled with acknowledges of credit and with respect. Empirical evidences, sharing ideas with concerned resource persons and experts, expert judgment and field observation wherever possible were accomplished during the course of preparation. Analog maps, digital maps including open sources like Google Earth, Open Street Map (OSM) and satellite imageries wherever and whatever available were provided as the evidences demanded by the questions in respective contexts. Statistical analysis, graphical representation, photographs and mapping based on Geographic Information Systems (GIS) were used in respective contexts as per the evidences and for comfortable visualizations.

Author expects constructive feedbacks from the sincere readers for its future improvement.

Author

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Chapter 1

DEFINITION, NATURE, SCOPE, DEVELOPMENT AND APPROACHES

1.1 Definition

The term 'environment' is common word to everyone's tongue to express wider types of feelings. If there is too hot, too smoky, too cold, too dry or too dusty people use there is no good environment. In contrast, if clean, greenish, mild conditions use good environment. Someone also use 'environment' for daily weather or seasonal and annual climatic condition of certain geographical location. Sometimes, common people confuse with climate, weather and even environment. However, the understanding of the common people clearly indicates to the condition of their local surroundings whatever the factors and level of understanding with them. From the teaching learning point of view, the common understanding and scientific understanding requires to be combined within a common thread. Therefore, it requires on searching the etymological meaning of the terminology we use in our daily life. Dictionary meaning of the term has been used in various ways too (https://www.dictionary.com/browse/environment). It is:

i. the aggregate of surrounding things, conditions, or influences; surroundings; milieu;
ii. ecology, the air, water, minerals, organisms, and all other external factors surrounding and affecting a given organism at any time;
iii. the social and cultural forces that shape the life of a person or a population;
iv. computers, the hardware or software configuration, or the mode of operation, of a computer system: In a time-sharing environment, transactions are processed as they occur;
v. an indoor or outdoor setting that is characterized by the presence of environmental art that is itself designed to be site-specific.

Even in the dictionary the term has been used in different ways to indicate different situation and condition with contextual representation. In this context, therefore, environment geography needs to define according to the geographical contextual ground being strict to the geographical matters.

The term 'Environmental Geography' was first used by K. Hewitt and F. K. Hare in their article on 'Man and Environment: Conceptual Frameworks Commission on College Geography Resource Paper No. 20' of the Association of American Geographers (Hewitt and Hare, 1973). They have clearly focused on the man-environmental relationships. The planet earth has the lithosphere, hydrosphere, atmosphere and biosphere. These are the major components of the environment. Man interacted within these components and made own habitat. Food, shelter, cloths and several necessities and comfortable items were extracted from the nature. Thus, the nature is the pool for the mankind from where they extract necessary goods incessantly without any hesitation. Minimal number of mankind, abundances of the natural stuffs and limited human knowledge were responsible to limit the amount of extraction of natural items in the past. Because of that the relationship of man and environment was in harmony for a long historical period.

Therefore, the geography deals with the contents of environment through the geographical perspectives. Environment does not stand alone. It has the combination of various environmental components. Those components are derived from atmosphere, hydrosphere, lithosphere and biosphere. Distribution, association, interaction and interrelationships of various environmental components, in consequences, create unique geographical space on the earth surface. The varied structure of geographical space, occurrence of different forces originated from different dimension of geographical space and their typologies of processes over the span of time result the space more complex. Thus, the 'environmental geography' has a close linkage with the feature creating forces, involving processes and their consequences over time of geographical space. The disaster, hazard, vulnerability and risk of earth surface are the events created due to the environmental consequences of such different environmental components over the geographical space. Within these circumstances, it is necessary to integrate the contents of geographical studies within the environment, hazard and disaster management. Here the term 'management' has been taken on the ground of human centric perspective. The usual appearance of environmental condition of a geographical space is a causative factor to create hazard and disaster which ultimately losses the lives and properties. Therefore, management of such occurrences requires dealing within the subject matter of geographical content.

1.2. Nature, scope and development of environmental geography

Availability of the natural items determines the human actions. But gradually both number and knowledge of human beings change over time and the proportion of use of natural stuffs increased, has determined the changing relationships of man and environment. Throughout the historical past people managed their resources according to their own perceptive skills and knowledge. Hunting, gathering, 'transhumance' or 'nomadism', construction of terraces over the rolling hillslope, irrigation courses made from the running water channels, use of fires and shifting cultivation techniques were common practices. At that time human numbers were relatively small and consumption patterns were less diverse and not complex. Therefore, both extraction and supply systems of resources were in harmony. However, this trend has been disrupted by the economic growth after the industrial revolution. The demands for resources compelled to expand the limits of use. In the western societies, George Perkins Marsh in Vermont, USA, has noticed this scenario as early as 1864. He has mentioned that "[M]an is everywhere a disturbing agent. Wherever he plants his foot, the harmonies of nature are turned to discords...Man has subverting the balance of nature" (Marsh, 1964:36). Within this conceptual ground the environment geography deals with the environment in its totality unlike some other disciplines which only focus on one or few of its aspects. It analyses the time-space relationship between man and the environment. Basically, the environmental geography comprises three facets i.e. environment, man and relationships between both. There are different approaches on the dealings of these facets. The environment has been dealt either from the perspective of natural sciences or in the human dimensions. Physical environment comprise the natural laws of ecosystems. Examples can be drawn from the land systems in physical geography including the landscape properties. Several such facets originate from the properties and components of the physical environments. The components of lithospheres, atmosphere, hydrosphere and the biospheres produce physical environmental systems. That system closely works in any unit of land and create habitat for biotic and abiotic species elements. Within the physical environmental system man works an individual physical man as an element; social man as a group of physical man including the community and social organization; and the economic man with its activities over the space to extract and utilize the resources from the system. Ultimately, the human and

the space have a close interaction within the framework of their relationships. The interaction generates:

- Extraction, exploitation and utilization of resources for the livelihood of man
- Economic activities like production, distribution, consumption and exchange and *non-economic* activities as well.
- Human progression
- Development and innovations
- Cause and effect
- Feedback system

The content of geography of environment, natural hazard and disaster management has to be built to cover a single or total of these consequences of interaction of man-environmental interrelationships.

1.3 Approaches on teaching environmental geography

The relationship closely associated with the space and time. It has clear space-time interaction. Some events over a space may have change with time. Illustration can be drawn from the value of resources extraction for the livelihood of the people. In the past, man used to extract resources from the hunting and gathering. The value system gradually changed and value of farmland increased along with the knowledge of crop farming. Similarly, several industrial establishments in the Western Europe in 18th and early 19th century moved to mineral resources and abandoned the cropland. Several big urban centers developed around the world with large population concentration. The functional transformation has been placed. Economic activities have large diversifications. Human progression appeared. Several causal relationships within man and environment visualized. The human knowledge systems over time permit feedback systems to adjust the environment. Therefore, the relationship appears in a dynamic system rather in static form. The core theme of the environmental geography comprises some basic concepts including:

- All the organisms and elements are mutually reactive and affect each other and the environment in various ways and vice-versa.

- Environment is highly dynamic in nature varying with time and space; there is state of equilibrium and disequilibrium.
- Every element, component and factor have specific role to play and perform some functions in orderly manner.
- Structure and function provide a base for the environment and it works on "cause and effect".
- Species make effort to maintain uniformity in structure, function, growth and development in the environment.
- Every community goes through some stages of establishment, growth and extinction.
- There are biomes which are specific areas where different organisms share a common climate.
- Chemical components move in a definite cyclic order, there is energy flow and biomass formation.
- There is man- environment relationship and interaction in different phases.

Within these conceptual bases the space, organism interaction over the time follow several rules. However, in the environmental geography focus has to be given on the man and environmental relationships within the human interaction with the physical properties and components which can be termed as geo-ecosystem. Within that geo-ecosystem the ecosystem functions of every organisms and the temporal change in ecosystem over time has to be scrutinized. The ecosystem works over the spatial dimension and change on space. Man and environmental perspective, global environmental perspective, hazard and disaster management perspective and environmental degradation and pollution and environmental management are also the subject matter of the environmental geography.

1.3.1 Human environmental inter-relationship

Geography teachers have been at the forefront in environmental education. Illustration can be drawn from our own country where we can see various geographical phenomena within short spatial differences. The plain of south has a warm climate. The middle hill has mild climate and the mountain has chilled climate. Similarly, the

southern plain is flat. People over that area have been following different human activities and which have much more differences than the middle hill and the mountain in the north. Differences on human activities and also for several environmental parameters have been seen associating with the physiographic differences. Thus, the students find themselves a wider world within a short geographical area of Nepal.

The physical environment determines what kinds of houses we build and clothes we wear; what kinds of food we can grow. While we see in different local areas senior citizens have been seen usually following different activities which have been trying to adjust with the local environment. To some extent, people also shape and change their environments, gradually. Societies have been interacting with each other and with their environments also. Some of the actions seem in ways which have been to the benefit of some for a short while but some have been negative impacts for the long run. That has been seen degradation of the environment so badly that it no longer be supportive for the people. Illustration can be drawn from the acts of man along the river network could be seen the sand and gravel query during dry season, but flood and side cutting of river during the monsoon in the plain area. Also could be seen the road construction in the steep hill-slope and the landslide occurrences in the monsoon. Both flood in the plain and the landslides in the middle hills and mountains damage several human settlements, loss of properties and lives. Similarly, the landscape of Kathmandu Valley changed over time. Almost all the green crop field in the past has been changed to concrete jungle at present. There are several environmental consequences resulted due to changes in landscape. The rural areas of the country for last few decades, rural farmlands have been converting to forest and bush land due to the shortage of agriculture labor which has been resulted by the foreign labor migration. These are few instances of how the man and environment interacting each other and have their interrelationships. These are also the examples of subject matters for the study of environmental geography.

1.3.2 Human and environmental ecosystem interaction

Encyclopedia Britannica defines 'Ecosystem' is "the complex of living organisms, their physical environment and all their interrelationships in a particular unit of land

(https://www.britannica.com/science/ecosystem). Ecosystem can be categorized into its abiotic constituents, including minerals, climate, soil, water, sunlight, and all other nonliving elements, and its biotic constituents, consisting of all its living members. Linking these constituents together are two major forces: the flow of energy through the ecosystem, and the cycling of nutrients within the ecosystem. Human beings are one of the active components of the system. The action of human being exerts its dynamic roles over the both biotic and aboitic constituents of the ecosystems. Illustration can be taken here from the farming activities of agriculture community. A farmer grow crop from her/his farmland. She/he prepares farm land by using water, manure, energy like nonliving elements and grow crop and produce cereals, fruits vegetables etc. Farmer applies her/his knowledge, skills, technology as of the enablers gained from her/his enabling environments. Those enabling environments also determine through society, culture, education, governance systems contributing by internal and/or external driving factors.

There is a fact that nature is often an invisible in the economic choices. We have been steadily drawing down our natural capital without understanding either what it really costs to replace services provided for free by nature, or that man-made alternatives are sometimes far too much expensive for the services to be replaced (https://eu.europa.eu/environemnt/nature/biodiversity/economics/). The study of geography of environment, hazard and disaster management bridges the natural ecosystems and human skills, knowledge and their enablers. The contents used to be developed through the holistic sensation. An example can be cited here a building is not 'only a sum of brick, rods, concrete and cement' as we usually use, but a building has something else that is the sensation of skills, knowledge, technology which come from the human mind. Similarly, the content has some invisible driving factors on interacting within the systems.

1.3.3 Concept of natural hazards and disaster management

Nature is quite broad. Several natural phenomena originate from the diverse natural landscape. A natural hazard is a threat of a naturally occurring event will have a

negative effect on human lives and properties. This negative effect is what we call a natural disaster. In other words when the hazardous threat actually happens and harm human, we call the event a natural disaster. Natural hazards (and the resulting disasters) are the result of naturally occurring processes those have operated throughout Earth's history. But beyond that several natural events aggravates by the human actions and the severity of the harm or damage to human increases and the degree of disasters become more severe. Sometime the human actions also provide opportunities on growing the micro organisms in the environment and exert negative impacts on human lives and properties, which provide negative effects on human lives i.e. health hazard and epidemics. Such events originate from the improper practice of waste management. Based on those roots of origin of events literarily we have a practice on categorization of hazard and disasters. Not all the times hazards can be categorized within the heading of natural induced and human induced. The illustration can be cited here from the people's death due to an earthquake event caused by the collapse of a dilapidated building or a structurally weak residential complex. The death has been caused due to the collapse of dilapidated building which is not a natural cause but the actor here came from the earthquake. Similarly, other examples can be listed here from the fire broken in a city after the earthquake and collapse of the building near the sea shore due to the tsunami. From these illustrations, it is clear that there is no clear boundary between natural and man-induced disasters, but disaster is a common nomenclature that damages the human lives and properties. Therefore, environmental geography needs to incorporate its contents from the man environmental interaction within the disaster studies perspective.

1.3.4 Linkages between environmental geography, hazards and disaster management

The environmental condition of the surrounding areas is the first concern of the people living in. The hazard and vulnerability situation of the surrounding areas put the people at risk. Therefore, National and international organizations have been giving their attention towards the hazard and disasters. The United Nations General Assembly proclaims the International Decade for National Disaster Reduction begins on 1st January 1990. Since then the international initiatives on understanding and management of hazard and disaster have been increasing all over the world. The UN General Assembly has initiated the United Nations Strategies for Disaster Reduction (UNISDR), Hyogo Framework of Action 2005-2015 and Sendai

Framework for Disaster Risk Reduction 2015-2030. On 27 July 2018, United Nations General Assembly has been put its' provisional agenda of disaster and risk reduction for sustainable development in its' seventy thirds session. The agendas have mentioned, since 2015 a global policy achievement has been developed with the aim of guiding the integration of disaster risk reduction, sustainable development and climate change adaptation. Many countries have or are in the process of developing national and local disaster risk reduction strategies towards the global target of the Sendai Framework to sustainability increase the number of countries with national and local disaster risk reduction strategies in place by 2020 (UN General Assembly the seventy third session, 27 July 2018).

Box #01

Sendai Framework for Disaster Risk Reduction 2015-2030

I. Preamble

1. The Sendai Framework for Disaster Risk Reduction 2015–2030 was adopted at the Third United Nations World Conference on Disaster Risk Reduction, held from 14 to 18 March 2015 in Sendai, Miyagi, Japan, which represented a unique opportunity for countries:

(a) To adopt a concise, focused, forward-looking and action-oriented post 2015 framework for disaster risk reduction;

(b) To complete the assessment and review of the implementation of the Hyogo Framework for Action 2005–2015: Building the Resilience of Nations and Communities to Disasters;

(c) To consider the experience gained through the regional and national strategies/ institutions and plans for disaster risk reduction and their recommendations, as well as relevant regional agreements for the implementation of the Hyogo Framework for Action;

(d) To identify modalities of cooperation based on commitments to implement a post 2015 framework for disaster risk reduction;

(e) To determine modalities for the periodic review of the implementation of a post 2015 framework for disaster risk reduction.

Source: Sendai Framework of Disaster Risk Reduction 2015-2030, United Nations

All these initiatives and global actions present the linkages of environmental geography and hazard and disaster management in an extensive scale.

1.3.5 Relevancy in teaching within academic programmes

The only effective means to cascade knowledge and skills to the society is the teaching within the academic programme. Specifically, the teachers deserve the knowledge and skill demanded by the specific curricula form the various sources and delivers those to the students. There are mandatory provisions also maintained in the structured curriculum of environmental geography and hazard and disaster management by which the learners gain the knowledge in a systematic way. The application of various

supporting technologies in teaching this subject like geographic information systems, remote sensing, mathematics and statistics enables to integrate several biotic and abiotic constituents of the environment, causative variables and drivers of hazard, disasters and their management components. Therefore, teaching this subject within the classroom deserves high relevancy.

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Chapter 2

RELATIONSHIP OF ENVIRONMENTAL GEOGRAPHY WITH OTHER BRANCHES OF GEOGRAPHY AND BIOLOGICAL SCIENCES

2.1 Introduction

The lithosphere, atmospheres, hydrosphere and biosphere are the sources of physical parameters. Physical parameters of the earth and its surroundings determine subject matter of environmental geography. Several components and their parameters of those spheres have strong role on determining the surrounding environment. From this perspective, the environmental geography is closely interlinked with the physical aspects and their components and parameters. Within the academic disciplines these subjects are delineated within the physical geography. Besides the physical determinants, several human activities are also confined in different geographical terrain. Those activities have separate geographical entities. They have their own spatial associations and specificities. Those activities are usually segregated as human and economic geography. Despite this, major cluster of physical, human and economic fields of knowledge there are strong role of biological sciences as well as the material and energy flow in the systems. Those impart influences in the environmental components, nature of change over space and time, their interrelationships with other organisms and matter and energy. From this perspective, the study of environmental geography has to be interlinked with other disciplines which are closely interacting on determining its scope.

2.2 Physical geography

Physical geography is one of the fundamental subjects in geography deals mainly the physical components and their parameters of the earth surface. The dictionary has defined physical geography as a field of knowledge that studies natural features and phenomena on the earth from a spatial perspective (http://www.physicalgeography.net/physgeoglos/z.html). The online version of Collins English Dictionary has defined it as the branch of geography that deals with the natural features of the earth's surface. The study of the features and nature of the

earth's solid surface and oceans, atmosphere and climate, distribution of plant and animal life, etc. William Harmon Norton (1901) has published an article "relation of physical geography to other science subjects" in Science Journal where he wrote physical geography is the basic science which deals several natural or physiographic factors (Norton, 1901). Philosophy in physical geography is done as much by boots and compass as by mental activity. Philosophy in physical geography is an active process open to change as the subject is practiced. As the philosophical trend has been reviewed, between 1850 and 1950, the main ideas that had a strong influence on the discipline were uniformitarianism, evolution, exploration and survey, and conservation. In 1960s, a new type of physical geography began to emerge that accentuated a concern with dynamic processes of earth systems. That approach, which has evolved to the present, is founded on basic physical, chemical, and biological principles and employs statistical and mathematical analysis. It has become known as the "process approach" to physical geography (Chorley et. al., 1985). In late 1980s, physical geographers, who have always acknowledged that the systems they study are complex, have turned to emerging ideas in the natural sciences about nonlinear dynamical systems and complexity to explore the relevance of these ideas for understanding physical-geographic phenomena.

It was conventionally subdivided into geomorphology, climatology, hydrology, and biogeography, but is now more holistic in systems analysis of recent environmental and quaternary changes. It uses expertise in mathematical and statistical modeling and in geographic information systems, remote sensing, develops research to inform environmental management and environmental design, and benefits from collaborative links with many other disciplines such as biology (especially ecology, geology and engineering'(Gregory 2002 cited in https://researchguides.dartmouth.edu/ physical_geography).

Advances in remote sensing, geographical information systems and information technology have enabled a more global approach. A second new development has been the advent of a more culturally-based approach throughout many branches of physical geography. By 2000, a series of issues can be identified including the increasingly holistic trend, greater awareness of a global approach and of environmental change problems and of the timely opportunities which can arise from closer links with human

geography and with other disciplines' (https://researchguides.dartmouth.edu/physical_geography). However, in the recent years physical geography focuses upon the character of and processes shaping the land-surface of the Earth and its envelope, emphasizes the spatial variations that occur and the temporal changes necessary to understand the contemporary environments of the Earth. Its purpose is to understand how the Earth's physical environment is the basis for and is affected by human activity (Inkpen and Wilson, 2013). The sub-discipline of physical geography remains firmly grounded in research undertaken to explain Earth's landscapes and its geomorphic, hydrologic, atmospheric, cryospheric, petrologic, and biogeographical processes, which change over time and space, the extent of the human "footprint" on this planet challenges physical geographers to pay greater attention to the role of people in environmental change and the interactions between people and their environments' (Mayhew, 2015). From these developmental processes of physical geography it is clear that it has a close interactive role to environment which is the basic subject matter of the man and environmental geography.

2.2.1 Landscape properties – Geological structure and lithology, altitude, slope, aspect, relief.

As the focal theme of physical geography concerns on physical landscape that has numbers of physical properties. Several environmental phenomena of the landscape determines by geological structure and lithology and surface morphometry like altitude, slope, aspect and relief features.

Geological structure and lithology

The landscape has its geological structure and lithology which have been associated with its formation process of landscape and its morphology. The formation of landscape with its underneath rocks, geological formation, structure and their properties imparts effects over the landscape. The endogenetic movement and forces originated from the interior part of the earth surface made changes above the surface. Examples can be cited about the earthquake and volcanic events on the surface which are clearly visible. The illustration can be taken from the occurrences of earthquake in the Nepal Himalayas where because of the convergence boundary of two plates in the region. Therefore,

tectonic movements cause changes on the surface. Similarly, the formation of surface landforms and features closely interlinked with the hardness and softness of the rocks. Several landslides in the middle hills and the Siwalik regions of Nepal originate within the loose soil and regolith. The exogenetic forces like snow, ice, glaciers, rainfall, winds work outside the surface but their actions have direct influence by the structure of geology and rock types. Thus, the causes of environmental degradation are mainly associated with geological structure and regolith of the landscape.

Morphometric parameters

Altitude, slope, aspect relief etc shape the geometry of the surface. Those factors also have the close linkages with the geology and lithology, however, these factors are closely linked with the surface forms. Man and environmental interrelationships determines because of such surface forms. Illustration can be cited here from the high hills and mountains of Nepal where due to high elevation the action of snow and ice introduced. The weathering and frost shattering may appear along with snow and ice actions. The reason for temperature reduction is due to 'environmental temperature lapse rate' from the valley floors to the hills top. Similarly, the increasing inclination of the ground results steep slope which initiate the acceleration of gravity flow of materials from the upper convexities to the base. Therefore, several landslide and rock/mass flow over the earth surface associated within the steep hillslope. Solar radiation on the ground at the hills and mountain aspects differs due to their directional locations. In the southern hemisphere the northern face of the mountain and hills get high radiation whereas in the northern hemisphere vise versa. That has been caused due to the position of Sun caused by inclination of the Earth over its axis. Because of that the southern aspect of hills and mountains in Nepal get more Sun exposure and remain warm round the year in comparison to northern aspect. Because of that people prefer to settle in the southern aspect. Human activities in the southern aspect give more pressure compared to the north. The relief features also determines the surface roughness. The undulating surface geometry contributes more susceptible terrain for the materials and energy flow. Because of these different morphometric characteristics the man and environmental relationships comprises with several differences.

2.2.2 River network or hydraulic systems

River network or hydraulic systems provides sources of water for the species existence as well as the opportunities for the materials and energy flow across the terrain along the network channels. Several large human civilizations in the past developed along the major river network channels around the world. The large agriculture farmland, and also the location of several modern industries are confined along the large river systems. Drinking water, irrigation water, navigation, hydropower, aquatic life and resources are some of the common examples of water provides to the people. From the environmental geographical perspectives river network or hydraulic systems and wetland play strong roles and leverage different opportunities.

2.2.3 Soils – acidification, salinization

Soils provide the life support activities to the human. From the environmental perspective the major soils characteristics like acidification and salinization exert major problem for the production system. Most of the soils having high content of acid supported by the acid rain from the polluted atmospheric environment and also from the adding of excessively high amount of ammonia cause the increment of the acidic soils. The acid rain and also the excessive amount of chemical substances of ammonia push the draughtness of the soils and enhance the salinization processes. The hard pan of salt minerals in the upper horizon of the soils developed. The soils ultimately convert to unproductive. From the environmental perspective both conditions of the soils i.e. acidification and salinization, are harmful for the species growth. Therefore, environmental geography needs to establish linkages with the concept of soils characteristics.

2.2.4 Climatic properties – sunshine, precipitation, temperature, humidity,

For the species growth and their dynamic changes in the earth surface the climatic parameters like sunshine, precipitation, temperature humidity, air pressure, wind etc are equally important. These are atmospheric parameters. The climatic parameters control any types of organism growth. Sunshine has a direct impact on the

photosynthesis process. Similarly the supply of water from the roots after the precipitation rules over the mineral and energy flow. Thus, these parameters have a great control over the plant growth, energy and materials flow from the earth surface as well as to control the hydrological cycle and food chain systems. The environmental geography has close linkages with the atmospheric or climatic parameters because manifold conditions of the environment determine by the climatic parameters.

2.3 Human and economic geography

By its definition of environmental geography, there are three basic components which are man, environment and their interrelationships. From this definition it is necessary to study man, their number, their habitat and the activities they follow for their livelihood. Within that context the population, settlement and human activities are the fundamental subject matter of environmental geography.

2.3.1 Population,

Within the population, the number, distribution, its composition and characteristics are the major contents within the population which are required to assess within the environmental geography. Environmental conditions of any geographical unit have the direct impacts of the population. Therefore, population is required to include within the environmental geography.

2.3.2 Settlement,

Human settlement creates certain types of landscape in the earth surface. They have their own morphological patterns. Urban and rural settlements have their own development processes. The settlement exerts various types of environmental geographical components.

2.3.3 Human activities (cultivation, infrastructure development, urbanization, industrialization)

Human activities contributes earth's surface in various ways. People cultivate their farmland, construct infrastructure, and develops urbanization and industrialization. These activities exert several types of impact on the environment of geographical space and geo-ecosystem. Therefore, the environmental geography needs to develop the linkages with human activities.

2.4 Biological sciences

Biological science is the study of life and living organisms, their life cycles, adaptations and environment. There are many different areas of study under the umbrella of biological sciences including ecology, ecosystem and biodiversity. The environmental geography entertains these biological sciences for ascertaining several impacts within it.

2.4.1 Concept of ecology

Ecology is the scientific study of the processes influencing the distribution and abundance of organisms, the interactions among organisms, and the interactions between organisms and the transformation and flux of energy and matter. From these perspectives the environmental geography requires to ascertain the ecological elements of the organisms.

2.4.2 Ecosystem and biodiversity

Biodiversity is a measure of the variety of life on earth. It can be assessed at genetic, species and ecosystem levels. An ecosystem is defined as a community of living organisms, together with the physical environment they occupy at any given time. The diversity of ecosystems is difficult to estimate as ecosystems grade into one another and large ecosystems may contain diverse than smaller ones. Our planet as a whole is an ecosystem, but it contains many others: forests, deserts and oceans for instance, which are themselves made up of smaller ecosystems. Changes in one ecosystem will impact

on the others with which it overlaps and into which it grades (Ecosystems and biodiversity, 2011)

2.4.3 Types of ecosystem

An ecosystem consists of all the living and non-living things in a specific natural setting. Plants, animals, insects, microorganisms, rocks, soil, water and sunlight are major components of many ecosystems. All types of ecosystems fall into one of two categories: terrestrial or aquatic. Terrestrial ecosystems are land-based, while aquatic are water-based. The major types of ecosystems are forests, grasslands, and deserts, tundra, freshwater and marine. The word "biome" may also be used to describe terrestrial ecosystems which extend across a large geographic area, such as tundra. Keep in mind, however, that within any ecosystem, specific features vary widely – for instance, an oceanic ecosystem in the Caribbean Sea will contain vastly different species than an oceanic ecosystem in the Gulf of Alaska (Harris, 2018).

2.5 Material and energy flow in the ecosystem

At the first trophic level, primary producers (plants, algae, and some bacteria) use solar energy to produce organic plant material through photosynthesis. Decomposers process large amounts of organic material and return nutrients to the ecosystem in inorganic form, which is then taken up again by primary producers. Energy moves life. The cycle of energy is based on the flow of energy through different trophic levels in an ecosystem. Our ecosystem is maintained by the cycling energy and nutrients obtained from different external sources. At the first trophic level, primary producers use solar energy to produce organic material through photosynthesis. The herbivores at the second trophic level, use the plants as food which gives them energy. A large part of this energy is used up for the metabolic functions of these animals such as breathing, digesting food, supporting growth of tissues, maintaining blood circulation and body temperature.

The carnivores at the next trophic level, feed on the herbivores and derive energy for their sustenance and growth. If large predators are present, they represent still higher

trophic level and they feed on carnivores to get energy. Thus, the different plants and animal species are linked to one another through food chains.

Decomposers which include bacteria, fungi, molds, worms, and insects break down wastes and dead organisms, and return the nutrients to the soil, which is then taken up by the producers. Energy is not recycled during decomposition, but it is released (https://www.tutorialspoint.com/environmental_studies/environmental_studies_energy_flow_in_ecosystem.htm).

2.6 Interlinking of environmental issues with ecology, ecosystem and biodiversity,

If biodiversity affects ecosystem functioning, ecosystem, ecologists can no longer ignore the dynamics of biodiversity within ecosystems. Ecology has traditionally regarded biodiversity as an epiphenomenon driven by the abiotic environment and ecosystem functioning. Community ecology and ecosystem ecology provide two perspectives on complex ecological systems that have largely complementary strengths and weaknesses. Merging the two perspectives is necessary both to ensure continued scientific progress and to provide society with the scientific means to face growing environmental challenges. Research on biodiversity and ecosystem functioning has contributed to this goal in several ways. By addressing a new question of high relevance for both science and society, by challenging existing paradigms, by tightly linking theory and experiments, by building scientific consensus beyond differences in opinion, by integrating fragmented disciplines and research fields, by connecting itself to other disciplines and management issues, it has helped transform ecology not only in content, but also in form. Creating a genuine evolutionary ecosystem ecology that links the evolution of species traits at the individual level, the dynamics of species interactions, and the overall functioning of ecosystems would give new impetus to this much-needed process of unification across ecological disciplines (Loreau, 2010).

From this discussion it has been revealed that the environmental geography has close relationships with other branches of geography as well as with biological sciences. Environmental geography has several such contents which have been brought from

different physical and biological sciences thus, without proper understanding the fundamentals of such sciences, it poses difficulties on understanding the philosophical route.

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Chapter 3

ENVIRONMENTAL ISSUES AND THEIR LINKAGES

3.1 Introduction

Environmental geography placed its important role on the environmental issues and their linkages in each component of the systems. Basically, those issues originate individually or sometimes interlinked with more than one causative factor. Land degradation, deforestation, loss of biodiversity and endangered species, carbon emission, air pollution, ozone depletion, climate change are some examples of the contemporary environmental issues which have direct or indirect contribution of human activities. Sometimes it is hard to distinguish their causative factors. But ultimately these issues become highly sensitive for the sustainable human development.

3.2 Land degradation

The word 'degradation' from its Latin derivation implies 'reduction to a lower grade'. The rank is in relation to actual or possible uses, and reduction implies a problem for those who use the land. Blaikie and Brookfield (1987) define land degradation through the social problem perspective. It is the purely environmental processes such as leaching and erosion occur with or without human interference, but for these processes to be described as degradation implies social criteria which relates to its actual or possible uses. The Environmental Management Agency (EMA) (2015) has defined the land degradation as any changes in the condition of the land which reduces its production potential. It is the deterioration in the quality of land, its productivity due to the loss of fertile topsoil, organic matters, or excessive or inappropriate exploitation. It is caused by multiple forces including extreme weather conditions particularly drought and human activities that degrade the quality of soils affecting food production, livelihoods and the production and provision of other ecosystem goods and services. It is a global issue. It has created serious implications worldwide on biodiversity, eco-safety, poverty reduction, socio-economic stability and sustainable development. The United Nations Convention to Combat Desertification (UNCCD) estimates that 50 million people may be displaced within the next 10 years as a result of desertification

which is a form of land degradation (UNCCD, 2013). However, the desertification and salinization are purely natural in origin (EMA, 2015), but the excessive land degradation associated with the human uses which lead to desertification (UNCCD, 2013).

In case of Nepal, land degradation is one of the major environmental problems. About 28.24% (3.262 million ha) of the total land is under the process of desertification in one or other forms. Of the total degraded land, the forests and the rangelands comprise more than 70%. About 10% of the rain-fed agricultural slopping terraces in the mountain areas are under degraded condition. Similarly, 37% area of pasture/range land is in degraded condition (MoST, 2008:15).

There are several factors responsible for the land degradation. We can distinguish the causative factors in two groups, i.e. natural and human induced. However, it is not that easy on dealing the two in separate order. The number of people is always used to put in the center for the causative/responsible factor for the land degradation. Many instances already proved that the number of people solely is not the prime culprit for the land degradation. The human knowledge, skill and several other local and global factors are responsible. The increasing global temperature contributes on changing rainfall pattern. The cloudburst results the ephemeral run-off and reduce the water infiltration. Due to sudden flow of rainwater in the form of run-off that has a direct impact on regularity on spring water discharge and the irrigation system changes. The scarcity on 'green water' causes reduction on productivity. But in the meantime farmers add chemical fertilizer to maintain the productivity for their livelihood. The additional adding of chemical fertilizer increases the salt level in the soil. The indirect threat of ecosystem results the land degradation and ultimately farmland changes to the desertification. This is a single example of how the land degradation starts. There are several causative factors which are:

- Biophysical and socio-economic and political factors which include urbanization, competition for scarce water, unsustainable water management, and policies contribute to land degradation.
- Poor farming practices and the absences of conservation works,

- Soil erosion due to improper maintenance work/or left without proper maintenance,
- Unplanned infrastructure development like road construction, dam construction, building construction, mining and query etc,
- Invasive alien species domination in the natural vegetal cover regimes and loss of biodiversity
- Forest fines and inappropriate use of marginal land
- Unplanned and over grazing

These causative factors quite often vary in different geographical regions. Therefore, it is hard to generalize in the global context. The local geographical, geological and socio-economic factors determine the intensity and extension of land degradation. If we see the context of land degradation in Nepal at least for last two decades, the degradation has been caused due to shortage of agriculture labor force due to labor migration to foreign land. Large part of the farm lands are not maintained properly and also left fallow. Besides this reason, the other reasons can be seen from the uncertainty on rainfall pattern, drying up of springs, and irregularity of weather conditions, transforming the socio-cultural and global economic system.

The UN Agencies estimates that 25% of the world's land area is either highly degraded or undergoing high rates of degradation. Land degradation is especially severe in developing countries. Two-thirds of African land is already degraded to some degree and that land degradation affects at least 485 million people (65% of the entire African population). By the 2050s, 50% of agricultural land in Latin America will be subjected to desertification (UNCCD, 2013). Moreover, in the context of developing countries, the issue of gender cannot be ignored, as (usually) poor women are most vulnerable to land degradation: "It is the world's poorest inhabitants that are most affected by negative alteration to the natural environment and climate change, and of the world's poor some 60 % are female. Because of their dependency on natural resources, rural women in developing countries are the group that is being hit the hardest by the effects of environmental degradation and depletion of natural resources, (UNU-LRT, 2013). Also, women often have less control over and less decision-making power regarding land.

A land degradation neutral world needs to be people centered because poor and marginalized populations are usually the most affected.

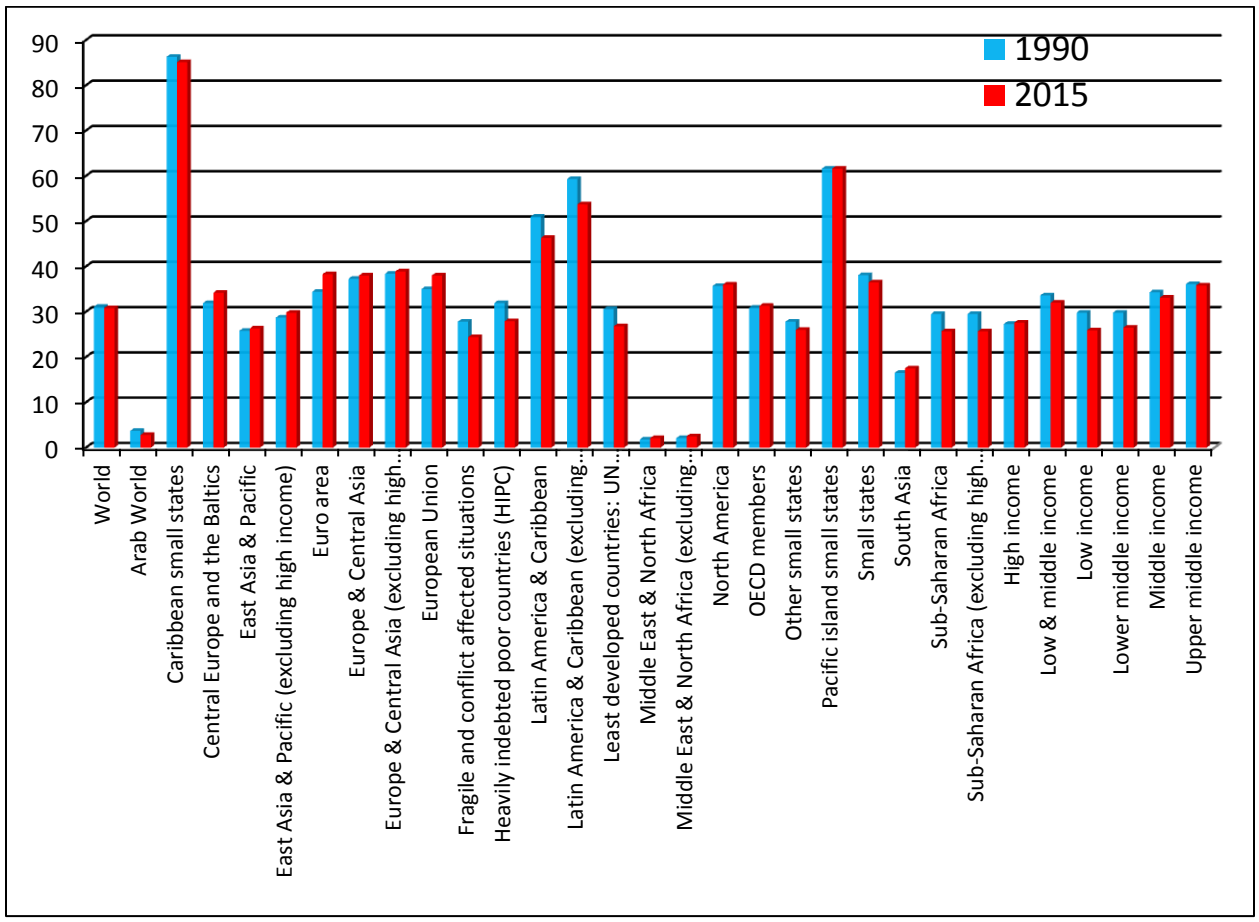
Land degradation exerts large impact on the ecosystem as well as the human life. The direct impact as the definition of land degradation carries the reduction of productivity due to loss of soil nutrition and production capability. While reducing the production capability of the soils there is a direct impact on human livelihood. Similarly, the land value decreases. People expand their activities further to marginal land to maintain their livelihood. That has a direct result on creating a vicious cycle on the land quality. Many developing countries of the world have a scenario of migration of active rural population to the urban and sub-urban areas as well as on non-farming activities. That has caused the changes over the practice on farmland and its management, reducing the crop productivity and food sustainability. At the end of the chain ultimately that leads the land degradation, marginalization and vicious cycle of livelihood.

3.3 Deforestation

The dictionary meaning of deforestation is 'the cutting down and removal of all or most of the trees in a forested area. Deforestation can erode soils, contribute to desertification and the pollution of waterways and decrease biodiversity through the destruction of habitat. It is a process of removal of forest and replaced by something else. But most often the term implies for the clearing of vegetal cover and practiced agriculture (https://www.dictionary.com/browse/deforestation). In the recent years, the observation reveals that the practice of deforestation has not been following only the marginalization of agricultural practices but also associated with other purpose like infrastructure development and commercial purposes.

World Bank data sheet presented the global forest coverage (World Bank 2015). The world forest coverage was 31.80 % of the total area in 1990 and it has been reduced to 30.825 % in 2015. As of the geographical region, the Middle East & North Africa (1.8 % in 1990 and 2.1% in 2015) and Arab world (3.7 % in 1990 and 2.8% in 2015) which have the least coverage. The Caribbean Small States and the Pacific Small States have the highest coverage of the forest. Over the last 25 years, between 1990 and 2015, the

estimated figures of the forest coverage show slightly negative changes despite a small fraction of positive changes in some geographical regions. South Asia is among them having positive changes on forest coverage over the last 25 years from 16.5 % to 17.5% (Fig.1).



Source:
https://data.worldbank.org/indicator/AG.LND.FRST.ZS?end=2015&start=1990&view=chart
Figure 1: Distribution of global forest coverage in 1990 and 2015

The UN Food and Agriculture Organization (FAO) on 22 February 2019, Rome, mentions deforestation is one of the major drivers of loss of biodiversity. Biodiversity is critical for safeguarding global food security, underpinning healthy and nutritious diets, improving rural livelihoods, and enhancing the resilience of people and communities. We need to use biodiversity in a sustainable way, so that we can better respond to rising climate change challenges and produce food in a way that doesn't harm our environment. In the case of associated biodiversity, while all regions report

habitat alteration and loss as major threats, other key drivers vary across regions. These are overexploitation, hunting and poaching in Africa; deforestation, changes in land use and intensified agriculture in Europe and Central Asia; overexploitation, pests, diseases and invasive species in Latin America and the Caribbean; overexploitation in the Near East and North Africa, and deforestation in Asia (http://www.fao.org/news/story/en/item/1180463/icode/). Habitat conservation is vital for stemming this loss. Conservation efforts have focused on protecting areas of high biodiversity. On a global average, more than one-third of all forest is primary forest, i.e. forest of native species where there are no clearly visible indications of human activities. The ecological processes have not been significantly disturbed. Primary forests, in particular tropical moist forests, include the most species-rich, diverse terrestrial ecosystems. The decrease of forest area is largely due to reclassification of primary forest to "other naturally regenerated forest" because of selective logging and other human interventions. Destruction of rainforests remains a significant environmental problem. Much of what remains of the world's rainforests is in the Amazon basin, where the Amazon Rainforest covers approximately 4 million square kilometers. The regions with the highest tropical deforestation rate are in Central America and tropical Asia. Large-scale planting of trees is significantly reducing the net loss of forest area globally (World Bank, 2015). The data between 1990 and 2015 show the forest loss high in Latin America and Caribbean countries.

According to the Nepal country report (MoST, 2008:15) and it's citation of different sources, the percentage of area covered with forest and shrub combined has been consistently declining from 42.7% in 1978/79 to 37.6% in 2005, whereas, the percentage of area covered with shrub land has been consistently increasing from 4.7% in 1978/79 to 12.9% in 2005. In contrary to this trend, Japan Forest Technology Association (JAFTA's) estimates (also published by CBS, 2006) show an increase in the percentage of forest area since 1990 and decline in shrub area since 1994. JAFTA's estimate for forest area is more than 8.4 percent point within 6 years between 1994 and 2000 which seems very high. According to FAO (2006) estimate, annual loss of forest area was 92000 ha between 1990 and 2000 and 53000 ha between 2000 and 2005. Similarly, annual increase in shrub land was 57000 ha between 1990 and 2000 and 29000 ha between 2000 and 2005. Th ough the pace of loss of forest area and increase in shrub land has decreased in

recent years, it is still very high. Between 2011-2014 detail forest assessments carried by Forest Research Survey (FRA) of Government of Nepal with the technical support of Finland Government (DFRS 2015). As per this assessment, Forest covers 5.96 million ha (40.36%), Other Wooded Land covers 0.65 million ha (4.38%) and Other Land covers 8.16 million ha (55.26%). Forest and OWL together comprise 44.74% of the total area of the country. Out of the total forest area of Nepal, 37.80% lies in Middle Mountains region, 32.25% in High Mountains and High Himal, 23.04% in Churia and 6.90 in the Terai. The Mid-Western Development Region has the highest (26.68 %) forest cover of Nepal, whereas Far-Western Development Region has the lowest (16.94 %) of the total forest area. Out of the total forest area of the country, 4.93 million ha (82.68%) lies outside Protected Areas and 1.03 million ha (17.32%) inside Protected Areas.

3.4 Loss of biodiversity and endangered species

The dictionary meaning of biodiversity is a biological diversity in an environment as indicated by numbers of different species of plants and animals (https://www.merriam-webster.com/dictionary/biodiversity). The Nepal National Biodiversity Strategy and Action Plan (NBSAP) 2014-2020 define biodiversity as to all the living things on Earth and the ecological processes associated with them. It is often described in hierarchical terms including ecosystem diversity, species diversity, and genetic diversity. The concept of biodiversity is linked primarily to the idea of biological variation, which still comprises a vast amount of knowledge and projected future value that is unknown to science (MoFSC, 2014). Biodiversity, which occurs in both terrestrial and aquatic environments.

Biodiversity itself may not remain static. In a certain geographical territory the number of species determines by its environment. The richness and poorness of species determines by several factors. It is constantly changing over time. It can be increased by natural evolutionary processes and genetic change or reduced by threats which lead to population decline and species extinction. It determines by the existences of species already existed in the environment or also adding the new species in the same environment. Some species survive for a longer time span and some may not. The loss

of biodiversity causes with changing other environmental parameters and disturbances of species habitat. Therefore, biodiversity is a dynamic element of the environment.

The capacity of an ecosystem to respond to changes and threats determines the rate of biodiversity loss. Biodiversity is important in a number of ways:

- species have utilitarian (subsistence and commercial) value to human,
- biodiversity represents the natural balance within an ecosystem that provides a number of ecological services, including nutrient cycling and pollination of plants, and
- species have intrinsic value.

Conserving biodiversity is thus an essential part of safeguarding the biological life support systems on Earth. In Nepal, biodiversity is closely linked to the livelihoods and economic wellbeing of millions of rural people who directly depend on natural resources for meeting their daily subsistence needs and cash income. The subject touches upon many aspects of life directly and indirectly, including agricultural productivity, food security, human health and nutrition, indigenous knowledge, gender and social equality, culture, climate, water resources and aesthetic value to the society. The country's biodiversity is also an important source of revenue to the government.

From this perspective, if the biodiversity loss happened in the country, it can create great loss in diverse sector. In a certain trophic level the chain starts and supports another species. The species diversity supports to maintain the number of trophic levels and survival of species within the ecosystem remains continue. Therefore, environmental geography needs to address the issues of biodiversity and endangered species. The knowledge and skills towards the biodiversity and endangered species enable students on understanding the value of species richness.

3.5 Carbon emission

National Aeronautic and Space Agencies (NASA) claim that the carbon is the backbone of life on Earth. We are made of carbon, we eat carbon, and our civilizations—our

economies, our homes, our means of transport—are built on carbon. We need carbon, but that need is also entwined with one of the most serious problems facing us today: global climate change (https://earthobservatory.nasa.gov/Features/CarbonCycle). Carbon has a cycle in our Earth. Biotic and aboitic organism develops along with the carbon cycle. Our atmosphere has a composition of approximately 0.033 % carbon dioxide (CO_2). But nearly 80 % of carbon contains in rocks basically sedimentary rocks, fossil fuels and oceanic organisms. 20 % carbon contains in different biological organisms i.e. human, plant species and micro organisms. In the earth surface there is a 'Carbon Cycle', maintains its balance. Within the cycle, if some substances release more carbon then the imbalance in the cycle caused and happened changes. In the recent years, the atmospheric CO_2 concentration is increasing, due primarily to fossil-fuel combustion and deforestation (Tristram and Marland, 2002). Besides those activities, factory level carbon emission seems to be a large contributor.

The vehicle exhaustion, forest fire, volcanic eruption, factory and urban activities exhaust high carbon in the form of smoke. Because of these activities the amount of carbon increases in the atmosphere and exerts impact on the heat budget. We called it greenhouse impact also. The biggest changes in the land carbon cycle are likely to come because of climate change. Carbon dioxide increases temperatures, extending the growing season and increasing humidity. Both factors have led to some additional plant growth. However, warmer temperatures also stress plants. With a longer, warmer growing season, plants need more water to survive. Scientists are already seeing evidence that plants in the Northern Hemisphere slow their growth in the summer because of warm temperatures and water shortages (https://www.sciencedaily.com/releases/2018/10/181003134507.htm).

In the last few years we have a carbon pooling concept or carbon reservoirs. That has been used for the conservation of forest and greenery without destruction. The healthy trees have a capacity to hold the carbon called 'carbon sequestration'. The developed countries which exhaust high carbon through burning fossil fuels by motor vehicles and large industries need to pay for the maintaining carbon reservoirs in least developed and developing countries. That action has been regulated by the 'carbon trade' concept and World Bank has taken the responsibility to manage it. Nepal is also a member of

carbon trade and getting certain amount of support for maintaining the carbon reservoirs. The United Nations Framework Convention on Climate Change (UNFCCC) special working group (AWG-LCA) and COP15 decided to provide the opportunities to the countries of the benefits of carbon pool. From these perspectives the environmental geography needs to entertain these issues in the global to the local contextual ground.

3.6 Air pollution

Air pollution is a mixture of solid particles and gases in the air. Car emissions, chemicals from factories, dust, and pollen and mold spores may be suspended as particles. Smog and different gases discharge from large cities. Some air pollutants are poisonous. Air pollution is also an associated phenomenon of the atmospheric events. Mostly the carbon emission, dust particles, smog, noise like several substances mixed within the atmospheric air and made the air pollution, which is more harmful for human health, too. Such types of changes also responsible to influence the carbon cycle, heat budget in the earth surface.

The National Geographic Channel presents Carbon dioxide, a greenhouse gas, is the main pollutant that is warming Earth. Though living things emit carbon dioxide when they breathe, carbon dioxide is widely considered to be a pollutant when associated with cars, planes, power plants, and other human activities that involve the burning of fossil fuels such as gasoline and natural gas. In the past 150 years, such activities have pumped enough carbon dioxide into the atmosphere to raise its levels higher than they have been for hundreds of thousands of years (https://www.nationalgeographic.com/environment/global-warming/pollution/).
Other greenhouse gases include methane—which comes from such sources as swamps and gas emitted by livestock—and chlorofluorocarbons (CFCs), which were used in refrigerants and aerosol propellants until they were banned because of their deteriorating effect on Earth's ozone layer.

3.7 Ozone depletion

The Encyclopedia Britannica describes, Ozone depletion is a gradual thinning of Earth's ozone layer in the upper atmosphere caused by the release of chemical compounds containing gaseous chlorine or bromine from industry and other human activities. The thinning is most pronounced in the polar regions, especially over Antarctica (https://www.britannica.com/science/ozone-depletion).

Ozone depletion is a major environmental problem because it increases the amount of ultraviolet (UV) radiation that reaches Earth's surface, which increases the rate of skin cancer, eye cataracts, and genetic and immune system damage. The Montreal Protocol, ratified in 1987, was the first of several comprehensive international agreements enacted to halt the production and use of ozone-depleting chemicals. As a result of continued international cooperation on this issue, the ozone layer is expected to recover over time.

This global decrease in stratospheric ozone is well correlated with rising levels of chlorine and bromine in the stratosphere from the manufacture and release of CFCs and other halocarbons. Halocarbons are produced by industry for a variety of uses, such as refrigerants (in refrigerators, air conditioners, and large chillers), propellants for aerosol cans, blowing agents for making plastic foams, firefighting agents, and solvents for dry cleaning and degreasing. Atmospheric measurements have clearly corroborated theoretical studies showing that chlorine and bromine released from halocarbons in the stratosphere react with and destroy ozone.

3.8 Climate change

The NASA has describes in its Global Climate Change document that the Earth's climate has changed throughout history. Just in the last 650,000 years there have been seven cycles of glacial advance and retreat, with the abrupt end of the last ice age about 7,000 years ago marking the beginning of the modern climate era — and of human civilization. Most of these climate changes are attributed to very small variations in Earth's orbit that change the amount of solar energy our planet receives

(https://climate.nasa.gov/evidence/). The current warming trend is of particular significance because most of it is extremely likely (greater than 95 percent probability) to be the result of human activity since the mid-20thcentury and proceeding at a rate that is unprecedented over decades to millennia.

Earth-orbiting satellites and other technological advances have enabled scientists to see the big picture, collecting many different types of information about our planet and its climate on a global scale. This body of data, collected over many years, reveals the signals of a changing climate. The heat-trapping nature of carbon dioxide and other gases was demonstrated in the mid-19th century. Their ability to affect the transfer of infrared energy through the atmosphere is the scientific basis of many instruments flown by NASA. There is no question that increased levels of greenhouse gases must cause the Earth to warm in response. Ice cores drawn from Greenland, Antarctica, and Tropical Mountain glaciers show that the Earth's climate responds to changes in greenhouse gas levels. Ancient evidence can also be found in tree rings, ocean sediments, coral reefs, and layers of sedimentary rocks. This ancient, or paleoclimate, evidence reveals that current warming is occurring roughly ten times faster than the average rate of ice-age-recovery warming (https://climate.nasa.gov/evidence/).

In the case of climate change in the Himalayan region a book published in 2012 titled "Himalayan Glaciers: Climate Change, Water Resources, and Water Security" prepared by the Scientific Committee of the National Research Council of America and published by the National Academy of Sciences through the National Academic Press, where some of the evidences of climate change in the region have been exclusively described. The Himalayas is the water tower provides water resource for almost half of the world population. Glaciers are the living warehouse of the water resources. The climate change is the direct factor causes changes over the physical properties of the glaciers. Because of that the large share of global population could come under the unsecured situation (NRC, 2012).

The Rio Earth Summit-1992, first convened the climatic agenda through the UNFCCC to tackle the growing problem of global warming and related harmful impacts of climate change, such as more frequent droughts, storms and hurricanes, melting of ice, rising

sea levels, flooding, forest fires, etc. Following the resolution of the Rio Summit, on 21 March 1994, Cooperation of Parties (COP) discussed the emission of greenhouse gases (GHGs) and its dangerous interferences with the climatic system. After the 'Fourth Assessment Report' of the Intergovernmental Panel on Climate Change (IPCC) in 2007, scientists published a report on global warming and associated climate change. IPCC Working Group-II in 2007 summarizes the likely impacts of climate change already under way and, the potential for adaptation to reduce vulnerability and the risks of climate change. Among others, the Himalayan mountains are reported to be highly vulnerable to global climate change (Beaumont et al., 2011; Li et.al., 2013; Shrestha et al., 2012; Thapa et al., 2015). Shrestha et al. (2012) indicated that temperature and precipitation changes will be greater than the upper bounds predicted by the IPCC. The second volume of the Fourth Assessment Report of the IPCC, addresses impacts, adaptation, and vulnerability. It provides a powerful impetus for the identification of clear social needs and associated research priorities (Brewer, 2008). The correlation between climate change and anthropogenic activities has been firmly established. The average global surface temperature has increased by about 0.8°C in the last century and 0.6°C within the last three decades (IPCC, 2007). The COP-21 meeting held in Paris on December 2015, which was also known as the 'Climate Conference' officially recognized the increasing earth surface temperature and in over 20 years of UN negotiations aimed to achieve a legally binding and universal agreement on climate with the aim of keeping global warming below 2°C (www.COP21Paris.org). Over 195 parties of the world were recognized and accepted increasing global warming, and agreed to that resolution.

Box #02

Climate change

Ahead of COP24 climate change summit going to be held at Poland on December 2018, UN said the levels of greenhouse gases in the atmosphere, the main driver of climate change, has hit a new record high. Un officials are again trying to raise the pressure on governments to meet the pledge of limiting warming to the less than 2^{o}C enshrined in the 2015 Paris accord.

Without rapid cuts in CO_2 and other greenhouse gases climate change will have increasingly impacts on life on Earth.

The last time the Earth experienced a comparable concentration of CO_2 was 3-5 million years ago, when the temperature was 2-3 ^{o}C warmer

Kathmandu Post, daily News paper quoted news from Agence-France-Pressse (AFP)

November 22, 2018.

In a statement to the 24th Conference of Parties (COP 24) to the United Nations Framework Convention on Climate Change (UNFCC,) President of Nepal Ms. Vidya Devi Bhandari said there is a surge in soil erosion and landslide in the hills while flood and inundation affects in the Tarai. She further said the snow clad mountains are converting to dark and exposed rocks. Fresh water springs are drying up. Plain areas are affected by changing rainfall pattern and changing land use system. In the mean time the outcome of the Conference has to maintain the atmospheric temperature increment at a threshold of 1.5 ^{0}C which was declared at Paris Summit in 2015. The summary of the statement was 'Nepal suffers climate change despite low emissions'.

Kathmandu Post Wednesday, 05 December 2018:p.2)

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Chapter 4
DEFINING HAZARD, VULNERABILITY, RISK, AND DISASTER

4.1 Definition

On 26 December 2004, the tsunami originated close to the north-western coast of Sumatra Island of Indonesia and advanced to Indian Ocean killed approximately 230,000 people across 14 countries. The 2010 floods in Pakistan directly affected around 20 million people, and have continued to displace substantial numbers each year. Floods in Bhaktapur, in Kathmandu Valley on July 12, 2018 and Kerala, South India on August 10, 2018 exert examples that flood may occur everywhere and affect lives and properties. Therefore, the UN IDNDR, in 1990s, has been flagging a slogan 'both too much and too little are problem". It shows that flood and drought are caused by too much and too little both of which results the problems on human lives and properties.

Source: Kathmandu Post, Bhaktapur flood, Kathmandu Valley, July 12, 2018,

Figure 2: Floods at Bhaktapur July 12, 2018,

Source: Times of India, Kerala flood, Friday, August 10, 2018, killed 29 and affected more than 50,000

Figure 3: Floods at Kerala August 10, 2018

Source: Nepali Times, EMPTY MOUNTAINS: Fallow fields at Himali village in Mugu which has suffered a four-year drought. Prakash Singh, https://www.nepalitimes.com/here-now/the-waste-land/

Figure 4: Fallow fields at Himali village in Mugu

The 'Rain Strom' in the Southern Tarai of Nepal on 31st March 2019, left at least 28 people dead and nearly 1500 houses damaged. According to the Department of Hydrology and Meteorology, Government of Nepal, a week later, confirmed the first of this kind of storm, was the 'Tornado' in Nepal (news from the DHM on 6th April, 2019).

Figure 5: Bara District, Nepal houses damaged by rain storm on 31st March, 2019
Photo source: http://kathmandupost.ekantipur.com/news/2019-04-01/test-20190401091809.html

The World Disaster Report has summarizes the disasters as, during 2011 and 2012, more than 12 million people in the Horn of Africa were severely affected in what has been called the worst drought in 60 years. The Ebola outbreak in West Africa, beginning in March 2014, led to 11,310 deaths across Liberia, Sierra Leone and Guinea…The Haiti earthquake of 2010 provided a terrifying 'perfect storm' of a major earthquake. Population dies between 100,000 and 316,000. During 2015, a total of 574 reported disasters, caused by earthquakes, floods, landslides and heat waves, had killed almost 32,550 people, affected over 108 million people, and caused US$ 70.3 billion in damage. For 2016, the greatest humanitarian challenge has been forced displacement across the world. With regards to migration caused by conflict, by May 2016, the war in Syria (probably exacerbated by drought-fuelled urban migration) has led to more than 4.8 million refugees fleeing the war-torn country, further 6.6 million Syrians are internally displaced and more than half the country's population in need of help. In addition, in 2015, 2.2 million people were displaced in Yemen, more than in any other country that year. In 2015, at least 3,770 migrants are thought to have died while attempting to cross the Mediterranean Sea to Europe, (WDR, 2016:12). These are some examples of global reports about the hazards and disasters. The devastating earthquake of Nepal on 25 April 2015 and its aftershocks killed 8790 persons in total and worth of over US $ 7 billion damaged. Besides the single devastating earthquake of 2015, Nepal heats by landslide, flood, lightning and several other types of hazards and disasters which lost around 400 human lives on an average and a large volume of properties approximately 0.2 % of the country's gross domestic production (GDP) every year (MoHA, http://drrportal.gov.np/disasterfocalperson).

These are some typical types of events we have been facing. From these illustrations it would be easier to understand about the disasters at local to the global context. Asian Disaster Preparedness Center (ADPC) has defined hazard "is any substance, phenomenon or situation, which has the potential to cause disruption or damage to people, their property, their services and their environment" (http://www.adpc.net/).

4.2 Hazard, vulnerability risk and disaster

The theoretical nexus of the terminologies we often use has two different aspects. Blaikie et al. (1994) in their publication on 'At Risk' conceptualize as: "Many aspects of the social environment are easily recognized: people live in adverse economic situation that lead them to inhibit parts of the world that are affected by natural hazards, be they flood plains or rivers, slopes of volcanoes, or earthquake zones. But there are many other less obvious political and economic factors that underlie the impact of hazards. These involve the manner in which assets and income are distributed between different social groups, and obvious forms of discrimination that occur in the allocation of welfare (including relief). Disasters are supposedly caused mainly by natural hazards to broader patterns of society. These two aspects cannot be separated from each other...Many disasters were usually a complex mix of natural hazards and human action."

The etymology of vulnerability is the condition of being vulnerable by a disaster, but it has been defined in various ways. Chambers has defined vulnerability as the condition of "defenselessness, insecurity, and exposure to risk and stress...Vulnerability has thus two sides (Chambers, 1989):

i. an external side of risks, shocks, and stress to which an individual or household is subject, and
ii. an internal side which is defenselessness, meaning a lack of means to cope without damaging loss.

Watts and Bohle (1993) define the vulnerability in terms of "exposure capacity and potentiality. Accordingly, the prescriptive and normative response to vulnerability is to reduce exposure, enhance coping capacity, strengthen recovery potential and bolster damage control." However, Blaikie et al. (1994) have claimed the refinement of vulnerability definition, and according to them "the characteristics of a person or group in terms of their capacity to anticipate, cope with, resist, and recover from the impact of natural hazards." Adhikari and Bohle (1999) have stated that all those definitions pointed to the two sides of the vulnerability articulated in Chambers's definition. Their basic emphasis has been led to the people's livelihood strategy. The vantage point is rooted to the entitlement theory after Amratya Sen logically embraces two related

approaches to hunger: food security and coping strategy models on the one hand, and social welfare, social security theories on the other (Watts and Bohle (1993)

The IPCC 14, Working Group (WG) II Assessment Report 5 has mentioned the climate-induced hazard into the three separate facets produced the risk to the human life and properties.

Hazard vulnerability and mitigation, disaster preparedness, emergency response, and disaster recovery take on different meanings depending on which systemic level is being considered (NRC, 2006).
Hazard: The dictionary meaning of hazard is something which could be dangerous to life and properties. Hazards refer to the extreme natural events which may affect different places singly or in combination at different times (Blaikie et al.1994)

Vulnerability: The term 'vulnerability' is a situation people experience or feel hazardous situation or they are at risk. It has been interlinked with the human dimension of disasters and is the result of the range of economic, social, cultural, institutional, political and psychological factors that shape people's lives and the environment that they live in (Twigg, 2004, 2015).

Risk: A risk index has some similarities with a risk analysis. They both define a relationship between the inherent hazard of a material and the exposure potential. For a risk analysis, the characterization of exposure and the assessment of the hazards are as detailed and well defined as possible (Rosenblum and Lapp 1989). 'Risk' faced by the people must be considered as a complex combination of vulnerability and hazard. (R = H + V) (Blaikie et al.,1994). In the later days that has been re-written as R = Hazard x Exposure x Vulnerability (https://www.preventionweb.net/risk/vulnerability),

Disaster: 'Disasters' are a result of the severely exposure of both hazard and vulnerability. A disaster occurs when a significant number of vulnerable people experience a hazard and suffer severe damage and/or disruption of their livelihood system in such a way that recovery is usually without external aid.

4.3 Typology of hazard and disaster

The national Academy of Sciences has grouped the hazard and disaster in four major categories as: Natural, Technological, Environmental and willful (NRC, 2006). These categories are almost the similar as categorized by Asian Disaster Preparedness Center (ADPC) based on their source of origin, as following (http://www.adpc.net/):

i. Natural/physical
ii. Biological
iii. Technological
iv. Anthropological/social

The natural or physical hazards are basically originated from the natural sources and follow the natural processes. Many of those hazards become vulnerable and increase the risk to human life and properties. They also convert to disaster due to human behavior and activities due to their ignorance and malpractices. Examples can be taken for the earthquake hazard which is solely originated from the interior part of the earth and shake the surface due to its geophysical action. If the people construct their shelters or buildings without considering the earth's geophysical processes the buildings or shelters collapse and the human lives and properties damaged. Sometimes the effects become more complex when a single cause of the hazard responsible to generate another hazard. Illustrations can be taken from the fire hazard in the large cities after the earthquake event or tsunami along the coastal area and the islands. There is an empirical example of cholera out broken after the devastating earthquake in Haiti 2010 and tsunami of 2004 in Indian Ocean. Therefore, it requires on being careful on accounting for disaster through its life and property loss. Here are some typologies of hazard and disasters according to their causative sources with the definition given mainly in the dictionary.

Within the natural source that can be sub-divided into:

- Geophysical – earthquake, volcanoes

Earthquake:

An earthquake is the shaking of the surface of the Earth, resulting from the sudden release of energy in the Earth's lithosphere that creates seismic waves. Because of the seismic waves the surface shakes and caused the damage of human built structures as well as the sensitive natural structure over the ground.

We have an experience of that devastating shaking trigger of Gorkha Earthquake on 25th April 2015 and its aftershocks of various magnitudes. Earthquake starts from the inner part of the earth crust called hypocenter and the shaking wave first reach on the ground surface on its perpendicular direction, called epicenter. The depth of earthquake is measured the distance between epicenter and hypocenter. Earthquake produces 4 different types of wave i.e. Primary (P) wave, Secondary (S) wave, Love (L) wave and Rayleigh (R) wave according to their respective differences of speed. From the P to R waves, they have a gap of travel time from few seconds to couple of seconds depends upon the intensity of shaking and depth of origin. P wave comes first in its horizontal or back-and-forth direction of movement immediately after the shaking starts. S wave comes after P wave in a vertical oscillation. L wave comes after the P and S waves with a direction of transverse direction of its plane. At the end of shaking, R wave follows with its circular movement. During the event the P wave is lesser in damage intensity and the R is in the most.

Volcanoes:

A volcano is a rupture in the crust of a planetary-mass object, such as Earth, that allows hot lava, volcanic ash, and gases to escape from a magma chamber below the surface. Earth's volcanoes occur weak boundaries basically formed by the rigid tectonic plates that float on a hotter, softer layer in its upper mantle. After its explosion the surface get new materials from the interior part and caused damage of human lives, properties as well as the new addition of materials over the ground. That has caused the changes on the ground and also become disaster for human lives and properties.

- Geological/geomorphological – landslide, sedimentation, sand/gravel/boulder creeping/falling, soil/mud flow, Landslide Lake Outburst Flood (LLOF),

Landslide:

A landslide is defined as the movement of a mass of rock, debris, or earth down a slope. Landslides are a type of "mass wasting," which denotes any down-slope movement of soil and rock under the direct influence of gravity. But sometimes they are added moisture or wet due to surface and percolated water and sometimes without it. They are faster to slow in motion, too as well as single or rotational in falling process. Landslide triggers in hills and mountain of Nepal are common events during the monsoon period.

Sedimentation:

Sedimentation is a process that the solid particles of the sediment flow with glacier, water, wind and underground water and deposited in the lowland with low velocity or turbulent. Mainly that has happened in the lakes and reservoirs. The morain dams, hydropower projects, drinking water and irrigation reservoirs get filled and ultimately burst and cause disaster.

Sand/gravel/boulder creeping/falling

In the dry mountainous terrain the sand, gravel or boulder creep and fall from the upper slope to down slope due to gravity. Sometimes it is called dry landslide. The intensity of falling depends on the amount of loose materials and the degree of inclination of the hillslope. That has caused the disaster in the settlements locating at the valley floor in the dry mountain areas.

Soil/mud flow

This is confined in the wet mountain regions where the large volume of soil or semi-fluid mud starts to flow downward due to gravity. This is also similar to landslide but the volume is much larger. This is also called solifluction. Whole settlements can flow along with mud.

Landside Lake Outburst Flood (LLOF),

Large landslides in the mountainous terrain block the stream/rivers and form temporary lake. In the course of time such landslides blocked break ultimately and a flood in the downstream may happen. The Jure landslide at Sindhupalchwok Nepal on August 24, 2014 blocked the Sunkoshi River for several days and made a temporary lake.

Box #03

Landslide and the dammed lake

The detail of the LLOF "the landslide created about 13.5 million tons of rock debris and dust. The rock debris avalanche dammed the Sunkohsi river completely within approximately 2 -3 minutes. A local quake of 3.3 magnitudes was recorded on that day due to the landslide. The two gates of the Sunkoshi hydropower dam was damaged due to the pressurized surging of the mud and debris created in the Sunkoshi river. After few minutes of this event the flow of the Sunkoshi was stopped and it took about 12 hours to over top the Natural dam created by the landslide. .. The length of the dam across the river was measured about 350m, the width of the dam along the river was measured about 700m and the height of the dam was about 55m (Ministry of Irrigation, 2014).

The similar case has been happened in Kali Gandaki nearby Beni Bazar in Myagdi district on 23 May 2015. A 2 km long and 100 metre deep lake was formed after the landslide dammed the river. The site is about 9 km north of Beni, the district headquarters of Myagdi. Massive rocks started falling, damaging 27 houses in Bhagawati and Ramche VDCs (https://www.thethirdpole.net/en/2015/05/24/landslide-blocks-kali-gandaki-river-in-western-nepal/).

Atmospheric – El Nino and La Niña, cloud burst, hailstone/storm, cold wave, hot wave, draught, Ozone layer depletion, thunderstorm and lightening, green house effect (surface warming), desertification, fog, air pollution, acid rain,

El Nino and La Niña

El Niño means 'The Little Boy', or 'Christ Child' in Spanish. *El Niño* was originally recognized by fishermen off the coast of South America in the 1600s, with the appearance of unusually warm water in the Pacific Ocean. *El Niño* is a part of a routine climate pattern that occurs when sea surface temperatures in the tropical Pacific Ocean rise to above-normal levels for an extended period of time. The opposite of *El Niño*, La

Niña, is when sea surface temperatures in the central Pacific drop to lower-than-normal levels. It is an irregularly occurring and complex series of climatic changes affecting the equatorial Pacific region and beyond every few years, characterized by the appearance of unusually warm, nutrient-poor water off northern Peru and Ecuador, typically in late December. The effects of El Niño include reversal of wind patterns across the Pacific, drought in Australasia, and unseasonal heavy rain in South America.

Cloudburst

Cloudburst is a sudden, very heavy rainfall, usually local in nature and of brief duration. Most so-called cloudbursts occur in connection with thunderstorms. In these storms there are violent up rushes of air, which at times prevent the condensing raindrops from falling to the ground. A large amount of water may thus accumulate at high levels, and if the upward currents are weakened the whole of this water fall at one time.

Cloudbursts are especially common in mountainous areas. This is probably because the warm air currents of a thunderstorm tend to follow the upward slope of a mountain. The effects of heavy rain are especially striking on mountain slopes because the falling water is concentrated in valleys and gullies. Mountain cloudbursts cause sudden and destructive floods. The intensity of rainfall in the most severe cloudbursts can only be conjectured. A rainfall of 63 mm in 3 minutes was registered by an automatic rain gauge at Porto Bello, Panama, on November 29, 1911, and one of 38 mm in 1 minute was registered at the Barot rain gauge near Les Abymes, Guadeloupe, on November 26, 1970. In Nepal a cloudburst was reported in Saturday 20 October 2018 in Far-Western Nepal by an Indian daily news paper, the death toll due to water havoc in various parts of Nepal after clouds outburst has risen to 56 (https://indianexpress.com/article/world/nepal-water-havoc-death-toll-rises-to-56-thousands-displaced-cloud-burst-in-nepal-4795684/). According to the data from the Police Headquarters in Kathmandu, a total of 19 people were reported to be dead in Eastern Nepal, 23 in Mid-Nepal, two in Western Nepal and 12 in Mid-West region of Nepal quoted by the Indian online news. (https://indianexpress.com/article/world/nepal-water-havoc-death-toll-rises-to-56-thousands-displaced-cloud-burst-in-nepal-4795684/). On 12th July 2018 the eastern part

of Kathmandu Valley received heavy cloudburst and filled all streams and lowland of Bhaktapur city and its peripheries. A big flood havoc was created for a week.

Hailstone/storm,
Solid precipitation in the form of hard pellets of ice that fall from cumulonimbus clouds is called hail. The hailstones that fall from deep, vigorous clouds in warm weather consist of a core surrounded by several alternate layers of clear and opaque ice, when the growing particle traverses a region of relatively high air temperature or high concentration of liquid water, or both.

It is convenient to distinguish between three types of hail particles. The first is soft hail, or snow pellets, which are white opaque rounded or conical pellets as large as 6 mm (0.2 inch) in diameter. They are composed of small cloud droplets frozen together, have a low density, and are readily crushed. The second is small hail (ice grains or pellets), which are transparent or translucent pellets of ice that are spherical, spheroid, conical, or irregular in shape, with diameters of a few millimeters. They may consist of frozen raindrops, of largely melted and refrozen snowflakes, or of snow pellets encased in a thin layer of solid ice. True hailstones, the third type, are hard pellets of ice, larger than 5 mm (0.2 inch) in diameter. That may be spherical, spheroid, conical, discoidal, or irregular in shape and often have a structure of concentric layers of alternately clear and opaque ice. A moderately severe storm may produce stones a few centimeters in diameter, whereas a very severe storm may release stones with a maximum diameter of 10 cm (4 inches) or more. Large damaging hail falls most frequently in the continental areas of middle latitudes (e.g., in the Nebraska-Wyoming-Colorado area of the United States, in South Africa, and in northern India) but is rare in equatorial regions. Terminal velocities of hailstones range from about 5 metres (16 feet) per second for the smallest stones to perhaps 40 metres (130 feet) per second for stones 5 cm (2 inches) in diameter.

On March 31, 2018 a daily newspaper published in Kathmandu, reported in Rautahat district of Nepal Tarai hit hard as the hailstorm damaged the crops and fruit orchards. Despite that several hills and mountain districts affect by hailstones every year (March 30, 2018, The Himalayan Times).

The storms are various natures and speeds cause large damages in the earth surface. Storm originates due to the high speed blow of wind results by the changing air pressure gradient on the surface. Common examples of such strong wind storms originate in the low pressure nuclei and form cyclone. Most of such cyclone have a whirling pool of with eye at the center of nuclei and move parallel to the isobars of pressure gradient with a shape of lee. Several strong wind storms experiences along the oceanic coastal parts of sub-tropical zone. The Hurricane in west coast of Atlantic Oceans, 'Typhoon in west coast of Pacific, Cyclones in Indian ocean coasts, Andhi and Toophan in the Bay of Bengal are some of the common names in different region of the world. But sometimes the sub-tropical continent experiences cyclone in the inner part of the continent. Specifically, in North America, it is called 'Tornado'. It has a rapid rotating column of air that is in contact with both the surface of the Earth and a cumulonimbus cloud or, in rare cases, the base of a cumulus cloud. On 31st March 2019, the Tarai of Nepal, landmass at least 27° North latitude experienced such type of whirling pool of strong wind over 55 kilometer per hours (30 knots) due to the mixing of warm Indian air mass and the cool upper surface Himalayan air mass. According to the meteorological records it was the first case of such strong lee of windblown in the mountainous country.

Figure 6: A picture of 'tornado' formation and moving on the ground with whirling pool. Image Source: https://www.google.com.np/search?q=tornado&rlz=1C1CHBD

Cold wave,

A cold wave (known in some regions as a cold snap or cold spell) is a weather phenomenon that is distinguished by a cooling of the air. It is an unusually large and rapid drop in temperature over a short period of time. In the low land plain area in Nepal and in the northern part of India it is called *sheet lahar*, where at least a week to a month of January to the early February the lower part of the atmosphere covers by thick fog and mist. Day time average temperature remains below 15^0C and the night time below 10^0C. People in the Tarai and Ganga Plain of India suffer from the cold and many die due to severe cold.

Hot wave,

Hot wave is a period of relatively high temperatures. Specifically, it is one caused by the southerly winds in front of an advancing cyclone or by the accumulating heat in a stagnant anticyclone. In India and Nepal the hot wave is named loo. The day temperature goes beyond 40^0 C and it remains dry but the night temperature goes down below 10^0C.

Draught,

It is a condition of dry and remains without rainfall. Basically, the draught is recorded not enough rainfall for the crop farming. It depends on seasonal variation and climatic variability. It became hazard for reducing soil productivity and production.

Ozone Layer depletion

Ozone depletion describes two related events observed since the late 1970s: a steady lowering of about four percent in the total amount of ozone in Earth's atmosphere (the ozone layer), and a much larger spring time decrease in stratospheric ozone around Earth's Polar Regions. Due to the depletion of ozone layer the Ultra Violet (UV) radiation of the Sun reaches to the earth surface and become hazardous for the human health.

Thunderstorm and lightening,

A thunderstorm, also known as an electrical storm, lightning storm, or thundershower, is a storm characterized by the presence of lightning and its acoustic effect on the Earth's atmosphere, known as thunder. Thunderstorms occur in a type of cloud known

as a cumulonimbus. The lightning causes human death and broken fire in building and electric goods, appliances and warehouses.

Green house effect (surface warming),

The greenhouse effect is a natural process that warms the Earth's surface. When the Sun's energy reaches the Earth's atmosphere, some of it is reflected back to space and the rest is absorbed and re-radiated by greenhouse gases. The volume of increasing green house gases hold re-radiation energy which increases the surface temperature. Warming the earth surface temperature is mainly caused by the green house gases. Climate change is the ultimate result of the increasing amount of the green house gases.

Desertification,

Desertification is a type of land degradation in which a relatively dry area of land becomes increasingly arid, typically losing its bodies of water as well as vegetation and wildlife. It is caused by a variety of factors, such as through climate change and through the overexploitation of soil through human activity

Fog,

Fog is a visible aerosol consisting of minute water droplets or ice crystals suspended in the air at or near the Earth's surface. This is more hazardous in during the winter months in the middle latitude and river basins. It becomes more hazardous in the surface and air traffic as well as the human health caused due to cold.

Air pollution,

Air pollution is a mixture of solid particles and gases in the air. Vehicular emission, chemicals from factories, dust, and pollen and mold spores may be suspended as particles. Smog gas is a major part of air pollution in cities. Due to air pollution human health becomes more hazardous.

Acid rain,

Rainfall made so acidic by atmospheric pollution that it causes environmental harm, chiefly to forests and lakes. The main cause is the industrial burning of coal and other fossil fuels, the waste gases from which contain sulphur, carbondioxides and nitrogen oxides which combine with atmospheric water to form acids. The direct effect of acid

rains is visible in the dried out of forest trees and bushes and converts the wide extension of land to desert.

Storm

A storm is any disturbed state of an environment or in an astronomical body's atmosphere especially affecting its surface, and strongly implying severe wreathe. Hurricane, Typhoon, Tornados, Andhi are some of the examples of storms which damage wide range of surface structure within a moment of few minutes.

Within the cryosphere regime the hazards and disasters like Glacial Lake Outburst Flood (GLOF), Avalanches occurs.

Glacial Lake Outburst Flood (GLOF),

A glacial lake outburst flood is a type of outburst flood that occurs when the dam containing a glacial lake fails. An event similar to a GLOF, where a body of water contained by a glacier melts or overflows the glacier, is called a Jökulhlaup. The dam can consist of glacier ice or a terminal moraine. Such outbursts cases have been frequently happening in the Nepal Himalayas. There are 21 very delicate glaciers lakes to burst in Nepal are identified so far, if they burst, results very large damage in the downstream valleys. The Imja Lake of Khumbu Valley and Tsho Rolpa of Gaurishankar are some of the widely studied potential GLOF location of the Nepal Himalayas from where water is released from artificial siphoning to reduce the possible outburst threat.

Avalanches,

An avalanche is a cohesive slab of snow lying upon a weaker layer of snow in the snowpack that fractures and slides down a steep slope when triggered. This also becomes more hazardous for the high mountaineering trekkers hikers and mountaineers. Also sometime causes glacial lake outburst. During the 25 April 2015 Gorkha Earthquake a massive avalanche was triggered in the Langtang Valley. That had killed large number of local people and tourist and damaged large village of the Valley.

Within the hydrological hazards and disasters are associated in both conditions of a little water and also with abundant water. Flood and flashfloods are associated with abundant water and desertification and drought with less water.

Flood,

A flood is an overflow of water on land which is usually dry. Sometimes a water resource (river, lake or pond) gets flushed with too much water. Unusually heavy rain causes floods in the downstream. This is one very common disaster in the world. Large rivers to a small ephemeral channel damage the human life and properties. Heavy rainwater is the major reason for the flood. Besides that the overflow of channel due to human interference and encroachments, broken the natural levee and dams constructed for hydropower irrigation reservoirs also results flood. Water inundation, back swelling and side cutting are quite common reasons for the flood in the plain areas.

Flashflood,

A flash flood is a rapid flooding of geomorphic low-lying areas: washes, rivers, dry lakes and basins. It may be caused by heavy rain associated with a severe thunderstorm, hurricane, tropical storm, or melt-water from ice or snow flowing over ice sheets or snowfields. In the case of Nepal most prominent examples of flash flood could be seen in the stream of Siwalik which are flowing to Tarai plain during the monsoon months.

Fresh water depletion,

Groundwater depletion, a term often defined as long-term water-level declines caused by sustained groundwater pumping, is a key issue associated with groundwater use. The situation arises when surface water, such as lakes and rivers, are scarce or inaccessible, groundwater supplies depletion starts. Cloudburst, and sporadic rainfall also responsible for the depletion of fresh water reservoirs. In the recent years several cases have been reported the dying out of natural springs in the mountain region due to climate change.

A number of hazards and disasters are listed in the biological regime. Among them biodiversity loss, wildlife habitat loss, threat from wild animals, epidemics are major one.

Biodiversity loss

Species have utilitarian value to humans. Diversity of plants and animals is a crucial component in the livelihood of millions of rural people who depend on diverse species and varieties of these biological organisms to meet their nutritional, medicinal and energy needs. Different cultures and social groups use, value, and protect these resources and services in a variety of ways. The genetic diversity of cultivated and domesticated species is also of great importance from a human perspective, because it allows the species to adapt changing conditions. Moreover, there are huge prospects of benefiting from unknown species and genetic diversity. Biodiversity represents the natural balance within an ecosystem. Detoxification and decomposition of wastes by biological communities (particularly bacteria and fungi), generation and renewal of soil fertility including nutrient cycling, and pollination of plants are just a few examples of ecological services associated with biodiversity. Loss of biodiversity or biodiversity loss is the extinction of species (plant or animal) worldwide, and also the local reduction or loss of species in a certain habitat.

Forest and grassland fire

A wildfire or wild-land fire is a fire in an area of combustible vegetation that occurs in rural areas. Depending on the type of vegetation where it occurs, a wildfire can also be classified more specifically as a brush fire, bush fire, desert fire, forest fire, grass fire, hill fire, peat fire, vegetation fire, and veldfire. Whatever the type of fire the loss of forest species, wildlife and sometimes even human settlements caught by the fire and become more disaster. Most often the forest fire cases are happened in the sub-tropical and semi-arid area of California, Spain, Australia and South Africa. Forest fire in Nepal is also a big disaster. In 2009, 13 army corps were killed in the central region of Ramechhap while dousing flames. Nepal suffers severely from crawling and crown fire. Some 268,618 hectares of forest were damaged by the fires in the period from January-May 2016 (DFRS 2017)

Epidemics

An epidemic (from Greek epi "upon or above" and demos "people") is the rapid spread of infectious disease to a large number of people in a given population within a short period of time, usually two weeks or less. It is a threat of biological organisms. Several types of biological bacterial borne diseases may convert to the epidemics. The Ebola is the recent examples in the African countries. Similarly, the Cholera of the Haiti became the epidemic of the recent years. In Nepal, the diarrheal outbreak in Far-western districts in 2010 is an example of epidemic (Emergency appeal n° MDRNP004 Operations update no 1, 27 May 2010).

Threats from wild animals

Several settlements close to the national parks, conservation areas or even close to the forest and bush land always suffered by the activities of wild animals. The wild animals of national parks and conservation areas come out of their territory for their prey and reach to the human settlement, farm land and damage their life and properties. The conflict between wildlife and human has been reported most of the boundary zones of the national parks. In the last few years the activities of monkey, porcupine, wild bear and wildboare are reported for damaging the crops in various parts of Nepal in a form of hazard and threat.

Habitat Loss.

Habitat loss or the destruction of habitat of several wild species has been reported due to climate change and human actions. Such situations are becoming more acute on marginal landscape.

Climate Change

Climate Change or global warming is the overall increase in average temperatures on Earth. Due to increasing global warming several new phenomena in the earth surface have been appeared. Thus the climate change has been taken one of the major causes for the several types of hazards and disasters. Climate induced hazard and disasters are widely spreading in different geographical regions and terrains.

Besides these major hazards and disasters within the biological regime, there are different types of phenomena like invasive and *e*xotic species appearances in new and creating new species habitat, producing air, water and soil pollution, illegal trapping and poaching wild and endangered species, accidental deaths and property loss due to human actions are other cases associated with the biological regimes.

There are some hazards and disasters which are associated within the technological regime. –

Gases explosion,

A gas explosion is an explosion resulting from mixing a gas, typically from a gas leak, with air in the presence of an ignition source. In household accidents, the principal explosive gases are those used for heating or cooking purposes such as natural gas, methane, propane, butane.

Chemical explosion/radiation leakage and explosion

Nuclear explosion is an explosion that occurs as a result of the rapid release of energy from a chemical chamber. It is possible to have an air-burst nuclear explosion without those clouds. Nuclear explosions produce radiation and radioactive debris. The Chernobyl disaster in 1986, also referred to as the Chernobyl accident, was a catastrophic nuclear disaster in the central Europe and Asia. The Carbide factory explosion on 2-3 December 1984 of Bhopal India and also the Nuclear reactor leakage in Japan due to Fukushima earthquake and tsunami in 2011, are other examples of technological hazards.

There are several hazards and disasters associated within the anthropological/social activities, such as war, civil war, deforestation, grassland degradation, air pollution, waste disposal, water pollution, road accidents, stamped, and asylum seekers and refuses which are interconnected to other different activities and regimes. Among them stamped and refuse mainly connected with the human actions.

War or civil war:

War between two different nations or allies groups caused severe damage of people and infrastructures. The last war between Western allies and coalition forces and Iraq in

early 2003 caused heavy losses in Iraq. Similarly the civil war in Syria has been lost several hundred thousand Syrian people, left home and fled out of the country as asylum and refugees, damaged structures and collapsed the national economy. In March 2011, pro-democracy demonstrations erupted in the southern city of Deraa, inspired by the "Arab Spring" in neighboring countries when the government used deadly force to crush the dissent, protests demanding the president's resignation erupted nationwide. The Syrian Observatory for Human Rights, a UK-based monitoring group with a network of sources on the ground, had documented the deaths of 367,965 people by December 2018.The figure did not include 192,035 people who it said were missing and presumed dead. By February 2019, some 13 million people were estimated to be in need of humanitarian assistance, including 5.2 million in acute need. (https://www.bbc.com/news/world-middle-east-35806229).

Stamped

Stamped is usually occurred within the gathering of large crowd in a small geographical space. It has been happened mostly in the football ground in the Europe and England after the clashes between two groups. But the stamped events are frequently reported from India during the religious activities. Over 10 dozen people dead in Amritsar city due to stamped and train crushed on 20 October 2018 is a large disaster (based on daily news reports on 20th October 2018).

Asylum or refuses

If someone is at risk of being persecuted in their own country, they may go abroad and ask for asylum in another country. Granting 'asylum' means giving permission to someone remain in another country because of that risk of persecution. But, during the time of civil war, national incidents or state mechanism caused the people to flee other parts of the world. Tibetan refuses in Nepal in early 1970s, Bhutanese refuses in early 1990s, Rohingya refuses from Myanmar to Bangladesh in 2015 to 2018, Syrian refuses to Europe and Middle-East are some of the major crowd in the contemporary world which have been creating disaster on humanitarian ground.

Hazard assessment is the process of studying the natural and man-made hazards determining its essential features (degree of severity, duration, and extent of the impact area) and their relationship. Hazard assessment helps to identify the key triggering

events, and nature as well as the probability of occurrence of the events. Vulnerability assessment is a way of projecting likely impact on identifiable population due to particular hazard. The pressure and release model is used for vulnerability assessment. Vulnerability is usually measured using a person's exposure to risk.

4.4 Hazards and disasters in Nepal

Being its' geographical location at the mountainous terrain Nepal has always faced the various types of disasters. The Disaster Preparedness Network Nepal (DPNet), a network of the organizations working in disaster sectors in Nepal, has summarized the country's disaster scenario as "it is exposed to a variety of natural hazards and human induced disasters. More than 80 percent of the total population of Nepal is at risk of natural hazards; such as floods, landslides, windstorms, hailstorms, fires, earthquakes and Glacial Lake Outburst Floods (GLOFs). The country is among the 20 most disaster-prone countries in the world. Nepal is also locating in a seismically active zone with a high probability for a massive earthquake. Globally, Nepal ranks 4th and 11th in terms of its relative vulnerability to climate change and earthquakes, respectively (DPNet 2017). Despite the number of disaster events occurred in the country, the summer monsoon brings the chaos to the people in every year. Particularly those who are in the mountains and hills always live under the threats of landslide and the people living in the downhill and plain areas with the floods. Both of these events are interconnected and also directly associated with the downpour. The uncertainty of the intensity of monsoon precipitation in the Himalayas has been reported (NRC 2012). The uncertainty over the monsoon precipitation it has been experiencing the changes over regular timing, amount and intensity of the precipitation. The cloudburst events in different locations with varied intensity have been experienced. Such events caused the sporadic occurrences of landslide events in the mountainous terrain. The major typology of the disaster and the impact within the country is given in *Table 1* .

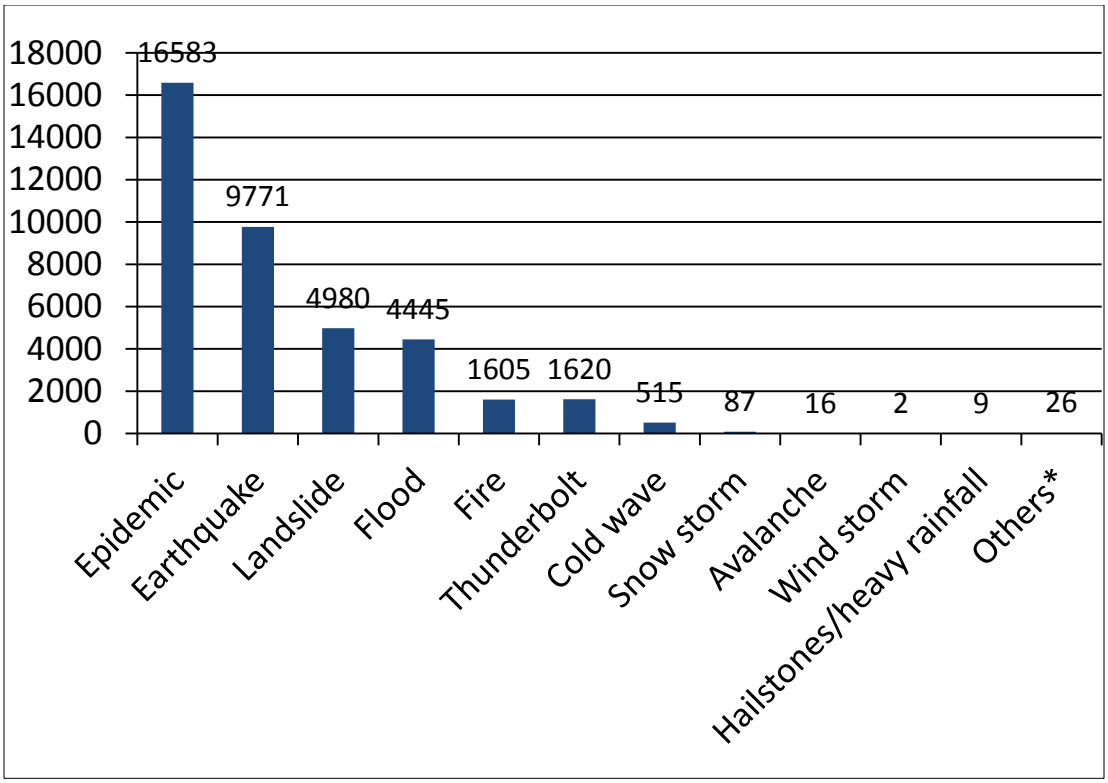
Table 1: Major Disasters in Nepal and the Damage and Loss, 1971-2016

Disaster type	No. of death	No.of person missing	No.of persons injured	No.of houses damaged/destroyed	No. of affected families	No. of incidents
Epidemic	16,583	-	43,111	-	512,989	3,452
Earthquake	9,771	-	29,142	982,855	890,995	175
Landslide	4980	174	1,871	33,617	558,264	3,246
Flood	4,445	42	544	216,190	3,710,065	3,950
Fire	1,605	-	1,619	86,261	259,935	8,721
Thunderbolt	1,620	129	2,684	963	7,140	1,711
Cold wave	515	-	83	-	2,393	390
Snow storm	87	7	-	-	-	5
Avalanche	16	3	7	-	-	2
Wind storm	2	-	11	215	191	44
Hailstones/heavy rainfall	9	-	24	155	3.280	131
Others*	26	2	51	1	36	29
Total	39,650	357	79,147	1,320,257	5,945,288	21,856

* This data is recorded since 2016 only. It includes high altitude, boat capsized, snake bites, wild animal attack and others.

Source: MoHA, 2017

From the recorded data the epidemic is appeared as the most killer hazard. Despite its high severity there is no properly maintained database about the outbreak of such events. Mostly such events are associated with diarrheal and vector-borne diseases. The next major one is earthquake. The event of Gorkha earthquake was the most killer one. Landslide and flood are quite regular events occur all over the country. The frequency of death toll caused by different hazard as of the records of MoHA has been presented in Figure 7.



** This data is recorded since 2016 only. It includes high altitude, boat capsized, snake bites, wild animal attack and others.*

Source: MoHA, 2017

Figure 7: Major Disasters in Nepal and the Loss of lives between, 1971-2016

Earthquake events in Nepal

Geophysical situation of Nepal is in between two rigid ancient landmasses, i.e. Eurasian landmass in the north and the Indian landmass in the south. Both of these landmasses are situating over the lithospheric continental plates. Geophysicists invented that those plates have a circular movements. Being such geophysical situations the plate boundary has a converging movement in between two rigid plates. The process of the convergence is still continuing and also the up-heave has been actively taking place. Because of these underneath geophysical situation, instability of the Himalayas is widely reported. Therefore, the Himalayan territory is under the high potential zone of earthquake. Nepal Himalaya is within such active earthquake trigger zone. Since the recorded earthquake events in the country, presents the high threat (Table 2)

Table 2: Earthquake records in Nepal

Year	Magnitude	Location of earthquake and damage caused
25th April 2015**	7.6 Richter scale Gorkha Earthquake	14 districts of Nepal severely affected, died 8970 persons, 195 were disappeared, 22302 persons severely injured, 604,930 houses severely, damaged
18th September 2011	6.8 Richter scale	Eastern part of Nepal was severely affected. One person died in Kathmandu also.
2058, Shrawan 01 B.S. (July 16, 2001 A.D.)*	5.9 Richter scale	The tremor was epicentered at Gorpha district. at least 20 houses including Government offices were damaged. Several areas had developed cracks but no one was lost their life.
2045 B.S. (1988 A.D.)	6.4 Richter scale	Udayapur earthquake, lost 721 lives, damaged 65000 houses in eastern Nepal
2037 B.S. (1980 A.D.)	6.4 Richter scale	Bajhang earthquake, lost 103 lives and damaged 2500 houses in Bhajhang and adjoining districts.
2023 B.S. (1966 A.D.)		Far-western region, 24 persons died and more than 2300 houses damaged.
1990 B.S. (1934A.D.)	8.3 Richter scale	The epicenter of the quake was located at the eastern part of Nepal. It was ever recorded largest earthquake of the country. It is also named as Mahabhukampa, died 8519 people and damaged 207,740 houses. Kathmandu Valley was the most affected location where 4296 lives lost.
1983 B.S. (1926 A.D.)		Affected Indian City fo Patna and southern border of Nepal
1973 B.S. (1916 A.D.)		Far-western region of Nepal was affected
1891 B.S. (1834 A.D.)		Kathmandu and its periphery
1890 B.S. (1833 A.D.)	7.8 Richter scale	18,000 houses all over the country were damaged. The largest loss was confined in the Kathmandu Valley.
1880 B.S. (1823 A.D.)		Kathmandu and its periphery
1866 B.S. (1809 A.D.)		Kathmandu and its periphery
1824 B.S. (1767 A.D.)		Kathmandu and its periphery
1738 B.S. (1681 A.D.)		Kathmandu and its periphery
1737 B.S. (1680 A.D.)		Kathmandu and its periphery

1464 B.S. (1407 A.D.)		Major damages caused in Kathmandy Valley
1311 B.S., (1259 A.D.		Same location as of above
1310 B.S. (1253 A.D.	Event recorded according to the damages of important temples monuments and houses in the Kathmandu city (estimated 7.7 Richer scale)	Kathmandu and its periphery (nearly one thousand population of then Kathmandu City were affected. Then King Abhaya Malla was died on that event.

Source: collection fo Mahesh Nakarmi, and Madhav Raj Pandey, "Cities at Risk" workshop-cum training on Natural Disaster Preparedness 27th November 1996, Kathmandu, Nepal Geological Society and Lutheran World Service Disaster Preparedness Project, Kathmandu.
**The Kathmandu Post (Mid week post supplement) Wednesday 25 July 2001.*
*** Gorkha Earthquake 2072 experienced and learning, (gorkha bhukapa, anubhav ra sikai), MOHA, Government of Nepal, 2073 B.S.*

The location of epicenter of major trigger of Gorkha Earthquake occurred on 25th April 2015 and its aftershocks above 4 Richter scale recorded by the National Seismological Center, Lainchaur until 30th November 2015 have been plotted in the map (Fig.8). It has presented the events are closely confined in the north of Kathmandu between Gorkha and Dolakha in a length of some 70 kilometers west to the east direction.

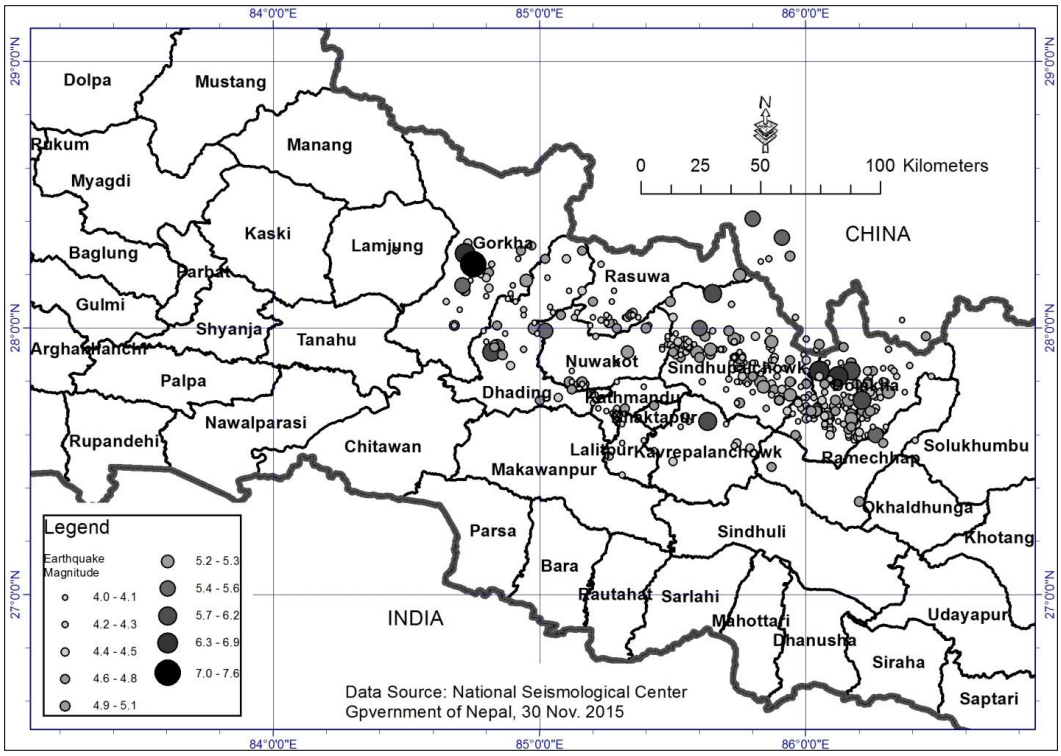


Figure 8: Distribution of epicenter of Gorkha Earthquake and its aftershocks between 25th April and 30th November 2015.

Since the 14 districts were under the severe damage, total death toll was around 9000 persons in different districts of the country. Those districts were confined between Gorkha to Solukhumbu. The maximum concentration of the severity was in Gorkha, Dolkha, Sindhupalchowk, Rasuwa, Kathmandu, Nuwakot and Dhading (Fig. 9).

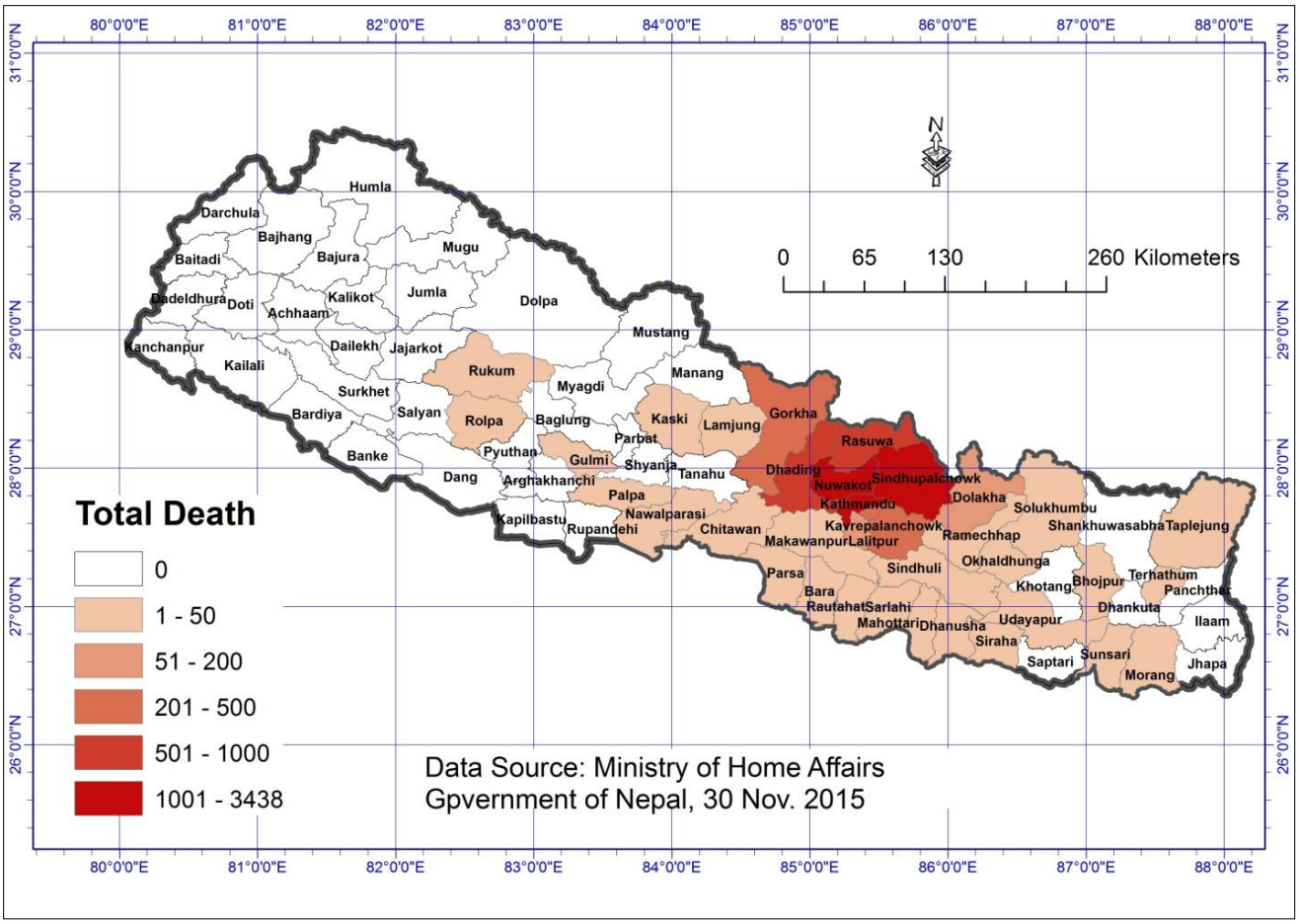


Figure 9: Distribution of the death toll caused by the Gorkha Earthquake 2015.

Because of heavy trigger the large number of traditionally constructed mud-stone mortar buildings and old monuments and temples were severely damaged. The damage had been extended most of the districts of the country (Fig. 10).

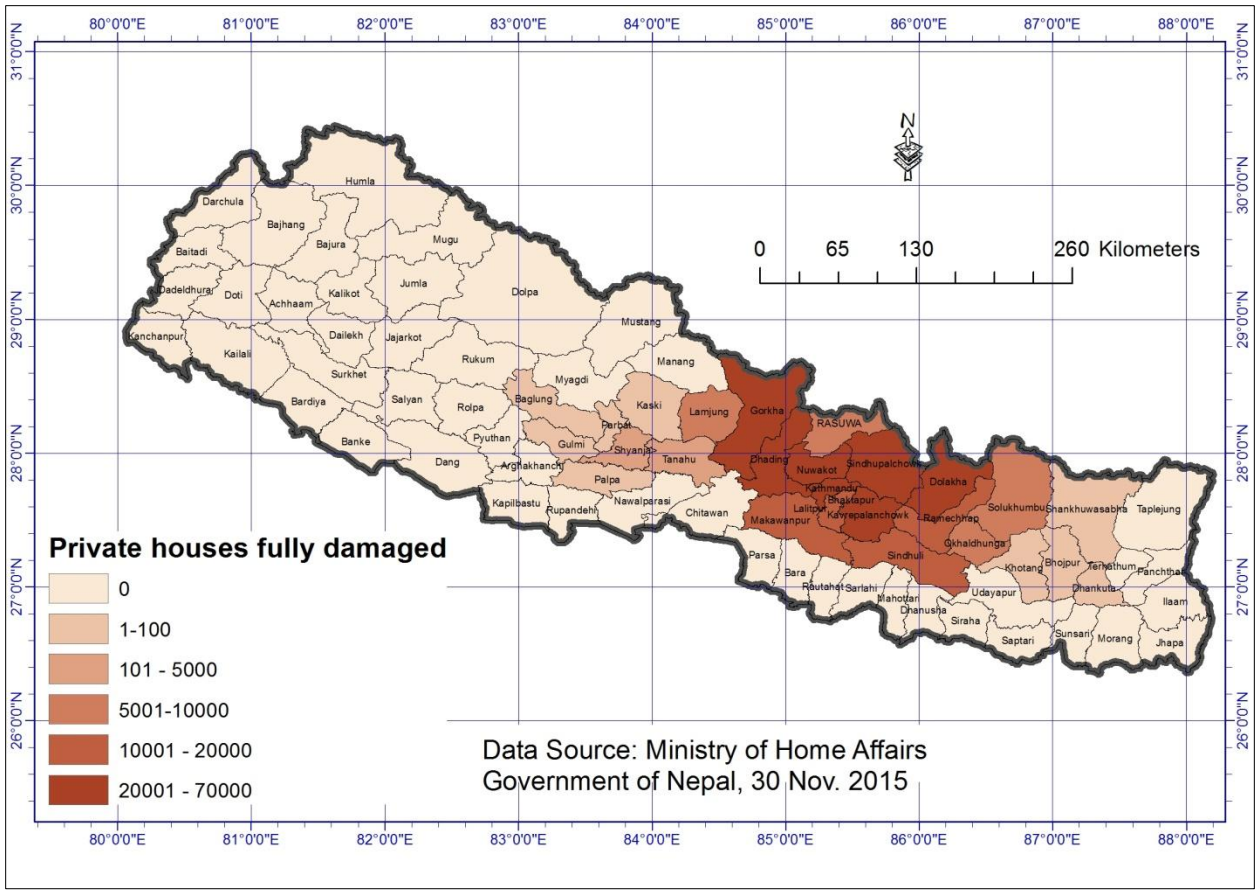


Figure 10: Distribution of houses damaged by the Gorkha Earthquake 2015.

The trigger of the disaster was widely distributed in the country. That was the most devastating event in the last nearly 80 year's interval since the past event occurred in 1934 A.D. Therefore, earthquake is a most devastating hazard in the Himalayan territory.

Landslide and floods events

The mountains and hills always live under the threats of landslide and the people living at the downhill and plain areas with the floods. Both of these events are interconnected and also directly associated with the downpour. The uncertainty of the intensity of monsoon precipitation in the Himalayas has been reported (NRC 2012). The uncertainty over the monsoon precipitation it has been experiencing the changes over regular timing, amount and intensity of the precipitation. The cloudburst events in different locations with varied intensity have been experienced. Such events caused the sporadic occurrences of landslide throughout the hills and the mountainous terrain. The records

between 1971 to 2016 as maintained by the MOHA, have show the number of death due to landslide in the country is third after the epidemic and earthquake events (Fig.11). However, the death toll in individual districts UNISDR Global assessment report 2009 has presented between 1971 and 2007 (https://www.unisdr.org/we/inform/publications/9413) The data presents the distribution of death toll is high in central Nepal Myagdi district in the west to the eastern hills to Tehrathum district.

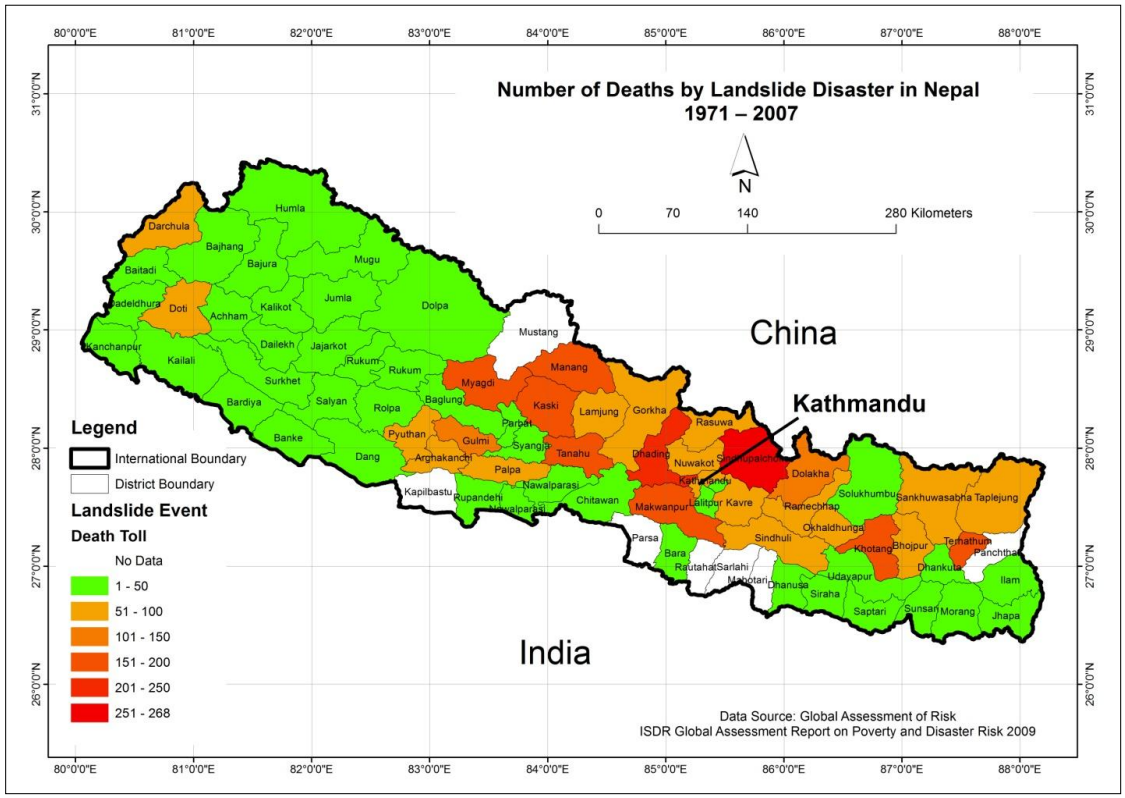


Figure 11: Distribution of death toll due to landslide events in Nepal between 1971 and 2007.

The total number of death was 4980 persons. The highest was in Sindhupalchwok district. The other districts, Myagdi, Kaski, Dhading, Manang Makwanpur, Tanahaun and Khotang also have over 200 persons died . It shows the death toll due to landslide hazard is mainly concentrated in a region hilly track of eastern and central Nepal.

Similarly flood is like a landslide event directly associated with the amount of precipitation. The death toll caused by the flood hazard is in fourth rank as of the data records between 1971 and 2016. The total death between those years was 4445 persons.

The ISDR Global Assessment Report 2009 shows the district was distribution of death toll caused of flood hazard is mainly concentrated in some districts of Tarai and middle hill with exception in Rasuwa district in the mountain. Saptari, Makwanpur, Mahottari, Sarlahi and Chitwan are the districts with high death toll (over 200 persons) in the last 35 years (Fig. 12).

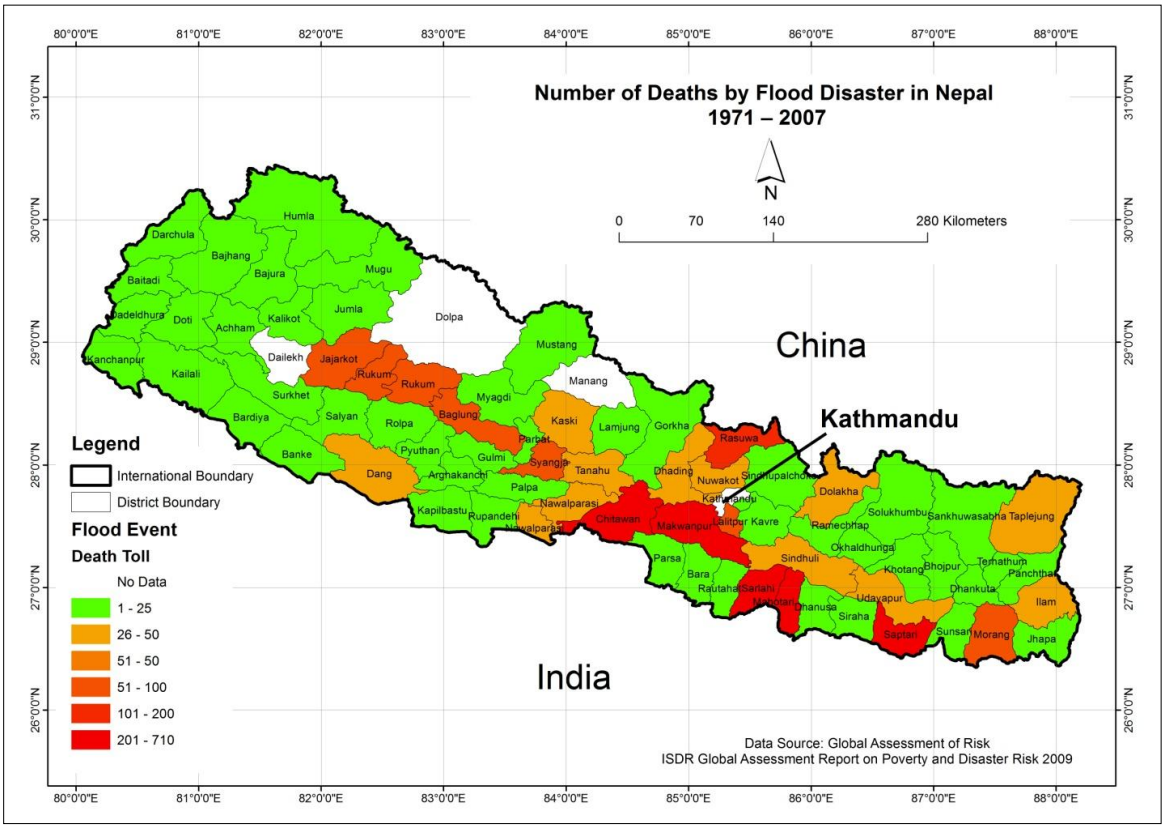


Figure 12: Distribution of death toll due to landslide events in Nepal between 1971 and 2007.

Besides these major hazards as of the records of MoHA, fire is a major one in the Tarai during the dry months. Specifically, fire becomes havoc in the compact rural village houses with thatched roofs. Despite the loss of lives, fire is a worst disaster for the property loss. This hazard mainly occurs due to human ignorance and negligence in the rural communities. Thunderstorms, lightning and cold wave are also other hazards. The pre-monsoon and post monsoon thunderstorms and lightning are more hazardous in the plain areas. Similarly, the cold wave is more active in lowland Tarai during the month of January and February. Rural poor are directly affected by this hazard.

Nepal has been affected by the multi hazards in different seasons round the year. For the mitigation of different types of hazards different organizations, including

government agencies, community organizations, volunteers and national and international non-governmental organizations are working with different strategies, agendas and programmes following both pre-disaster preparedness as well as in during and post disaster response activities.

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Chapter 5

ACCOUNTING HAZARD AND DISASTER FOR THE SCHOOL SAFETY

5.1 Schools at risk

Schools are only place where a large number of young children live together for a longer time. One student in her/his school life throughout grade I to XII normally spends around 15,000 hours within the school class room and its premises even though she or he is a day student. But if she or he is a border or day boarder they spend much more time. If the school is not safe in terms of any form of disaster their life is always in vulnerable and at risk. From this juncture, it is extremely necessary to think about the school safety contextual ground from any type of disaster.

The empirical records around the world presents the earthquake is the major destructive disasters for the school children. A devastating quake of 25 April 2015 named 'Gorkha Earthquake in Nepal' collapsed 6700 school buildings. Most of those were public or community schools (MoHA, 2017) with a total loss of NPR 31.3 billion (NPC, 2015).. This was triggered on Saturday mid-day or 11:56 a.m., of Nepal Standard Time (NST), school holiday in Nepal, and children were not within the school. The Udayapur earthquake also occurred at 23:09:09 hrs UTC time on 21 August 1988 with a magnitude of 6.9 Richter scale destroyed 6000 schools in Nepal. The event was occurred at the early morning of NST. Therefore, students were fortunately not within the school otherwise the casualties would be alarming. But the Pakistan – Kashmir earthquake triggered in October 2005, destroyed 10,000 schools, died 17,000 school children, over 50,000 seriously injured and affected 300,000 school children. It has been shown that school children used to be highly affected round the world by the earthquake events.

School children are also affected by hazards like landslide, flood, fire, epidemics and several others but those seems to be less reported and also not in mass scale. However, in any case the school safety contexts are highly essentials. Because of that there are number of international and national initiations and campaigning has been made towards the school safety. In the recent years, international organizations, governments and non-governmental organizations, agencies and communities are jointly involving

on developing comprehensive school safety programmes and developed common agendas and international compliances, too. The Hyogo Framework of Action 2005-2015 and the Sendai Framework 2015-2030 for DRR are such international initiations mandatory to every signatory country. The UN initiation for sustainable Development Goals (SDGs) has also incorporating the school safety agendas within the DRR perspective and every UN member are compelled to achieve the targeted objectives by 2030.

There are several factors responsible for schools at risk. With a view on realizing the vulnerability and risk of school children, different organizations including UNICEF, Inter-agency Network for Education in Emergencies (INEE), International Federation of Red Cross and Red Crescent Societies, Child Fund, Save the Children, ADPC, World Vision, Plan jointly working towards a global framework for climate-smart disaster risk reduction for bridging development and humanitarian action in the education sector have set different goals of comprehensive school safety programme based on the guidelines of HFA on March 2013 (Comprehensive School Safety, 2013). The goals were to:

- protect learners and education workers from death, injury, and harm in schools
- plan for educational continuity in the face of expected hazards
- safeguard education sector investments
- strengthen climate-smart disaster resilience through education

To achieve the stated goals the comprehensive school safety has addressed by education policy and practices aligned with disaster management at national, regional, district and local school site levels based on three pillars:

1. Safe Learning Facilities
2. School Disaster Management
3. Risk Reduction and Resilience Education

Multi-hazard risk assessment is the foundation for planning for Comprehensive School Safety. Ideally, this should be part of Educational Management Information Systems at national, sub-national and local levels. It is part of a broader analysis of education sector policy and management in order to provide the evidence base for planning and action.

The core actions of the pillar 1 as envisaged for the comprehensive safety are:

- Safe site selection
- Building codes
- Performance standards
- Disaster resilient design
- Builder training
- Construction supervision
- Quality control
- Remodeling
- Retrofit

The core actions of pillar 2 are:

- Assessment & Planning
- Physical & Environmental Protection
- Response Skills & Provisions
- Representative/participatory SDM committee
- Educational continuity plan
- Standard operating procedures
- Contingency planning

Actions for pillar 3 are:

- Formal curriculum integrations & infusion
- Teacher training & staff development
- Extracurricular & community-based informal education

However, there is an overlapping common zone in between pillar 1 and pillar 2 which includes the actions for:

- Building maintenance
- Non-structural mitigation
- Fire safety

The overlapping common zone between pillar 1 and pillar 3 has the actions of:

- Structural safety education

• Construction as educational opportunity

Similarly, the overlapping zone between pillar 2 and pillar 3 has the actions of
• Household disaster plan
• Family reunification plan
• School drills

All three pillars overlap in a point where the common actions for the safety are:
• multi-hazard risk assessment
• education sector analysis
• child-centred assessment & planning

For the achievement of the comprehensive safety, the actions required to be followed. But, on following the actions gaps have been remained and the disaster occurred. Same situation has been happened during the Gorkha Earthquake in April 2015 in Nepal. From the empirical data it has been marked gaps on the first action of pillar 1.

5.1.1 Physically unsuitable school location

The history of formal school education in Nepal is not very old. It was started just after the democratic establishment of 1951 (2007 B.S.). During the Rana Regime formal school education was limited only within the Rana Ruler's family and their relatives. Schools were a few. After 1951, common people felt need of education and involved voluntarily to open schools. Almost all schools until New Education System Plan (NESP) in 1971 were running by the community with sole governance. Only the School Leaving Certificate Examination was handled by the Government. But after the NESP, all community schools brought within the Central Government System. This trend has been remained until 1990s. After democratic restoration in 1990s, government granted permission to open schools to private sectors, too. Because of those changes, country has both community or public and also the private owned schools. The share of public or community run schools is over 90 %. Large part of rural areas has only public or community schools. Those schools are initially established within the public or community initiations. Even though the government has putting teachers, running

curriculum and taking responsibilities of examination and other governance, despite that, the schools are within the responsibilities of community and also remain as common properties of the local people. Therefore, direct involvement of the local people is associated with site selection for the establishment and also for the construction activities. Being a common property, most of the schools are located at the naturally vulnerable marginal lands which have cheaper land value or in government owned fallow, degraded marginal land or bush and margins of forest land. Sometimes schools location decided based on compromising in between two or more settlements or villages due to the reason of accessibility in between them even though the location is physically not suitable like bank of stream, top of the cliff or landslide prone area. In some cases the location of the school determines by the number of students and the leadership of the society rather than the physically better landscape. Gautam (2013) rightly reviewed the situational factors of several public schools in Nepal and due to several such conditions most of the schools in the rural geographical areas have physically vulnerable location. In such landscape the earthquake, landslide, flood disasters seem to be more disastrous. School children suffer from such disasters and not in safe.

5.1.2 Unsafe school building structure

Public schools in Nepal are within the jurisdiction of common pool property of the local people. Several public schools have old building constructed before the new building code implemented by the Ministry of Education (MOE). Those old structures are already in a dilapidated condition. The current government practices and policies also have been incorporated the regulatory provision of School Management Committee (SMC) among the local guardians of the community. SMC is directly participated on decision making of school construction and physical management activities. In practice, Government follows the people's participation policies and in the construction the main role goes to the local. Therefore, the role of SMC is always remaining on the top of construction of school buildings. In several conditions the infrastructure building activities determine by the building materials availability at the local area. The process of quality control often depends upon the knowledge and skill of SMC and also the interest of the construction parties. The SMC members are from the local community

and not necessary to aware about the technical skill of quality control. On the other side, several old and dilapidated buildings in the remote inaccessible areas are still existed and are more vulnerable. Because of that the Udayapur earthquake and the more recent Gorkha Earthquake caused heavy damage. Still, several public schools buildings are not in a good condition from the DRR level, even though government has claimed for the safe school compliances, implementation of building code and DRR education to the community level, a large task has to be done by the government and communities to converts the schools as safe place for the kids. Before that it should be confirmed the quality of school building in terms of DRR level through the actual ground realities. The school mapping agenda of the MOE needs to be included these variables and implement this agenda in the wall-to-wall level within the country. The environmental geography has to be developed the skill to map such vulnerable buildings and suggest for the retrofitting or new construction to save the life of school children at risk.

5.2 Risk and vulnerability assessment (RVA)

As we know schools are the place where a large number of children live together for a longer time. School children are being exposed to both unsafe location of schools and the unsafe building structure, thus they are accounted for vulnerable situation and having with high risk. Specifically, the earthquake events become more dangerous for the school children. Collapse a school building may leave the death to all students inside it. That has happened in the Pakistan-Kashmir Earthquake in October 2005. Despite the structural damage of the school building, school always threatened by the vulnerability and risk of multi-hazards and disasters, too. School kids are more volatile due to their age and thinking levels, therefore, they may expose to other hazards like health, security and abuse including natural and technological hazards.

UNDP defines risk as the probability of harmful consequences resulting from interactions between natural or human-induced hazards and vulnerable conditions. Risk assessment is a process to determine the nature and extent of such risk, by analyzing hazards and evaluating existing conditions of vulnerability that together could potentially harm exposed people, property, services, livelihoods and the environment on which they depend (UNDP, 2010). Risk and vulnerability assessment

is highly complex. There are number of factors responsible for risk and vulnerability. The National Research Council (2006) summarizes that the relationship between disaster risk and development is complex and multifaceted. Risk refers to potential for loss of life and property damage. Disaster risks are products of the disaster event and the degree of vulnerability of human communities that sustain losses from the event. The destructive power of the disaster event is influenced by several physical characteristics (e.g., magnitude and scope of impact, length of forewarning) as well as the degree of exposure to impacts. The physical force of a disaster, however, is insufficient to explain risk. Areas that experience equivalent levels of physical force of a given disaster event have widely varying levels of risk. Vulnerability is the concept that explains why, with the equivalent force of disaster, people and property are at different levels of risk. Vulnerability consists of various social, economic, and natural and built environmental indicators of societal development that represent the capability of a human community to cope with a disaster event (NRC, 2006). From these analogies there is not a single and simple procedure to assess the risk and vulnerability. Specifically in the context of schools at risk, there are several factors responsible. The site locations of school building, structure of school building, the class room design, and regularity of maintenances are some of the basic factors. Similarly, the children's learning materials to cope the event, economic status of family to support the learning materials and household environment for the disaster resilience are some other aliening factors. School kids always may suffer due to the social structure of the community, too. Sexual abuse, narcotic drug abuse, political and militants miss guidance like social abuse as well as epidemic and mass hysteria like health hazards affect the school kids in masse. Therefore, schools are always at risk and require to build the physical, social and learning environment of schools with *'safety first'* ground.

5.3 Preparedness and control measures

Risk and vulnerability of any hazards are unwanted events occur within little known period or unpredictably. The intensity of hazard can be severe and that may go beyond the resilience capacity of the individual, society, community or even up to the local level and central level of government. That may need the assistance from outside to cope.

That becomes the disaster. But, before the event actually occurred, the severity of the disaster could be reduced or mitigate with certain action of preparedness.

"Disaster preparedness includes actions taken in advance of disasters to deal with anticipated problems of emergency response and disaster recovery. These actions include the development of formal disaster plans; the training of first responders; the maintenance of standby human, material, and financial resources; and the establishment of public education and information programs for individual citizens, households, firms, and public agencies. Of particular importance to disaster recovery preparedness, hazard insurance is designed to provide financial protection from economic losses caused by disaster events, the purchasing costs of which are based on actuarial risk" (NRC, 2006:19-20).

Disaster is an unwanted event. It has its own causative factors. It is not fully controlled by the actions prior to its occurrence. Hazards and disasters research basically has been taken within two major components i.e. hazard component and disaster component (NRC, 2006:19-20). Hazard components involves to risk and vulnerability and its mitigation sector. The risk and vulnerability assessment give the prior knowledge for anticipated disasters. Similarly, the possible areas for mitigation provides by the research or hazard components. This has more connection with the earth science including geography and geology. However, the response and recovery of disaster research comes after the event occurrences. It is directly associated with the sociology, psychology and economics. Therefore, preparedness actions have been taken in advance to deal with anticipated problems of the both components.

Therefore, risk and vulnerability assessment (RVA) and hazard mapping are technical action which have to be involved the technical expertise having knowledge of spatial sciences. The knowledge of physical geography and related information regarding the geological structure, lithology, landscape morphology i.e. slope, aspect, relief, undulation, surface roughness, hydrological and meteorological characteristics, ground coverage and human activities over the landscape required to scrutinize. The database and information of different parameters needs to integrate in a single whole. The time series data regarding the past events would be more meaningful for the triangulation of the current possible outcomes. Therefore, the time series data of the landscape can be

taken from the satellite imageries. All the datasets can handle by applying Geographic Information Systems (GIS). Thus, remote sensing and GIS play an important role on RVA. Basic understanding of remote sensing and GIS is mandatory for every personnel working on RVA.

5.4 Safety measures for the schools

On the top of Hyogo Framework of Action (HFA) 2005-2015 and Millennium Development Goals (MDGs) 2000-2015 under taken by the UN Agencies, there are Sustainable Development Goals (SDGs) and Sendai Frameworks (SF) which have envisaged their targets to meet by 2030. The Comprehensive School Safety (CSS) is also aligned with SDGs 2015-2030 and Sendai Framework for Disaster Risk Reduction. The expected outcomes of integrating Comprehensive School Safety into Sustainable Development and Disaster Risk Reduction policies and practices as:

- Improve all children's equal, inclusive, and safe access to education.
- Develop and strengthen institutions, co-ordination mechanisms and networks, and national capacities to build resilience to hazards and threats to the education sector at international, national, sub-national and local levels.
- Incorporate risk reduction approaches into implementing emergency preparedness, response, and recovery programs in the education sector.
- Monitor and evaluate the progress of initiatives for reducing disaster and conflict risks.
- Increase availability of and access to hazard-related evidence, such as multi-hazard early warning systems data and disaster risk information.

The expected outcomes have to fulfill by the joint action of local, regional, national and international initiatives. Among them the government has to play supreme role for creating enabling environment to meet the targets through its policies and practices.

Box #4

Sustainable Development Goal (SDG) Targets 2015-2030 and Comprehensive School Safety

The Comprehensive School Safety framework is intended to strengthen our approaches to fulfilling these SDG targets:

TARGET 1	End Poverty in all its forms everywhere (1.4, 1.5)
TARGET 3	Ensure healthy lives and promote well-being (3.3, 3d)
TARGET 4	Ensure inclusive and equitable quality education opportunities for all (4.1 4.a)
TARGET 6	Ensure availability and sustainable management of water and sanitation f (6.2, 6.4, 6.a, 6.b)
TARGET 9	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation (9.1, 9.4, 9.a)
TARGET 10	Reduce inequality within and among countries. (10.3, 10.7)
TARGET 11	Make cities and human settlements inclusive, safe, resilient and sustainab (11.5, 11.6, 11.b. 11.c)
TARGET 12	Ensure sustainable consumption and production patterns (12.5, 12.8)
TARGET 13	Take urgent action to combat climate change and its impacts. (13.1, 13.3, 1
TARGET 16	Promote peaceful and inclusive societies for sustainable development, pro access to justice for all and build effective, accountable and inclusive institutions at all levels. (16.1, 16.7)
TARGET 17	Strengthen the means of implementation and revitalize the global partner for sustainable development (17l.16, 17.17, 17.18, 17.19)

Interpreting the Sendai Framework for Disaster Risk Reduction (SFDRR) 2015-2030:

The 'Sendai Seven' targets for the education sector

The "Sendai Seven" Targets	Global Targets for the Education Sector
1. Substantially reduce global disaster mortality by 2030, aiming to lower average per 100,000 global mortality between 2020-2030 compared to 2005-2015.	Minimise the number of deaths and injuries due to hazard impacts on schools.
2. Substantially reduce the number of affected people globally by 2030, aiming to lower the average global figure per 100,000 between 2020-2030 compared to 2005-2015.	Substantially reduce the number of school children affected by disaster impacts of all sizes.

3. Reduce direct disaster economic loss in relation to global Gross Domestic Product (GDP) by 2030.	Reduce education sector investment losses due to hazard impacts.
4. Substantially reduce disaster damage to critical infrastructure and disruption of basic services, among them health and educational facilities, including developing their resilience by 2030.	Minimize school days lost due to hazard impacts.
5. Substantially increase the number of countries with national and local Disaster Risk Reduction strategies by 2020.	Countries have education sector risk reduction strategies.
6. Substantially enhance international co-operation to developing countries through adequate and sustainable support to complement their national actions for implementing this framework by 2030.	Countries work together to achieve Comprehensive School Safety.
7. Substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to people by 2030.	Schools have access to, and use early warning systems.

The Sendai Framework Priorities for the education sector

SFDRR Priorities	Priorities for the education sector
PRIORITY 1: Understanding disaster risk	• A comprehensive and inclusive approach to school safety is the foundat for integrating risk reduction and resilience into education sector strategie policies and plans. • Child-centered risk assessment is in place at all levels in the education sector. • Multi-hazard risk assessment has been conducted to analyse and priorit risks affecting the education sector. • A systematic plan for assessing and prioritising retrofitting and replacin unsafe schools has been developed and is being implemented. • The National Disaster Management Authority and Education authority nationally adopted consensus- and evidence-based, action-oriented key messages as a foundation for formal and non-formal education. • The education authority has infused Risk Reduction and Resilience (RRI Education into regular curriculum, including (but not limited to) climate education, Disaster Risk Reduction education, and conflict-sensitive education.

	• Schools convey RRR Education via non-formal education. This can include participation in school disaster management and after school clubs, assemblies, and extra-curricular activities.
PRIORITY 2: Strengthening disaster risk governance to manage disaster risk	• Enabling policies and legal frameworks are in place at national and/or sub-national levels to address the key elements of Comprehensive School Safety. • Organisational arrangements, leadership, and coordination for RRR Education is established by senior management, and includes designated leaders who are responsible at all levels. • Guidance and regulations for safe school construction are in place. • Safe school site selection, design and construction are monitored for compliance/enforcement by the appropriate authorities. • Schools annually review school Disaster Risk Reduction and management measures. For example, this can be part of school-based management and/or school improvement including (but not limited to) ensuring guidance and plans are in place for preventing and responding to attacks on education, conducting school-based hazard drills, and evacuation.
PRIORITY 3: Investing in Disaster Risk Reduction for resilience	• Funding is in place to reduce education sector risks. • Monitoring and evaluation for Comprehensive School Safety is underway. • Funding, monitoring and evaluation is in place for generating hazard-related evidence to increase access to and availability of risk-related data. • A prioritisation plan for upgrading existing unsafe schools is being resourced and implemented. • Education authorities promote routine maintenance and non-structural mitigation for increased safety and protection of investments in public schools. • The education authority has needs assessment, strategy, and an implementation plan to develop staff and student capacity for participation in school-based Disaster Risk Reduction and management at the necessary scale. • The education authority has needs assessment, strategy, and an implementation plan to develop teachers' capacity for teaching RRR Education. • The country has enough quality (RRR) Education materials to implement RRR Education at scale.
PRIORITY 4: Enhancing disaster	• Planning is undertaken for limited use of schools as temporary shelters or collective centers during the school year. • The education authority has multi-hazard risk assessment based national

preparedness for effective response	and sub-national plans for education sector risk reduction and management. The focus is on safety and security, educational continuity and contingency planning, and protection of education sector investments. • The education authority has established and relevant simulation drills that are held annually at all levels to practice response preparedness and to review and adapt response plans as needed.

Source: Comprehensive School Safety: A global framework in support of The Global Alliance for Disaster Risk Reduction and Resilience in the Education Sector and The Worldwide Initiative for Safe Schools March 2017, UNISDR and Global Alliance for Disaster Risk Reduction and Resilience in the Education Sector

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Chapter 6

DISASTER MANAGEMENT WITH REFERENCE TO NEPAL

6.1 Introduction

Within the precarious disaster situation of the country, Nepal has been adopting different strategies for the coping disaster events. Towards this direction, then His Majestic Government of Nepal had enacted the first Act in 1982 (2039 B.S.) to address the natural disaster rescue and relief activities through the "Natural Calamity Relief Act, 1982" (www.lawcommission.gov.np). During that time the disaster has been named as being caused by the divine power or natural event. Thus, it has been named as '*daivi prakop*'. The Act has defined the events as 'earthquake, fire, storm, flood, landslide, excessive rainfall, draught, and famine, epidemic and the similar types of hazardous situation. The term was extended to address the technological hazards and explosion in its first amendment in 1990.

Natural Calamity Relief Act 1982 and Local Self Governance Act 1999 were the legal foundations for disaster response in Nepal. Natural Calamity Relief Act 1982 mandated the Ministry of Home Affairs as a lead agency for immediate rescue and relief work as well as disaster preparedness activities. Ministry of Home Affairs had also been coordinating preparedness and rehabilitation initiatives pursuant to the responsibilities given by the Work Division Regulation 2007 (2064 B.S.) of the Government of Nepal to oversee the overall activities of the disaster response in Nepal (MoHA, 2013:3).

At present, as following the essence of clause 1 of article 296 of Constitution of Nepal implemented in September 2015, (Ashwin 2072 B.S.), the Disaster Risk Reduction and Management Act 2074 (2017) has been enacted. According to this Act, terminology has been changed from the previous *'daivi prakop'* to *'bipad'*, where the *daivi prakop* was treated only for the natural hazard but the new changes have accepted the hazards of both natural and human-induced. The non-natural or human induced are categorized as:
epidemic, famine, wildfire, insecticides, micro-biological havoc, flu originated from birds and animal, pandemic flu, snake bits, wildlife's encroachment, mining related

incidents, aero plain accidents, road accident, water and industrial accidents, fire incidents, chemical leakages, gas explosion, radiation leakages, food adulteration, environmental pollution, deforestation, physical infrastructural damage, accident during rescue operation and similar types of hazard and disasters originated from the human actions.

The act has defined the natural hazards and disaster originated due to natural processes and categorized as:
snow, hailstone, avalanche, Glacial Lake Outburst Flood (GLOF), excessive rainfall (cloudburst), draught, flood, landslide, soil erosion, water inundation, storm, cold wave, hot wave, thunderbolt and lightning, earthquake, wildfire, volcanic explosion and such events originated from the natural causes.

For the disaster management in Nepal, Ministry of Home Affairs (MoHA) is the focal ministry. MoHA has been maintaining the disaster database as well as the producing biennial disaster reports (Nepal Disaster Report - NDR) since 2009 with the support from different development partners and stakeholders. The MoHA dataset archives maintain data for a total of 16 kinds of active disasters in Nepal. The disasters noted are, in alphabetic order:

- Asinapani (heavy rainfall with hailstones),
- avalanche,
- boat capsize,
- cold wave,
- drowning,
- earthquake,
- epidemic,
- fire,
- flood,
- heavy rainfall,
- high altitude,
- landslide,
- snow storm,
- lightning ,

- wind storm,
- tornado (as reported by DHM, Government of Nepal for 30th March storm of Bara and Parsa districts of Tarai)
- others.

This simple fact well illustrates that Nepal is exposed to multiple hazards at a time. On 24 September 2017, the legislative-parliament unanimously passed a new Disaster Risk Reduction and Management Act, 2017. The Act is considered far progressive than the hitherto existing Natural Calamity Relief Act, 1982 in many respects. Its approach to disaster is much comprehensive and recognizes both risk reduction and management as integral part of the task. Instead of committee-based coordination mechanism, the Act proposes a clear multi-tier institutional structure of disaster risk reduction and management (at the centre, the provinces, the districts and the local levels) (DPNet, 2017:viii).

6.2 Disaster management cycle – Preparedness, Response, Rescue, Rehabilitation, Reconstruction

Disaster management cycle is directly connected with the mitigation measures for disaster events. Quite often, the adverse stages of hazard, vulnerability and risk events aggravate and become a disaster which has result loss of human lives and properties. The adverse impacts of hazards often cannot be prevented fully, but their scale or severity can be substantially lessened by various strategies and actions. Mitigation measures encompass social, psychological, engineering techniques and hazard-resistant construction as well as improved environmental policies and public awareness.

Regarding the disaster management concerns the disaster events usually have two different stages i.e. pre-disaster stage and post-disaster stage (Fig. 13). But someone may categories it into during disaster time. Usually that may happen in volcanic eruption and earthquake events, which may take some time interval from its start to the end point. Despite that, most of the events have their moment of occurrence usually keep in very short time. Therefore, it would be hard to manage within the event moment, thus, after occurrence it falls on post-disaster. However, the post-disaster has long duration

remains. It can be grouped immediately after the event occurrences to its long recovery and rehabilitation period.

Source: https://sites.google.com/site/dimersarred/disaster-management-cycle
Figure 13: Risk management

6.2.1 Pre-disaster stages

In the pre-disaster stage, disaster management has been viewed within the risk management perspective. At first, risk and vulnerability assessment (RVA) has to be carried on the understanding of risk and vulnerability condition of any geographical space. In a simple term, it is like a pre-feasibility study what every people know in any type of project. However, the methodology of prediction is more rigorous. It might have several techniques based on wider knowledge and skills developed by different scientists in different geographical contextual grounds. The precision of the RVA depends upon the scientific integration of the spatial factors, variables and their properties whatever concerns on each type of event. In the recent scientific society, the RVA has been widely practiced within the framework of multi-criteria models based on time series datasets of different aspects. Diverse sets of data have been usually integrated with the help of Geographic Information System (GIS) platform along with the User's Interface Neural Network (UINN) and Artificial Intelligence (AI) systems. These systems basically depend upon the modeling parameters and level of accuracy. Based on the RVA findings, preparedness activities towards the mitigation measures

have to be applied. The preparedness activities depend upon the degree of predictable event/s through the RVA. The individual household levels to local, national and international initiations and involvement on preparedness activities may require based on the RVA result. Examples of such activities can be in a wider scale and varieties, such as check-dam and gabion wall construction along the roadside to a building code implementation for the building construction. Similarly, for the flood hazard mitigation, the prediction and early warning system (EWS) have to be established. The pre-disaster stage has sometimes more confusions and very high social cost will be involved. The activities are determined on the predictable outcomes, and the cost involves in an unseen event. It is hard to convince common people, thus, the scientists have great challenges on reaching the scientific conclusions of any possible or probable disaster for any geographical space in future.

Box #5

In the preparedness phase, emergency managers develop plans of action for when the disaster strikes. Common preparedness measures include:

- The Communication plans with easily understood terminology and chain of command
- Development and practice of multi-agency coordination and incident command
- Proper maintenance and training of emergency services
- Development and exercise of emergency population warning methods combined with emergency shelters and evacuation plans
- Stockpiling, inventory, and maintenance of supplies and equipment

An efficient preparedness measure is an emergency operations centre (EOC) combined with a practiced region-wide doctrine for managing emergencies. Another preparedness measure is to develop a volunteer response capability among civilian populations. Since, volunteer response is not always as predictable and plan-able as professional response; volunteers are often deployed on the periphery of an emergency unless they are a proven and established volunteer organization with standards and training.

On the contrary to mitigation activities which are aimed at preventing a disaster from occurring, personal preparedness are targeted on preparing activities to be taken when a disaster occurs, i.e. planning. Preparedness measures can take many forms. Examples include the construction of shelters, warning devices, back-up life-line services (e.g. power, water, sewage), and rehearsing an evacuation plan. Two simple measures prepare you for either sitting out the event or evacuating. For evacuation, a disaster supplies kit should be prepared and for sheltering purposes a stockpile of supplies.

Source: https://sites.google.com/site/dimersarred/disaster-management-cycle

Pre-disaster preparedness activities may arise some sorts of social costs. Example can be set from the pre-disaster evacuation actions. Local people are keenly associated with their fixed properties, value of local area and social cohesiveness. They might have uncountable things and bit and pieces of day-to-day required goods. Everything cannot be taken while the evacuation decision is made. Therefore, there would be a great disaster on their social system before the real disaster occurs. Even within the pre-disaster preparedness there might be certain time interval may remains for their prediction and also the accuracy on predictive decision. The prediction largly depends upon the source of information. For example the The atmospheric weather condition can be predicted more precisely and accurately than any sorts of landslide events. In the same way, basin area flood has more accurate and time lagging on prediction than the flashflood at the mountain valleys. Earthquake has still not certain predictive science in advance, and less known its magnitude before the event occurrences. The effectiveness of mitigation measures in pre-disaster events are depending upon accurate database for the prediction, predictive science and its workable methodology, and also determines by its time between prediction and event occurrence. Therefore, effectiveness, cost involvement and reliable preparedness activities always remain as dependable variables for the mitigation of any disaster events. The preparedness action may jeopardize unless having good teamwork and multi-level coordination. Preparedness is a generic term for national mechanisms for coordination and policy guidance on disaster risk reduction that are multi-sectoral and inter-disciplinary in nature, with public, private and civil society participation involving all concerned entities within a country.

Box #06

The clause 7.8, 7.9, 7.10, 7.11 and 7.12 of National Disaster Risk Reduction Policy 2075 B.S. of Government of Nepal has specified that for the preparedness activities satellite remote sensing, Geographic Information System and multi-disciplinary team of scientist and experts need to carry a RVA for the disaster events.

Source: National DRR Policy, 2075 B.S., Government of Nepal

6.2.2. Post-disaster stage

After the disaster event occurs the preparedness or protection stage over and the recovery phase starts. Immediate aftermath of a disaster, the response is an immediate task. It follows rescue or relief, recovery, rehabilitation, impact assessment and the reconstruction activities starts.

Response phase

The meaning of response as defined by the Ministry of Home Affairs, Government of Nepal (2015) is "the provision of emergency services and public assistance during or immediately after a disaster in order to save lives, reduces health impacts, ensure public safety and meet the basic subsistence needs of the people affected" (MoHA, 2015). The clarification of the definition is extended as disaster response is predominantly focused on immediate and short-term needs and is sometimes called "disaster relief". The division between this response stage and the subsequent recovery stage is not clear-cut. Some response actions, such as the supply of temporary housing and water supplies, may extend well into the recovery stage.

The response phase includes the mobilization of the necessary emergency services and first responders in the disaster area. This is likely to include a first wave of core emergency services, such as fire-fighters, police and ambulance crews. They may be supported by a number of secondary emergency services, such as specialist rescue teams.

Response immediately aftermath needs to be deal with great humanitarian ground. During the disaster aftermath the most sufferers would be senior citizens, children, physically disable population. Despite the first attention to them, all the lives are equally important to bring them out of the difficult situation.

Box #07

SURVIVAL LAW OF 3S

Sometimes it is useful to remember the survival law of 3's is significant if you consider the survival profile of the person and the situation and add that to the other important factors in a survival situation. This works in a displaced wilderness scenario or a disaster, such as earthquakes in an urban or austere / mountainous environment.

The survival law of 3s is often quoted as:

1. Air 3 Minutes without air
2. Water 3 days without water
3. Food 3 weeks without food

- Shelter Finding shelter is important to keep warm or cool and protected.(Some say 3 hours without shelter in harsh areas)
- Health Proper healthy living, nutrition, activity, medical, etc., is needed.
- Company / Moral: Some add - 3 months without company.

Where required, search and rescue efforts commence at a very early stage. Depending on injuries sustained by the victim, outside temperature, and victim access to air and water, their location, etc., the vast majority of those severely affected by a disaster may die within 72 hours after impact. Within a week of a major incident SAR Teams often leave and the incident enters a 'Recovery phase'. Medical response obviously has obvious important applications in the 'Direct Impact' phase and the 'Indirect Impact' phase – as a secondary result of the incident. (like disease, infection and post trauma treatment.)

Source: https://sites.google.com/site/dimersarred/disaster-management-cycle

The response phase of an emergency may commence with a search and rescue phase. However in all cases the focus will be on fulfilling the basic needs of the affected population on a humanitarian basis. This assistance may be provided by national and/or international agencies and organizations. Effective coordination of disaster assistance is often crucial particularly when many organizations respond and Local Emergency Management Agency (LEMA) capacity may be over-stretched and diminished by the disaster itself.

The response follows with 4 S i.e. rescue, relief, rehabilitation and reconstruction. The DRR & M activities can be cited as of the task undertaken during the 25th April 2015 Gorkha Earthquake and its aftershocks.

Rescue operation

The rescue operation lasted intensively within the first few days up to two weeks. There was maximum survival rate of people within the debris and building materials within first one to two days. Gradually the survival rate of stranded people decreases day-after-day. There was few strange survival even after 3 weeks. Such cases were in rare. However, some shorts of disasters like US Bangladesh Aircraft crashed in Tribhuvan International Airport on March 12, 2018 where 49 out of 71 passengers onboard were killed within a time interval of 30 minutes of accident. The accident was happened after the fire broken inside the craft. Therefore, the rescue operation is such action which needs to operate immediately aftermath the disaster occurred in such situation survival rate can be increased with minimal loss. The rescue operation mobilization requires instant and up-to-date team and rescue gears. Well established information network, swift decision making system, smart chain of command are highly essential for the rescue operation. Therefore, National Arm Force, Police Force, Organized Volunteers, Hospital Doctors and sometimes Organized Community Volunteers and Para-Medical Teams also mobilized for the rescue operations along with ambulances and fire-brigades. But, it depends on the type and the intensity of the disaster. Like in flood disaster the equipments might be the boat, and ropes etc along with enough volunteers.

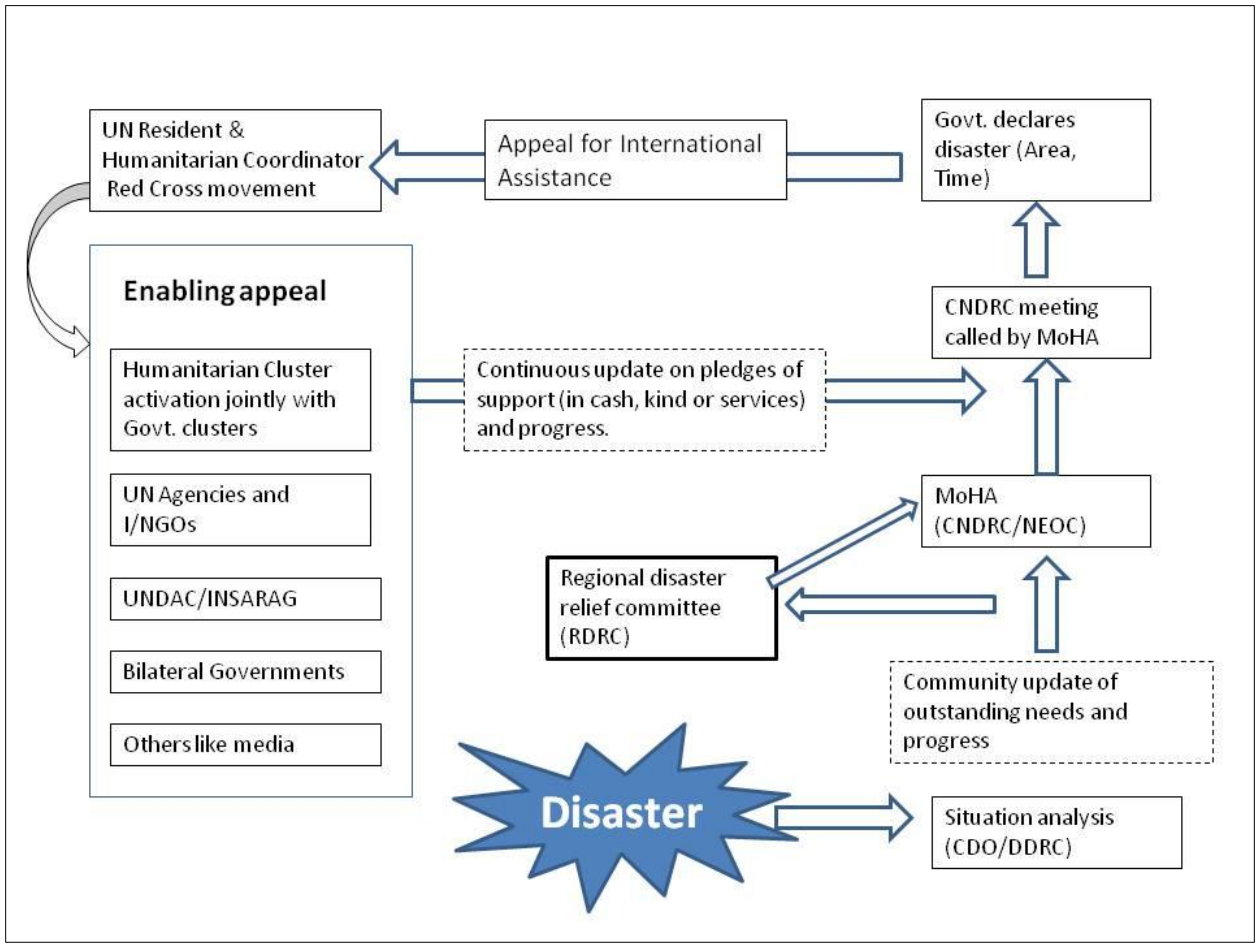
Relief work

Relief phase followed immediately after the Rescue phase. During the relief phase, the focus is to provide basic necessities to victims of the disaster and to restore social equilibrium. Detailed assessment of human and other losses is also usually carried out during the relief phase, which helps in optimal allocation of resources.

Relief phase may last between 1 to 3 months depending on the severity of the disaster like earthquake and the resources of the government. Community, supported by government is usually the central point. Added resources of the NGOs and the international organization substantiate this effort. Temporary shelter with food, water and sanitation, some first aid medicines are required. Team of volunteers of para-medicines, operation of trauma centers snf food depot is to be established. required. During this phase senior citizens, children, disable members and women remain high

vulnerable situation. The social risk also becomes high. Therefore, social security, health security and food security needs to be operated properly.

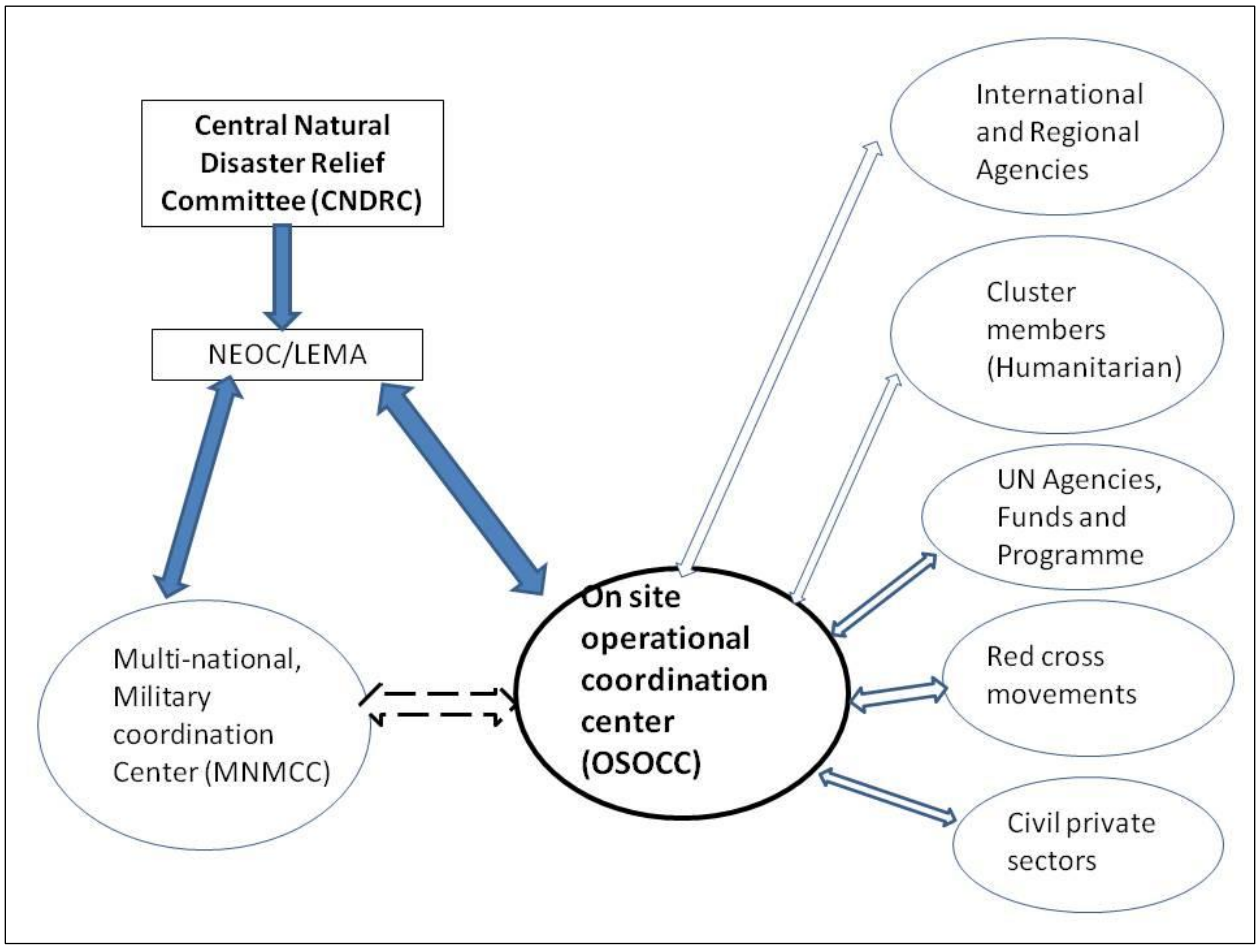
In Nepal Relief work following a major disaster in Nepal has been guided by the Natural Calamity Relief Act 1982. The National Strategy on Disaster Risk Management provides a strategic direction in covering all phases of the disaster management cycle. The National Disaster Response Framework has been prepared (Fig. 14). This response framework had been envisaged for the effective coordination and implementation of disaster preparedness and response activities by developing a National Disaster Response plan that clarifies the roles and responsibilities of Government and Non Government agencies involved in disaster risk management in Nepal (MoHA, 2013).



Source: MoHA, Government of Nepal, 2013 National Disaster Response Framework (NDRF), P.5

Figure 14: National disaster response framework

The response framework had been designed Central Natural Disaster Relief Committee (CNDRC) with a view to operate effectively coordinating the central level to the local level by coordinating through a mechanism among National Emergency operation center (NEOC/LEMA) Onsite Operation Coordination Centre (OSOCC)' Multi National Military Coordination Centre (MNMCC) shall be automatically established for the effective coordination during mega disaster (Fig. 15).



Source: MoHA, Government of Nepal, 2013 National Disaster Response Framework (NDRF), P.6

Figure 15: Disaster response coordination

However, the provision has been changed after the new DRRM Act (2074 B.S.) implemented in 2018. The response work has been designed within the federal governance mechanism. The Federal government will work at the center and the

provincial state government and local levels will play a coordinating role for the disaster events (MoHA 2018).

Rehabilitation/reconstruction phase

Rehabilitation/reconstruction phase aims to restore the communities to the pre-disaster status. During this phase, the social and other infrastructure is restored and economy revitalized. The rehabilitation/reconstruction phase typically starts at the end of relief phase and may last for several years.

The short term plans of the recovery process are clearance of debris, building housing units, restoration of the lifelines and infrastructures, while the long-term objective is to build a safer and sustainable livelihood. Past experiences show that the efforts are sustainable only with community / government partnership, while NGOs and international organizations role is reduced after a certain period. In case of Gorkha Earthquake in Nepal the reconstruction work is still going on even after 4 years of its occurrences. Some victims of flood Mid-Western Region occurred in 2014 monsoon are still waiting for the reconstruction work. Therefore, the reconstruction is basically determined by the willingness of the community, Government financial allocation and external pressure of rebuilding. The basic slogan of the reconstruction is 'built-back-better'.

6.3 Disaster management initiatives (Role of GOs, NGOs and INGOs)[1]

The Disaster Risk Reduction and Management Act, 2017 has been enacted National Disaster Risk Reduction and Management Centre (NDRRM Centre) at the Ministry of Home Affairs as the implementing arm of the government. The NDRRM Centre will be headed by a Secretary as the Chief Executive. The NDRRM Centre will work under direct supervision of the Executive Committee headed by Minister for Home Affairs. The Executive Committee, in turn, will make sure that the decisions and policy directives of the National Disaster Risk Reduction Council (NDRRM Council), the apex body headed by the Prime Minister, are implemented. MoHA has been working as the

[1] The source of information has been taken from the excerpts of the DPNet Annual Report 2017.

lead ministry in the field of disaster management in Nepal. The MoHA has been carrying out the responsibility of effective rescue and relief measures through the arrangements of Disaster Relief Committees at central, regional, district and local levels. The Ministry has gained technical and managerial experience in preparedness, rescue and relief, and coordination related to effective disaster management.

6.3.1 UN Agencies and initiatives from UN-SPIDER

The United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER) was established in 2006 under the United Nations Office for Outer Space Affairs. UN-SPIDER develops solutions to address the limited access developing countries have to specialized technologies that can be essential in the management of disasters and the reducing of disaster risks (http://www.unoosa.org/oosa/en/ourwork/un-spider/index.html). The first technical advisory mission (TAM) of UN SPIDER to Nepal was made between 31st July and 4th August 2017. The TAM has reviewed the following agendas. Here some of the excerpts from the report are re-stated.

- Current Policy and Gaps
- Availability of Geospatial Information
- Current use of space based information
- Data sharing practices
- Applications of geospatial information
- Challenges and constraints
- Existing capacity and needs
- Institutional linkages and coordination

The TAM has made observation and reviewed the situation and recommendation of each point has been made. Examples of the policy recommendation are cited here.

- Integrate space based and geospatial information while the following policy documents are revised: DM Act, National Strategy for Disaster Risk Management (NSDRM), 2009 and National Disaster Response Framework (NDRF), 2013
- Create a national data policy that includes data standards (including geospatial data), which pointsto a clear need for National Spatial Data Infrastructure (NSDI);

- Develop guidelines for a disaster inventory database and clearly spell out, who will provide services, who will use them, and for what purpose.
- To ensure the efficient use of resources in support of DRR, there should be a department or entity that is entirely dedicated to coordination. ;
- In the meantime, there can still be coordination between agencies producing and using data for disaster management and emergency response. MoHA can convene an information management or GIS working group. This group will coordinate data management activities, share data, develop standards, and work toward there being no duplication of efforts
- Army, APF, NGOs (KLL, Nepal GIS Society), Survey Department and ICIMOD are important players

For the strengthening disaster risk reduction TAM has recommended

- Critical role by NEOC in facilitating hazard, vulnerability and risk maps using Earth observation;
- National mission guiding the use of geospatial technology in disaster management include inventory, monitoring, spatial analysis and modelling and developing GIS based tools for hazard, vulnerability and risk analysis.
- Establishment of a technical centre within NEOC which can be partly manned by staff from stakeholder ministries. This centre should be able to coordinate and use information generated by all stakeholder agencies during all stages of disaster management; and
- For disaster risk reduction, preparation of hazard zonation maps, early warning and mainstreaming guide lines are considered as key areas to focus.
- DRR should be a key component of sustainable development (SDG) and integrate climate change adaptation.

The second mission of the US-SPIDER TAM to Nepal has been made on December 17 to 20, 2018. The mission had organized intensive meeting in different offices, training and workshop in Kathmandu.

6.3.2 The government institutions

Department of Hydrology and Meteorology (DHM) is the principal government institution to generate and manage data related to meteorology and hydrology. The principal activities of DHM are to collect and disseminate hydrological and meteorological information. DHM also develops operational flood forecasting and early warning system for major flood prone rivers of Nepal. The DHM also has a flood forecasting system. It also assesses hazards, vulnerabilities and risks due to floods in major river basins. It has innovated river flow forecasting models for major rivers of Nepal, thereby establishing flood early warning systems on major flood prone rivers of Nepal.

Department of Water Induced Disaster Management (DWIDM) has been achieving water induced disasters by the appropriate management and conservation of rivers and river basins in Nepal. It has been formulating and implementing water-induced disaster management policy and plans; preparing hazard maps and risk zoning; strengthening the network for disaster mitigation and establishing disaster information systems; activating Indo-Nepal Inundation committee(s); and identifying environment-friendly water-induced disaster mitigation measures and construction methodology.

Department of Soil Conservation and Watershed Management (DSCWM) has been working on critical situation of soil erosion and watershed degradation in the country. DSCWM aims to contribute to the livelihood and well-being of the people through sustainable watershed management of the river basins. The main activities of the Department are to assist in maintaining ecological balance by reducing pressure from natural hazards such as floods, landslides and soil erosion through conservation and development of important watersheds of the country; and maintain land productivity, reduce soil erosion and contribute to development infrastructure protection by scientific management of watersheds.

Department of Mines and Geology (DMG) operate National Seismological Centre which monitors seismological shocks throughout the country through its network of 21 short period seismic stations and 7 accelerometer stations. Micro-seismic monitoring is a very

fast and efficient tool to understand the seismic-tectonics. It is an instrument for seismic surveillance allowing a fast post earthquake rescue operation. For regional and global earthquake location and related seismological studies it provides a valuable database.

Department of Health Services (DHS) manages and maintains Health Management Information Systems (HMIS). Through Epidemiology and Disease Control Division (EDCD) it also looks after epidemic/outbreak surveillance, outbreak preparedness and control programme. The EDCD is also mandated for health sector disaster management programme. The DHS also has GIS system as part of health facility mapping initiative. The DHS has also implementing Health Emergency Operation Centre (HEOC) that functions as a high level operational centre. HEOC hosts necessary resources and data for effective coordination and response during emergencies. During emergency, the centre functions on round-the-clock basis with trained and dedicated staff and equipment.

Department of Survey (DoS) has technical capacities for the mapping. This is the sole authority for land mapping in the country Map compilation, cartographic processing and updating the topographical base maps of the country as well as operate all mapping activities and quality control. DOS supports the DRR maps for the post disaster and also the base map for the pre-disaster activities.

Central Bureau of Statistics (CBS) is the central agency for the collection, consolidation, processing, analysis, publication and dissemination of statistics. It generates periodic and reliable socio-economic statistics mainly through the operation of censuses and surveys. It compiles and archives sectoral statistics on population, agriculture and forest, social statistics, environment, poverty and labor.

Besides these Departments, there are all Ministries and Departments which have more or less responsibilities to work on the DRR sector. For example, the Ministry of Education directly works for the school safety and educational curriculum sector. Similarly, Ministry of Physical Infrastructure and Transport, Ministry of Federal Affairs and General Administration, Ministry of Culture, Tourism and Civil Aviation, Ministry of Forests and Environment, Ministry of Land Management, Cooperatives and Poverty

Alleviation, Ministry of Urban Development, Ministry of Science, Technology and Environment, Ministry of Agricultural and Livestock Development are directly or indirectly working on different sector of DRR&M. Nepal Police, Arm Police Force and Nepal Army are always mobilize force for post disaster basically response to search and rescue and rehabilitation of any types of DRR events..

Existing institutional entities and assignment:

There are numbers of institutional entities enact by the NDRRP 2017 and DRRM Act 2017 different roles to play on matter of DRRM in Nepal.

DRRM National Council

The Council will be chaired by the Prime Minister and there will be the other members including the line ministries, opposition leader of the federal parliament, Chief Ministers of all Provinces, Vice Chairmen of National Planning Commission, Chief Secretary of Government of Nepal, Chief of Nepal Army, Secretaries of the Ministries, at least three nominated DRR experts and Chief of Executive Officer of DRR Authority. This Council shall work as an apex body for the decision making for the DRRM, financial management and to play international and national coordination roles for the DRRM.

Executive Committee

The executive Committee will be chaired by the Minister of Home Affairs. Other members of the Committee will be the Ministers of Urban Development, Health, Federal Affairs and Administration, Secretaries of concerns Ministries, secretaries of Prime Minister's Office, Army General of Nepal Army, Chief of Nepal Police, Arm Police Force and National Research Wing, Executive Director of Nepal Rastra Bank, Chairman of Nepal Telecom Authority, Member Secretary of Social Welfare Council, President of Nepal Chamber of Commerce, President of Nepal Red-Cross Society, Chairman of Nepal Udhyog Banijya Mahasang, Chief Executive Officer of DRR Authority. This Committee will be responsible for the development of DRRM Policies, Guidelines, Planning and actions. This Committee with establish the linkages between National, Provincial and Local Level for the DRRM and also handle the national and international rescue and relief actions.

National DRRM Authority

For the direct action towards the DRRM, a DRRM Authority has been enacted by the DRRM Act 2017. The Authority has been mandating to work as a secretariat for the DRR Council and Central Committee. The detail structural arrangement of the Authority has yet to be designed by the Federal Government of Nepal, but it will be a central executive body for the action for DRRM. It has a wide range of actions to work at national level and to a local level. The Authority has mandates of preparation and action plan and execution of DRRM activities through its preparedness to the response and rehabilitation and recovery stages.

The Province Level DRRM Committee

For the execution at the respective Province Level a Committee for the DRRM at the respective Province will be enacted under the chairmanship of Province Chief Minister. This Committee has wide range of rights and duties for the DRRM and also coordinates the District Coordination Councils and Local Levels within the Province.

District and Local DRRM Committee

Under the chairmanship of Chief District Administration Officers (CDO) a District and Local Level DRRM Committee will be formed. The Committee will be structured with the members of Representative of District Coordination Council (DCC), Mayor and Chairman of Municipalities, Chiefs of District Health Organizations, Chiefs of Security Organizations, Chiefs of district level Social Development and Infrastructure Building Organizations, Representatives of National level political parties, District level chief of Nepal Red-Cross Society, district level representative or Chief of NGO Federation, District level Chief of Udyog Vanijya Sangh, representatives or Chief of District Level Journalist Association. The member Secretary of the Committee will be the Government Officer nominated by the CDO.

Local Level DRRM Committee

A local level DRRM Committee shall be formed under the chair of Mayor or Chief of respective municipalities. The Committee will be formed as of the mandate of the Local Level Act and will be responsible to handle all the DRRM activities at local level.

6.3.3 The Non-Governmental activities

The role of DRRM in Nepal is quite notable; however, it is very difficult to find exact number and their specific activities and geographical location of action. The only national level network for the disaster sector is handled by the DPNet Nepal. According to it's information, numbers of non-governmental (NGOs), UN agencies, International non-governmental (INGOs) and academia are the organizational members. Thus, it is assumed, DPNet may provide somehow close information regarding the number of organization working in the DRR sector in the country. As of the list of the membership of the DPNet there are 95 organizations in the country working in DRR sector. The distribution is given in the Table 3 .

Table 3: Institutional members of DPNet (Updated until November 2017

Province	INGO	NGO	UN Agencies	Academia	Total
1	0	2	0	0	2
2	0	7	0	0	7
3	32	36	4	3	75
4	0	2	0	0	2
5	0	3	0	0	3
6	0	1	0	0	1
7	0	5	0	0	5
Total	32	56	4	3	95

Source: DPNet database 2017

The data shows the most of the NGOs are confined at Province Number 3. That means the concentration of such NGOs and INGOs are only in accessible capital city.

In the country, Association of International NGOs in Nepal, are listed 143 total entrees. All of them are working one way or another for the DRR sector (http://www.ain.org.np/member_ingos.php). The mandate of work as well as geographical distribution is not delimited. It shows that the INGOs in Nepal have

strong and wide involvement in DRRM. The experience of Gorkha Earthquake has also shown the notable responses of INGOs during the devastating disaster in the country.

The role of Nepal GIS Society on DRR&M in Nepal

The Nepal GIS Society (NEGISS) is a Geo-Information professional society founded in July 23, 1995 (Shrawan 07, 2052). Broad vision of the Society is to establish network among the Geo-Information professionals and stakeholders for geo-Information knowledge, skills, technology and overall development of GIScience through workshop, seminar, research, advocacy, consultation service, training and awareness programmes at national and international level. Main mission of the Society is to establish wider network among the resourceful GeoInformation professionals, expand GI education and develop spatial decision support systems for the sustainable development through workshop, seminar, advocacy, consultation service, training and awareness programmes and outreach research in multi and trans-disciplinary fields at national and international level. Nepal GIS Society has been formed with clear objectives of furthering the use and application of Geo-Information Science and spatial data analysis technologies in the country as an aid to mainstream endeavors in ensuring sustainable human development through effective management and mobilization of spatial diversities, resource bases and human capabilities (http://www.negiss.org.np/).

Capacity building has been stated one of the main goal of the Society. Within that goal Society has developed the specific curriculum and has been delivering the basic, mid-level and professional level training since its establishment. Until the December 2018 the Society has trained 348 male and 125 female (only included training organized by Society alone and not included other training organized by in association with) human resources in the country (Fig. 16). Many of those trained human resources have been involved in disaster management activities. That has been seen the activities of Society during the period of Gorkha Earthquake in 2015. The society mobilized their resources for the emergency mapping jointly mobilized with ICIMOD and other non-governmental organizations (Fig. 17).

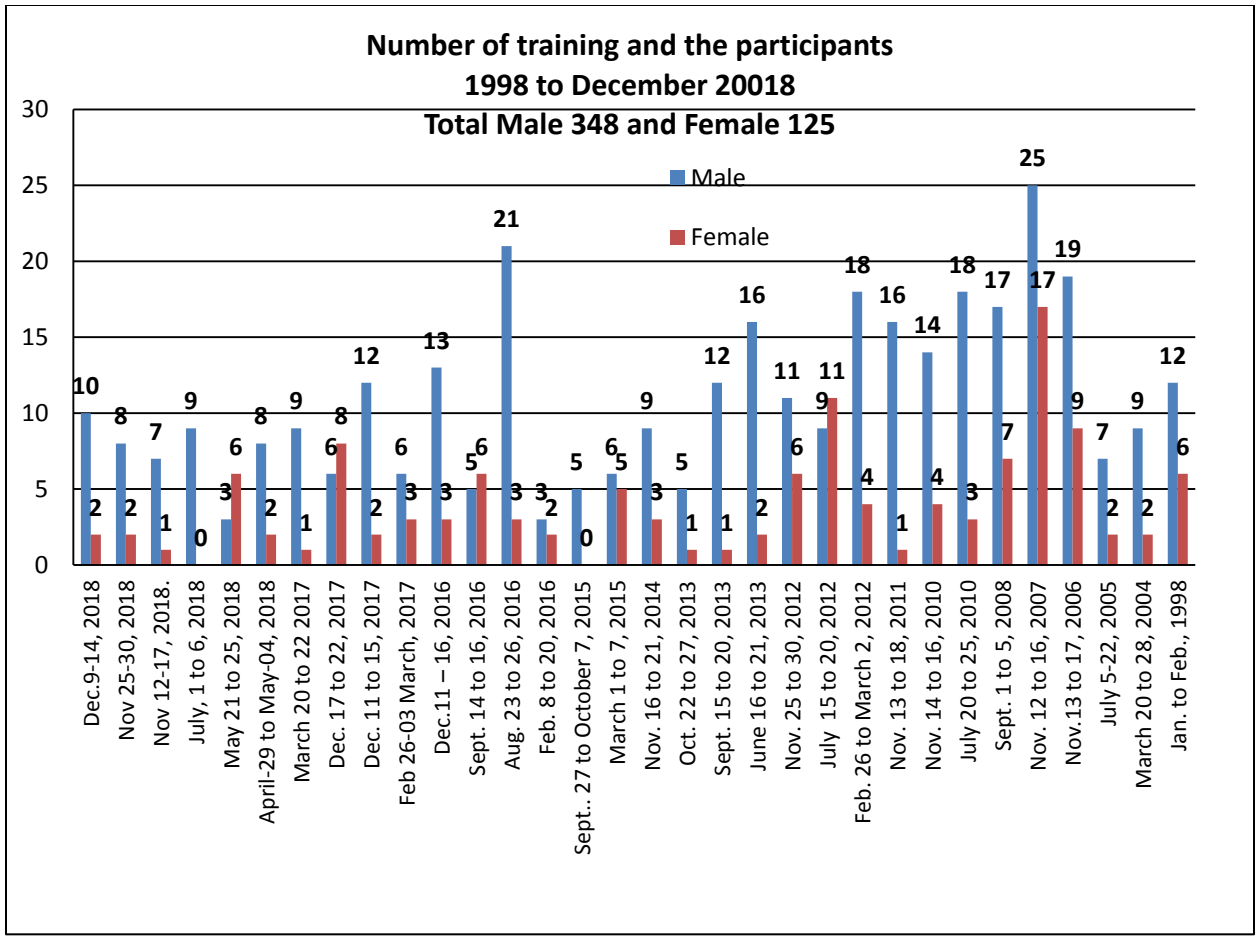


Figure 16: Training and the number of participants organized by Nepal GIS Society from 1998 to 2018

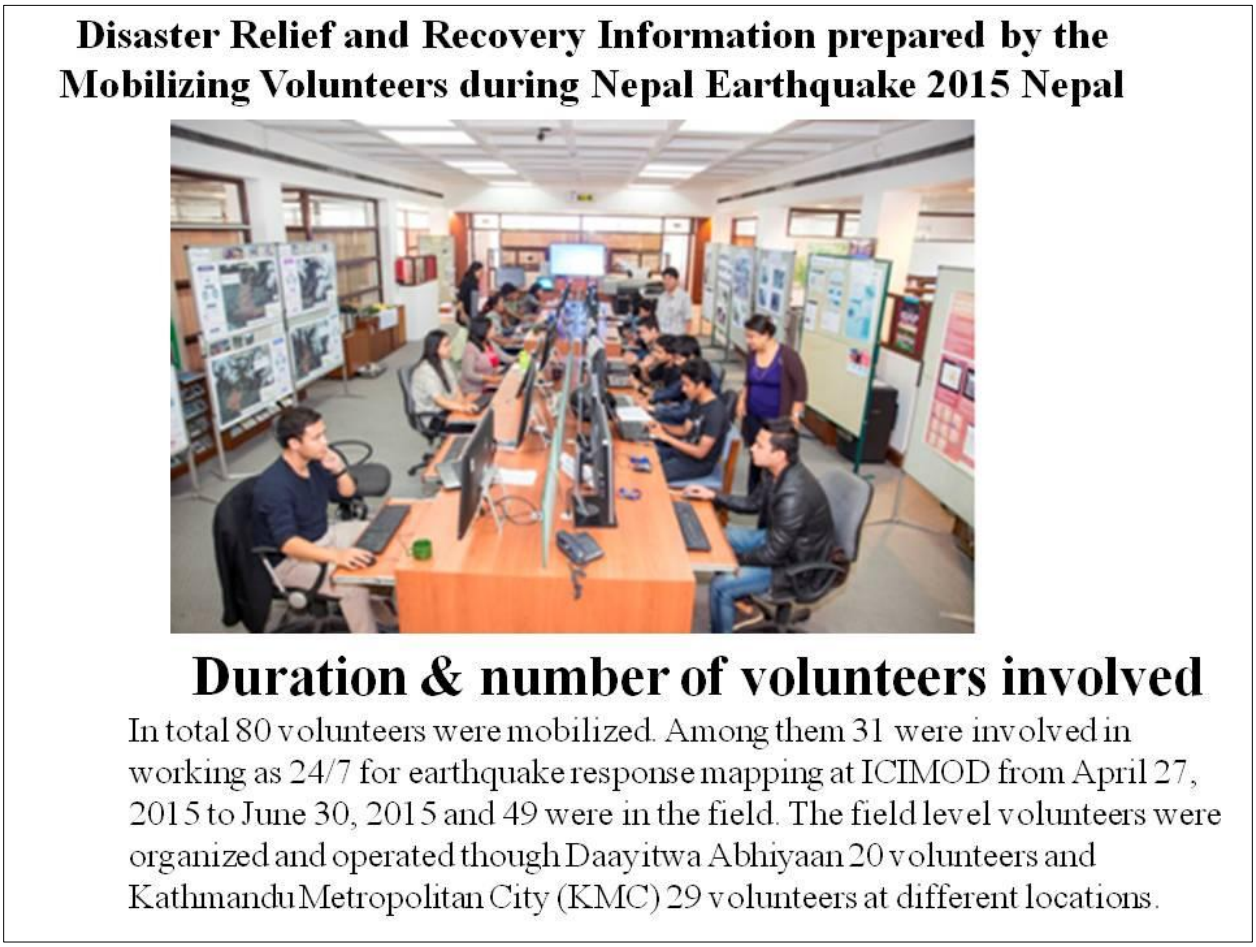


Figure 17: Mobilization of disaster mapping volunteer during the 2015 Earthquake

6.4 Development practice and disaster mitigation for sustainability

Until the first National Calamities (Relief) Act 1982, Nepal had not been clearly involving in an organized disaster relief actions. Local communities and individual were working from their own humanitarian ground. But the promulgation of Natural Calamities (Relief) Act, 1982- with an aim of smooth implementation of relief and rescue initiatives under the leadership of MoHA, remained the blueprint for DRM in Nepal for about 35 years. The Act also made provisions of institutional coordination mechanisms required for DRM. Despite of two consecutive amendments afterwards in the Act, it still missed the provision of proactive risk reduction measures, such as mitigation, preparedness, and mainstreaming DRR in development process.

Local Self Governance Act, 1999-The Local Self Governance Act, 1999 has promoted the concept of local-self governance within the decentralization framework for managing the environment-friendly development. The Act has given due emphasis to interrelationship between development process, environment, and disaster. The Act encourages local entities, i.e., District Development Committees (DDCs), Municipalities, and Village Development Committees (VDCs) for finding suitable solutions to local problems and challenges by themselves. In the absence of necessary rules, regulations, frameworks and predictable amount of budget, the Act was not effectively implemented by local bodies despite the responsibility given to them.

National Strategy on Disaster Risk Management (2009)- The National Strategy for Disaster Risk Management (NSDRM) (2009) was developed and enacted by government of Nepal in line with the Hyogo Framework for Action (HFA) (2005-2015). NSDRM is the result of the necessity felt for a concrete, meaningful and integrated document based on (HFA) reflecting the global common concept, which the United Nations declared in 2005 in participation of 168 nations including Nepal. NSDRM is a national framework on disaster risk management with commitment of the government to protect its citizen, properties, physical and cultural assets. NSDRM was developed and endorsed by government almost after five years of the HFA. NSDRM (2009) tried to translate all five priority areas of HFA (2005-2015) into action. Therefore, based on the situation (policy, institutional mechanism, national capacity and financial resources), it emphasized the importance of mainstreaming disaster risk reduction to development at all levels. The NSDRM (2009) was useful to continue the advocacy on importance of mainstreaming DRR into development, capacity building, bringing private sector in DRR and post disaster related activities, and to some extent urban disaster risk reduction initiative in Nepal. However, the activities initiated during HFA period not well documented neither detail evaluation of the completed activities except the regular country level HFA report (2005-2015). But, there was not any detail assessment of HFA progress at macro-level in Nepal.

National Disaster Response Framework (2013)- The Government of Nepal endorsed the National Disaster Response Framework (NDRF) in 2013 with a view to guide more

effective and coordinated national response in case of a large scale disaster. It's scope were :

- limited to the response preparedness and emergency response at national, regional, district and local levels, and
- it consisted of actions taken immediately before, during and after the disaster directly to save lives and property, maintain law and order, take care of sick, injured and vulnerable people, and to provide essential services and to protect public property.

The NDRF (2013) clearly stated how the government should function after a major disaster strikes in the country, the coordination with international teams, donors, the cluster mechanism, special arrangement for national response, and the anticipated activities to be performed by organizations from zero hours of the incident till a month time. It has also clearly indicated the future course of action on emergency response preparedness in Nepal. The government is revising the NDRF (2013) to make it more practical based on 2015 earthquakes response.

DRM Priorities in the 14th Development Plan: DRM has been under priority of periodic development plans since the 10th Five Year Plan. The current 14th Plan (2072/73-2075/76) (NPC 2016) accords programmatic priority to water-induced disaster risk management under its sectoral development policies. It aims at mitigating potential loss of human lives and properties and physical infrastructures by effective river embankment programmes in order to control floods and landslides, and to mitigate their effects. It has also kept in priority in addressing the problem of flood and inundation. The Plan, under its cross-cutting development policies, accords priority to disaster management in combination with risk management related to environment and climate change. Efforts to mainstream disaster risk management in sectoral development priorities, however, remained as missing opportunity.

On 22-26 May 2017, Ministry of Home Affairs of Government of Nepal had presented a National Position Paper titled "Disaster Risk Management in Nepal: Status, Achievements, Challenges and Ways Forward" at Global Platform on Disaster Risk

Reduction, Cancun, Mexico. The paper has summarized the causes of disaster in Nepal as;

"Nepal is exposed to several recurrent hazards every year. Due to lack of land use planning and zoning, rapid and unplanned urbanization, low per capita income, loss of natural vegetation in upstream coupled with inadequate preparedness, and extant vulnerabilities, Nepal's exposure to multi-hazards often turns into medium to mega disasters."

Box #08

Existing legal and policy framework on DRM in Nepal:

Natural Calamity (Relief) Act, 1982

Local-self Governance Act, 1999

National Strategy on Disaster Risk Management, 2009

National Disaster Response Framework, 2013

Guidance Note on Disaster Preparedness and Response Planning, 2011

National Guidelines for Search and Rescue, 2014

District Disaster Preparedness and Response Plans

Standard Operating Procedures of NEOC (and DEOCs) National Emergency Operational Centre (NEOC)

Source: MoHA, 2017

6.5 Challenges

Since the declaration of new Constitution of Nepal in September 2015, Nepal is now adopting the federal governance system. According to the new constitution the government has been enacting the Disaster Risk Reduction and Management Act 2017 and NDRN Policy 2017 with a new framework of action to tackle the disasters. However, the country had long been practiced responsive actions through the legacy of natural calamities relief. In this context, the new Act has been provoking the DRRM with a view to address all the stages of disaster management. Therefore, there are major challenges of DRRM in the country as noted in the national position paper by the MOHA (2017).

Box #09

Major challenges as visualized by the MOHA 2017

- Nepal had been following response centric DRRM for a long time, giving more attention to providing rescue and relief in the aftermath of a disaster and does not fully support disaster risk reduction and preparedness for recovery which is essential for building resilient communities and nation. In this context, there is a need to orient all the stakeholders for comprehensive disaster management that encompasses the entire disaster management cycle with appropriate institutional set up that will remain relevant in the changed national context,

- Despite on-going efforts on mainstreaming disaster risk reduction into development planning, which is moving ahead rapidly, the process has faced several setbacks and challenges due to inadequate technical skills and willingness to shift to risk-informed, evidence based development planning. Thus, disjoint remains in approaches for integrating disaster risk reduction and climate change adaptation into national development planning.
- Nepal's capability to respond to mega disaster is highly constrained by limited high-tech equipments and specialized capacities to conduct effective search and rescue (SAR) operations which has been evident from the Gorkha Earthquake.
- Nepal needs to enhance its technical and functional capacities to fully utilize available expertise, experiences, research, and human resources available within and outside the region to support its on-going efforts. Nepal can benefit from cross learning between the countries in the area of early warning, raising technical skills, disaster management information system upgradation and information sharing, hazard and risk mapping and developing capacities for risk informed approach to sustainable development.
- Nepal's disaster management information system should be strengthened. Disaster information so far remains scattered and disintegrated, which constrain making timely analysis of loss and damage, and building scenarios for future impacts that could have helped in risk informed financing and planning for preparedness, response, risk reduction and ultimately resilience enhancement.
- Investments in DRR have been limited overall and depend to a large extent on funding from development partners.
- Development programmes and policies are not fully cognizant of, and informed by risks. As a result, there are continued and recurrent impacts on sectors, dragging down hard-earned development gains.

- There continue to be siloed approaches in development and also emergency management for instance, effective integration of forecasts and early warning into decision-making remains a challenge.
- Increasingly variable weather and climate, probably attributable to climate change poses a great threat to lives and livelihoods of large sections of Nepal's population who are either directly or indirectly dependent on agriculture-and natural-resource based activities as source of income.

Source: Ministry of Home Affairs of Government of Nepal National Position Paper "Disaster Risk Management in Nepal: Status, Achievements, Challenges and Ways Forward" 22-26 May 2017,

Despite those challenges noted by the Government of Nepal in 2017, there are couple of challenges which are not yet addressed can be visualized. Some of those can be listed here:

1. Designing building code, construction of urban building structure and building materials are not accounting for the disaster management perspective. Almost all the urban areas have a mess of building structure without maintaining any urban land use policies, quality control on building materials and use of building. The result is obviously visualized chaotic distribution of urban buildings, uncontrolled building materials and haphazard use of building. The action has alarmed the disaster vulnerability.
2. Large volume of private and also the government investment is dumping on unproductive construction of the country, but that has alarming the both DRRM cost and effective action.
3. The approach of payment for environmental Service (PES) has not yet been accounting for the disaster management while extraction of resources is being doing for the building construction which is much more excessive than the personal use of sole residential use. Many urban dwellers have been constructing building excessive than their personal use and lend to rent which are neither within the net of government tax nor paying the environmental cost they are using the services. But the DRRM cost is quite high.
4. Government has not yet been working for the DRRM costing of any types of constructions (massive construction of roads on steep and vulnerable mountain

hill-slope or any infrastructure), query and resource excavation from the river and steep hillslope.

5. Disaster risk indexing, mapping and developing the management plan of geographical contextual ground is not properly practiced yet, which poses problems on risk reduction and management action.

6.6 Ways Forward

Despite of several challenges faced by the country, Nepal is striving hard to reduce disaster risk and improve its preparedness and response mechanism. Based on the progress made over the years since the commencement of the IDNDR and HFA, and lessons learnt from past efforts on responding to disasters, Nepal has been enacted new comprehensive disaster risk reduction and management legislation, National DRR Policy and Strategic Action Plan that fully support multi-faceted and multi-stakeholder engagement in reducing the disaster risks and preparing for effective response and recovery as envisaged by Sendai Framework for DRR (SFDRR).

- A Comprehensive Disaster Risk Reduction and Management Act as per the Constitution of Nepal and international commitments and Strategic Action Plan in line with SFDRR has been implemented by adopting 'Build Back Better' principle and 'Whole-of-Society Approach' to realize the vision of resilient Nepal. Nepal will strengthen disaster management governance from federal to local level.
- Risk informed approach to sustainable development backed by understanding of risks will be streamlined at all levels and across the sectors to integrate principles and practice of Disaster Risk Reduction and Climate Change Adaptation into planning, budgeting and monitoring and evaluation.
- With the priority to engage whole of society into disaster risk reduction agenda and learning from experiences of other countries, new institutional set up for disaster risk management from national to sub-national levels in line with new federal system of governance, will be established.

- To achieve the goal of resilient Nepal, emphasis will be given on fostering partnership with non-state actors, private sector and international agencies for effective disaster risk reduction, response and recovery.
- Learning from Gorkha Earthquake of 2015, disaster preparedness for response and recovery will be strengthened at all levels through provisions of adequate logistics, capacities, guidelines and standard operating protocols (SOP), and establishment of medium and light search and rescue (SAR) teams.
- A network of emergency operation centers and early warning system will be expanded and further strengthened to support disaster risk reduction including response and recovery and coordination of humanitarian actions that directly result into saving lives and reducing the losses.
- Disaster Management Information System (DMIS) will be strengthened by the government to produce reliable statistics on disaster loss and damage, and report on anticipated disaster to guide priority setting for disaster management planning at national and sub-national levels and support in risk informed decision making.
- Government will initiate a massive program on community based disaster management activities in all disaster-prone areas (both urban and rural) of the county based on the experiences from 2015 earthquakes and ensure developing a mechanism to mobilize youth, volunteers and self-help groups in a massive scale at the time of disasters.
- Government is committed to develop a mechanism for cross-learning between countries about knowledge, research and experiences relevant to disaster risk reduction and management and creating platforms for disaster information sharing between Nepal and neighboring countries.

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Chapter 7

STRATEGIES IN TEACHING LEARNING GEOGRAPHY OF ENVIRONMENT, NATURAL HAZARD AND DISASTER MANAGEMENT

7.1 Basic understanding

Strategies in teaching and learning 'geography of environment, hazard vulnerability and risk management' has to be taken due consideration on following contents:

- philosophical and theoretical concept
- first hand observation and field survey
- problem identification
- technical tools and methodologies for searching causative factors and their possibilities of occurrences, intensities and severities
- behavioral, financial assessments and search for the consequences of hazards/disasters event in the human life and their beloved things (properties) at present and in future, too.
- Ultimately, the action should have broader mission, vision and concise goals to attain the risk reduction for human life and properties.

7.2. Philosophical and theoretical concept

Towards these concerns, Jerry T. Mitchell et al. (2008) put a question 'Why do we teach about hazards? Simply put, at the most basic level we do so with the belief that knowing something about their occurrence might help us to avoid their consequences. The environmental parameters and their variables are the subject matters of the environmental geography. The hazard, vulnerability and risk may occur in any geographical environment. As we have discussed in the previous chapters, these are interconnected, therefore, the content has to be entertained through the understanding of environment and the occurrence of hazard, vulnerability and risk events and their consequences on human lives and properties. These have close linkages with physical environment as well as human activities. In the pre-disaster stage, RVA is the first action. RVA is based on the learning of philosophical and conceptual ground and

requires an intensive knowledge, skills and value systems interconnected with the discipline. However, the subject has also been interlinking with its practical and behavioral part. The knowledge and skill should cascade to the society and also to each individual. The consequences of the hazard events have to be widely addressed through the human centric perspective. People and properties at risk and their resilience actions have to be addressed closely with space-event-time contexts. Because the physical environment possesses structural limiting factors of the nature. The environmental limiting level has to scrutinize through the human knowledge level to establish any types of construction activities. For example someone construct building in a slopping hillside. It means the sloping hillside has the possibilities of landslide due to its physical limiting factors. But, person construct building without considering the possible level of occurrence of the landslide that means the risk of vulnerability of the slide is further aggravated due to the additional accumulation of mass on the sloping landscape. Ultimately life and properties of that newly constructed building might threatened by the natural process. Several such examples can be traced out from the field about the hazard, vulnerabilities and risk which have to be linked with the causative factors. Therefore, the strategy requires establishing the linkages with philosophical and theoretical concept about the environmental, hazard, vulnerability and the risk. Poudel (2003) conceptualized the PORELI (Population, Resource, Limiting Factors) triangle in the context of reducing the environmental degradation in the mountain watersheds of Nepal through his imperial study (Fig. 18).

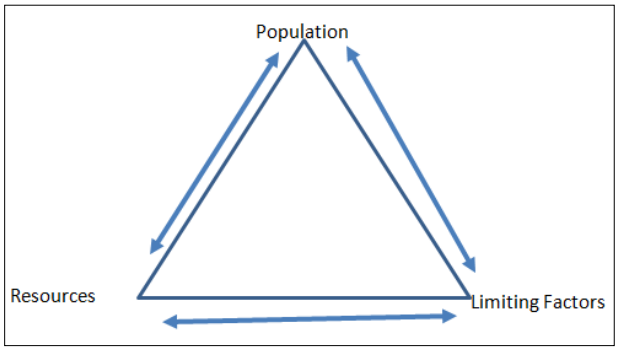

Figure 18: PORELI Triangle (After Poudel 2003).

Knowledge of understanding among physical limiting factors, human population and the behavior of the people on extraction or utilization of resources in the geographical territory is the first strategy for the teaching and learning the subject.

Mitchell et al. (2008) has further emphasized the components of hazard studies and they have re-cited original views of Oliver 1982 from Lidstone 1990. There have suggested five components:

- an analysis of the potentially threatening physical event,
- the identification of other physical circumstances which may modify the behavior of the hazard and the severity of its impact,
- an analysis of the community social structure;
- an analysis of the economic system; and
- a study of environmental sensitivity.

These components have close linkages among the physical environments and social settings and activities. The study has to integrate both aspects by following the holistic approach. Hazards have multi facets. The cumulative effects of various parameters, different processes and their multi dimensional effects result complex consequences. The study, thus, needs to address such complexities more carefully through adopting different strategies.

The strategy requires to analyze different components individually Examples can be taken here such as the landslide event in the mountainous terrain and floods in the plain areas. The potentiality of such threatening events can be analyzed by applying different methodologies or algorithms. It needs to scrutinize morphometry of the hill-slope, climatic condition, and rock and soil composition, anthropogenic activities over the terrain and the number of people and the amount of properties. These activities directly establish theoretical ground of the linkages of issues of environment, hazard, vulnerability and risk assessment.

7.3 Field observation and survey

At the undergraduate level, field observation is an important means of understanding the geographical space. Environmental parameters over the geographical space determine their specific situations which are responsible for certain types of hazards. The surface morphology of a space is clearly visible through the observation. In such

morphological parameters, altitude, slope, aspect, relief features and surface roughness are important. Similarly, the geological structure, alignments, composition of underlying rocks and their nature for softness and hardness, dip-strike relations are some of the basic parameters which can identify through the field observations. For the spatial knowledge and skill support, large scale topographic maps, earth observation satellite imageries and GPS devices help for the positional referencing. Thus, during the field observation needs to carry are:

- large scale general topographic maps (topo-sheets)
- handheld GPS devices or GPS calibrated smart mobile phone
- field notebook
- pencil/cutter
- high resolution camera or mobile camera
- color printed analogue (hardcopy) copy of Google Earth imageries or any other high resolution satellite imageries

While operating the field observation, some ground benchmark like river meander or confluences of tributaries, road crossing and junctions, big buildings and corners of the human structure would be better and needs to calibrate the positional accuracy. The accurate intensity and amount of climatic parameters like temperature, precipitation, sunshine, humidity, wind direction and speed are measured by the instruments; however, other indirect methods such as vegetal cover, soil moisture contents, exposure of the landscape, crop fertility can be used to identify those climatic or meteorological parameters during the field observation. Eyes are very strong tools for confirming the characteristics of the real world, possible hazard events likely to occur or for its response after the occurrences. Once directly observed things and happenings are rarely forgotten by any one. Therefore, field observation helps to identify the geographical location for different types of hazard-prone areas. For any type of hazard and disaster studies, field observation is the first strategies for teaching and learning.

Before the field observation, it requires to develop the observation strategies. First task is to prepare detail field plan. Based on the plan, list out the required equipments and field gears (torchlight, umbrella or raincoat, warm cloths if the area has low temperature or in winter season, proper trekking shoes if needed to walk on foot and

comfortable clothes), and other necessary arrangements like basic secondary information about the field, means of travel and other safety measures including First-Aid medicine, insurance and so on.

7.4 Case study

Case study of certain disaster nearby the location of student's institution is always desirable from the accessibility point of view. Specifically, the nearest location from the institution bears the economic efficiency. Therefore case study site of any type of hazards near by the academic institution helps students to understand easily.

The DRR related case study generally requires finding the following parameters:

Generic information:

- Location of the Hazard/disaster site: Tole/village, Ward No., Municipality/GPS Location
- Site or associated features: River/stream bank, road sides, village side, mid-hill, downhill, plain, summit, construction sites, agriculture field etc.,
- General features: wetland, dry land, geological structure (weak/hard/stable/fragile etc.), human activities (intensive/abandoned/sometimes etc.)
- Types of disaster/hazard/vulnerability: (see from the typology),
- Natural causes/man-induced causes
- Volume or intensity
- Accessibility provisions to disaster/hazard/vulnerable sites
- History or time series information about the disaster/hazard events
- Distribution of life and properties over the area

Information regarding pre-disaster mitigation:

- Preparedness activities: individual/community/local government/agencies initiations
- Awareness and resilience activities
- Early warning systems: prediction, information network and sharing machismo
- Mitigation: safe shelter, food, water, medicine storage and operational mechanism

Response mechanism

- Rescue and search operation mechanism
- Mobilization of relief team
- Food and water management
- Shelter, sanitation and hygiene system
- Post-disaster monitoring and assessment mechanism
- Recovery, rehabilitation, reconstruction
- Resilience

An example of landslide hazard monitoring

- Landslide volume measurement i.e. Length, breadth and depth
  This will provide information - intensity and/or size as well as type of the landslide, severity of the slide, volume of waste materials from the slide, and also helps for the planning of mitigation measures.
- Types of the slide – rotational, slump, gullies, rills, scares, fall, flow, topple, etc.
- Age of the slide – old active, old passive, new
- Location of the slide – road edge, river/stream side/bank, open space, forest, grazing land, building/dwelling/construction sides, agricultural terraces (khet, bari, kitchen garden etc),
- Observed site information - geological structure, soils, rock, dip and strike, regolith, slope, aspect, human activities and use system over the ground
- Observed causes of the slides – due to engineering structures (i.e. road, building, canal, drinking water), farming, fencing, grazing, deforestation, seepage, back wasting, washed out, etc,
- Loss or possibility of loss from the slide – number of human and cattle, land volume, crops, fruits, timber etc (both in kind and estimated cash properties),
- Affected number of people, number of families, number of houses, social capital (school, community hall, religious structures, health institutions, cooperative building etc)
- Observed possible mitigation plan – check dam, drainage control, bio-engineering, structural construction etc

The records of the case study can be used further interpretation and analysis and can be developed for the DRRM.

7.4.1 Resource persons

The scope of environmental geography covers wide range of knowledge and skills. Several environmental hazards and disaster events associated in different lithospheric and atmospheric conditions along with different human-induced factors. Bridging physical science and human or social science is needed. Therefore, it is an interdisciplinary subject. Because of that the subject needs different resource persons with cross-cutting as well as multidisciplinary knowledge and ideas. The role of different disciplinary experts would be highly desirable for the teaching of environmental geography, hazard and disaster risk reduction and management.

7.4.2 Key informants

Occurrences of hazard and disaster events associated with local physical and social elements. Most often local knowledge reflects the historical and local environmental factors on occurrences of hazards and disasters. For the auditing of accurate local environmental causes, reasoning and knowing historical events, local key informants play major roles. Thus, entertaining local key informants is required for understanding and dissemination the knowledge on environmental geography, hazards and disaster management.

7.4.3 Focus Group Discussion (FGD)

Social knowledge and ideas have strong roles on DRRM cycle. In such condition, the discussion with the social groups and communities is highly essentials. Group discussion with local people easily and accurately evaluate the local physical and social causes of disaster events as well as enabled for accurately monitoring the effect of the disaster. Pre-disaster and post-disaster events can be accurately monitored with the help of local people. Therefore, FGD is required. At least 10 to 15 people with various age groups, cross gender and diverse ethnic group of the communities can be requested for the discussion and extract local information. In a group the personal views of the individual person will be triangulated by each individual. Thus, the FGD remains an effective instrument for the social auditing.

7.4.4 Use of local materials and their collection

Local materials give the factual information about the local events. Usually, the local reports, stories, event records and memories of senior citizens, old maps, sketches and photographs give the real records of any geographical units. Therefore, the teaching learning should be focused on recording the local materials.

7.5 Analysis tools and techniques

Environmental geography, hazard and disasters are the result of multi factors. Both physical or natural and human induced components and their multiple factors and properties, their cause and effect relationship act alone or with combination. Explanation of a single component or simple and singular approach fails to achieve good output. Therefore, studies require having integration of skills, knowledge and also the factors and their parameters. Several spatial parameters along with their inherent characteristic result very complicated relationship. Simple data handling techniques remains inadequate. Application of GIScience on handling such a large and varied spatial datasets is a best technological support. GIScience refers to technologies for collecting manipulation, management, analyzing, dissemination and networking spatial information of real world within a comfortable duration and cost management level. The main types of technology are global positioning systems (GPS), remote sensing imageries of various altitude levels, including low altitude unmanned aviation vehicle (UAV) commonly known as 'drone' to high altitude space satellite, cartography/visualization and Geographic Information System (GIS). It has a fundamental theoretical base for geographic database management, spatial data analysis and modeling and dissemination and cartographic communication through paper maps and Internet-based webGIS. Several such data sets can be stored in cloud. Google Earth Maps, Open Street Maps (OSM) and other several portals can be the sources of database and information. GIScience as an interactive teaching technology can foster a rich student learning environment as students are immersed in project-based learning (learning by doing), rather than listening to a discussion about the disaster events. Through project-based learning, students gain thinking about the environmental condition, the start point of hazard, people's vulnerable situation and

risk on lives and properties out of that. The first hand observation, data entry and integration in machine for analysis and output generation after the analysis and real-information based modeling might be an real-event based exercise. Such learning by real project work helps to record the events for long lasting. The devise for such studies requires computer hardware, data analysis software, digital data with geo-referenced form, proper data handling skills and spatial knowledge. Therefore, it is strongly recommended that every student or any professional working in the DRRM should have basic knowledge of spatial data handling techniques. At least, the basic knowledge of spatial data handling needs to cover map reading, geo-referencing, data structure and computer software skills on geo-processing.

7.6 Result interpretation and reporting

At the final stage of the strategy of any teaching and learning activities is to be bringing the outcome in a concise and consolidated reportable form. Therefore, the end product of the study of environment, hazard, vulnerability and risk has to be integrated into a single, comprehensive but simple and understandable form. Many such reportable form of the study has to be backed with datasets of lives and properties of damage and loss analysis using different statistical tools and techniques, easily understandable maps, field photographic illustrations and real-time stories presented by the local people. Time series graphic representations and short and comprehensive narrative expression enrich the quality of report.

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