FEASIBILITY STUDY OF LANDSLIDE RISK ASSESSMENT AND MANAGEMENT

A Case Study of Kolti VDC, Bajura

Group of Helping Hands (SAHAS) Nepal

2015

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ACKNOWLEDGEMENT

Group of Helping Hands (SAHAS) Nepal and the study team would like to acknowledge all the personnel and organizations that directly or indirectly supported us to conduct this research. The many persons who contributed to this study, are too numerous to list her, but their contribution is duly recognized.

SAHAS would like to thank the FELM for entrusting us and providing the support for such a noble research study. We would like to express our deepest gratitude to the people of Kolti VDC. The help and assistance received from the SAHAS Bajura field staffs during the field work have been invaluable and special thanks to SAHAS Nepal CEFALS Bajura team including Project Officer Mr. Hem Chandra Sharma.

EXECUTIVE SUMMARY

On 31st May 2012, a devastating landslide triggered by intensive rainfall and hailstone washed away 57 houses and shops and left five people dead and many injured in the remote village of Pipaldali, located in ward 9 of Bandhu VDC, Bajura. The disaster has destroyed the Kolti Water Supply System, Kolti Primary Health Centre, 4-5 km of Kolti Pipaldali road, 50-60 ropanis of agricultural land and local irrigation systems. On 7thJune 2014, six houses were swept away and claimed three lives in Kolti VDC due to landslides. More than 70 households were affected; hospital and army barrack were also destroyed while hundreds of families were displaced after devastating landslides.[1]At present, the market settlement including Kolti airport in Ward number 1, 2 and 3 of Kolti VDC are in the high risk zone of landslide.

With the aforementioned context, this study aims to identify physical, socio-cultural, environmental and biological impacts of existing landslide through reconnaissance survey of study area within Kolti VDC. This study includes documentation of baseline information and proposes viable short and long term mitigation measures based on field information. The main objectives of the study are to:

- Conduct preliminary field survey (Reconnaissance survey) to Identify Causes and Impact of Kolti landslide
- Document the current practices to minimize/mitigate the Kolti landslide
- Recommend viable measures to minimize/mitigate landslide.

The assessment of physical, biological and socio-cultural environment were conducted through penetration test, transect walk of existing vegetation and forest area, focused group discussion and key informant interview.

Geologically Kolti VDC lies in Galyang and Ranimata Formation which consists of dolomitic with in the slate along with phyllitic quartzites metasandstone. For the soil analysis, the pH, texture, total nitrogen, available phosphorous and available potassium were analyzed. There are 3 community forests namely Bhawanimandu, Smaundrapal and Thodomelo in the study area covering an area of 108.85 hectares. Wild olive (Jaitun) is the dominant plant species found in the study area. More than 20 plant species were recorded during the study period. Some major threatened species are also found in the project VDC are Black bear, Eurasian otter, Wild dog, Cinerous Vulture, Egyptian Vulture, Lammergeier etc. According to CBS 2011, Kolti VDC has 7134 population in 1330 houses. Five major ethnic groups live in project area. Dalit is dominant group followed by Chhetri, Bramhin, Indigenous and Thakuri. Majority of houses are of traditional type with roof of thatch grass. The economy of the area is mainly dependent on traditional agriculture system. The literacy rate is 55.8% in the VDC while in project area it is about 65%. Male is more literate (74.8%) than female (55.5%). More than 55% household lack toilet in the study area. Around 94% have access to piped drinking water, while the rest depends on river or canal. Majority houses have radio. Some houses have television and computers, but no access of internet till date. Kolti has no access to road transportation but connected with air transportation

Forest biomass (firewood) is the major source of cooking as well as heating energy. 95% houses use electricity generated from micro hydropower while the rest depends on solar panel.

[1] Source: SAHAS Nepal

Basically flood (landslide and erosion), hailstone and drought are the major hazards perceived by local community in the last two years.

Debris flow (erosion) due to heavy rainfall is the only major hazard agent at Kolti Bazar. It was unusual in the past, but since the last three years, it has become most frequent and severe. There is no any emergency preparedness practices (EPP) in the affected areas. After twice hit by debris flow, users of Bhawanimandu Community Forest from ward Number 2 and 3 of Kolti VDC have initiated plantation on bare land during July-August of this year. They have also banned rock collection/excavation and grazing in community forest areas. However, after the destruction of nursery, the plantation program has stopped. After the landslide event, security personnel and local people themselves worked together for early recovery works. District Administration Office supported some sorts of financial assistance for victims. After the 2012 disaster, SAHAS-Nepal also initiated a rapid relief response and the post relief and rehabilitation assistance with the support of Finnish Evangelical Lutheran Mission (FELM), Finland and constructed 18 houses in Badhun VDC ward no 9, along with the community participation.

There might be two major causes that initiate the landslide. The first one is debris flow in historical landslide due to rainfall and another is rock boulder extraction from old river terraces and landslide deposition zones for construction purposes. Most local people believe that some malpractices of local people — deforestation, overgrazing, rock collection, construction of roads, forest fire and negligence for conservation — are major causes for the debris flow. After the construction of airport at Kolti in 2041 BS (1984 AD), house construction and settlement expansion took place rapidly. People used the deposited rocks and boulders for house construction. Due to excavation of big rocks and boulders, only loose and small debris were remained, those were easily eroded by torrential rainfall. Due to high demand of firewood for cooking and heating, trees, shrubs and bushes were cleared. Some ethic groups, migrated some years ago, even dig out roots for firewood to make local alcohol. After insurgency, people did not care about conservation and let livestock freely grazing on public land and community forest areas. During field work, more than 200 cattle entered into community forest areas for grazing from a single point. This aggravated land degradation. Bush burning on hill slope by local sheep herders is common here for better grasses during the following spring. This makes the soil and rock fragments more vulnerable for erosion. Similarly, construction of roads along the toe of deposited mass and through the deposited mass body has disturbed the slope stability. During Maoist insurgency period, a large number of trees, bushes and vegetation have been cut out in the greater surrounding areas, making the area openly vulnerable for erosion and hazard. The region has observed over time the following climate change issues, such as decreased snowfall in high altitude regions, shifting of rainfall pattern, humid climate and excessive rise of temperature in summer season, occasional non-monsoon and torrential rainfall with large hailstone, shifting of flowering time for plants such as Rhododendron and dewfall.

Moreover, SAHAS Nepal has already access to community and gain trust of local community. The local community has become familiar and appreciated working approach of SAHAS Nepal which is an added value to launch disaster preparedness program. SAHAS Nepal can include the mitigation activities in CEFALS current phase and go into action in cooperation with Budinanda Sirjansil Bikash Manch (Budinanda Creative Development Forum) CBNO partner and other stakeholders. Short-term protective measures proposed include awareness-raising and disaster preparedness, protection of erosion area, afforestation, temporary seedling and mulching.

Until now, there is no disaster risk management project in the study area. Thus it would be better to develop a Disaster Risk Management Project to address the problem of landslides with focusing mobilization of local communities and utilizing local resources with low cost technologies so that the community can manage and sustain the project efforts in long run. Some long term measures include detailed geological study, electrical resistivity survey, check dam structures and debris flow retention nets.

ACRONYM

AAS	Atomic Absorption Spectrophotometer
CBO	Community-based Organization
CEFALS	Community Empowerment for Food and Livelihoods Security
CF	Community Forestry
DDC	District Development Committee
EPP	Emergency Preparedness Practices
FAO	Food and Agriculture Organization
FELM	Finnish Evangelical Lutheran Mission
FGD	Focused Group Discussion
GoN	Government of Nepal
GPS	Global Positioning System
ICS	Improved Cooking Stove
IFCO	Improving Food Security through Community Organizing
LAPA	Local Adaptation Plan for Action
NGOs	Non Governmental Organizations
NPR	Nepalese Rupee
PIGAISF	Project and Promotion of Income Generation Activities for Improve Sustainable Food Security
SALS	Sustainable Agriculture for Livelihood Security
SL	Sandy Loam
SLC	School Leaving Certificate
USDA	United State Department of Agriculture
VDC	Village Development Committee

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1 BACKGROUND OF THE ORGANIZATION PREPARING THE REPORT

The Group of Helping Hands (SAHAS)-Nepal is a non-profit, non-governmental, social development organisation, founded in 1996, building on the successes and lessons from previous work; SAHAS-Nepal has been working in the remote areas mainly focusing on the poor and socially excluded groups of the country using bottom-up and inclusive community-based approaches. Since its inception 19 years ago, SAHAS-Nepal has been expanding quickly and has now become a prominent NGO in Nepal covering a vast geographical area in the country.

Our programme focuses mainly on: (a) Community development, (b) Advocacy and (c) Action-research. The thematic activities under community development are: (i) livelihoods - agriculture, livestock, and on-farm and off-farm income generation activities, (ii) education and training – civic and human rights, awareness raising, skilled base practical trainings, (iii) institutional development - leadership development, capacity enhancement, project planning, communication, networking and alliance and documentation, (iv) disaster and relief activities, (v) infrastructure development – irrigation system, rain-water harvest, suspension bridge, drinking water scheme, collection centres, village-road, etc. (vi) health and sanitation- nutrition and (vii) climate change – education on the effects of the climate change (global warming) on their lives and livelihoods, and mitigation and adaptation strategies, building resilience and strengthening the capacity of the communities to cope with diverse situations, Local Adaptation Planning (LAPA) preparation and implementation. The eco health activities include promotion of organic farming, community seed promotion, local variety selection, promotion and development of healthy ecology, enhancement of ecosystem services. SAHAS Nepal has been advocating in major themes like Food Security, Environmental Conservation, Eco-health, Social upliftment, Education and women's empowerment at community, national and international level. Advocacy activities include: organization of conventions and mobilization of local communities to influence the policy-making bodies for social, economic and institutional transformation for empowering the community people. Action research includes: Making attempts to evolve and innovate, through implementation of development projects, to make a difference to the quality of their lives. The research follows a systematic planning process on the identified relevant issues, taking action practically and finding out the alternative solutions to make the impacts of our development projects more meaningful to the real life situation of the target communities. The key research areas include: Natural resource management and agriculture with a special focus on neglected crops, and biodiversity. Dissemination of research findings and modification and replication of success result in other similar areas.

In 2014, SAHAS-Nepal's working area covers 14 districts situated in the eastern, central, western, mid-western, and far-western region of the country. The project districts include: Okhaldhunga, Udaypur, Lalitpur, Dhading, Tanahu, Gorkha, Lamjung, Rasuwa, Dailekh, Mugu, Bajura, Kalikot, Rautahat, Bara and Makwanpur. There are 11 programmes/projects being carried out, with direct beneficiaries of more than 53000 households. Nine Community-based Organizations (CBO) Networks have been successfully formed in Okhaldhunga (5), Udaypur (1), Dhading (1), Gorkha (1) and Tanahu (1). Compared to the previous year, one more district, i.e. Rasuwa has benefited from SAHAS-Nepal's work, through the Sustainable Agriculture for Livelihood Security (SALS) project. Four projects namely (i) Right to Food (Okhaldhunga & Udayapur), (ii) Nutrition and Food Security improvement (Okhaldhunga), (iii) Raising goat to enhance income generation, livelihood, climate change resilience and ecological health of people living in Chudikhola catchment (Tanahu) and (iv) Socio Economic Empowerment with Dignity and Sustainability (Rautahat, Bara and Makwanpur) have been was launched this year. There are also several projects being concluded in 2013, including the Civic Education Project, Home Garden Project, Improving Food Security through Community Organizing (IFCO) Project and Promotion of Income Generation Activities for Improve Sustainable Food security (PIGAISF) project.

CHAPTER II

2 INTRODUCTION

2.1 Background

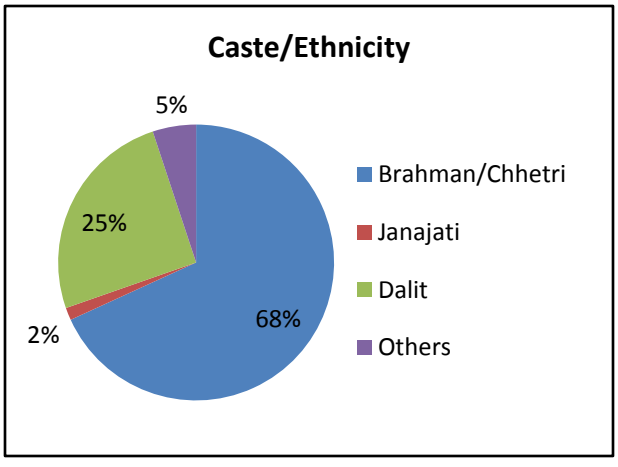
Nepal is a fragile mountainous country that straddles the boundary between the Indian and Himalayan tectonic plates (David et.al, 2007). Being geologically very young, landslides are one of the major natural hazards that occur frequently; more often in the monsoon seasons (Dikshit, 1983) causing increasing levels of economic loss, human casualties, loss of productive and agriculture land and damages in infrastructure. Landslides have been identified as a major source of hazard which results in environmental, social and economic loss. In addition, the country is regarded as a disaster hotspot with its fragile geography and steep topography.

With a diverse landscape ranging from high Himalayas to fertile Terai regions, people of Nepal face massive landslides every year. This intensity is more, especially in monsoon season as the heavy rainfall triggers irregular drainage patterns in the fragile mountains causing debris flow and landslides. Moreover, due to haphazard urbanization and lack of planned settlements and landuse implementation policy, some habitat settlements face severe risk.

2.2 Project Area Description

Nepal, a country rich in biodiversity and socio-cultural aspects, occupies a very low position on the scale of human development, currently ranking 157 out of a total of 187 nations with HDI value of 0.4902. Within the country, Mountains region has the least HDI value of 0.44, followed by Terai (0.468) and High Hills (0.52).

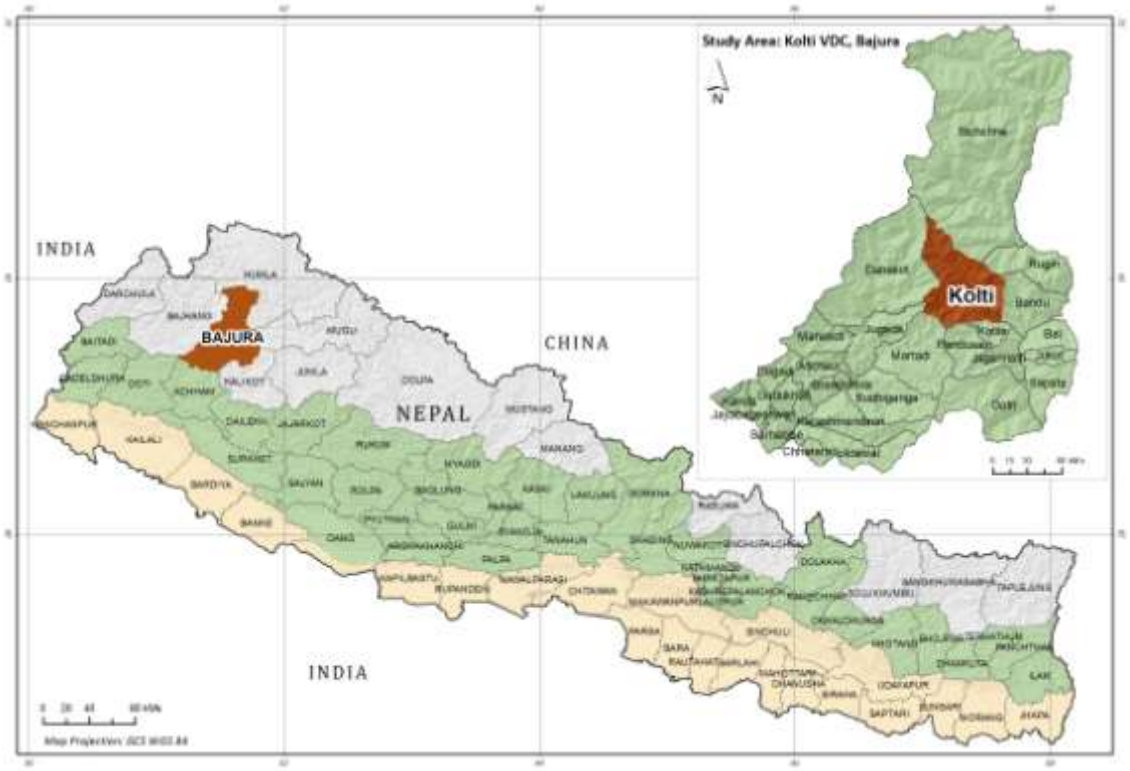
Bajura is a mountainous district in Far-Western Nepal, located in Seti zone. Bajura district covers an area of 2188 square kilometers. Political bordering of Bajura district is; Eastern: Mugu & Kalikot; Western Bajhang; Northern: Humla and Southern: Achham. Martadi is the district headquarters and there are 28 VDCs in the district. Bajura holds the position of 71 on ranking according to the overall composite index of Nepal and rank 72 on poverty deprivation index (DDC Profile, 2011). This ranking also reflects the status and poor scenario of the district. According to the report on climate change vulnerability mapping for Nepal, the adaptation capability (socio-economic) of Bajura district is very low (0.768-1.000) (GoN, 2010). Landslide vulnerability of Bajura district ranges from 0.47-0.629 (GoN, 2010).



[2]UN Human Development Report Nepal, 2014

Total population of Bajura district is 134912 where female constitutes 51% of total population. Among all ethnicity, Brahman/Chettri holds the highest percentage of 68% and Janajati holds the least (2%) of total population. And Dalit holds 25% of total population.

Kolti is the second biggest market of Bajura after district headquarter Martadi, has an airport and a primary health care center. The village is also the commercial center of 11 VDCs of Bajura and other nearby VDCs of Mugu, Jumla and Kalikot districts. The study area is approximately 1kmstretch above Kolti market center and Airport as shown in Map 1.



Map 1. Location of Kolti VDC

2.3 Rationale for conducting Landslide Assessment Study

On 31st May 2012, a devastating landslide triggered by intensive rainfall and hailstone washed away 57 houses and shops and left five people dead and many injured in the remote village of Pipaldali, located in ward 9 of Bandhu VDC, Bajura. Besides this, it has also destroyed the Kolti Water Supply System, Kolti Primary Health Centre, 4-5 km of Kolti Pipaldali road, 50-60 ropanis of agricultural land and local irrigation systems. Most of the victims are from poor families and many are "Dalits".

Furthermore, on 7thJune 2014, six houses were swept away and claimed three lives in Kolti VDC due to landslides. More than 70 households were affected; hospital and army barrack were also destroyed while hundreds of families were displaced after devastating landslides.[3]At present,

[3] Source: SAHAS Nepal

the market settlement including Kolti airport in Ward number 1, 2 and 3 of Kolti VDC are in the high risk zone of landslide.

Photo 1: Loss of human life from 31st May 2012 landslide

Photo 2: Loss of human life from 7th June 2014 landslide

With the aforementioned context, this study aims to identify physical, socio-cultural, environmental and biological impacts of existing landslide through reconnaissance survey of study area within Kolti VDC. This study includes documentation of baseline information and proposes viable short and long term mitigation measures based on field information.

Map 2. Imagery of overall landslide zone

2.4 Objectives of the Study

The main purpose of the study is to assess the landslides hazard risk in Kolti, Bajura district. The main objectives of the study are to:

- Conduct preliminary field survey (Reconnaissance survey) to Identify Causes and Impact of Kolti landslide

- Document the current practices to minimize/mitigate the Kolti landslide
- Recommend viable measures to minimize/mitigate landslide.

2.5 Study Approach

Landslides are geo-morphological processes that largely depend on soil configuration, material structure, tectonic, seismic, hydro-geological, climate and vegetation conditions of the area in which they appear. Preliminary investigation of landslide includes field observation, assessment of existing geological setting, environmental, social and economic aspects. Besides, field observation and expert interpretation, large amount of information can be collected through questions such as "What", "Where", "How strong" and "How often" to identify the hazard scale.

This study is based on a reconnaissance survey conducted in the study area between 19th November and 23rd November 2014. This study examines contemporary and past slope erosions and landslide processes in the Kolti VDC through on site investigation and focused group discussion. Following details describe the study approach:

Step 1: Desk study; acquisition of data (geology, environmental and socio-cultural), Review of existing images (Satellite/photographs)
Step 2: Field investigation
Step 3: Data analysis and interpretation
Step 4: Report preparation.

2.5.1 Desk Study

Desk study was conducted to collected existing data from available secondary sources. This included collection and review of existing geological data and maps, review of available satellite images, preparation of field work plan and maps, collection of data on social, environmental and biological parameters of the study area.

2.6 Field Study

Field Survey was done from 19th November to 23rd November 2014. Field survey comprised of walkthrough survey, consultation with community, site inspection and observation. The following tools were used for the collection of primary data.
A thorough walkthrough survey in the project area was carried out to gather information on the physical, biological and socio-economic and cultural environment. GPS was used to collect the geographic coordinates of the project area. Consultation with community, Focus Group discussions, site inspection and observation were also carried out in the project area to generate the baseline data of the area.

In order to cross-check the local information, local officials, particularly Village Development Committees, government officials, political leaders, NGOs/CBOs etc. were contacted to solicit site specific information.
From the field survey the following tasks were accomplished:

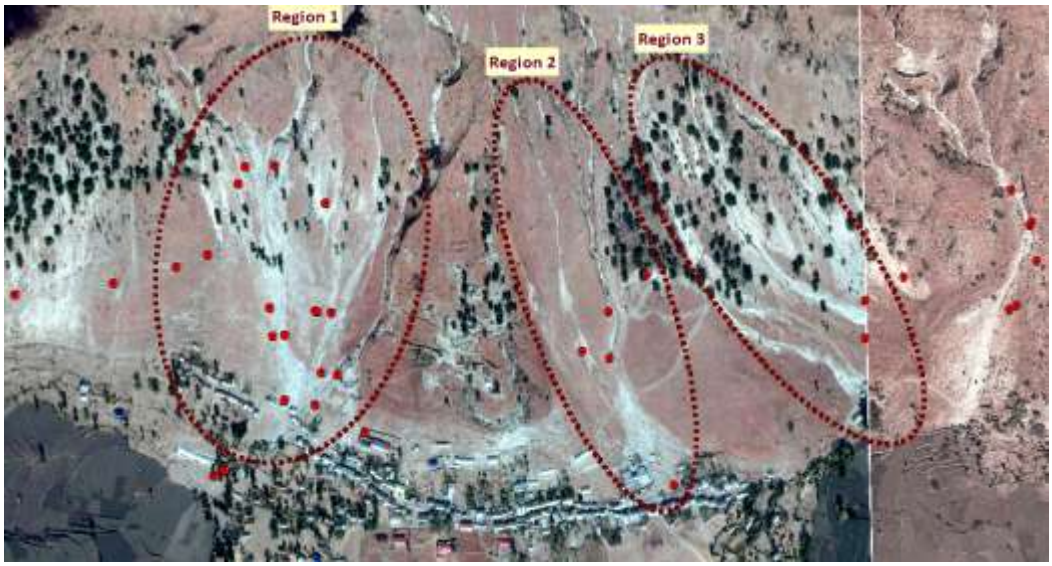
- Assessment of Physical Environment.
- Assessment of Biological Environment
- Assessment of Socio-cultural Environment

2.7 Physical Environment

Penetration test was conducted to assess the indication of relative density of existing ground which helps to have a basic understanding of the existing ground. This test is a simple and inexpensive method that includes penetration of metal pipe on the different locations using blows of sledge hammer. Ductile iron pipe of 35mm diameter was penetrated with hammer blows weighing 5km in different locations of landslide and erosion zone. Number of hammer blows, penetration depth, GPS locations, soil type, slope stability etc. was recorded in different locations of study area ranging from crown of the erosion to the toe deposits. Further, close observation of erosion was done for geological parameters and soil/rock samples were collected from test locations.

Photo 3: Conducting Penetration test

Photo 4: Measuring the width of the Gully erosion



Map 3. Three major erosion zones above Kolti market and airport area with GPS locations of test site

2.8 Biological Environment

Assessment of biological environment was done through transect walk of the existing vegetation and forest area. Vegetation and trees identification, fauna identification and listing were done

which was followed by questionnaire interview with existing forest user groups. Personal on-site interviews were also conducted with local residents and farmers.

Information on the flora and fauna, protected, rare and endangered species, sensitive habitats, and species of commercial importance in the project area were collected. Vegetation status, forested area, forest types and their distribution, distribution of plants species and their importance, community forests, plants with other cultural values, and endangered, vulnerable and protected plant species were documented.

Photo 5: Interviewing with staff of Kolti Forest department

Photo 6: Information collection from forest user group

Photo 7: Transect survey

2.9 Socio-cultural and Economic Environment

For identification of existing practices and community approach towards landslide, focused group discussion and key informant interview were conducted. This discussion included key personnel from VDC office, forest user groups, female groups, marginalized communities, market management committee and local stakeholders and the was focused more towards on community awareness and low cost mitigation practices with locally available resources. Further, data collection such as VDC profiles, rainfall information and existing publications were also done from government/private institutions and line agencies.

Photo 8: Focus group discussion in Kolti VDC

Photo 9: Key informant interview with Kolti VDC Secretary

2.10 Documentation of Current Practices and local Adaptation to landslide

On the basis of field observation, FGD and key informant interview the current practices and local adaptation mechanisms to protect hillsides were documented.

CHAPTER III

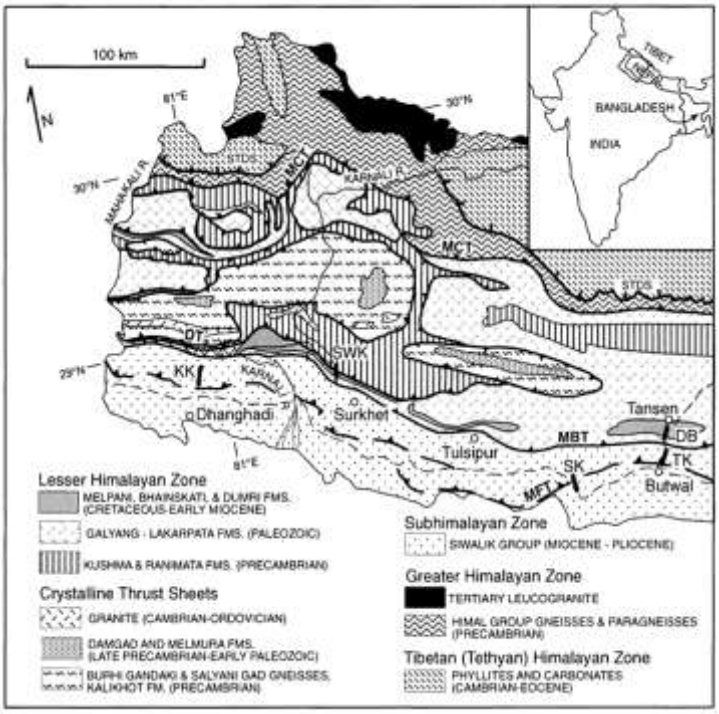
3 Baseline Information

3.1 Existing Environmental Condition

3.1.1 Physical Environmental Condition

3.1.1.1 Geological Setting

Geologically Kolti VDC lies in Galyang and Ranimata Formation (fig) which consists of dolomitic with in the slate along with phyllitic quartzites metasandstone.



Map 4. Geology of Kolti VDC

3.1.1.2 Rainfall

Due to data of short period, it is difficult to show the trendline, although the annual rainfall trend shows in decreasing order from decadal rainfall analysis. Rainfall in 2061 BS (2003) is unusual that deviates all the data. Even excluding the rainfall data of 2061 BS, the trend is negative by -4.8 mm per year. There is no consistency in monthly rainfall also. However, on overage Shrawan (July-Aug) has the highest rainfall of 191 mm and Kartik (October-November) has the lowest of 4.5mm.

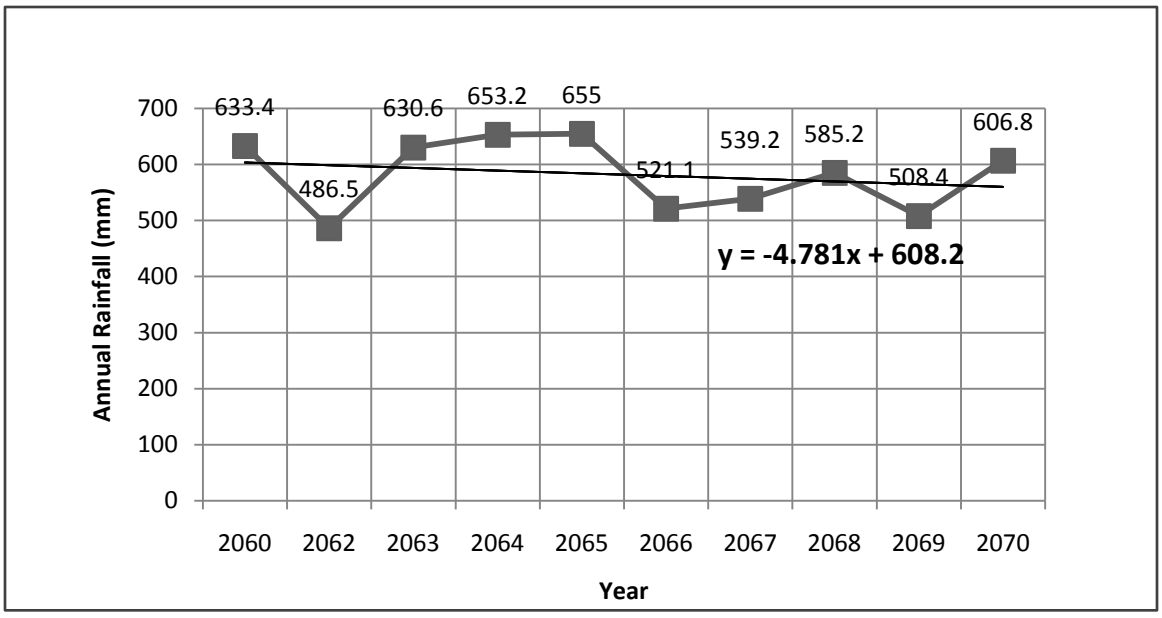


Figure 1: Annual Rainfall trend of Kolti Area

3.1.1.3 Soil Analysis

For the soil analysis, the major landslide/debris flow zone is chosen for the soil sample. The sampled soils were dug out from the depth of 2 feet to avoid the humus material in the soil. The pH, texture, total nitrogen, available phosphorous and available potassium were analyzed. Soil test result was given in Annex 1 in table 2.

pH

Soil pH is a measure of the acidity or alkalinity of the soil. pH of the soil is defined as the negative logarithm of hydrogen ion concentration present in the soil sample which means that for a pH decrease of one, the acidity increases by a factor of 10. Because hydrogen ion concentration varies over a wide range, a logarithmic scale (pH) is used. It is a 'reverse' scale in that a very acid medium has a low pH and a high hydrogen ion concentration.

Soil pH value of the study site was found to be 8.1 which indicate that the soil is of alkaline nature. At high (alkaline) pH values, the hydrogen ion concentration is low.

Texture

The look and feel of a soil is referred to as soil texture and is determined by the size and type of particles that make up the soil. Soil texture has an important role in nutrient management because it influences nutrient retention. For instance, finer textured soils tend to have greater ability to store soil nutrients.

From the soil texture analysis, the Sandy Loam (SL) soil was found in the study area where silt percent is high almost 68% and clay percent is very low (4.8%).

Total Nitrogen

Total nitrogen is the sum of total kjeldahl nitrogen (ammonia, organic and reduced nitrogen) and nitrate-nitrite. It is an essential nutrient for plants and animals. Total nitrogen was found to be 0.19.

Available Phosphorous

Phosphorous is one of the essential macronutrient element required by plants. From the laboratory test of soil, the available phosphorous was found to be 47.17 µg/g.

Available Potassium

Potassium is also one of the essential nutrients required by plants. From the laboratory test of soil, the available potassium was found to be 0.34 µg/g. From the test value, it clearly indicates that the soil is in deficient of potassium.

3.1.2 Biological Environment

3.1.2.1 Vegetation and Community Forest

The project VDC Kolti lies within subtropical zone to temperate bio-climate zone. The study site has very sparse vegetation. The major tree species found in the study area is wild olive *(Olea cuspidata*) which is locally named as Lautho (Jaitun). The plant species like *Agave Americana, Berberis aristata, Cassia fistula, Celtis australis, Chrysopogon gryllus, Euphorbia royleana, Jatropa curcas, Melia azederac, Sapium insigne, Themeda arundinaceae, Vitex niguldo, Xanthium strumarium, Zanthoxylum armatum* etc can be found in the study site. See Annex 2 (table 4) for list of plant species.

Photo 10: Community Forest

There are 3 community forests namely Bhawanimandu, Smaundrapal and Thodomelo in the study area covering an area of 108.85 hectares which is listed in table1. Among three CF, Bhawanimandu CF covers the largest area (53.5 ha.) And Smaundrapal has the least area. In total 391 households are the members of these three community forest where Samundrapal community forest is fully managed by women groups.

Map 5. Community forest of study site

Table 1: List of Community Forest

S.N.	Name of Community Forest (CF)	Ward No.	Area (ha)	Households	Remarks
1	Bhawanimandu CF	2&3	53.5	251	
2	Samundrapal CF	1	22	40	Women Groups
3	Thadomelo CF	2	33.35	100	
			108.85	391	

Source: Source: VDC Profile 2014, SAHAS Survey 2014

Photo 11: *Olea cuspidata*

Photo 12: *Sapium insigne*

3.1.2.2 Birds and Fauna

Some major important animals and birds found in the project VDC are Barking Deer, Ghoral Jackal, Yellow Throated Marten, Porcupine, Monkey, Nepal Grey Langur, Black Kite, Yellow Breasted Greenfinch, Kalij Pheasant, Partridge, Bulbul, Dove, Sparrow, Koklass Pheasant, Chukar Partridge, Common Kestrel, Jungle Crow, Rock Pigeon, Babbler etc. Besides these faunal species some major threatened species are also found in the project area such as Black Bear, Wild Dog, Eurasian Otter, Serow, Himalayan Vulture, Egyptian Vulture, Cinerous Vulture, Lammergeier, Satyr tragopan and Stork.

Photo 13: Egyptian Vulture (Endangered)

Photo 14: Himalayan Vulture(Nearly Threatened)

Photo 15: Cinerous Vulture (Nearly Threatened)

Photo 16: Lammergeier (Nearly Threatened)

Photo 17: Black Kite

3.1.3 Socio-cultural and Economic Environment

3.1.3.1 Population, Ethnicity and Religion

According to CBS 2011, Kolti VDC has 7134 population in 1330 houses. The male female ratio of Kolti VDC is 1.03. The project area covers ward number 1, 2 and 3 of the Kolti VDC. All together 1792 people reside in 300 houses with average family size of 6 members. Male female ratio in project area is 1.09 (VDC 2011). The age group shows that the economically active group is more than 50% of total population (Figure 2). Total population distribution of project area is given in Annex 3 table no. 6.

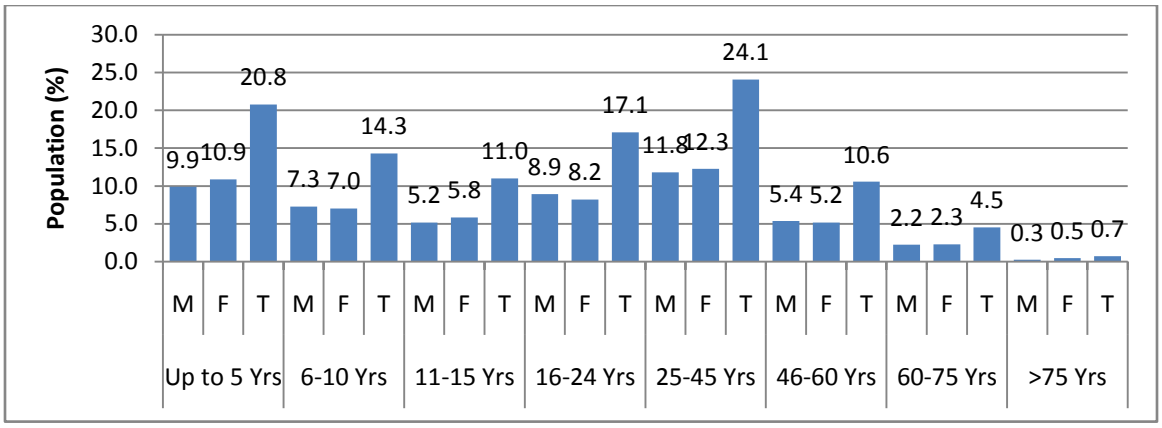


Figure 2:Age group

Five major ethnic groups live in project area. Dalit is dominant group followed by Chhetri, Bramhin, Indigenous and Thakuri (Figure 3). Around 99% populations are of Hindu religion while the rest are Buddhists in the area.

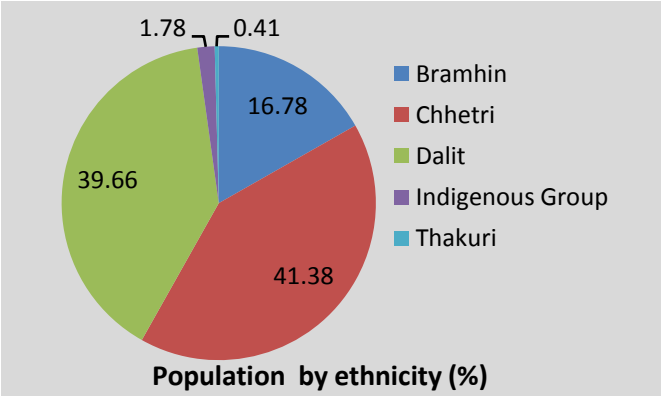


Figure 3:Population based on Ethnicity

3.1.3.2 House Condition, Occupation and Economy

Majority of houses are of traditional type with roof of thatch grass. Galvanized zinc sheet and concrete cement can also be seen at present. See detail in Annex 3, table 7.

Photo 18: Central Area of Koliti VDC and Kolti Airport

The economy of the area is more or less dependent on traditional agriculture system. Around 60% are directly involved in farming and livestock rearing. Due to the existence of the market centre, some of them are involved in business. Some people have been attracted to take up foreign employment also. Majority of them are in India. A large population is dependent on labor work (Figure 4). Youth (16-24 Yr) employment is similar with majority depending on agriculture but better involvement in business (Table 8). Majority of people have little land (Figure 5) although irrigation facility is mostly available all year round. Only 6% households have enough food throughout a year (Figure 6). To meet the deficiency, about 1800 quintal of cereal are imported along with 474 quintal of pulses, 59 quintal of oil seed and 24 quintal of vegetable. Only a little amount of vegetable is exported (Table 11). Rearing of cow/ox, buffalo, goat, mule, chicken, duck and beekeeping are common for household purposes (Table 12). All the breeds are local. Due to traditional agriculture farming and unproductive livestock, agriculture and livestock contribute only about 15% in annual income. Service and Pension, and wage labor contribute more in annual income of the area (Table 13).

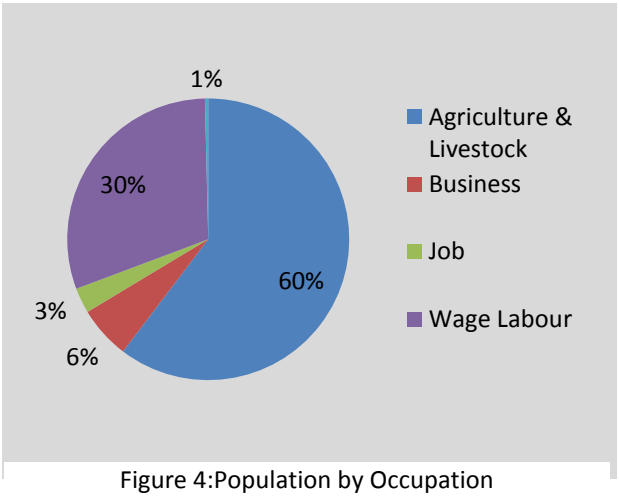


Figure 4:Population by Occupation

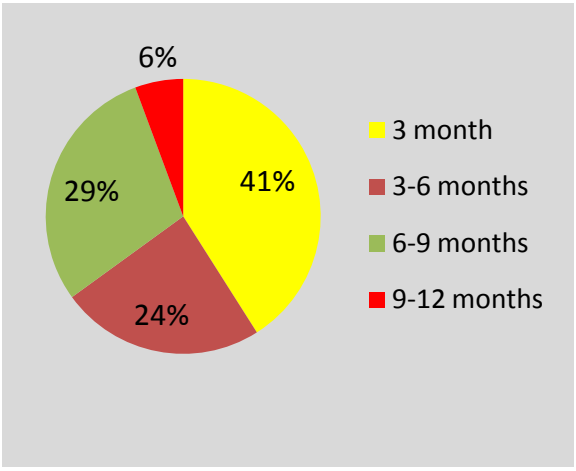


Figure 6:Household Food Security

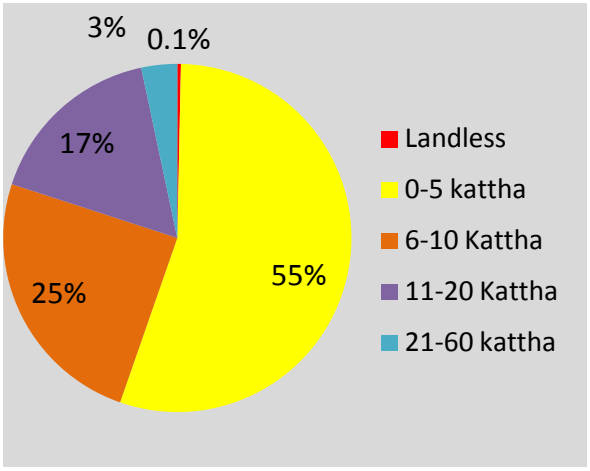


Figure 5: Population by Landholdings

3.1.3.3 Literacy and Educational Status

The literacy rate is 55.8% in the VDC while in project area it is about 65%. Male is more literate (74.8%) than female (55.5%), See Annex 3 in table 14. There are 9 education institutions in three wards — 3 in ward 1, 6 in ward 2 and 1 in ward 3 (Table 15).

Education is not widespread in the project area. Out of total population, only about 6% population have crossed SLC or above. Most of them have passed only SLC (52%). Population with higher education is very few (Table 16).

3.1.3.4 Health, Sanitation and Drinking Water

There is a primary health centre in the VDC at Kolti Bazaar that lies in our study site. Prevalent diseases in the area are pneumonia, typhoid, tuberculosis and diarrhea. Majority of people suffer from pneumonia (table 17). Sanitation condition is not good in the area. More than 55% household lack toilet in the study area (table 18) and garbage are everywhere in Kolti Bazaar.

In Kolti VDC, around 84.26% population has access on drinking water. In study area, around 94% have access to piped drinking water, while the rest depends on river or canal (table 19). The water supply system is not good as it is often irregular and people has to depend on river water or has to walk for about an hour to fetch water. About 10% households have drinking water at their house premises while 44% have to walk for a distance of up to 15 minute and 42% households for 15-30 minutes (table 20).

3.1.3.5 Communication and Transportation

Majority houses have radio. At present, communication facility has become easier due to mobile and wireless services provided Nepal Telecom. Some houses have television and computers, but no access of internet till date (table 21).

Kolti has no access to road transportation but connected with air transportation. Kolti is a major business center of Bajura district due to Kolti airport (DDC, 2071). Mule, Goat and Sheep are highly used as a goods carrier in Kolti VDC.

Photo 19:Mule carrying goods

Photo 20: goat and Sheep carrying goods in Kolti VDC Market Area

3.1.3.6 Energy

Forest biomass (firewood) is the major source of cooking as well as heating energy. All houses uses firewood from nearby forest. All houses are using traditional cooking stoves for cooking purposes. For light, 95% houses use electricity generated from micro-hydropower while the rest depends on solar panel.

3.1.3.7 Natural Hazards

Basically flood (landslide and erosion), hailstone and drought are the major hazards perceived by local community in the last two years. Almost all houses are impacted by these hazards.

CHAPTER IV

4 Hazard, Impact, Causes and Responses

4.1 Hazards

4.1.1 Hazard Agents Identification and Characteristics

Based on consultation and focus discussion with local stakeholders which included local decision makers, political leaders, government officials, affected families and local people, debris flow (erosion) due to heavy rainfall is the only major hazard agent at Kolti Bazar. It was unusual in the past, but since the last three years, it has become most frequent and fearful. The debris flow occurs for a short time, mostly within the second week of June, caused by heavy rainfall with hailstone.

There is a history of huge mass movement in the past. About 200 years ago, a huge landslide occurred and buried the whole village. Household utensils were found during the excavation works of airport in 2041 BS (1984 AD). After then, nobody has experience of such destructive debris flow in their lifetime. Basically, Kolti Bazar has been built on the debris deposited by past landslide. There are huge mass deposits along the foothills. On 18th Jestha 2069 (31st May 2012) night (in-between 8-9 PM), heavy rainfall with hailstone brought huge mass of debris. The same case was repeated on 24th Jestha 2071 (June 2014). Both events occurred due to torrential rainfall with hailstone for a very short time, not more than half of an hour.

4.1.2 Nature of Erosion

Short intensive rainstorm which occurred throughout the different years form rills and gullies of approximate width up to 15 meters and depth up to 8 meters. The mass movement occurs through formation of branch and tributary gullies that merge into main gully channel causing rapid debris flow. Gully Erosion problem grows as interconnecting systems of gullies spread across the old land surface of different slopes. The resulting run-off from the hillsides brings debris into the settlement areas threatening the villagers and causing major damages.

Photo 21: Inspecting the gully erosion by Experts

The erosion occurred in 2012 and 2014 where a single intensive rainfall on accumulated debris triggered large amount of debris flow overwhelming the village and causing major risks to the villagers.

4.1.3 Emergency Preparedness Practices

There is no any emergency preparedness practices (EPP) in the affected areas, even though there is a Disaster Preparedness Response Plan of Bajura District.

4.1.4 Hazard Mitigation Practices

There were no practices to check debris flow in the past. After twice hit by debris flow, users of Bhawanimandu Community Forest from ward Number 2 and 3 of Kolti VDC have initiated plantation on bare land during July-August of this year. Similarly, they have banned rock collection/excavation and grazing in community forest areas. However, after the destruction of Nursery due to last landslide (June 2014), the plantation program has stopped.

Photo 22: Hoarding board on Bhawanimandu CF displaying prohibited activities in CF

Photo 23: Plantation in Bhawanimandu CF

4.1.5 Community Recovery Resources and Extra-community Assistance

As per discussion with local stakeholders, community has nothing as recovery resources due to scarce forest produces, poor water supply system, low agriculture productivity, lack of road transportation and insufficient health facility (for victim of debris flow). After the event, security personnel and local people themselves worked together for early recovery works. District Administration Office supported some sorts of financial assistance for victims (NPR 40,000.00 for loss of human life, NPR 10,000.00 for completely damaged houses and NPR 5,000.00 for partially damaged households.

4.1.6 SAHAS Nepal Rapid Relief Response

SAHAS Nepal CEFALS project was concentrated in the landslide affected area and instantly act through rapid relief response. SAHAS-Nepal in coordination with Red Cross, SAPPROS and other NGOs immediately engaged in relief works and supported affected families. SAHAS Nepal provided food for the displaced families and Red Cross provided plastic sheet, utensils and blankets for 41 families. To ensure cleanliness of the landslide affected areas, and prevent

spreading of maladies, SAHAS Nepal gathered all dead animals and skeletons and disposed it in a safer way. Furthermore, SAHAS Nepal has worked to empower the landslide affected communities to improve their food security and livelihood.

4.1.7 FELM and SAHAS Nepal Post Relief and Rehabilitation Assistance

After the catastrophic disaster from debris flow on 31st May 2012, SAHAS Nepal initiated the post relief and rehabilitation assistance with the support of Finnish Evangelical Lutheran Mission (FELM), Finland. During that period, SAHAS-Nepal along with the community participation, constructed 18 houses in Badhun VDC ward no 9. The houses were all 2 storeys and contain 4 rooms in each. Further all the houses were equipped with smokeless stove and toilet. The project contributed 27% and the remaining 73 % were managed by the community itself. In addition 9 Dalits landless families were supported and land ownership certificate was distributed in the combine name of both husband and wife. These Dalit families were bounded labour since generation to generation for local landlord so called upper caste. SAHAS Nepal has made an agreement with the Land Registration Office that these families are restricted to sale a house for coming 25 years. This arrangement protected them from forceful taken a house by the landlord. Now, this rehabilitation area is known as SAHAS Basti (town). Furthermore, SAHAS Nepal have also constructed 12 drinking water taps, 2 dams, 1 collection chamber, 1 distribution chamber and 2 RBT(20m3&30m3).

Photo 24: Community Participation for reconstruction

Photo 25: Land Ownership Certificate handed to the victim Families on 2013

4.2 Impacts

The past landslide (about 200 years ago) buried whole village and new settlements were developed on deposited materials. On 18th Jestha 2069 (31st May 2012) night (in-between 8-9 PM), heavy rainfall with hailstone brought huge mass of debris and buried and washed away 57 houses and shops houses in both Bandhu and Kolti VDCs. This disaster killed 5 people and injured many. The debris flow destroyed water supply system, Primary Health Centre at Kolti, irrigation canals, 5 km road and agriculture land. The same event occurred on 24th Jestha 2071 (June 2014) that washed out 5 houses and completely destroyed 6 houses. The disaster claimed 3 lives from Kolti Bazar. The event affected more than 70 households and many buildings of Primary Health Centre and Army Barrack. The mass movement has eroded public land especially community forest areas heavily. Similarly, it damaged forest nursery with 12,000 plant seedling.

Photo 26: Damaged Hospital

Photo 27: Damaged House

4.3 Causes

4.3.1 Major Cause

During the reconnaissance survey, it was observed that there might be two major causes that initiate the landslide. The first one is debris flow in historical landslide due to rainfall and another is rock boulder extraction from old river terraces and landslide deposition zones for construction purposes. Further verification and detailed studies are required in second round of study.

The field survey along with interviews with local residents and focused group discussion revealed the historical backdrop of the region. A massive landslide that occurred almost more than 200 years ago had swept the whole village. Later, the village developed itself on the accumulated debris from the slide. According to the local residents, this event was further verified during the construction of Kolti airport in 1984 where buried ancient products such as utensils were discovered. The following has been identified as major causes of erosion:

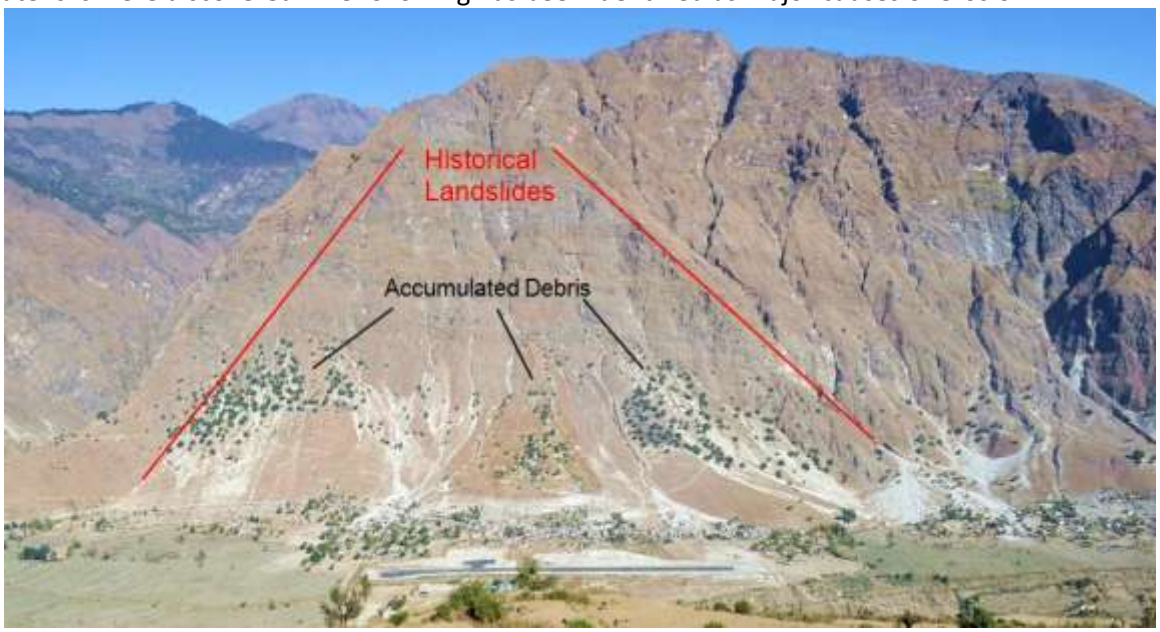
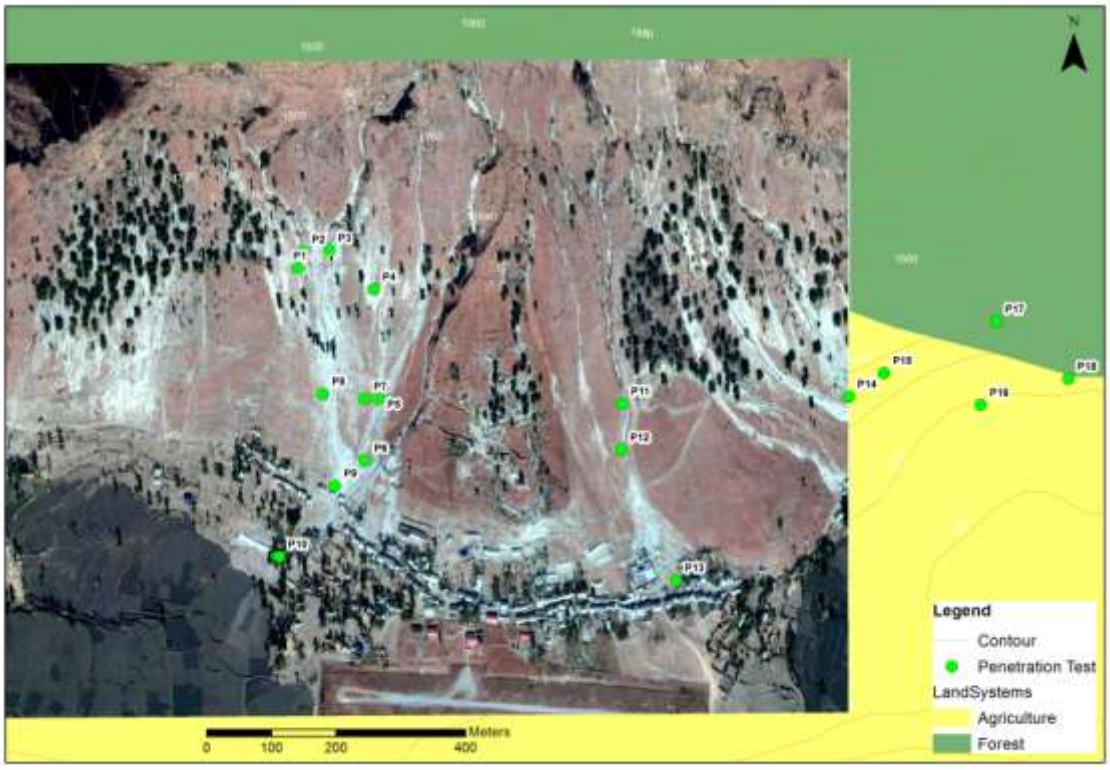


Figure 7: Historical Landslides

The concave nature of the rock indicates a massive landslide as shown in figure 7. The whole area has dolomite dipping against hill slope. The penetration test result shows that the upper part consists of debris deposit up to 2 to 3m then alluvial deposit of nearby river. These deposits is unsettled and mostly composed of granular and weathered rocks with high porosity that makes rainfall to infiltrate at a quicker rate causing massive mass movement. Jure landslide of Sindhupalchok might be the characteristic example of this area; the river terrace covered by the slope failure but detailed geological and geophysical investigation need to be carried out to confirm it. Map 6 shows the Penetration Test Location and the nature of erosion occurred in 2012 and 2014 where a single massive rainfall on accumulated debris triggered large amount of debris flow overwhelming the village and causing major risks to the villagers



Map 6. Penetration Test Location

4.3.2 Past Insurgency & Security Issues

Security camp (Nepal Army barrack), situated upstream of Kolti market was established in 2059 BS (2002 AD) during insurgency and comparatively in a safer area. Considering the safety of Nepal army barrack during Maoist insurgency period, a large number of trees, bushes and vegetation have been cleared out in the surrounding areas.

Further, stone and gabion walls along the foot trails built for protection of community forests has been demolished for security reasons. This activity has also triggered the area more vulnerable for erosion and hazard. Locals believe that the bushes used to control the debris flow and the stone wall also holds over land debris flow and check the speed of both water and debris.

4.3.3 Local Practices Vs Climate Change

Most local people believe that some malpractices of local people — deforestation, overgrazing, rock collection, construction of roads, forest fire and negligence for conservation — are major causes for the debris flow. After the construction of airport at Kolti in 2041 BS (1984 AD), house construction and settlement expansion took place rapidly. People used the deposited rocks and boulders for house construction. Due to excavation of big rocks and boulders, only loose and small debris were remained, those were easily eroded by torrential rainfall. Due to high demand of firewood for cooking and heating, trees, shrubs and bushes were cleared. Some ethnic groups, migrated some years ago, even dig out roots for firewood to make local alcohol. After insurgency, people did not care about conservation and let livestock freely grazing on public land and community forest areas. During field work, more than 200 cattle entered into community forest areas for grazing from a single point. This aggravated land degradation. Bush burning on hill slope by local sheep herders is common here for better grasses during the following spring. This makes the soil and rock fragments more vulnerable for erosion. Similarly, construction of roads along the toe of deposited mass and through the deposited mass body has disturbed the slope stability. The unmanaged spoils resulted from road construction has also created another problem covering ground vegetation, thus leading overland flow with huge unconsolidated debris.

Besides the local malpractices, locals are experiencing local climate change. People are experiencing more heat in Kolti areas than in the past. In uphill area, snowfall is little compared to the past. Paddy was uncultivable at Kuru (Kolti-6/7), but now people cultivate. Most rainfall used to occur during the month of Ashadh (June 16-July 15), at present rainfall mostly occurs during Srawan (July 16-August 15). Flowering time of rhododendron has shifted from Chaitra (March 16-April 15) to Magh (Jan.16 - Feb. 15). Hailstones rarely fell and if any, were very small. But hailstone occurred in 2012 and 2014 were totally uncommon with big sizes and large numbers.

4.3.3.1 Haphazard Boulder collection

Local residents have been collecting large rock and boulders from the foothill zone of accumulated debris for construction purposes. As observed in the field, currently there are only smaller boulders and weathered rock deposits present. As shown in pictures, large boulders are extracted even from digging the tree roots causing massive damages to soil moisture holding capacity and ultimately causing erosion.

Photo 28: Stone extraction digging beneath the tree root

4.3.3.2 Deforestation and forest fires

Deforestation is another major cause; especially tree roots and branches are frequently extracted as firewood supply. Excessive collection of grasses, shrubs and nettle species is also the major cause of rapid deforestation. Further, forest fires are common in the area as sheep herders and mule transporters fire the grazing lands for new grasses.

Photo 29: Collection of nettle species (Sisnu)

Photo 30: Collection of fodder grasses

4.3.3.3 Road and trail construction

Kolti being one of the major market centers of the region, surrounding VDCs have weaker transportation linkage with it. Construction of road without proper knowledge of soil structure and geology across the disaster prone areas has caused major damages in the vegetation as well as terrain resulting debris flow. As shown in the pictures, the erosion has taken place along the downstream side of road alignment.

Photo 31: Road construction in Bhawanimandu CF

Photo 32: Road construction in Thadomelo CF area

4.3.3.4 Animal Grazing

Large numbers of quadruplet domestic animals are left alone in the forested area, erosion and surrounding areas for grazing resulting in damage of grasslands, plants and vegetation.

Photo 33: Large number of cattle grazing in CF area

Photo 34: Cattle grazing in Thadomelo CF

4.3.3.5 Inefficient Monitoring Efforts

Even though the Bhawanimandu and Samundrapal Community forest have started conservation practices, there are many loopholes in the monitoring of the community forest. Although Bhawanimandu community forest has deployed forest guard local people continue to disobey the rules and regulations of Community forest and excessively harvest forest resources. Stone extraction and animal grazing are also widely taking place.

Photo 35: Local people disobeying the Bhawanimandu CF Rules and Regulations and taking her cattle for grazing

4.3.3.6 Climate change issues

With the existing malpractices of local residents and aforementioned issues, the region has experienced following climate change issues which were observed over time:

- Decrease in snowfall in high altitude regions of Kolti.
- Shifting of rainfall pattern approximately up to a month.
- Humid climate and excessive rise of temperature in summer season.
- Occasional non-monsoon and torrential rainfall with large hailstones
- Shifting of flowering time for plants such as Rhododendron
- Dewfall

CHAPTER V

5 Mitigation Measures

5.1 Impact Minimization

Conservation of the impacted area must be the first priority in advance for impact minimization and mitigation. Local malpractices such as open grazing, haphazard fire, rampant rock collection and excavation and deforestation must be controlled or checked. Greenery must be maintained to protect surface exposure. For all these, locals should be made aware.

Barbed wire fencing can control livestock entry to the forbidden area. Check dams along major gullies should be constructed. Appropriate bio-engineering technique might be useful to prevent mass movement as long term protection measures. As it is due to high erosion, long rooted plant species (grasses, bushes and trees) can prevent the soil erosion. But plantation with protective engineering structure is prerequisite.

Along with direct protective works, improvement in livelihood is also necessary through appropriate intervention. Similarly, technology can be used to reduce dependency on forest through replacing traditional cooking stoves and installation of biogas and improved cooking stoves.

5.2 Program/Project Implementation

5.3 Modality

Involvement of local people ensures success of any implemented programs/project. At present, the affected area lies in three Communities Forests— Bhawanimandu, Samundrapal and Thadomelo. The problem cannot be addressed separately. Therefore, user groups of three community forest should be mobilized simultaneously through one door system. A GROUP can be formed from three community forest users and identified programs can be implemented through this group.

5.4 Hazard Mitigation

Hazard awareness and adopting local mitigation practices are some key aspects that should be vitally considered to increase the resilience of local community towards the disaster. Based on the field survey, it is clearly observed that there is a strong need of awareness for emergency preparedness and disaster mitigation at local level. Some efforts have been recently made by existing community forest for protecting small area against animal grazing and human intrusions. However considering the widespread nature of debris flow and lack of monitoring, this effort is completely insufficient to protect Kolti market and airport region.

Based on the reconnaissance survey of Kolti landslide region, hazard mitigation can be adopted with two approaches as short term and long term measures. Short term measures include immediate actions that should be taken with low cost and locally available resources/methods that help to mitigate the erosion for a short period of time, while long term measures include

detailed study, mapping and construction of protective engineering structures with larger investment. The Study team suggested following hazard mitigation measures for the Kolti region:

5.4.1 Short term protective measures:

5.4.1.1 Awareness and disaster preparedness

Community awareness campaigns should be conducted focusing on slope safety to minimize the effect of erosion. This can include proactive actions that should be taken before, during and after the occurrence of landslide. This campaign can be followed up by actions such as placement of Landslide warning signs and posts, distribution of posters and leaflets and formation of community local groups for slope monitoring and management.

5.4.1.2 Protection of erosion area:

Immediate protection of erosion area against unauthorized access for human intrusions such as boulder collection, grass cutting and cattle grazing should be done. For this purpose, community forest groups can be promoted for the use of local manpower, material and community participation. Low cost fencing wires can be provided to construct fences covering the entire erosion region.

5.4.1.3 Afforestation:

Native plants, grass and trees should be planted with community participation in different areas of the region. Plants such as *Olea cuspidate, Vitex niguldo, Melia azederach, Themeda arundinaceae, Sapium insigne, Jatropa curcas* can grow extensively in the region with good grip on the soil that helps to maintain soil moisture content reducing the risk of debris flow.

5.4.1.4 Temporary Seeding and Mulching:

Seeding and Mulching is one of the best solutions after fencing of the area. Locally available plant seeds can be spread across the slope with grass mulching and surface protection with timber cribs and poles. This technology is low cost and can be very affordable with locally available materials.

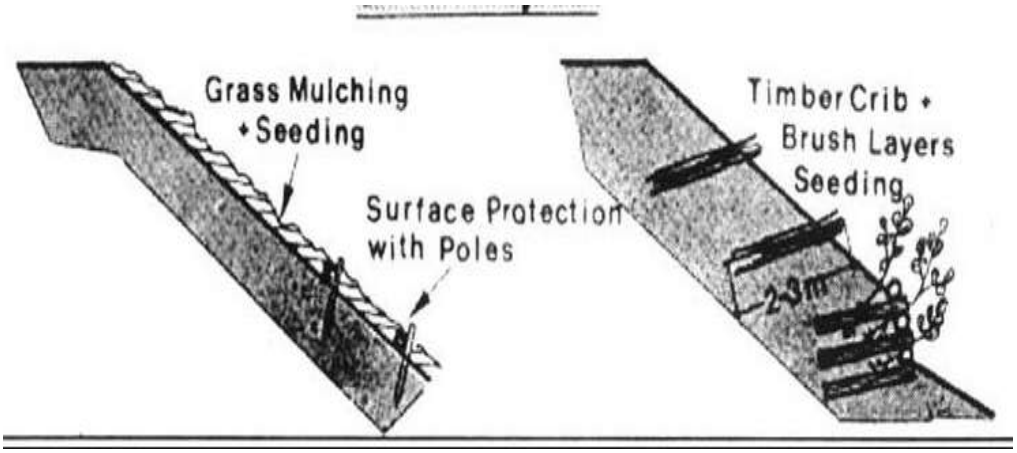


Figure 8: Examples of seedling and mulching

5.4.1.5 Other short term protective measures

- Control and management of unnecessary forest fires.
- Control of trail and road construction that occur without detail study and design.
- Promotion of alternative energy and fuels for cooking such as ICS, bio gas and solar energy.

5.4.1.6 Development & Implementation of Disaster Preparedness Plan in ongoing CEFALS Project

SAHAS Nepal is implementing the CEFALS project in Bajura with the support of FELM and EED. Moreover, SAHAS Nepal has already access to community and gain trust of local community. The local community has become familiar and appreciated working approach of SAHAS Nepal which is an added value to launch disaster preparedness program. SAHAS Nepal can include the mitigation activities in CEFALS current phase and go into action in cooperation with Budinanda Sirjansil Bikash Manch (Budinanda Creative Development Forum) CBNO partner and other stakeholders. Besides that SAHAS Nepal should develop an action plan on disaster preparedness plan in CEFALS and overall organization level.

Furthermore, the above short term mitigation measures should be adopted immediately with sufficient community participation and awareness. To strengthen the implementation process, organizations working in the social and livelihood sector in Kolti region should have a stronger co-ordination. In this regard, disaster management activities and community awareness programs can be incorporated in the ongoing projects.

5.4.2 Long term protective measures:

5.4.2.1 Development of Disaster Risk Management Project

This is different than the ongoing development projects in Bajura. Thus it would be better to develop a Disaster Risk Management Project to address the problem of landslides with focusing mobilization of local communities and utilizing local resources with low cost technologies so that the community can manage and sustain the project efforts. To ensure sustainability, local CBNO such as Budinanda Creative Development Forum (BDCF) can be capacitated and can carry on the disaster risk management activities.

5.4.2.2 Detailed Geological Study:

Detailed geological study and hazard mapping on the scale of 1:100m is suggested in the area to identify the local geological condition that will help to understand the mass movements. Seismotectonics analysis needs to be done to better understand the fault lines and its roles for the mass wasting phenomena. This can be done with the help of recent instrumentally recorded events, accounts of historical earthquakes and geomorphological evidence. This information can also be used to quantify the seismic hazard of that site.

5.4.2.3 Electrical Resistivity Survey

Electrical resistivity survey should be conducted to identify the material properties with respect to different depth. This survey will be particularly helpful in this region to know the exact thickness of the sliding mass. As according to the local residents and field inspection, it was observed that monsoon water directly percolates though the gully and vanishes within the granular material suggesting highly permeable surface with possibility of water sprouts and aquifer directly below the market and airport area. Thus for construction of engineering protective measure, exact knowledge of amount of debris/terrace thickness is required that can be identified with electrical resistivity survey. In this survey, metal probes (electrodes) are inserted into the ground at different spacing and current and voltages are measured to identify the local resistivity of the ground at different depth (Fig 8).

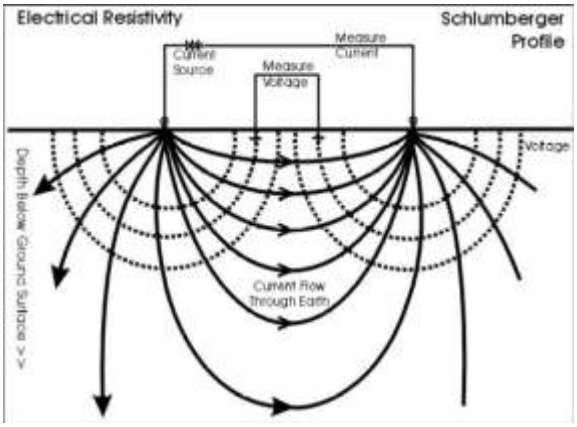


Figure 9:Electrical resistivity

5.4.2.4 Gully control check dam structures / Sabo Structure

Loose stone and boulder check dam structures can be helpful for grade stabilization and slope control for a life span of 3 to 8 years. Considering the availability of stones in the region, construction of series of stone terraces at different spacing can also be an effective preventive measure.

Sabo dam structures are particularly helpful for gully erosion control. A vertical concrete structure across gully is constructed to trap sediment material and retain the debris. Height of the dam depends on the gradient of the surface.

5.4.2.5 Debris-flow retention nets

Another option is to install Debris-flow retention nets which can be used for both temporary and permanent protection. This will hold all the debris rolling down gulley, which totally minimizes the risk of danger for affected residents. A wire net can be used to trap a debris flow. The advantage of this structure is that it does not require people to work inside a torrent bed. After a debris flow, the debris is removed and the wire net isreplaced depending on its damage level. Although some doubts have been raised about its durability, retention nets have been used successfully in Switzerland and Japan.

Photo 36: Examples of debris flow retention nets

5.4.2.6 Other long term protective measures

- Construction of drainage control diversion ditches.
- Development of disaster preparedness and mitigation Plan.
- Sensor based Landslide Monitoring and Early warning system.

CHAPTER VI

6 Conclusion

From the preliminary studies conducted, it is evident that the level of disaster risk reduction and emergency preparedness in the Kolti-Bajura District are unsatisfactory and necessary to be improved. Several socio-economic causes of landslides have been identified, which can be addressed with immediate interventions. For instances, activities of boulder collection, grass cutting, and cattle grazing can be controlled through immediate protection of erosion area against unauthorized access Other immediate actions required are awareness-raising regarding slope safety, afforestation, temporary seedling and mulching in vulnerable areas. Long term measures include detailed geological study, electrical resistivity survey, check dam structures and debris flow retention nets. Moreover, SAHAS Nepal has already access to community and gain trust of local community through CEFALS project. Henceforth, SAHAS Nepal can include the mitigation activities in CEFALS current phase and go into action in cooperation with Budinanda Sirjansil Bikash Manch (Budinanda Creative Development Forum) CBNO partner and other stakeholders. Besides that, it would be better to develop a Disaster Risk Management Project to address the problem of landslides with focusing mobilization of local communities and utilizing local resources with low cost technologies so that the community can manage and sustain the project efforts.

Annex 1: Physical Data

Table 2: Soil Test Result of kolti Landslide area

S.N.	Parameters	Test Methods	Observed Values
1	pH @ 16°C (1:1)	pH Meter, J.M. & Ingram, J.S.I./USDA	8.1
2	Texture	Hydrometer; Anderson J.M. & Ingram, J.S.I	SL
a	Clay (%)		4.8
b	Silt (%)		67.5
c	Sand (%)		27.7
3	Total Nitrogen (%)	Kjeldahl Digestion, FAO Fertilizer & plant Nutrition Bulletin No. 19	0.19
4	Available Phosphorous, (µg/g)	Olsen, ASA Monograph Number 9. FAO Fertilizer & plant Nutrition Bulletin No. 19	47.17
5	Available Potassium, (µg/g)	AAS, FAO Fertilizer & plant Nutrition Bulletin No. 19	0.34

Note: The analysis was carried out in air dried samples.
SL: Sandy Loam
USDA: United State Department of Agriculture
FAO: Food and Agriculture Organization
AAS: Atomic Absorption Spectrophotometer

Table 3: 10 years Rainfall Data of Kolti VDC

Year	Baisakh	Jestha	Ashad	Shrawan	Bhadra	Aswin	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra	Monthly Annual Rainfall
2060				448	103.4	-	-	-	2.1	-	-	79.9	633.4
2061	94.3	100.4	21.2	305.3	223	220.8	-	-	-	190	62.2	21.8	1239
2062	-	-	-	171.6	93.9	81.6	-	-	35.3	-	53.4	50.7	486.5
2063	97.3	21.5	37.1	51.3	170.1	44.5	21.5	16.2	47.8	44.3	45.3	33.7	630.6
2064	18.4	29	56	214.6	157.3	55.5	-	5.2	62.5	3.2	24.4	27.1	653.2
2065	34.2	35.4	48	222.3	171.3	73.5	-	-	-	1.4	43.5	25.4	655
2066	17.3	50.3	19.7	210.2	132	20	-	-	8.2	42	-	21.4	521.1
2067	17.3	43.8	114.4	182.6	43.5	20.3	-	11	31.4	7.1	56.1	11.7	539.2
2068	21.2	70.1	110.5	207.1	24.2	68.9	26.2	-	20.2	18.7	-	18.1	585.2
2069	41	60.4	45.4	196.3	54.7	23.1	1.2	12.1	10.5	35.2	13.3	15.2	508.4
2070	22.4	92.3	57.4	198.3	110.6	5.2	-	13.5	17.1	30.7	30.7	28.6	606.8
2071	15.4	136.5	58.4	186.8	18.3	80.2	-						
Average	37.88	63.97	56.81	216.2	108.52	63.054	16.3	11.6	26.12	41.4	41.11	30.32	

Annex 2: Biological Data

Table 4: List of plant species

S.N.	Sci. Name	Nepali Name	Common Name
1	*Olea cuspidata*	Jaitun/Lautho	Olea
2	*Adhatoda vasica*	Asuro	Malabar Nut
3	*Agave Americana*	Hattibar/Kettuke	Century plant, Agave, American aloe
4	*Berberis aristata*	Chutro	Indian Barberry
5	*Cassia fistula*	Rajbriksha/Amaltas	Golden Shower tree
6	*Celtis australis*	Khari	European Nettle tree
7	*Themeda triandra*	Khar	Rui grass
8	*Colebrokia oppositifolia*	Dhusur	Indian Squirrel Tail
9	*Eucalyptus sp.*	Masala	Lemon Scented Eucalyptus
10	*Euphorbia royleana*	Siundi	Cactus Spurge
11	*Heteropogon Contortus*	Arthunge	black speargrass, **tanglehead**
12	*Jatropha curcas*	Sajiwan	Barbados nut
13	*Melia azederach*	Bakaino	white cedar, chinaberry tree
14	*Salix sp.*	Baisa	Willow tree
15	*Sapium insigne*	Khirro	Tiger's Milk Spruce
16	*Themeda arundinaceae*	Dhaddhi	Ullash grass
17	*Urtica sp.*	Sisnu	Stinging Nettle
18	*Vitex niguldo*	Simali	Indian Privet
19	*Xanthium strumarium*	Bhende kuro	Cockle Bur
20	*Zanthoxylum armatum*	Timur	Nepal Pepper

Table 5: List of Birds and Fauna

Fauna		**Birds**	
Major Mammals	**Threatened**	**Major Birds**	**Threatened**
Barking deer	Black bear	Babbler	Cinerous Vulture
Ghoral	Eurasian otter	Black Kite	Egyptian Vulture
Jackal	Serow	Bulbul	Himalayan Vulture
Monkey	Wild dog	Chukar partridge	Lammergeier
Nepal grey langur		Common kestrel	Satyr tragopan
Porcupine		Dove	Stork
Yellow throated marten		Jungle crow	
		Kalij pheasant	
		Koklass pheasant	
		Partridge	
		Rock pigeon	
		Sparrow	
		Yellow Breasted Greenfinch	

Annex 3: Social Data

Table 6: Total population distribution in project area

Ward No.	Name of Settlement	No. of HH	Population		
			Male	Female	Total
1	Paain	24	79	80	159
	Jansal	17	50	58	108
	Serkot	10	36	37	73
	Dunikuchha	20	43	56	99
	Thipichaur	4	15	9	24
	Total	**75**	**223**	**240**	**463**
2	Dalit Tol	61	184	132	316
	Kolti Bazar	49	144	144	288
	Total	**110**	**328**	**276**	**604**
3	Kolti Bazar	49	161	150	311
	Kolti Bazar	3	13	11	24
	Kolti Bazar	13	42	35	77
	Giri Tol	25	98	80	178
	Damai Tol	25	70	65	135
	Total	**115**	**384**	**341**	**725**
	Grand Total	**300**	**935**	**857**	**1792**

Table 7: House condition based on Roof

Ward No	Roof with thatch grass	Roof with Slate/Tiles	Roof with Galvanized Zinc Sheet	Roof with Concrete Cement	Total
1	25	50	0	0	75
2	95	14	0	0	109
3	72	35	6	2	115

Table 8: Youth Employment

Ward No	Agriculture and Livestock			Business			Service			Wage Labour			Total		
	F	M	T	F	M	T	F	M	T	F	M	T	F	M	T
1	41	29	70	6	7	13	2	6	8	2	11	13	51	53	104
2	12	13	25	6	4	10	0	0	0	1	4	5	19	21	40
3	37	41	78	9	7	16	3	4	7	6	10	16	55	62	117

Table 9: Land Ownership

Ward No	HH No with land ownership					
	Landless	Up to 0.16 ha	0.16-0.37 ha	0.37- 0.68 ha	0.68-2.04	Total
1	0	28	24	23	0	75
2	1	87	17	1	4	110
3	0	50	33	26	6	115

Table 10: Food availability

Ward No	Food Availability			
	up to 3 month	3-6 month	6-9 month	9-12 month
1	34	11	30	
2	67	23	20	

3	22	38	28	17

Table 11: Annual Import and Export of Agriculture products

ward	Agriculture Product				
	Import (Quintal)				Export (Quintal)
	Cereal	Pulses	Oil seed	Vegetable	Vegetable
1	500	230	10	4	4
2	645	120	15	8	6
3	676	124	34	12	5

Table 12: Livestock in study area

Ward	Cow/Ox	Buffalo	Goat	Mule	Chicken	Duck	Beekeeping
1	336	35	59	4	45	5	12
2	220	57	130	0	71	11	15
3	205	96	121	0	38	28	26

Table 13: Annual Income of the study area

Ward No	Agriculture and Livestock	Business & Industry	Service & Pension	Remittance	Wage Labor	Others	Total
1	567654	456740	1265474	128008	126780	0	2544926
2	867567	940000	1586000	0	2115000	80000	5588567
3	973483	837000	2019700	0	2317500	87000	8133493

Table 14: Literacy

Ward No	6-15 Yrs				16-45 Yrs				45-60 Yrs				>60 Yrs			
	Literate		Illiterate		Literate		Illiterate		Literate		Illiterate		Literate		Illiterate	
	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M
1	73	71	7	4	64	71	43	16	6	18	16	14	0	3	11	3
2	74	91	27	13	71	70	84	33	4	5	36	24	0	2	21	9
3	71	79	25	21	52	72	34	13	5	16	28	16	1	5	5	3

Table 15: Educational Institution

Ward No	Primary		Lower Secondary		Secondary		Higher Secondary		College		Total
	Private	Government	Private	Government	Private	Government	Private	Government	Private	Government	
1	2			1							3
2	2	1				1		1		1	6
3		1									1

Table 16: Educational Status

Ward No	SLC			PCL/Higher Secondary			Bachelor/Undergraduate			Graduate			Total		
	F	M	T	F	M	T	F	M	T	F	M	T	F	M	T
1	14	13	27	7	8	15	0	2	2	0	0	0	21	23	44
2	7	18	25	10	12	12	1	1	2	0	0	0	18	31	49
3	22	32	52	14	18	32	3	14	17	1	0	1	40	64	104

Table 17: Diseases and Treatment Status in the VDC

Diseases	No of Patient	Recover after Treatment	Referred	Died
Pneumonia	1045	900	145	2
Diarrhea	40	40	0	0
Tuberculosis	65	50	15	9
Typhoid	335	327	0	8

Table 18: Status of Toilet

Ward No.	No of HH	No of HH with Toilet		No of HH without Toilet
		Kacchi	Pakki	
1	75	35	1	39
2	110	52	1	57
3	115	41	4	70

Table 19: Sources of drinking water

Ward No.	HHs Using Piped water	HHs Using river/canal water
1	60	15
2	110	0
3	112	3

Table 20: HHs as per walking distance for drinking water

Ward No.	Water Available at House	15 Minute walking distance	15-30 minute Walking distance	> 30 minute walking distance
1	30	30	15	0
2	0	45	65	0
3	0	65	47	3

Table 21: Communication services at household level

Ward No.	HH with Radio set	HH with Telephone	HH with Computer
1	86	32	0
2	66	34	0
3	69	49	2

Table 22: Affected households by different hazards

Ward No	Affected HHs		
	Flood	Hailstone	Drought
1	0	75	75
2	109	109	109
3	115	115	115

(Source: VDC profile)

Table 23: List of participants in FGD

S.N.	Name	Organization/Institution	Address	Position
1	Anoj Raj Giri	Jana Prakash Higher Secondary School	Kolti	Principal
2	Arun Poudyal	SAHAS Nepal Consultant		Engineer
3	Bhim B. Karki		Kolti-2	Political Leader
4	Bhimsara Karki	Bhawanimandu CF	Kolti-2	Group Member
5	Devaki Devkota	Samundrapal CF	Kolti-1	Group Member
6	Dhan Bahadur B.K.	Bhawanimandu CF	Kolti-2	Secretary
7	Dhan B. Shrestha	SAHAS Nepal Consultant		Sociologist
8	Dipak Sahani	Ward Citizen Forum		President
9	Hemchandra Sharma	SAHAS Nepal		Project Officer
10	Kashiram Thapa	Market Management Committee	Kolti-1	President
11	Kofila Khatri	Samundrapal CF	Kolti-1	Group Member
12	Manlal Khatri	Bhawanimandu CF	Kolti-3	Group Member
13	Pansa Karki	Samundrapal CF	Kolti-1	President
14	Prem Bahadur Aryal	Hatemalo Sirjansil Boarding School	Kolti-2	Teacher
15	Raju Devkota	Bhawanimandu CF	Kolti-1	Group Member
16	Ramdatta Neupane	Kolti VDC	Kolti	Kolti VDC Secretary
17	Sunil Thapa	SAHAS Nepal		Environment & GIS Expert

Table 24: List of Contacted Persons

S.N.	Name	Address	Institution	Remarks
1	Raghu Sarki	Kolti-2		Local People
2	Jay lal B.K.	Kolti	Illaka Forest Office	Forest Guard
3	Rupu Devkota	Kolti-1		
4	Kashi Ram Thapa	Kolti-1	Market Management	President
5	Dipu Nepali			
6	Birman			Teacher
7	Baldev Regmi	Kolti-3	UML Secretary (District)	Leader
8	Lok Bahadur Bista	Kolti-2	Lumbini Hotel	Enterpreneur
9	Rajkala Aryal	Kolti-2		
10	Deepak Sahani	Kolti-2	Kolti Drinking Water Supply	Secretary
11	Janesh Bhandari			

Table 25: SAHAS Nepal (Project) Staff in Bajura

S.N.	Name	Position
1.	Mr. Hem Chandra Sharma	Project Officer
2.	Mr. Ram Bahadur Khatri	Team Leader

3.	Ganga Bikram Karki	Sub-Overseer
4.	Nain Kumar Pariyar	Admin. and Finance Assistant
5.	Ms. Ambika Shrestha	Auxiliary Nurse Midwife
6.	Ms. Hima Bhatarai	Agriculture Junior Technical Assistant
7.	Mr. Purna Bahadur Bishwokarma	Veterinary Junior Technical Assistant
8.	Mr. Surendra Shahi	Community Development Worker
9.	Mr. Narendra Bahadur Karki	Community Development Worker
10.	Mr. Dhan Bahadur Karki	Community Development Worker
11.	Mr. Prakash Khatri	Community Development Worker
12.	Mr. Sanka Lal Jayse	Office Helper

Annex 4: Minutes

आज मिती २०७१/८/६ का दिन सहयोगी संस्थाको समूह- सहास - नेपाल, बाजुरा - कोल्टीको कार्यालयमा आज कोल्टी बजार [illegible] पहिरो तथा बाढीको प्रकोपले प्रभावित भएकोले सहास केन्द्रिय कार्यालयले [illegible] समूह बनाई उक्त प्रकोपको प्रभावित अध्ययन तथा [illegible] गरि उपयुक्त प्रविधि पहिचान गर्ने क्रममा भएको छलफलमा निम्न व्यक्तिहरुको उपस्थिती रह्यो।

उपस्थिती

	नाम	संस्था/पद	सही
१.	रामदत्त [illegible]	कोल्टी [illegible] सचिव	
२.	काशीराम थापा	कै. [illegible] १ बजार	
३.	दीपक साहनी	जनजागरी मञ्च अध्यक्ष	
४.			
५.	अनेज राज गिरी	जनप्रकाश उ.मा.वि. कोल्टी - प्राचार्य	
६.	मनकाली खत्री	कोल्टी ३ युवा	
७.	देवकी देवकोटा	,, १	
८.	कोकीला खत्री	,, १	कोकीला
९.	निस्सरा काकी	,, २	निस्सरा काकी
१०	रामु देवकोटा	,, १	
११	पार्वती काकी		
१२	धन बहादुर [illegible]	[illegible] माल्पा सजीली	
१३	प्रेम बहादुर अर्याल	कोल्टी-२ बुद्धिजिवी	
१४	भीम बहादुर काकी	कोल्टी २ समाजसेवी	
१५	अरुण पौड्याल	सिभिल इन्जिनियर consultant	
१६	सुनिल थापा	सहास नेपाल, [illegible]	
१७	[illegible]	consultant, सहास नेपाल	
१८	हेमचन्द्र शर्मा	Project officer, SAHAS Nepal	

छलफल

१. [illegible] कोल्टी क्षेत्रमा भएको बाढी पहिरो सम्बन्धि विस्तृत छलफल सुरुवात भयो।

2. उक्त समस्या प्रस्तुत हुँदा मानविय क्रियाकलापको साथ साथै जलवायु परिवर्तनका कारणले भएको हुँदा यहाँ स्थित तिनवटै सामुदायिक वनहरु क्रमश: भवानी माई, सप्तप्रपात र ठाडोभेलो मार्फत संरक्षणका कार्यक्रम संचालन गर्नका लागि आवश्यक कदम चाल्नेबारे छलफल सम्पन्न भयो।

3. मुख्य समस्या भूक्षय नै हो भन्ने पहिचान गरिसकिएकोले उक्त समस्या न्यूनिकरण गर्न वृक्षरोपण, तारजालि तथा चेकड्याम निर्माणको लागि सहास नेपाल लगायत अन्य संघ संस्थाहरु पहिचान गरि समूहगत रुपमा सहयोगको लागि अनुरोध गर्ने र समुहको तर्फबाट यहाँको स्थानिय समुदायहरुलाई परिचालन गरि ढुंगा निकाल्ने, चरिचरण लगायतका कार्यलाई तत्काल रोक्ने गरि छलफल आगामि बढाउन पहल गर्ने प्रतिबद्धता जाहेर गरियो।

4. स्थलगत अध्ययन अनुसार आएको प्रतिवेदन एक महिना भित्रमा स्थानिय समुदायलाई उपलब्ध गराउ त्यहाँ उल्लेखित भूक्षय न्यूनिकरणका उपायहरु बारे स्थानिय समुदायलाई जानकारी दिने व्यवस्था प्रतिबद्धता जाहेर गरियो।

Annex 5: Photos

1.Recording GPS coordinates of penetration test sites

2. Big gully erosion

3. Agave americana

4. Jatropa curcas

5. Zanthoxylum armatum

6. Destruction of Nursery

7. Kolti Range Post

8. Debris materials in health post

9. House buried after debris flow

10. More damaged households as a result of debris flow

11. Army men briefing the impact of landslides

12. Discussion with local people

13. Discussion with the school teachers

14. Kolti Settlement

15. Kolti VDC fertile agricultural land

16. Excessive stone collection

17. Local people lining up for a packet of salt

18. Study team with SAHAS Bajura staffs