Landslide Disaster Management in Nepal

A Near-future perspective

Prepared by

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CHAPTER I

INTRODUCTION

1.1 Background

Nepal is a mountainous country which covers about 15% area by snow capped mountains Himalayan Region (altitude 4877-8848m), 68% area by hills and mountains including inner valleys, (altitude 610-4877m) and remaining 17% by Terai region (altitude 60-610m) Figure 1.1, (Nepal information, webpage: http://www.nepalinformation.com/geography.htm). The Natural disaster is a common phenomenon in various part of the world. The rugged mountain topography and fragile geology of young Himalayan Mountains are subject to frequent soil erosion, high intensity monsoon rainfall (The average annual is about 1600mm and in the central region of the country ranges from 2000mm to 3000mm) and earth tremor, all of which contribute to severe landslide problems. Moreover the unscheduled cloudburst rain due to climate change reveals additional threatening of catastrophic disasters. Losses from natural disasters are on the increase due to rapid population growth and improper planning of infrastructure building activities in context of Nepal

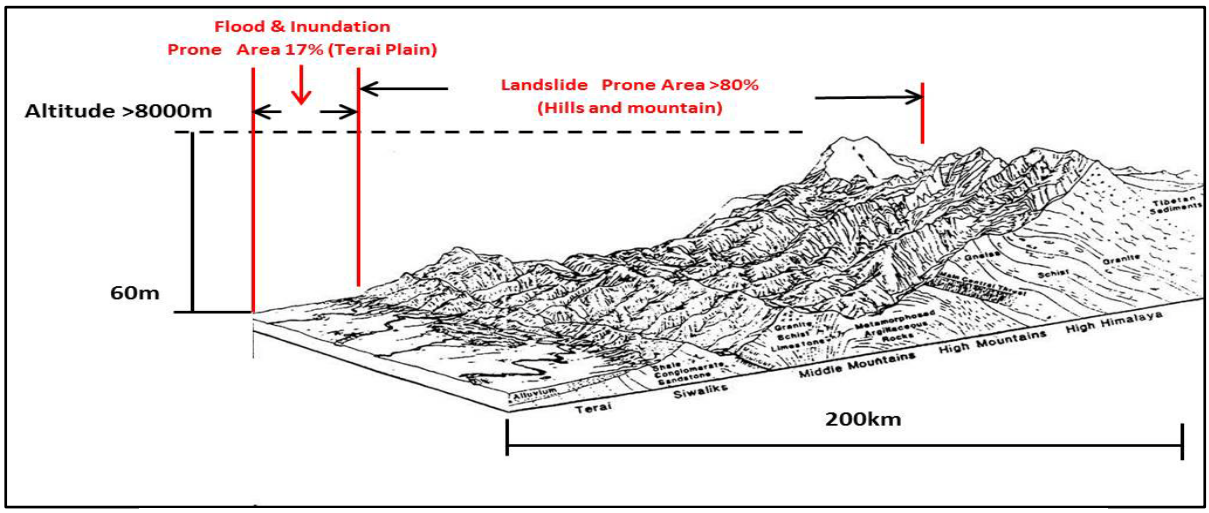


Figure 1.1: Physiographic region of Nepal (Amatya SC and Joshi J., 2015)

A huge variation of topography from low lying areas of the Terai plain with an altitude of less than 60m in the south to the higher Himalayas with an altitude of about 8848m in the north within an average lateral distance of 200 km characterizes the steep topography of Nepal. The agricultural terraces in the hills which cover about

68% are being either eroded or covered by debris of landslide and they require heavy effort for yearly maintenance. The conditions like rapid population growth, lack of education, deforestation, and intensive agricultural practices even in hill slopes and over grazing have increased the vulnerability of the landscape due to frequent landslides and soil erosion problems. Besides, the non-uniform precipitation during the four months of monsoon further enhances the problem of frequent water induced disasters. These landslides have mostly affected the development of infrastructures, and lives and properties of the people of Nepal. Besides, they have also given rise to most of socio-economic problems, like deforestation, intensive agricultural practices.etc.

The Siwalik Hills which is the southernmost hill range of the Himalaya consisting of mainly unconsolidated conglomerate, sandstone, and mudstone. So the geology in this range is very weak and fragile. Moreover the deforestation is increasing in this area due to encroaching by village and farm land. Thus the Siwalik range is becoming more vulnerable and prone to slope failure and debris flow as well as flash floods in Nepal (Upreti B.N. and Dhital M.R. 1996). One can find the fan deposits in the foot hills of the Siwalik range due to flash flood and widening of the river and starts to bank erosion in the downstream plain area (Ghimire, S. and Higaki, D., 2012).

As per the disaster data from Ministry of Home Affairs in year 2071 BS (2014/15 AD), the total casualties due to different types of disaster in Nepal were 529, (Figure 1.2) of which the casualties due to landslide and flood (water induced disasters) only covers about 50% of the total loss of human lives from disasters in Nepal.

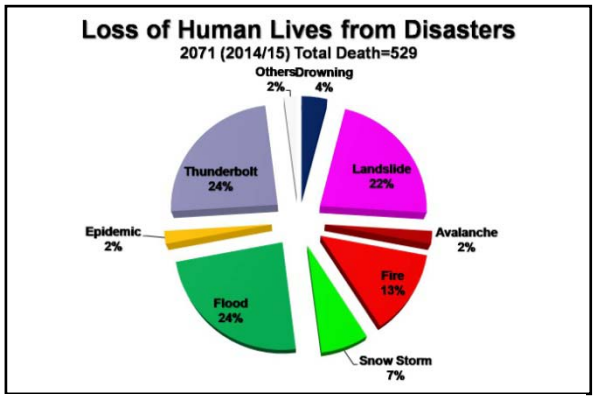


Figure 1.2: Casualties due to different disasters in Nepal, (MoHA 2016)

The recent outstanding water induced sediment related disaster and river disaster events in Nepal can be noted as follows. The photographs of those disasters are presented in Annex III.

Flood and landslide in Bhotekoshi 2016: This disaster occurred on July 6, 2016. More than 200 houses were swept away by the flood and bank cutting at Larcha to Liping of Tatopani VDC. The Flood in the Bhote Koshi River was triggered by heavy rains (and could be snow avalanche) across the border in China, (The Himalayan Times, July 07, 2016). The location of the disasters is shown in figure 1.3.

Gorkha Earthquake 2015: The Gorkha Earthquake in Nepal on April 25, 2015 and May12, 2015 killed 8,962 people and 22,302 people injured. (http://drrportal.gov.np). The location of the disaster is shown in figure 1.3.

Taplejung Landslides 2015: The Taplejung district is prominent for the biggest landslide area in Nepal, namely Hangdewa and Hireba Landslides which were started since 1931 and considerably extended since 1934 Nepal-Bihar earthquake (January 15, 1934). The landslides affected about 200 houses periodically to date and had migrated to other places (according to the local users committee chairman Mr. Yogesh Bhattari). Moreover, the Taplejung landslide which occurred on June 10, 2015 was debris flow and mud flow type of mass movement. It killed 53 people. It affected the entire area of Liwang, Khokling, Thinglabu and Lingtep VDCs. (Recent National Disasters 2015). The location of the disaster is shown in figure 1.3.
(*http://www.disaster-report.com/2015/06/taplejung-nepal-mudslide-disaster.html)*

Jure Landslide 2014: The Jure Landslide occurred on August 2, 2014, The width and length of the landslide was about 850m and 1200m respectively with about 25m depth. The landslide created a landslide dam on the Sunkoshi River with reservoir volume of about 8Mcu.m. The dam was breached in managed way by Nepal Army with technical support of DWIDP, DMG and DHM. The disaster killed 156 people with about more than 40 houses were buried. The rainfall at Barhabise station about 3 km upstream from the event point was recorded as 164.2mm (from July 30-August 2), (Amatya, S.C. (Ed.), 2014). The location of the disaster is shown in figure 1.3

Darchula Flash flood 2013: The Darchula Flash flood was occurred from June 16, 2013. Nine people were killed and more than 4400 people were affected, (EHA-WCO Nepal Emergency Situation Report, ESR-1, 2013). The rainfall in that period was about 305mm (from June 16-19, 2013)(Paudel, P.et al, 2013). The location of the disaster is shown in figure 1.3.

Seti Flash flood 2012: The devastating Seti Flash flood occurred on May 5, 2012. A huge rockslide with ice near Machhapuchhre Mountain in Kaski district triggered a catastrophic flash flood in Seti River, sweeping the settlements and breaching of a temporary river blockage downstream on 05 May 2012 at around 0930AM in Kharapani village, Sardikhola Village Development Committee (VDC) and Sadal village in Machhapuchhre VDC are worstly hit by the powerful outburst. (OCHA Humanitarian Support Unit Nepal 2012*)*.The disaster killed 72 persons and a significant damage to infrastructure and property (Gurung N., 2012), (Oi et al, J.). The Bird's eye view of the Seti watershed and photographs of analysis of the Seti Flash Flood Disaster 2012 are presented in Annex IV (Oi et al, J.). The location map of the disasters is shown in figure 1.3.

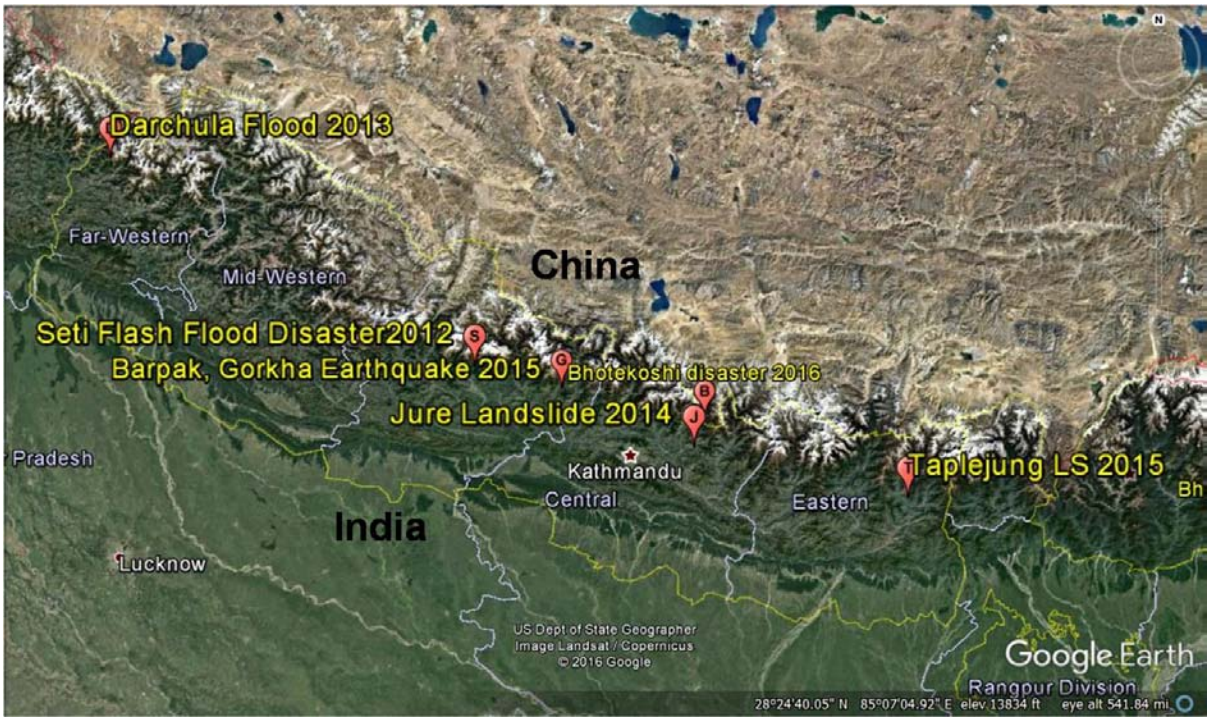


Figure 1.3: Map of Nepal with Location of recent outstanding water induced disasters (red balloons)

The analysis of losses of life and property due to landslide and flood disasters in Nepal from 2009/10 to 2015/16, 7 year (2066-72) is shown in figure1.4 (Source: MoHA). The figure shows that the casulties due to landslide is higher than that of flood. But the property losses are much higher due to floods than that of landslides.

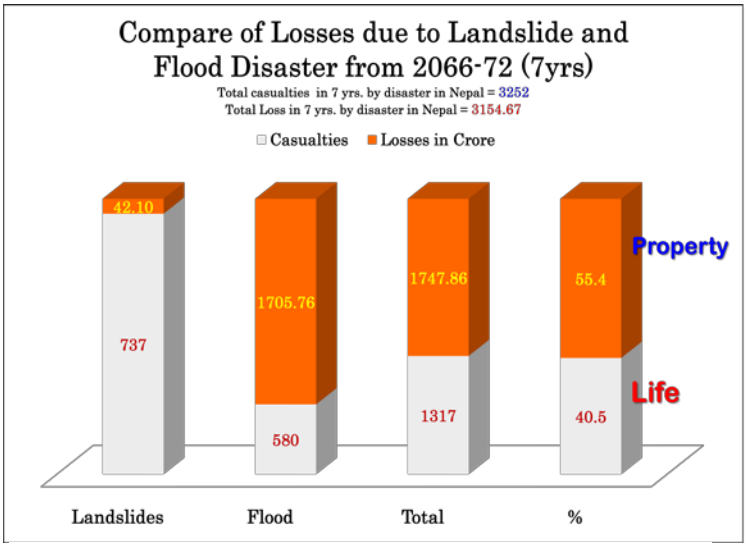


Figure 1.4: Losses of Life and property due to Landslide

As Nepal suffers from various types of water-induced disasters such as landslides, debris flow, slope failure, flood, bank erosion and so on due to its rugged topographically weak geological formations, active seismic conditions, occasional glacier lake outburst floods, concentrated monsoon rains associated with unscientific land utilizations, impacts on the vital infrastructures of the nation, human lives and properties and posing a severe threat to the sustainable development of the country. To address such type of disaster issues, the Water Induced Disaster Prevention Technical Centre (DPTC) was established under then Ministry of Water Resources (presently, Ministry of

Irrigation) with cooperation of Government of Japan on October 7th, 1991. To institutionalize the objective and achievement of DPTC, the Department of Water Induced Disaster Prevention (DWIDP) was established on February 7th, 2000 and it was changed to Department of Water Induced Disaster Management (DWIDM) and in addition, the Landslide Study and Management Division looked over by Deputy Director General (DDG) was establishment within the Department in FY 2015/16. The model sites for disaster phenomena and their countermeasures were implemented for water induced disaster management in different locations of Nepal by the DPTC and earlier period of DMSP/DWIDP. The location map of the Model sites is shown in the figure 1.5. The major model sites were listed as;

1. Deep-seated landslide Model site work using SABO toe protection works at Ilam Landslide (62km) along Charali-Illam Road, Ilam District, **(Ilam Landslide Model site, DPTC).**
2. Landslide Model site work using SABO check-dams at Amare landslide (48km) and Okharpauwa Landslide (19 km) along Kathmandu-Trishuli Road, **(19km and 48km landslide Model site, DPTC).**
3. Landslide model site work using SABO check-dams at Right bank of Tinau River at upstream, Butwal Bazar, Lumbini District**, (Butwal Model site, DPTC).**
4. *River training Model site work using embankments* at Dodhara-Chandani, Mahakali River, Kanchanpur District, **(Mahakali River training Model site, DPTC).**
5. *River training and bioengineering works using SABO guide bank, spurs and check*-dams (with establishment of nursery for bio-engineering) at Girubari, Nawalparasi District, (**Girubari Model site, DMSP/DWIDP).**
6. River training and gully erosion protection works using SABO embankment, SABO check-dams and bioengineering works at Khajuri and Musar Khola watershed, Udaypur District, **(Udayapur Model Sites, DMSP/DWIDP).**
7. *Slope failure and Bioengineering works using SABO check-dams* at Dahachowk, Kathmandu District, **(Dahachowk Model site, DMSP/DWIDP)**
8. *Debris flow Model site work using SABO series of check-dams* at Matatirtha, Kathmandu District, **Matatirtha Model site, DMSP/DWIDP).**

9. Landslide and River training Model site work using SABO toe protection and guide bank at Bungmatee, tributary of Bagmatee River, Lalitpur District, **(Bagmatee Model site, DMSP/DWIDP).**
10. Landslide and Slope failure Model site works using SABO toe protection and check-dams at Kathmandu-Naubise highway (at 7 chainages sites, 12+800, 13+000, 13+050, 13+500, 15+250, 15+300, 15+350, 17+000), **(Naubise Model site, DMSP/DWIDP).**

Figure 1.5: Map of Nepal with Location of Model Sites (in red balloons)

11. Debris flow and gully erosion protection Model site works using SABO check-dams at Lele, Lalitpur District, **(Nallu Model site, DMSP/DWIDP).**
12. Gully and surface erosion protection Model site works using SABO check-dams and bioengineering at Pipaltar, Nuwakot District, **(Pipaltar Model Site, DMSP/DWIDP).**

Thus, the DPTC/DWIDP personnel and local people learned the utilization of appropriate SABO Technologies for both surveying/monitoring, remedial and preventive works and awareness creation among people as well in appropriate places from the successfully constructed model sites.

The utilization of the SABO technology in Nepal through the DPTC/DMSP/DWIDP/DWIDM is found successful, suitable and environment friendly so that he SABO technology is replicating more frequently to water induced

disaster areas of Nepal and gaining popularity. In the result, this technology is spreading very quickly all over the country successfully. The national highway construction projects of Mugling-Narayanghat (MuNa) and Sindhuli Bardibas (SiBa) are the evidence of them. Some evidences of successful photos are presented in the Annex II.

1.2 Objectives/Activities/Output

NFAD (Nepal-Japan Friendship Association on Water Induced Disaster Prevention) considers supporting activities of DWIDM to reduce water induced disasters in Nepal according to its mandate, with rather limited available resources. Since the Landslide Division was recently established in DWIDM, it is quite important to proceed to reduce landslide (erosion and sedimentation) disasters at this time. It should also be noted that in accordance with “Sendai Framework for DRR” and “Recommendations of International SABO Symposium 2015 in Sendai”, each country is preparing national plan for disaster reduction for 2016-2030. Meanwhile, the Division chief, Mr. S. C. Amatya who has developed landslide mitigation technology for many years in DWIDM retires in 2016. The Expertise knowledge and experiences in landslides which has been accumulated in DWIDM should be transferred to new generation of technical staff responsible for landslide disaster in DWIDM and to the society of disaster management in Nepal. Considering the present situation mentioned above, NFAD requested DWIDM to propose through a report on near-future perspectives for landslide management in Nepal.

1.3 Implementation Framework

The Implementing formation of DWIDM at present is as per the organization structure presented in Figure 1.6 below. The total manpower in the Department is 534 out of which the number of technical staff is 350 and the number of non-technical staff is 184in 2016 AD. The level-wise break down of the staff number is given in the table 1.1 below.

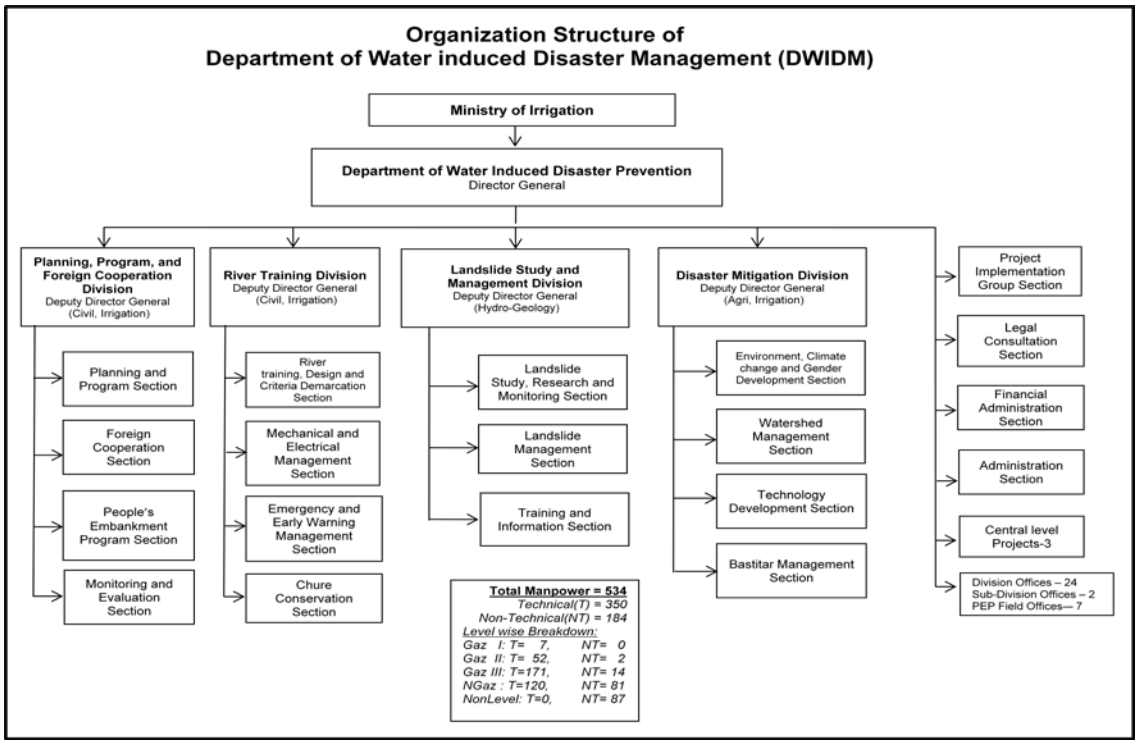


Figure 1.6: Organizational Structure of DWIDM (source: DWIDM)

Table 1.1. Level wise Breakdown of Staff Number: (source: DWIDM)

Level	**Technical Staff Number.**	**Non-Technical staff Number.**
Gazetted Officer I	7	0
Gazetted Officer II	52	2
Gazetted Officer III	171	14
Non-Gazetted I	120	81
Non Level	0	87
Total = 534	**350**	**184**

1.4 Issues and challenges

Although huge amount of fund has been invested by the government for disaster management field every year, the landslide is not treated as one of the important parameters during the planning and designing stage. Even if treated, it is done without detailed study and investigation which further enhances the problem. The

landslide is affecting the national infrastructures like hilly highways, roads, settlements and even hydropower enormously in every monsoon season which has been enhancing the development and poverty alleviation of the country. So development of appropriate and sustainable technology suitable for various types of landslide is vital for the reduction of landslide disaster in the country. In this regards, there are many challenges that have to be noticed.

Responsible Institution for Landslide Disaster

Ministry of Home Affairs (MoHA) is only the Government agency which has been looking over all the disasters of Nepal. The MoHA acts as National Focal Agency on Disaster Management and it is responsible lead agency for implementation of the Natural Calamity (Relief) Act, 1982. As per the Act, MoHA is responsible in the area of rescue and relief work during disaster, disaster data management and management of collected funds and resources for disaster victims. After the disaster the reconstruction/rehabilitation of the natural disaster area, Risk Assessment, study and investigation of disaster area for countermeasures, disaster prevention/mitigation and preparedness sectors are not mentioned in the Natural Calamity relief Act 1982. So, MoHA does not look over those sectors. More over those sectors are scientific and technical part and MoHA do not have any technical man power recruited.

In this regard, among the natural disasters, the GLOF disaster management has been looked over by Department of Hydrology and Meteorology (DHM), Ministry of Population and Environment, the Department of Water Induced Disaster Management (DWIDM), Ministry of Irrigation has been looking over the deep seated landslide and flood disaster management in Nepal and the shallow seated landslides in watershed management and soil conservation works by Department of Soil Conservation and Watershed Management (DSCWM), Ministry of Forestry.

As we know, in Nepal, more than 80% land is covered by mountainous area and that are prone to landslide. The casualties due to landslide disaster covers about 25% of total disaster in Nepal and from the disaster data analysis it is found that the casualties due to landslide disaster in Nepal is very high in compare to flood disaster. To address the landslide disaster management, the country is in need of Landslide Inventory Map of all over the country and the Landslide Hazard maps with zoning of selected hot spots. The planning of structural and non-structural countermeasures, preparation of Land use map and early warning system (EWS) planning works in the Landslide hazard areas will be possible only after preparation of the Landslide Hazard Maps of the country. The catastrophic Jure landslide can be considered as a national issue in Nepal. The longitudinally and transversally ridge shaped convex slope is considered to be over burdened. The ridge is composed of highly fractured

and weathered due to gravitational deformation for long period. The source area of Jure landslide coincides with the slope of such geomorphological and geological conditions which were prone to landslide. However, we should pay more attention to surface ruptures or shallow landslide occurred at the base of source area and its marginal part for longer than 20 years. They were a precursor signs of a big landslide (Yagi et.al.). As per the local people, the university excursion team and Nepal Red Cross Society team used to say that the Jure landslide was slowly moving since many year, so the local people needed to be move to safe side. Thus if the authentic governmental institute could study and forecast those situations before the event, at least the life of the people can be saved. The Jure landslide formed landslide damming to Sunkoshi River which had threatened to the upstream and downstream people. In that condition, the authentic government agency did not have any preparation of technology, equipments and experts about them due to which the authentic agency faced big problem. In this regard, to address the management of Landslide disaster in Nepal, it was felt that a responsible national institute/agency has to be established and Landslide Disaster Management strategy in Nepal should be formulated. At present, the Government of Nepal just established the Landslide Study and Management Division looked over by Deputy Director General (DDG) under Department of Water Induced Disaster Management, Ministry of Irrigation since the fiscal year 2015/16 to address the landslide disaster issues in Nepal.

Prioritization of Landslide Disaster Management in National Plan of Nepal.

The Landslide disaster management works were initiated in Nepal since the establishment of DPTC under the then Ministry of Water Resources, Government of Nepal. The disaster data of MoHA shows that in average more than 100 people are killed by Landslide disaster each year. The hills and mountain areas in Nepal cover 83% most of which are prone to landslide. (Pariyar, D., 2008). The landslide in Nepal is damaging the national infrastructure, settlements, and life and property losses each year which directly affecting to the development and poverty alleviation plan of the country. In this context the 13ththree year plan of Nepal and the recent 14th three year plan of Nepal mentioned about Water Induced Disaster in Nepal as;

The 13th Three Year Plan of Nepal (FY 2013/14 – 2015/16) mentioned the Water Induced Disaster with the *objective:* To protect human settlements, arable land and built infrastructures by minimizing the impacts of water-induced disasters. And the *Expected Outcome: as,* Embankment protection, arable land, physical infrastructure and human settlements protection, land reclamation, hazard map preparation of six watershed areas, and implementation of landslides and sediment-flow mitigation activities.

The 14th Three Year Plan, Base paper (FY 2016/17-2018/19) mentioned the Water Induced Disaster with the *Goal:* To mitigate the loss of life, property and damaged infrastructures due to different types of water induced disaster, the mitigation and management of water induced disaster will be implemented and help to promote the employment and poverty alleviation. And the *Strategy:*1) Improvement of policy and institutional management to make effective Water induced Disaster management. 2) Identify, develop and extend the appropriate technology for effective Disaster control (unofficial translation).

The 13th Plan of Nepal mentioned very few about landslide disaster management. Besides that the 14th Plan of Nepal mentioned few more about policy, institutional and technology development for water induced disaster management in Nepal. Thus, it is so vague about landslide disaster management vision in the National Plan.

To address the landslide disaster management in Nepal, we have to prepare so many factors related to landslide disasters as, landslide inventory map, landslide hazard map, land use map of landslide, analysis of the property of soil and rock for landslide, threshold value of rainfall for landslide, appropriate early warning systems for landslide, development of appropriate countermeasure technologies, and appropriate data management and so on which are very much preliminary stage at present in Nepal and it needs a bulk of allocation of budget with detail plan. In this regard, the National Plan of Nepal needs to prioritize the Landslide disaster management in Nepal.

National Strategy of landslide Disaster Management in Nepal

Since the vision for landslide disaster management in the National Plan of Nepal is much vague and on the other side the information about the landslide in Nepal is in very preliminary stage. More over the trained manpower and experts related to landslide are very limited. In this relation, to address the landslide disaster management in Nepal with sustainable future perspective, establishment of the National Strategy of landslide disaster management in Nepal is needed on the base of "Hyogo Framework of Action (HFA 2005-2015)" and "Sendai Framework for Disaster Risk Reduction 2015–2030" and "Recommendation from the International SABO Symposium 2015 in Sendai (18 March 2015), Japan". Nevertheless, the National Strategy for Disaster Risk Management in Nepal was established by Government of Nepal on 2009 with the base of Hyogo Framework of Action (HFA 2005-2015).

Policy, Act, Rules and Regulation of landslide disaster management

Recently the Government of Nepal established the Water Induced Disaster Management Policy 2072 since the FY 2015/16 through Department of Water

Induced Disaster Management, Ministry of Irrigation which covers the river disaster management and landslide disaster management in Nepal. Besides the Policy, Acts, Rules and Regulation of landslide disaster management is needed to be established in community level to control the human casualties in the disaster area.

REFERENCE

AN APPROACH PAPER TO THE THIRTEENTH PLAN,(FY 2013/14– 2015/16), Government of Nepal National Planning Commission, Singha Durbar, Kathmandu, Nepal, July, 2013

Amatya S.C. and Joshi, J., 2015, Landslide Treatment in Nepal: by DWIDP/DSCWM, Consultative Workshop on Landslide Inventory, Risk Assessment and Mitigation in Nepal 28-29September 2015, ICIMOD, *(www.icimod.org/resources/19798)*.

Amatya, S.C. (Ed.), 2014, Report on Jure Landslide, Mankha VDC, Sindhupalchowk District, Ministry of Irrigation, Government of Nepal.

Basic Approach Paper to the Fourteenth Plan,(FY 2016/17– 2018/19), Government of Nepal National Planning Commission, Singha Durbar, Kathmandu, Nepal,2016

DPTC 1999, A Technical Guideline on Landslide Mitigation Work, Water Induced Disaster Prevention Technical Center, Ministry of Water Resources, and Government of Nepal.

EHA-WCO Nepal Emergency Situation Report, ESR-1, 2013, Flash flood and Landslides in Far Western Region, Nepal, World Health Organization, Country Office Nepal.

Ghimire S. and Higaki D., 2012, Soil and Water Conservation, A focus on Siwalik Hills of Nepal Himalaya, Siwalik Hills Research and Development Group (SIRED), GPO Box,9200, Kathmandu, Nepal.

Gurung N 2012, Causes and Effects of Seti River Flash Flood 2012,Kadoorie Agricultural Aid Association, British Gurkhas , Pokhara, Kaski, Nepal

Hyogo Framework for Action 2005-2015:Building the Resilience of Nations and Communities to Disasters, International Strategy for Disaster ReductionISDR. www.unisdr.org/wcdr

MoHA 2016, Disaster Data 2068 to 2072 MoHA GON, May 18, 2016. *(http/neoc.gov.np/uploads/newsfile/Five%20year%20data_20160623112212)*

Natural Calamity (Relief) Act. 2039 B.S. (1982) (including First Amendment Act, 2046 and Second Amendment Act, 2049), Nepal

National Strategy for Disaster RiskManagement in Nepal 2009, Government of Nepal,UNDP, EU and NSET.

OCHA Humanitarian Support Unit, Nepal 2012: Updates on the Flooding in Seti River Situation Report-01, 06 May 2012, OCHA Humanitarian Support Unit Nepal.

OI, H., HIGAKI, D., YAGI, H., USUKI, N. and K. YOSHINO, 2014, Report of the investigation of the flood disaster that occurred on May 5, 2012 along the Seti River in Nepal, International Journal of Erosion Control Engineering Vol.7, No. 4, pp.111-117, 2014

Pariyar, D., 2008,Country Pasture/Forage Resource Profiles Nepal, FAO 2008.

Paudel, P., Regmee, S.B., Upadyaya, S.N., 2013, Overview of June 2013 Flood and Landslide with focus on Darchula Disaster, Jalsrot Vikas Sanstha(JVS)/GWP, Nepal.

Recent Natural Disasters 2015, Nepal: Devasting Taplejung Landslide kills 53, Recent Natural Disaster June 11, 2015, Nepal.

Recommendation from the International SABO Symposium 2015 in Sendai (18 March 2015), Japan

Sendai Framework for Disaster Risk Reduction 2015-2030, United Nations

The Himalayan Times, July 07, 2016, Floods in Bhotekoshi wreak havoc, The Himalayan Times, Nepal.

Upreti, B.N. and Dhital, M.R. 1996, Landslide Studies and Management in Nepal, International Centre for Integrated Mountain Development (ICIMOD), Kathmandu, Nepal.

YAGI H. (Yamagata Univ.), SATO G. (Teikyo Heisei Univ.), HIGAKI D. (Hirosaki Univ.), AMATYA S.C. (DWIDP, Nepal) and DANGOL V. (Trichandra Campus, Tribhuvan University), Geomorphological and geological background of Jure landslide and a subsequent natural damming of Sun Kosi river, central Nepal, occurred in August 2014.

CHAPTER II

RECENT STATUS OF LANDSLIDE DISASTER MANAGEMENT IN NEPAL

2.1 Recent phenomenon of disastrous landslides

Rainfalls that provoke mass movements are part of natural process of erosion that can result in catastrophic loss of life, extensive property damage and environmental degradation in mountainous with densely populated area each year. As population expansion on or near steep hill slope continues, the human and economic cost associate with sediment-related disaster will increase.

Since Nepal is situated on the region of tectonic collision of Indian and Tibetan plates, there are so many considerable big faults and fractures in Nepal like Main Central Thrust (MCT), Main Boundary Thrust (MBT), Himalayan Frontal Thrust (HFT) and so on. In this way, Nepal is a potential Earthquake prone area. There are so many catastrophic earthquake events in Nepal and the latest one is the Gorkha Earthquake 2015 with 7.8magnitudeswhichcaused 8,891 dead, 22,302injured and forming thousands of earthquake induced landslides affecting to many settlements, agricultural lands, national highways and infrastructures.

Nepal is facing not only the natural disasters but the man-made landslide disasters as well. The landslide occurred due to road slope cutting, landslide due to leakage of irrigation water, slope failure and debris flow due to deforestation and forest fire are the considerable area of instances.

In this way, Nepal is facing different types of considerable catastrophic natural as well as anthropogenic landslide disasters.

2.1.1 Catastrophic disasters (caused by extremely heavy rainfall, earthquake, others) Ex. Annapurna LS-Seti flash flood, Jure LS, Gorkha EQ

In Nepal, the water induced disasters (landslide/debris flow, slope failure and flood) are constantly threatening the human lives, properties and infrastructures. These phenomena have resulted into disastrous events during the monsoon period. Monsoon precipitation being one of the major parts of the climate and the climate change on the other hand is more prominent in this time which frightening to the water induced disaster field in Nepal. The people are living in the young and fragile mountainous terrain with steep and rugged morphology including numerous fault

and fracture zones which are prone to sediment related water induced disasters, such as slope failure, debris flow, and landslide. The erosion process (landslide, soil erosion etc.) are constantly affecting the settlement and infrastructures such as road, bridge, Highways, Hydropower, Irrigation Canal, Agricultural land built in the hilly terrain of Nepal Himalaya giving threats to Development of the Country. Few instances of catastrophic water induced disasters in Nepal are;

- **Jure Landslide** and **Natural Dam,** Sindhupalchowk, occurred on August 2, 2014 killed 156 people and dammed the Sukoshi River.
  - Affected Arniko Highway and Sunkoshi Hydropower, settlement, and agricultural lands
- **Hangdewa and Hireba Landslide,** Taplejungwhich were started since 1931 and considerably extended since 1934 earthquake (January 15, 1934), migrated people of about 200 houses. And the **Taplejung Debris flow** occurred on June 10, 2015 killed 53 people. (According to the user's committee chairman, Mr. Yogesh Bhattari).
  - Affected Airport, headquarter, residents and agricultural lands
- **Ramche Landslide,** Rasuwa, activated in 1983 and reactivated on August 14, 2003, night killed 23 army camp people, dammed the Trishuli River for many hours. (Ghimire, T. et. al, 2007).
  - Affected Pasang Lhamu Highway, agricultural land and settlement
- **Taprang Landslide (Local name: Nanuko Pahiro)**, Kaski, activated since the 1934 earthquake with periodical minor movements each year. It was reactivated on August 3, 2010, 8:45 AM due to torrential rainfall which had been dammed the Madi River for 5 hours, killed 5 persons, affected ninety houses and local infrastructures and threatened to downstream areas (according to the user's committee chairman Mr. Deo Gurung and Rikesh Gurung).
  - Affected the Pokhara-Taprang highway with historic settlement of Gurung and Sildujure settlement and agricultural land.
- **Sheri Landslide and Rara Lake area Landslide,** Mugu started due to 7.0 magnitude earthquake, 24 km from Dārchulā**,** Western Region**,** Nepal on Monday, August 28 1916 12:24 PM, 100 years ago, (according to the users committee chairman Mr. Hemraj Malla). *(http://earthquaketrack.com/quakes/1916-08-28-06-39-41-utc-7-0-20).*
  - Affecting the Headquarter, settlement, agricultural land, environment and tourism industry.

- **Other Big Landslides** as
  Gyapche Landslide, Ramechhap activated since July 1954,
  Kerunge Landslide, Nawalparasi activated due to earthquake on 1961 and periodically moved down slowly in each rainy season and reactivated on July 2006 due to torrential rainfall affected Shivamandir, Argyauli and Kawasori VDCs,
  Kapurkot Landslide, Salyan, started to activate since 1981 and periodically moved down slowly in each rainy season and reactivated on July 1985 due to torrential rainfall.
  Myagdi Landslide, Myagdi**, Subeda Landslide**, Bajhang, **Baglung Landslide**, Baglung and so on
  - Affected settlements, road and agricultural lands.
- **Seti River Flash Flood,** Kaski, occurred on May 5, 2012 killed 72 persons.
  - Affected Kharapani and Sadal Village, infrastructures and agricultural land.
- **Darchula Flood,** Darchula, occurred on June 16, 2013 killed nine people.
- **Banke flood** occurred on August 13, 2014 killed 15 people and affected all the 44 VDCs and 2 Municipality.
  - Affected huge area of agricultural land and settlement.
- **Bardiya flood** occurred on August 13, 2014 killed 32 and affected all the 23 VDCs and Municipality. and so on
  - Affected huge area of agricultural land and settlement.

The recent Gorkha Earthquake 2015 caused Earthquake induced landslides in many settlements, agricultural lands, National highways and infrastructures of the country which threatened the country very wickedly. The Study team under J-rapid program found that the Gorkha Earthquake created 13,097 new earthquake induced landslides (Chigira, M. et al) which were concentrated mainly in river valleys in hard rock like dolomite, Benighat slate, and gneiss. The earthquake induced landslides were shallow in depth and located mainly in more than 36^{o} slopes. (Chigira, M. and Dangol, V.2016), *(http://www.jst.go.jp/inter/sicp/country/j-rapid/nepal/pdf/j-rapid_nepal_chigira.pdf).*

2.1.2 Monsoon-induced disasters (normal but frequent occurrences) (Climatic changes which are indicated by increases in frequency of heavy rainfall, extension of monsoon, increase in scale and intensity of disasters may be included.)

The average annual rainfall pattern of Nepal is shown in (Figure.2.1). The figure shows an erratic pattern of average annual rainfall. There is neither increasing pattern nor decreasing pattern. The Erratic average rainfall events in Nepal exhibits

higher intensity of rains but less number of rainy days and unusual rain with no decrease in total amount of annual precipitation. Such events increase possibility of climatic extremes like irregular monsoon pattern which will create droughts, floods, inundation and landslides (G. Malla 2008).

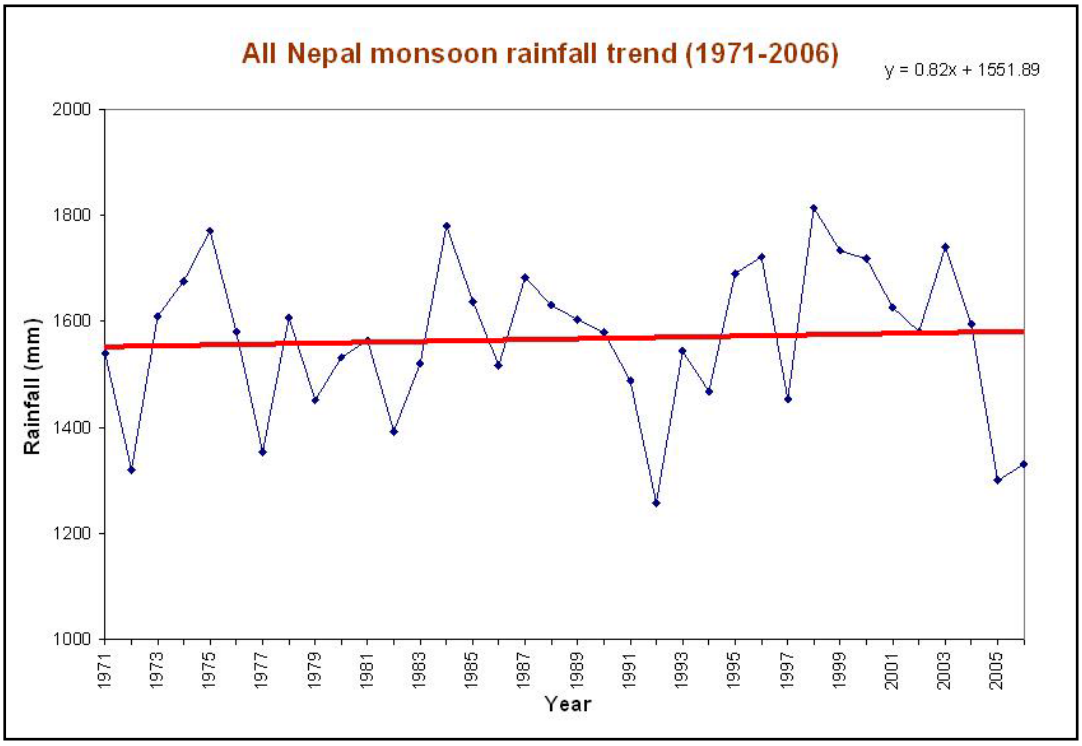


Figure 2.1 Trend of total precipitation (G. Malla 2008)

In Nepal, the Monsoon normally starts in the second week of June (June 10) and reaches full development in July and ends on 4rd week of September (September 23). Monsoon is the wettest season and main source of precipitation in Nepal, which enters from eastern part of the country. The effect of monsoon is prominent in the eastern half of the country and the western half especially the northern parts of mid-western development region are generally drier compared to the eastern half. As the monsoon enters Nepal, topography plays an important role for the distribution of precipitation ranging from about 150 mm to over 5000 mm per annum. Out of which about 80% of the annual precipitation falls during this period which helps to generate water induced disasters like flood and landslides.

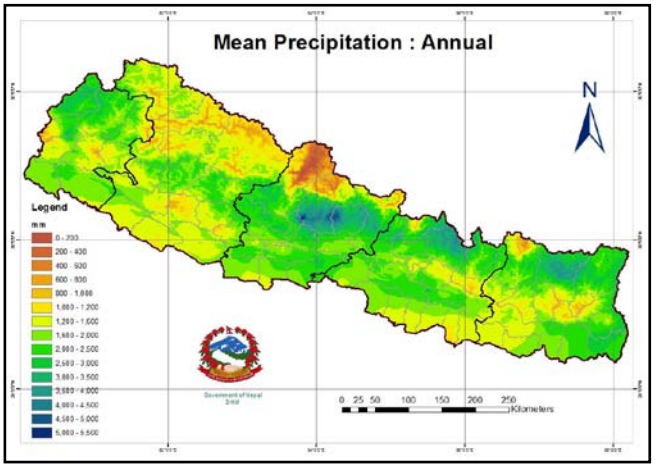


Figure2.2 Mean Annual Precipitation variations over Nepal (DHM)

The mean annual precipitation of Nepal (figure 2.2) was found to be around 1800mm with the high precipitation pocket areas in monsoon season are Kaski, Sindhupalchok and Sankhuwasabha Districts and the highest annual precipitation recorded in Lumle of Kaski District with mean annual precipitation of about 5500mm. The lowest precipitation site is recorded in Upper Mustang Dhiee, Lomanthang area of Mustang District with mean annual precipitation of less than 150mm. Both of these highest and lowest precipitation sites of the country are in Annapurna area (based on analysis of 1961 to 2012 rainfall data).

The three highest precipitation pocket areas - southern slope of Makalu range in eastern development region, Southern slope of Langtang range in central development region and south of the Annapurna range in western development region were observed in the country. Similarly, two lowest precipitation pocket areas - Manang and Mustang, were observed at the leeward side of the Annapurna range.

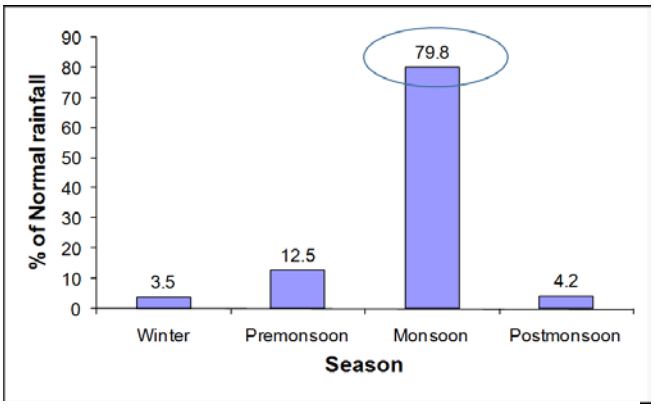


Figure 2.3 Seasonal contribution in four different seasons (Percentage of annual precipitation) over Nepal. (Draft Report 2015)

Figure 2.3 shows the seasonal contribution of precipitation in percentage in four different seasons over Nepal. Meanwhile, it is observed that the 24 hour accumulated extreme precipitation is higher over Churia range. The value is more than 400mm/day in the Churia where as it is below 100mm/day in mustang region. (Draft Report 2015, Study of Climate and Climatic Variation over Nepal).

Shifting and extension trend of Monsoon with onset, withdrawal and duration variations.

From the long-term data, the mean summer monsoon onset date for Nepal is June 10 and the withdrawal date is 23 September which shows duration of 105 days. The onset date, withdrawal date and duration of the Monsoon

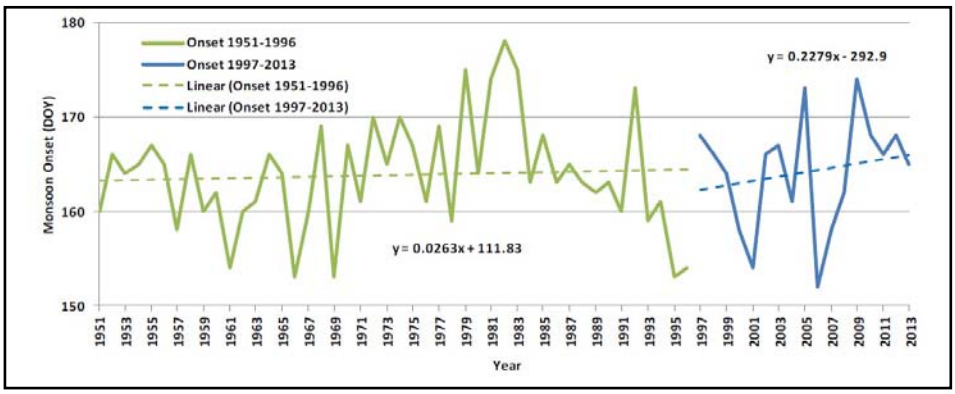


Figure 2.4a Monsoon onset showing significant late trend (Gautam, D.K. and Regmi, S.K., 2013)

against the year 1951- 2013 were performed with time series plot figure 2.4 (a-c).The date of onset varies from 1st June to 27th June. Similarly, the date of the withdrawal varies from 31st August to 19th October and the duration of the monsoon period varies from 72to 130 days. The mean date of the onset is 13thJune which is 3 days later than the date fixed by the Department of Hydrology and Meteorology (DHM).However, for 1997-2013, the mean date of withdrawal is 3rd October which is10 days later than the normal date. The durations of the monsoon are found to be higher than normal for 11 days. Thus the onset dates show delayed trend of0.2279 days per year for 1997-2013,the delayed trend of withdrawal for recent 17 years(1997-2013) is 0.8873 days per year and the monsoon durations in recent years shows increasing trend of 0.6593 days per year. See Figures 2.4(a –c) (Gautam, D.K. and Regmi, S.K., 2013). The data of Monsoon Onset, Retreat and duration Days of Nepal 1986 to 2014 are presented in table 2.1

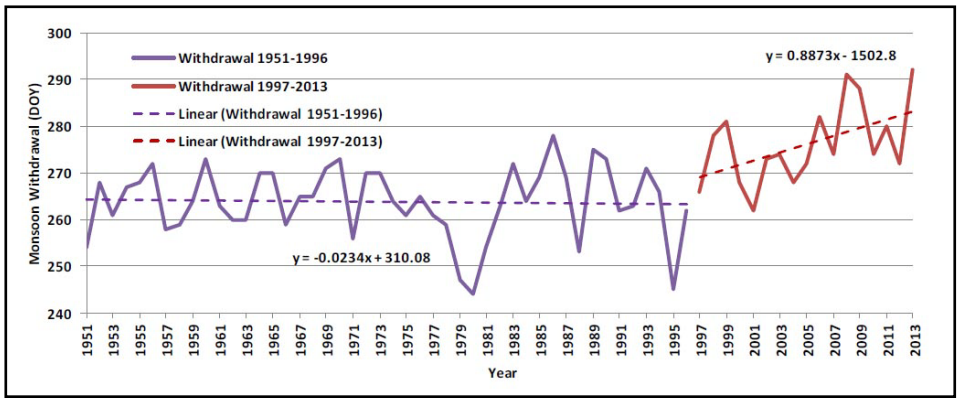


Figure 2.4b Monsoon withdrawal showing significant late trend (Gautam, D.K. and Regmi, S.K., 2013)

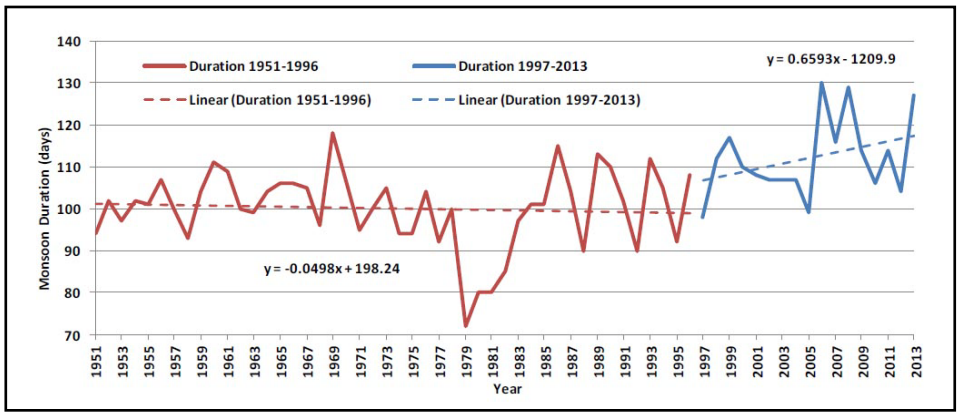


Figure2.4c Monsoon duration showing significant increasing trend (Gautam, D.K. and Regmi, S.K., 2013)

Table 2.1: Monsoon Onset, Retreat and duration Days of Nepal

Year	Onset day	Retreat Day	Duration of Monsoon days	Year	Onset day	Retreat Day	Duration of Monsoon days
1968	17-Jun	21-Sep	96	1992	21-Jun	19-Sep	90
1969	2-Jun	28-Sep	118	1993	8-Jun	28-Sep	112

1970	16-Jun	30-Sep	106	1994	10-Jun	23-Sep	105
1971	10-Jun	13-Sep	95	1995	4-Jun	2-Sep	90
1972	18-Jun	26-Sep	100	1996	31-May	18-Sep	110
1973	14-Jun	27-Sep	105	1997	14-Jun	23-Sep	101
1974	19-Jun	21-Sep	94	1998	13-Jun	3-Oct	112
1975	16-Jun	18-Sep	94	1999	11-Jun	8-Oct	119
1976	9-Jun	21-Sep	104	2000	6-Jun	25-Sep	111
1977	18-Jun	18-Sep	92	2001	3-Jun	25-Sep	114
1978	8-Jun	16-Sep	100	2002	15-Jun	19-Sep	96
1979	24-Jun	4-Sep	72	2003	16-Jun	30-Sep	106
1980	12-Jun			2004	9-Jun	1-Oct	114
1981	23-Jun	11-Sep	80	2005	20-Jun	2-Oct	104
1982	27-Jun	20-Sep	85	2006	1-Jun	29-Sep	120
1983	24-Jun	29-Sep	97	2007	7-Jun	9-Oct	124
1984	11-Jun	20-Sep	101	2008	10-Jun	17-Oct	129
1985	17-Jun	26-Sep	101	2009	23-Jun	15-Oct	114
1986	12-Jun	5-Oct	115	2010	17-Jun	1-Oct	106
1987	14-Jun	26-Sep	104	2011	15-Jun	7-Oct	114
1988	11-Jun	9-Sep	90	2012	16-Jun	28-Sep	104
1989	11-Jun	2-Oct	113	2013	14-Jun	19-Oct	127
1990	12-Jun	30-Sep	110	2014	20-Jun	7-Oct	109
1991	9-Jun	19-Sep	102				

Source: Draft Report, Study of Climate and Climatic Variation over Nepal 2015

In this relation, the landslides listed in section 2.1.1 above are the monsoon rain water induced one. Moreover, we are facing these days with the climate change water induced disasters(concentrated cloudburst rainfall) such as, Darchula Flood, Surkhet flood(August 15, 2014, killed 18 and missing 36) , Dang, Bake And Bardiya Flooding and Landslide and so on which affected huge area of agricultural land, settlement and infrastructures of Nepal. In the same way, country is facing water induced landslides in Eastern and Central region of Churia (Siwalik) range due to extreme monsoon precipitation.

2.1.3 Man-made landslide disaster

Now-a-days, the anthropogenic landslide disaster is becoming more common in Nepal. It seems in practice that the implementing agencies constructing the infrastructures so hastily that even the existing reports were not considered. The Mugling Narayanghat Road sector was badly damaged due to the cloudburst rainfall on 2003, figure 2.5. It was studied by JICA project from July 2007 to February 2009

with detail hazard maps, (JICA/Nippon Koei 2009). The Mugling-Nayanghat Water Induced Disaster Prevention Project (MuNa Project) was formulated for water induced disaster countermeasure works on Jan 2005 under Japan Non-Project Grant Assistance (NPGA) of total amount 302M NRS(including Nepal Government counter fund) and it was completed on July 2009successfully, (Pandit, S., 2009). The Mugling-Narayanghat Road section is now under construction for widening to 2lanes since FY 2015 by department of road. The project is arranging to work with a schedule that the road will be closed from 11 am to 3 pm daily. They are cutting the slopes to meet the 2 lane straightly without consideration of the detail chainage-wise hazard map of Mugling Narayaghat road section. Now the people are facing a big difficulty to pass the road. Many accidental events with casualties were occurred due to slope failure and landslides. In the monsoon season there was even much complicated condition. This situation may happen due to the information gap between the successors.

Figure 1.5: Damage of Road Shoulder in Ch.33+000 Mugling-Narayanghprojects. (source: DWIDM)

The government is planning to develop village roads to connect the VDCs from the main networking road and allocating considerable amount of budget as well for that work each year. Based on that concept, village roads are developing by just opening of track by excavation each year using excavators without any preliminary study and security measures. In the result, the slope failure, debris flow and landslide during the monsoon season are facing by the local people. The people are facing from not only the natural disaster but the man made landslide disasters as well. The landslide occurred due to road slope cutting (MuNa Road widening work, Araniko highway maintenance work including Jure and many other places where the village road are constructed without any study), landslide due to leakage of irrigation water (Okharpauwa, Kathmandu-Nuwakot road section), slope failure and debris flow due to deforestation and forest fire (Sindhuli-Bardibas road and in the Siwalik Hills) are the considerable instances.

2.2 Response to landslide disasters (referring to sec.1.1)

The Government of Nepal has included Disaster Management programs in its 10th National Development Plan for the first time. The 10th five year plan set its objectives

as ‘to contribute substantially to make the public lie secure by managing the natural and man-made disaster systematically and effectively and by making the development and construction related programs in the country sustainable, reliable and highly gainful’.

The Legal documents the *Natural Calamity (Relief) Act* of 1982 and the *National Strategy for Disaster Risk Management (NSDRM) 2009 of Nepal* illustrate a disaster management strategy through various institutional frameworks from central level to local level. The act focuses on executing pre and post-disaster relief and rescue works by bringing the work of disaster management under the scope and responsibility of the government. NSDRM is based on the *Hyogo Framework for Action 2005–2015*, which outlines five priorities of actions to manage disaster risk in the country. All the government and non-government bodies, including non-governmental organizations (NGOs), international NGOs, and United Nation agencies, are directly or indirectly involved in disaster risk management (DRM). In order to mitigate water-induced disasters, the Department of Water Induced Disaster Prevention (DWIDP) came into existence on February 7, 2000 under the Ministry of Irrigation along with twenty-four divisions and two subdivisions offices. The Government of Nepal has approved the *Water Induced Disaster Management Policy 2072 (2015/16).* Besides these measures, the Government of Nepal has proposed the *National Disaster Response Framework (NDRF), March 2013* with clear and quick guidelines for national response to large and medium-scale disasters in Nepal. The framework has guidelines for effective and comprehensive responses to disasters whose aim is to address the national, regional, district, and local levels in terms of disaster preparedness and response. This document illustrates the proper national and international coordination structure, cluster, and response activities during emergencies. The Government of Nepal also formed the Nepal Risk Reduction Consortium (NRRC) in February 2011, which is supported by the donor communities and focuses on five major “Flagship Programmes”, namely, School and Hospital Safety, Emergency Preparedness and Response Capacity, Flood Management in the Koshi River Basin, Integrated Community Based Disaster Risk Reduction, and Policy/Institutional Support for Disaster Risk Management. Based on them, the government is making efforts to response the disasters of Nepal including landslide disaster management. Even though, the country still lacks a new, practical disaster management act and rules for well management of disaster.

2.2.1 Government, National and District levels

Nepal is the pioneer country in formulating Disaster Management Act in South Asia. The Natural Disaster Relief Act of 1982, Local Self Government Act 1999, Building

Code 1994, National Strategy for Disaster Risk Management (NSDRM) 2009 is some of the existing legal provisions in Disaster Management in Nepal.

On the base of Natural Calamity (Relief) Act 1982 and the National Strategy for Disaster Management in Nepal 2009, the Ministry of Home Affairs (MoHA) is the nodal body in the field of Disaster Management in Nepal. As per the Natural Calamity (Relief) Act 1982, a framework of disaster management in Nepal is developed from central government level to local level such as, Central Natural Disaster Relief Committee, Regional natural disaster relief committee, and district natural disaster relief committee to coordinate the disaster preparedness and response activities in the country. In this regards, the Government of Nepal has been following a trend of providing immediate response as rescue and relief work during a disaster, especially during the monsoon floods and landslides utilizing the armed police force and Nepalese army. Besides that the disaster data management and national and international disaster fund management is the responsible field of the Ministry of Home Affairs.

Since the Ministry of Home Affairs do not have any technical wings, the Government of Nepal utilizing the governmental organizations such as Department of Water Induced Disaster Management (DWIDM), Department of Soil Conservation and Watershed Management (DSCWM), Department of Mines and Geology (DMG), Department of Hydrology and Meteorology (DHM) and NGOs and INGOs so far for response of disaster management in Nepal such as study and implementation of countermeasures and preparedness works.

In this way, the response of landslide disaster management work is mainly focused by DWIDM for medium and large deep seated landslides in Nepal. The WIDM Policy 2015/16 categorized the landslides as up to 50m toe width to small landslide, 50-100m toe width to medium landslide and more than 100m toe width to large landslide. The shallow landslide countermeasure works are addressing by DSCWM. The DHM is addressing the study and implementation of flood EWS and DMG addressing the geological and seismological study field of Nepal.

2.2.2 Community level

The DWIDM established 24 Division offices and 2 sub-division offices in Nepal which will reach up to the community level flood and landslide management works. In the same way the DSCWM reach up to the community level for shallow landslide and soil conservation works.

2.2.3 Successful example

Most of the Landslides and flood countermeasure model sites constructed during the

DPTC time and continued by DWIDM in cooperation with JICA were the successful examples of the Landslide and flood countermeasures in Nepal. Besides that so many other countermeasures works like Hangdewa and Hireba Landslide Taplejung district, Khadichour and Lyang khola Landslide Sindhupalchowk, Lothar watershed management Chitwan and Makawanpur, Kerunge Landslide Nawalparasi, Kapurkot landslide Salyan district and so on were constructed by DWIDM successfully by its own budget, the photographs are presented in Annex II.

2.3 Preparedness to landslide disasters

The preparedness is the most important sector of disaster management field as the pre-disaster management. It belongs to the non-structural mitigation method of the countermeasures of disaster. It is believed that the successful non-structural mitigation covers about 50% of the disaster risk reduction. The preparedness sector covers the preparation of Hazard maps with zonation, preparation of early warning system, land use, awareness educations of landslide disasters and so on.

2.3.1 Hazard zonation and mapping (Deep-seated landslide, Debris flow, Landslide-dam)

Although the country faced so many landslide disasters, landslide-dams and debris flow disasters including flash flood and bank cuttings in the past, the country did not keep kept it in priority. The gigantic Jure landslide occurred on August 2, 2014 which dammed the Sunkosi River with about 60Mcum volume of debris. This event and possibility of breach of the landslide dam threatened not only the downstream people of the area but also to the Sindhuli road project in the downstream of the Sunkoshi river and even to the government of India. Thus, the issue became international. In this regard, just the Government of Nepal felt the need of landslide disaster management as preparedness of landslide disaster with need of landslide study, preparation of landslide Hazard map, early warning system and proper land use in the disaster area and so on. Then with the pressure of technocrats, the government established the Water Induced Disaster Management Policy 2072 for Landslide Disaster Management and River Disaster Management in Nepal. This Policy 2072 clearly defined the classification of landslides, Hazard zone of landslide, categorization of landslide hazard zone and land use type in hills and slopes. In this regards the government also established a Landslide Study and Management Division under the Department of Water Induced Disaster Management to look over the Landslide Disaster Management and allocated considerable budget for Landslide Study, preparation of inventory map, Landslide hazard map, early warning system and structural countermeasure works. Thus the DWIDM started to address theHazard zonation and mapping for Deep-seated medium and large landslides,

Landslide-dams, Debris flow, Slope failure and so on from present Fiscal Year 2016/17.

2.3.2 Early Warning System (EWS)

Since the Government of Nepal established the Landslide Study and Management Division under the DWIDM to look over the Landslide Disaster Management in Nepal, the Department is starting to prepare the inventory of Landslide in Nepal and preparation of Landslide hazard map of selected districts. Immediately after the preparation of the landslide hazard map, the department is planning to establish the Landslide Early Warning System (EWS) in Nepal. The Department has past experiences about the establishment of early warning system with support of JICA/Government of Japan in Kabilash Village Development Committee, Chitwan district which was the first successful history in Nepal.

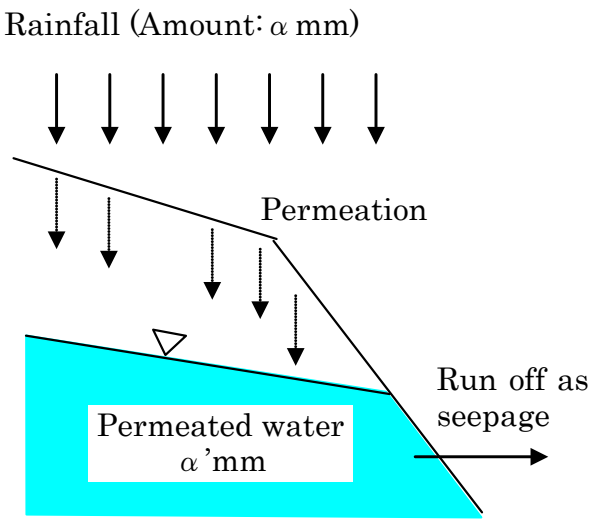
The brief description about the EWS implemented in the Kabilash VDC, Chitwan district were based on the Criteria and concepts mentioned as below (Amatya SC 2013)..

The EWS Criteria: The Criteria of Early Warning System made by using the "Modified rainfall amount of 12 hour-half value" which is based on the *two assumptions.*

1. There is a linear correlation between the rainfall and the groundwater stored by percolation of the rain water.
2. If the accumulation of groundwater crosses the limit, probability of sediment related disaster will be higher.

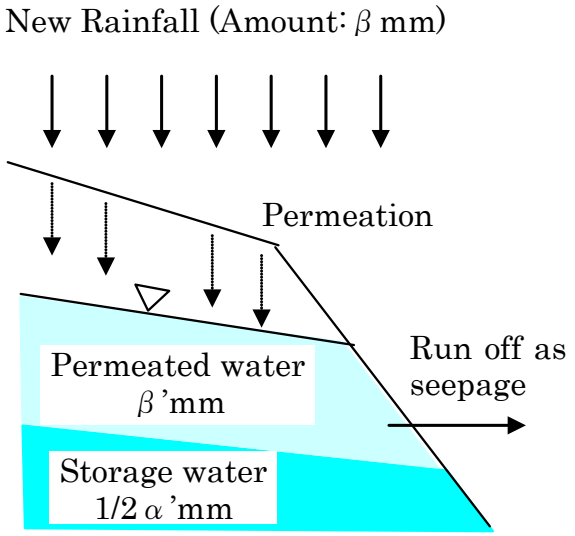
The Concept of Modified rainfall amount of 12 hour-half value: It is an indicator of rainfall amount which is calculated considering infiltration and runoff of previous hourly rainfalls.

The hourly rainfall will be added by each hour. Previous ground water storage will be reduced by half in every 12 hours. Critical water level (warning threshold) should be set by considering the level of past disaster or return period of the modified rainfall amount. The concept of Modified Rainfall amount is shown in the figure 2.6a and 2.6b below.



Rainfall at a certain time;
Rainfall amount at α mm influences on stability of ground.

Figure 2.6a: Influence of Rainfall on stability



After 12 hours from rain α;
Only new Rainfall amount at β mm does not influence stability of ground, but storage water at 1/2 α mm also has an effect on it.

Figure 2.6b: Influence of Previous Stored Rainfall on stability

Warning Levels: Considering the Concept of Modified rainfall amount of 12 hour-half value, the return period data of Nepal and practice in Japan, three Warning Levels are classed for village resident evacuation.

- *Level I – Warning:* If 12-hour half-value modified rainfall amount becomes more than 140 mm (10-year return period), this *Warning* Level will be issued to evacuate of specific inhabitants of dangerous area for water-induced disasters until 'Modified rainfall of 12 hour half-value' is under Level III (60 mm).
- *Level II – Caution:* If 12-hour half-value modified rainfall amount becomes more than 80 mm (5-year returns period), the *Caution* Level Notice will be issued to prepare evacuation of specific inhabitants of dangerous area for

water-induced disasters

- *Level III – Care:* If 12-hour half-value modified rainfall amount becomes more than 60 mm (2-year returns period), *Care* Level will be announced to early warning/evacuation team and ward representatives; and to start monitoring of the rainfall hourly by the assigned persons.

Information dissemination network of Kabilash village: Software had been developed on the base of the concept of modified rainfall amount of 12 hour-half value and warning levels linked to the automatic rain gauge station. As the warning levels will meet, the equipment will beep then the operator will inform to the concerned agencies and persons for timely evacuation. The information dissemination network of Kabilash village is shown in the figure 2.7 below.

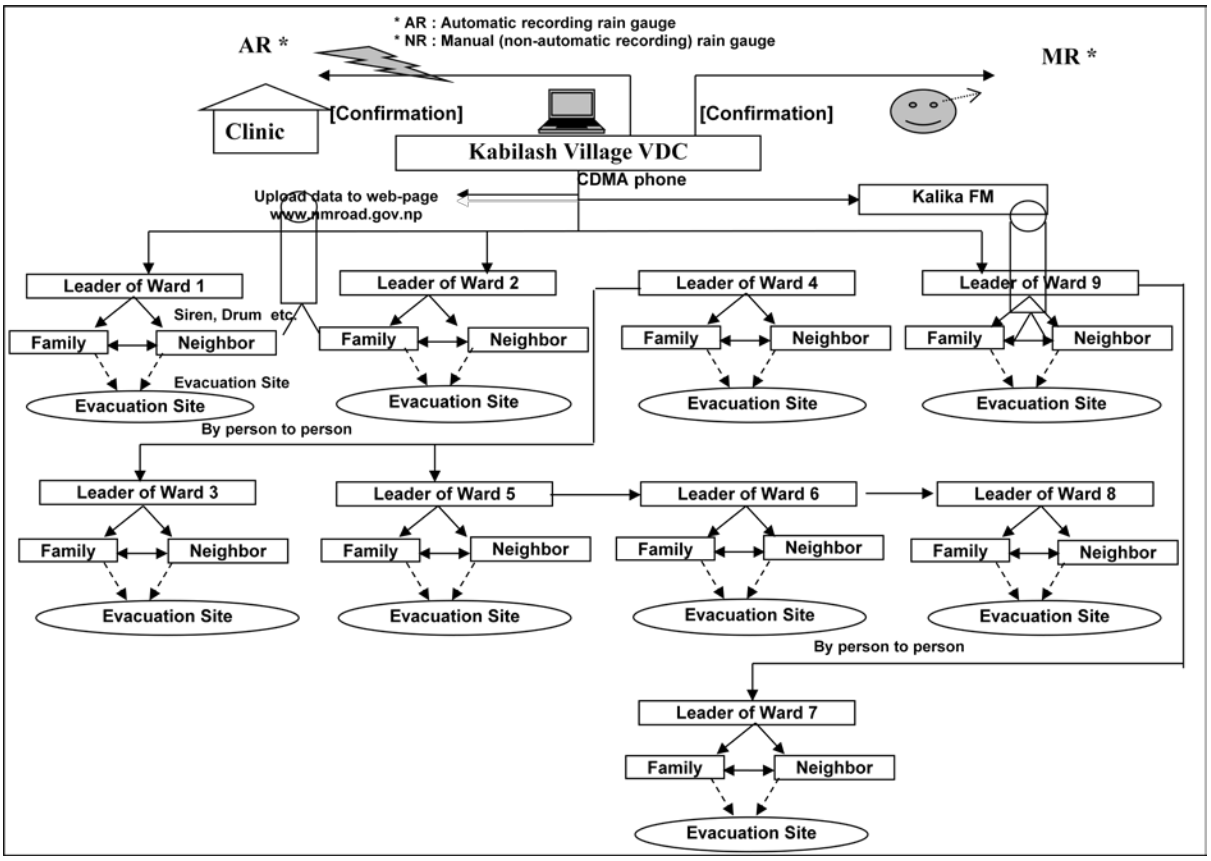


Figure 2.7: The information dissemination network of Kabilash village, Chitwan.

2.3.3 Disaster education

The Disaster awareness education is the most effective phenomenon in community level. There is a saying as “the disaster does not come with belling” but in nature, it gives some sort of indications of disasters. If we can grasp them, at least we can save our life. A few examples of the indicators of disasters are the falling sound of rocks

and trees in upper part of hills, peculiar blasting or cracking sounds, changing of water level in dug well and ponds, turbidity in well water, reveal of new springs, river seems dry even in rainy days and so on. The DWIDM has a regular program of such awareness trainings as Roving Seminar (figure 2.8) to the community of different districts each year which used to provide Disaster awareness trainings with audio visuals and education materials. From the past experiences, these type of awareness programs are much fruitful and worthy in the community.

Figure 2.8: Roving Seminar in Rupandehi district.

2.4 Remedial (Rehabilitation)works for landslide control

Since the establishment of Water Induced Disaster Prevention Technical Centre (DPTC) in Nepal on October 7, 1991 with financial and technical support of JICA/Government of Japan, the remedial works of landslide were initiated by a authentic institution and it is continued to date by Department of Water Induced Disaster Management (DWIDM), Ministry of Irrigation through Water Induced Disaster Mitigation Support Program (DMSP) which was established from September 1, 1999. Before DPTC, the Department of Soil Conservation and Watershed Management (DSCWM) was doing the remedial works of small and shallow landslide in watershed to some extent which is continuing to date.

2.4.1 Cost and effectiveness (sustainability)

The remedial works of landslide was initiated since the establishment of DPTC in Nepal. The allocation of government budget for remedial works of landslide was initiated from the establishment of Department of Water Induced Disaster Prevention (February 7, 2000) under then Ministry of Water Resources. The allocated amount for remedial works of landslide was initially much small about 20million Nepalese rupees only. Since then the amount allocated for landslide rehabilitation works are increasing very inadequately to date. The total budget of the Department in FY 2001/02 was NRs. 670 million whereas the budget allocated for landslide remedial works were Nrs 26.8 million which would be 4% of total budget. At present, the total budget of the department increased to NRs. 6.88 billion in FY2015/16 whereas the budget allocated for structural and non-structural

countermeasure works of landslide disaster in the country increased to NRs. 160million in central level and NRs 180 million in local level which would be 4.94% of total budget. The average percentage of budget allocated for landslide disaster management is 3.92% of total budget of the department. The trend of budget indicates least priority given to landslide countermeasures in Nepal. Thus, the effectiveness/sustainability of landslide disaster management in term of cost is very low and inadequate.

2.4.2 Planning and Design process including field survey and drilling

The landslide victims will inform or demand to the Department of Water Induced Disaster Management or its division offices for the rehabilitation work of landslide disasters. Then the landslide technical persons will visit disaster sites for preliminary survey. The landslide technical person will prepare the preliminary survey report with estimation of study and implementation of countermeasures. If the landslide is much bigger and complex, it will be recommended to conduct further detail study with master plan which is rare case in present time due to need of large budget. Based on the report, the budget will be proposed to the government. After the allocated budget is approved, the related disaster engineer will be deputed to visit the site for detail field survey and drilling for planning and design of the remedial works for countermeasures. As per government rules, if the estimated amount is below 6 million Nepalese rupees, the countermeasure construction works could be done by local user's committee also, and otherwise it will go to the tendering procedure for the construction works.

2.4.3 Protection of Infrastructures (road etc.)

If the infrastructures are in vulnerable conditions and requested to DWIDM to solve them, the department will take over to study in such cases and provide recommendations but could not provide budget for the mitigation works. If the concerned institution can arrange budget, the department will not have any objections to cooperate.

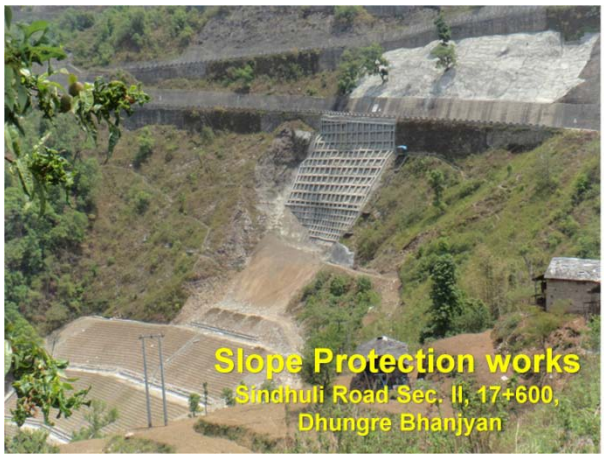


Figure 2.9: Slope Protection Work in Sindhuli Road, Sec. II, 17+600, Dhungre Bhanjyan

The Department of Road (DoR) and DWIDM have a Memorandum of Understanding (MoU) that the disaster issues within 25m from the right of way of road corridor, the DoR will take over for

mitigation works. The disaster issues out of 25m from the right of way of road corridor will be taken over by DWIDM for mitigation works. In such cases the DoR will inform to DWIDM about the disaster issues along the road corridor, then the DWIDM will do survey, reporting, estimation, allocation of budget, planning, designing mitigation works. The Sindhuli Road Project(Banepa-Sindhuli-Bardibas Road)is the good example of them(see figure 2.9 to 2.12). The Sindhuli Road (Banepa-Sindhuli-Bardibas Road) is one of the most important arterial roads in Nepal, linking Kathmandu City – the capital of the country – with Terai plain area in South. The construction of Banepa Sindhuli Bardibas Road started in November 1996 with a grant assistance of Government of Japan. The total cost of the project from start to completion was NPR. 21.5 billion (¥ 26 billion). The development of the Sindhuli Road, having160 km in total, has been divided into four sections. The first section of the project namely Section I Bardibas- Sindhulibazar section (37km):the bridge works was started in 1996, consequently Section IV Nepalthok-Dhulikhel section (50km) and Section II Sindhulibazar- Khurkot section (39km) were started afterward and all three sections have been completed by 2009. The Section III Khurkot - Nepalthok section (32km), which was under construction as the last section of the project since 2009, was

Figure 2.10: River Bank protection with construction of Ground sill, Sindhuli road, sec IV, Rosi Khola

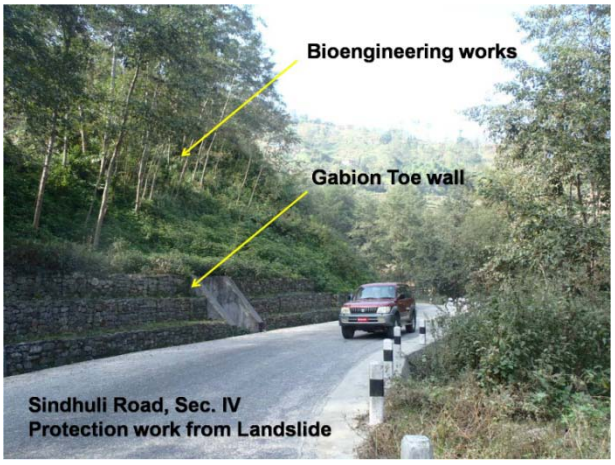


Figure 2.11: Road protection from landslide by construction of gabion toe wall and bioengineering works, Sindhuli Road, Sec. IV.

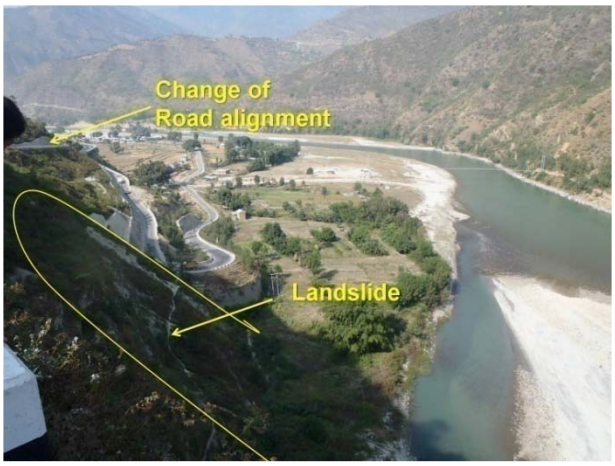


Figure 2.12: Change of road alignment to protect from landslide, Sindhuli Road, Sec. III, Mulkot.

completed at the end of February 2015. As the result, the whole section of the Sindhuli Road was opened to the public and handed over to DOR at the beginning of March, 2015 (DoR 2015).

2.4.4 Protection of community

If the community is facing water induced disasters like landslide and flood, the community will inform or demand directly to the DWIDM or through its division offices. Then the related disaster engineer will be deputed to survey and report. If the disaster is found emergency case such as possibility of landslide and river bank cutting due to flood during rainy season, the DWIDM/Division offices can provide the GI wire mesh, sand bags etc immediately to the effected community to protect the settlement. Afterwards the procedures of disaster mitigation will be as explained in section 2.4.2 above. The DWIDM has been organizing disaster awareness educations to local community of different districts through Roving seminar every year which were found much effective for more than 20 years (Fig.2-8 in 2.3.3).

REFERENCES:

Amatya, S.C., 2013, Early Warning System as a Preventive Measure for Landslide Risk Reduction in Kabilash Village, Chitwan, District Nepal, Proceedings International Seminar on "Water Related Disaster Solution", September 6-8 2013, Yogyakarta, Indonesia, Himpunan Ahli Teknik Hidraulik Indonesia (HATHI), Indonesian Association of Hydraulic Engineers, 4th International Seminar 2013, Indonesia, vol.1, pp342-354.

Chigira,M., et al 2016, Inventory mapping of landslides induced by the2015 Gorkha earthquake, Jrapid, Japan.

Chigira, M. and Dangol, V., 2016, Inventory mapping of earthquake-induced landslides and hazard mapping of future landslides for making the plan of better reconstruction, Japan-Nepal Urgent Collaborative Projects regarding the April 2015 Nepal earthquake within the J-Rapid Program, Final Report, Japan.

DoR(Department of Roads)2015, The Project for the operation and maintenance of the Sindhuli Road, Progress Report No. 7 (Jan.2015-Aug.2015), Department of Road Ministry of physical Infrastructure and Transport, Government of Nepal, August 2015.

Draft Report 2015, Study of Climate and Climatic Variation over Nepal, Department of Hydrology and Meteorology, Ministry of Science, Technology and Environment, Government of Nepal.

DWIDM 2015/16, Water Induced Disaster Management Policy 2072 (2015/16), Ministry of Irrigation, Government of Nepal.

Gautam, D.K. and Regmi, S.K., 2013, Recent Trends in the Onset and Withdrawal of Summer Monsoon over Nepal, ECOPERSIA. 2013, 1 (4), 353-367.

Ghimire, T., Paudel, L.P., Pant, B., 2007, The Devastating Ramche Landslide (Rasuwa) and the Future of Polchet Residents, Journal of Nepal Geological Society, Vol 36 (2007), Nepal.

Government of Nepal, 2013, National Disaster Response Framework (NDRF), Ministry of Home Affairs, Government of Nepal, March 2013.

JICA/Nippon Koei 2009, The study on Disaster Risk Management for Narayangharh-Mugling Highway, Main Report Vol.II, DWIDP/Ministry of Water Resources, DOR/Ministry of Physical Planning and Works, Government of Nepal.

Malla, G, 2008,Climate change and its impact on Nepalese agriculture, The Journal of Agriculture and Environment Vol:.9, Jun.2008.

Pandit, S.,2009, Mugling Narayangarh Water Induced Disaster Prevention Project (MNWIDPP): Progress Report 2065/66, Presentation, DWIDP/Govt. of Nepal.

CHAPTER III

ACTIVITIES OF DWIDM IN LANDSLIDE DISASTER MANAGEMDNE-PRESENT STATUS

Nepal is facing the wrath of natural and human induced disasters with greater frequency and intensity. Disasters are so penetrative in every Nepalese geographic and societal framework that the people are constantly under the threat of a multitude of natural disasters such as highly vulnerable recurrent floods and landslides. These factors, combined with peculiar meteorological conditions where the rainfall and river flow vary tremendously in both time and space, make the landscape vulnerable to water-induced disasters such as floods, landslides, slope failures and debris flows. In addition to these natural processes, the continuous human induced vulnerability stems from activities such as deforestation, cultivation of marginal land, road building in hills and mountains, and encroachment of flood plains. The water-induced disasters, thus, have been occurring more frequently in recent times. Thus the mitigation of water induced disaster activities is mandatory in Nepal.

3.1 Roles, Responsibilities and Activities assigned to DWIDP (Legal assignment)

The Water Resources Strategy of Nepal2002, (HMGN 2002) and The National Water Plan 2005, (HMGN 2005)exhibit the roles and responsibilities of the Department of Water Induced Disaster Management. And the Natural Disaster Relief Act (NDRA) 1982 (HMGN 1982) and the Local Self-Governance Act 1999 (HMGN 1999)primarily provide the legislative framework for disaster management. Thus the roles, responsibilities and Activities assigned to DWIDM are explained as below.

The Water Resources Strategy of Nepal2002 explains as**;**

"*The goal during the Strategy's first five years is to enhance institutional capabilities for managing water-induced disasters. To that end, the Department of Water Induced Disaster Prevention (DWIDP) will be designated as lead agency and given a clear mandate to implement output activities, including the development of a disaster management policy and plan. DWIDP will also be responsible for coordinating efforts to reduce risks and mitigate damages. Other agencies involved in the prevention and management of water-induced disasters will include the Department of Hydrology and Meteorology (DHM), the Department of Irrigation (DOI), and the Ministry of Home (MOH).*

In the following ten years, effective measures will be adopted to better manage and mitigate the effects of water-induced disasters. High-risk areas will be identified and warning systems will be established in locations subject to flooding and landslides. A disaster relief plan will be developed for each priority area and DWIDP and other agencies will assist local authorities in carrying out community awareness and education campaigns. Within 25 years, the Strategy's goal is to make Nepal's water disaster management system fully functional, effective and responsive to people's needs. In such a way the Activities and Indicators will be as;

Activities

- *Prepare and implement a water-induced disaster management policy and plan.*
- *Conduct risk/vulnerability mapping and zoning.*
- *Strengthen the disaster networking and information system.*
- *Establish disaster relief and rehabilitation systems.*
- *Carry out community awareness/education on disaster management.*
- *Activate Inundation Committee(s) with respect to neighboring countries.*
- *Prepare and implement floodplain action plans.*
- *Implement disaster reduction/mitigation measures.*
- *Strengthen institutional set-up and capacity.*

Indicators

- *by 2007, potential disaster zones identified by type and located on district maps;*
- *by 2007, emergency relief materials are available in all five regions;*
- *by 2017, infrastructure for mitigating predictable disasters put in place in 20 districts;*
- *by 2017, warning systems established and functioning, encompassing the country;*
  and
- *by 2027, social and economic losses reduced to levels experienced in developed Countries."*

The National Water Plan 2005 explains as**;**

"The Department of Water-Induced Disaster Prevention (DWIDP) was established in February 2000 and is organized at both central and district levels. The DWIDP has been made responsible for managing and mitigating water-induced disasters. At present, the Natural Disaster Relief Act (NDRA) 1982 and the Local Self-Governance Act 1999 primarily provide the legislative framework for disaster management. DWIDP has been designated as the lead agency for water-induced disaster (WID) management.

Targets

- *by 2007 potential disaster zones are identified by type and located on district maps.*
- *by 2007 emergency relief materials are available in all five regions.*
- *by 2017 infrastructures for mitigating predictable disasters are put in place in twenty districts.*
- *by 2017 warning systems are established and made functional encompassing the whole country.*
- *by 2027 social and economic losses due to water-induced disaster are reduced to the levels experienced in other developed countries.*

Action Programmes

The focus of the WID management during the first five years of the plan is to enhance institutional capabilities for managing water-induced disasters. In the following ten years, effective measures will be adopted to better manage water-induced disasters and mitigate their adverse effects. The long-term goal of the Plan is to make Nepal's WID management system fully functional, effective and responsive to people's needs. The total programme is expected to directly address the needs of the poor and marginalized people, thereby contributing to improved living conditions for the poorest sectors of the Nepalese population."

In order to achieve the goal of Government on water induced disaster management; DWIDM is implementing the preparation of hazard risk assessment and hazard mapping of hazard prone areas and implementation of structural and non-structural countermeasures through DMSP program under DWIDM. Under this program, DWIDM has prepared several small scale flood hazard maps and landslide hazard maps. The Water Induced Disaster Management Policy 2072 B.S. was established on last Fiscal Year 2015/16 by the Government which gives the mandate to DWIDM to assist the Ministry of Irrigation on river disaster management and landslide disaster management in Nepal.

3.2 Current activities in reference to 3.1

The DWIDM conducted following activities as per the Water Resources Strategy of Nepal2002;

- *Prepare and implement water-induced disaster management policy and plan-**developed and implemented the WIDM Policy 2072.***
- *Conduct risk/vulnerability mapping and zoning- **in process.***
- *Strengthen the disaster networking and information system-**in process.***
- *Establish disaster relief and rehabilitation systems-**in process.***

- *Carry out community awareness/education on disaster management-**conducting each year.***
- *Activate Inundation Committee(s) with respect to neighboring countries- **in process.***
- *Prepare and implement floodplain action plans-**in process.***
- *Implement disaster reduction/mitigation measures- **implementing each year.***
- *Strengthen institutional set-up and capacity-**developed some extent.***
- *The Department of Water Induced Disaster Prevention (DWIDP) will be designated as lead agency- **DWIDP playing as lead agency***
- *high-risk areas will be identified and warning systems will be established in locations subject to flooding and landslides- **in progress.***

The DWIDM conducted following activities as per the Target of National Water Plan 2005**;**

- *by 2007 potential disaster zones are identified by type and located on district maps – **Policy about them are established and implementation of them are in process***
- *by 2007 emergency relief materials are available in all five regions – **Implementing them from all 24 DWIDM division and 2 sub-division offices to the community of all five regions.***
- *by 2017 infrastructures for mitigating predictable disasters are put in place in twenty districts – **in considerable progress***
- *by 2017 warning systems are established and made functional encompassing the whole country - **at present, budgets are allocated for them and DWIDM is doing effort to establish them very soon.***
- *by 2027 social and economic losses due to water-induced disaster are reduced to the levels experienced in other developed countries **– in process***

3.2.1 Research, Investigation and collaboration works with other organizations

There is a Hydraulic laboratory in Godavari which was established by JICA/Government of Japan under DWIDM during DPTC period, figure 3.1. Hydraulic model, landslide and debris flow model and geotechnical analysis including chemical laboratory

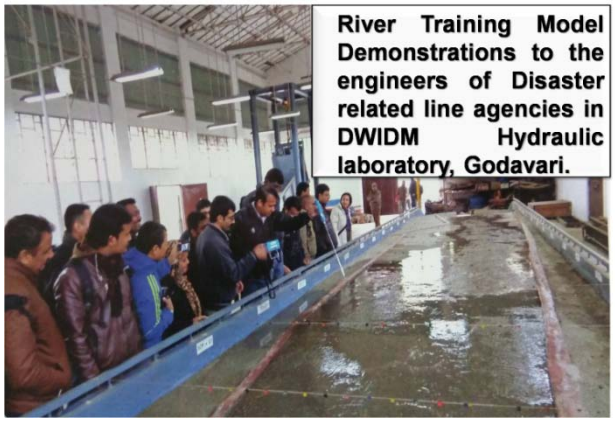


Figure 2.1: DWIDM Hydraulic laboratory at Godavari

facilities are available in the laboratory. The research and investigation works are mandatory for Landslide and flood management. Even though, after completion of DPTC period, there are no such activities of research and investigation works. These were prioritized in DWIDM but it has a plan to resume in near future.

3.2.2 Technical support to other organizations and communities

The DWIDM is managing technical support to Department of Road, Nepal Electricity Authority, Department of Soil Conservation and Watershed Management, and so many local communities.

3.2.3 Human resource development (training, study etc) in and outside of Nepal

The DWIDM provided opportunity to more than 50 DWIDM technical personnel to date to abroad trainings and Masters Courses to develop human resources of DWIDM and it is continuing to date. Most of them are for Japan organized by JICA/Government of Japan and few for Korea, China, and Thailand and so on. Similarly, DWIDM is providing in-house technical and administrative trainings to two personnel each year.

3.2.4 Human resource development of Nepali technical staff (provision of training to outside of DWIDM)

The DWIDM is providing trainings/workshops to the technical staffs of DWIDM organized by different government organization, NGOs and INGOs such as;

In time to time different INGOs and NGOs organize different types of trainings and workshops related to disasters such as,

ICIMOD organized training/workshop related to disaster as “Consultative workshop on landslide Inventory, Risk Assessment, and Mitigation in Nepal 2016”.

Trainings on “flood hazard modeling and sediment monitoring” targeting the officials from DWIDP, DSCWM, was organized by Community based flood and glacial lake outburst risk reduction project (CFGORRP), DHM, Ministry of Science and Technology and Environment, GON.

Similarly, “Advanced administrative staff trainings for engineers”, organized by Nepal Administrative Staff College (NASC), GoN, each year and so on.

3.3 Budget

As the Nepal is facing different types of natural and anthropogenic disasters, the water induced disasters such as river bank cutting, flash floods, landslides, slope failures and debris flow are occurring more frequently in recent times due to

geo-climate in Nepal. Thus the mitigation of water induced disaster activities is mandatory in Nepal. To address them the DPTC was established in Nepal with cooperation of JICA/Government of Japan. After DPTC, the DWIDM is continuing to address the objective of DPTC. Since the establishment of DWIDM, the Government is allocating budget in DWIDM to address the landslide and river disaster management in Nepal. Initially the budget for DWIDM was started from NRs. 670million in FY2001/02 which increased gradually to NRs. 6.88billion in FY2015/16. Out of that the budget allocated for landslide disaster management was initiated from NRs 26.8million in FY2001/02 which is increased gradually to NRs.340million (NRs.160million in central level for medium and large landslide management and NRs.180 in district level for small landslide management). In comparison to the total budget of DWIDM, the average percentage of budget allocated for landslide disaster management is 3.92% only. The trend of budget distribution indicates least prioritization is given to landslide countermeasures in Nepal where more than 80% of area of Nepal is covered by mountains and hill which are prone to landslide disaster and more than 100 casualties each year by landslide disaster only in Nepal. The allocation of budget of DWIDM since FY2001/02 to FY2015/16 is shown in Table 3.1.

Table 3.1: Department of Water Induced Disaster Management Budget Allocation

amount in NRs Crore (*10,000,000)

FY(BS)	FY(AD)	Total Budget	LS budget	%	Remarks
2058/59	2001/02	67.07	2.68	4.00	
2059/60	2002/03	55.20	2.21	4.00	
2060/61	2003/04	58.28	2.33	4.00	
2061/62	2004/05	68.47	2.74	4.00	
2062/63	2005/06	91.19	3.65	4.00	
2063/64	2006/07	92.79	4.40	4.74	for DMSP
2064/65	2007/08	120.98	4.52	3.73	for DMSP
2065/66	2008/09	188.79	5.54	2.94	for DMSP
2066/67	2009/10	286.92	6.16	2.15	for DMSP
2067/68	2010/11	250.99	8.32	3.31	for DMSP
2068/69	2011/12	229.50	9.20	4.01	for DMSP
2069/70	2012/13	263.49	7.96	3.02	for DMSP
2070/71	2013/14	357.64	10.74	3.00	for DMSP
2071/72	2014/15	411.21	20.19	4.91	for DMSP+ local

2072/73	2015/16	688.59	34.04	4.94	for DMSP+ local
2073/74	2016/17	550.42	32.59	5.92	for DMSP
	Total	**3781.52**	**157.26**	**3.92% Avg.**	

Source: DWIDM, LS=landslide disaster management

3.4 Activities of other organizations (Dept. of Mines & Geology, ICIMOD, DoLIDAR, Universities, NGOs etc.)

Besides the Department of Water Induced Disaster Management (DWIDM), there are so many other Governmental organizations, NGOs, INGOs and Donor Agencies are involved in the field of Disaster Management in Nepal, such as Ministry of Home Affairs (MoHA), National Reconstruction Authority (NRA), the Department of Mines and Geology (DMG), Department of Soil Conservation and Watershed Management (DSCWM), Department of Local Infrastructure Development and Agriculture Roads (DoLIDAR), Universities, NGOs like DPNet, Nepal Red Cross Society, INGOs like ICIMOD, Donor Agencies like, UNDP, WB and so on. The brief activities of other than DWIDP institutions which are involved in disaster management are explained here under.

Ministry of Home Affaires

The Ministry of Home Affairs (MoHA) is the National Focal Agency of Disaster Management in Nepal and as per the Natural Calamity (Relief) Act, 1982, MoHA is responsible in the area of immediate response of disaster such as rescue and relief work during the disaster, disaster data management and management of collected funds and resources for disaster victims. The MoHA do not look over the disaster prevention, mitigation and preparedness as EWS sector which are more scientific and technical part and MoHA do not have any technical man power recruited to address them.

National Reconstruction Authority (NRA)

The National Reconstruction Authority (NRA) was established after the Gorkha Earthquake event April 25, 2015 to address the rehabilitation of the devastated area due the earthquake. The NRA is also going to prepare earthquake induced landslide inventory and hazard map of the earthquake affected areas which will be utilized during the planning of rehabilitation work.

Department of Mines and Geology (DMG)

The Department of Mines of Geology (DMG) is implicated mainly geological mapping of all over the country, geological study, mining, licensing of mine and petroleum exploration study. The DMG prepared small scale GIS based landslide hazard maps of a few regions. It is not implementing agency but study, investigation and licensing

institute of government related to mines and geology. So DMG do not have much data about landslide disaster study, landslide inventory, landslide hazard maps, and land use and so on. In addition, DMG studied the earthquake induced landslides of Gorkha Earthquake 2015 for need assessment of shifting of settlement from possible earthquake induced landslides and fractured area playing lead role of the mission.

Department of Soil Conservation and Watershed Management (DSCWM)

The Department of Soil conservation and Watershed Management (DSCWM) was established0n August 1974 under the then Ministry of Forests as Department of Soil and Water Conservation and in 1980, it was renamed as Department of Soil Conservation and Watershed Management (DSCWM)to better represent its roles and responsibilities of soil erosion with shallow landslides and watershed degradation management. DSCWM has been planning, implementing and monitoring soil conservation and watershed management programs/activities based on the principles of integrated watershed management. The shallow landslide treatments will be done as per necessary during watershed management. There is not mentioned as separate landslide projects in DSCWM. Anyway, the landslide inventory works are going on Siwalik range under the President Chure-Terai Madhesh Conservation Development Board, GON.

Department of Local Infrastructure Development and Agriculture Roads (DoLIDAR)

The objective of DoLIDAR is to undertake infrastructure development programmes in accordance with decentralization policies for attaining the goals set forth by the GON's National Strategy for Rural Infrastructure Development by making the local authorities technically capable and competent and ensuring their accountable participation. For this various infrastructure development activities funded through government and donor agencies are to be undertaken, in co-ordination with other concerned agencies, in professional and sustainable manner so as to ensure desired quality. In this regard, the DoLIDAR expresses that it is not an implementing agency but facilitator. So, even there are so many issues related to landslide disasters during the local infrastructure development works, the DoLIDAR did not have any studies, monitoring, and management of landslide disasters. The issues are managing by the individual projects wherever it will happen.

Universities

The Central Department of Geology, the Geological Department of Tri-chandra Campus, and the Department of Civil Engineering, Central Campus, Pulchowk Institute of Engineering, Tribhuvan University studied some extent about landslides of different locations of Nepal and the studies during the student's field excursions.

The Nepal Engineering College Kathmandu under Pokhara University did some Landslide disaster related seminars and studies in different areas of Nepal under "Ehime University –Nepal Engineering College Joint Research Program on landslides and Earthquake in Nepal."
(*http://www.soil.cee.ehime-u.ac.jp/English/EU-nec-research.htm)*

Similarly, the Kathmandu University which was established in November 1991 as a non-profit, autonomous, public university of Nepal is doing research works in Glacial Lake Outburst Flood (GLOF) area such as Thulagi Glacial Lake, Tso-rolpa Glacial Lake with cooperation of ICIMOD and GLOF in Gorkha and Solukhumbu districts. The university studied also the Lantang valley which was badly affected by the Gorkha earthquake 2015.

NGOs like DPNet

Disaster Preparedness Network Nepal (DPNet Nepal) is a national Network of organizations and individuals working in the field of Disaster Risk Management (DRM) in Nepal. In 1996, DPNet Nepal was established as a non government, service oriented and nonprofit making network to strengthen the mechanism of coordination and sharing information among organizations and professionals involved in disaster risk management in Nepal. DPNet-Nepal aims to assist and work closely with the Government institutions but as facilitator to disaster risk management activities in Nepal through its agencies, which are concerned with disaster preparedness, disaster response, and disaster risk reduction. DPNet-Nepal is concerned with disasters such as earthquake, floods, droughts, landslides, epidemic and fire that occur often in urban and rural communities.

Nepal Red Cross Society (NRCS)

Nepal Red Cross Society (NRCS) came into being in 1963. It was recognized by the ICRC in 1964 and affiliated to the International Federation of Red Cross and Red Crescent Societies in the same year. NRCS has, over the years, grown to be the largest humanitarian organization in Nepal, with its network of District Chapters (DCs) extended in each of the 75 districts of the country. District Chapters receive organizational support from more than 800 Sub-Chapters and Co-operation Committees under them. A significant portion of its activities are also borne by students and youth volunteers of Nepal Junior and Youth Red Cross Circles organized at schools, campuses and communities. Out of many other working fields of NRCS the Disaster Management works is one of them. In Disaster Management field the NRCS is mainly involved in following sectors;

Disaster Management works,

- Disaster Response (Relief and Recovery)

- Disaster Risk Reduction (Preparedness and Mitigation)
- Displaced population (people displaced as a consequence of conflict/internal disturbances and refugees)

Major Community based Disaster preparedness aspects,

- Relief Supply Management (Warehouse Management)
- Princep Disaster Relief Fund
- Human Resource Development
- Community Based Disaster Preparedness(CBDP) programme

INGOs like ICIMOD

The International Centre for Integrated Mountain Development (ICIMOD) is a regional intergovernmental learning and knowledge sharing centre serving the eight regional member countries of the Hindu Kush Himalayas – Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal, and Pakistan – and based in Kathmandu, Nepal. Globalization and climate change have an increasing influence on the stability of fragile mountain ecosystems and the livelihoods of mountain people. ICIMOD aims to assist mountain people to understand these changes, adapt to them, and make the most of new opportunities, while addressing upstream-downstream issues. And ICIMOD aims to serve the region through information and knowledge generation and sharing to find solutions to critical mountain problems. Inside the wide vision, mission and strategy of ICIMOD, it studied about landslide disaster in many regions of Nepal and prepared publications about them. ICIMOD had organized number of international seminar/workshops/ trainings related to landslide disaster.

Donor Agencies like, UNDP, WB

UNDP Nepal works with the people and Government of Nepal, and other development partners to pursue equitable and sustainable human development goals through eradication of poverty, increase in livelihood opportunities, improvement in community resilience against conflict, disasters and impact of climate change, while laying down strong foundations for a society based on rule of law with an inclusive and participatory democracy. UNDP has been supporting the Nepalese people in their struggle against poverty since it opened an in-country office in 1963.

UNDP is the UN's global development network, an organization advocating for change and connecting countries to knowledge, experience and resources to help people build a better life. UNDP is on the ground in some 170 countries working with them on their own solutions to global and national development challenges

UNDP's actions and programmes are defined in its Country Programme Action Plan (CPAP) which is prepared between UNDP and the Government of Nepal. The CPAP is

based on the broader United Nations Development Assistance Framework (UNDAF). UNDP's current CPAP (2013-2017) is based upon UNDAF 2012-2017.

Within this framework, the Programmes address the following priority areas for Nepal's development:

- Transitional Democratic Governance
- Inclusive Growth & Sustainable Livelihood
- Peace Building and Recovery
- Energy, Environment and Natural Disaster Management

Thus the UNDP has the working field related to Disaster management in Nepal. UNDP has been implementing Comprehensive Disaster Risk Management Programme (CDRMP), Five **Flagship programs as: Flagship 1**: School and Hospital safety, **Flagship 2:** Emergency preparedness and response **Flagship 3:** Flood Management in the Koshi River Basin, **Flagship 4:** community Based Disaster Risk Reduction/Management, and **Flagship 5:** Institutional Support for Disaster Management (DRM). Although UNDP is involved in so many disaster management programs, there is void in landslide disaster management in Nepal such as landslide study, landslide monitoring, landslide hazard mapping, landslide EWS and so on.

WB (World Bank) has working field especially in post disaster rehabilitation phase. Post Disaster Need Assessment (PDNA) work of Gorkha Earthquake Nepal April 25, 2015 is considerable work.

REFERENCES:

HMGN 1982, Natural Disaster Relief Act 1982, His Majesty's Government, Ministry of Home, Singha Durbar, Kathmandu, Nepal.

HMGN 1999, Local Self-Governance Act 1999, His Majesty's Government, Ministry of Law and Justice, Law Books Management Board, Nepal.

HMGN 2002, Water Resources Strategy Nepal 2002, His Majesty's Government of Nepal, Water and Energy Commission Secretariat, Singha Durbar, Kathmandu, Nepal.

HMGN 2005, National Water Plan Nepal 2005, His Majesty's Government of Nepal, Water and Energy Commission Secretariat, Singha Durbar, Kathmandu, Nepal.

CHAPTER IV

ACTIVITIES TO BE CARRIED OUT IN 2015-2030 BY DWIDP FOR LANDSLIDE DISASTER MANAGEMENT IN ACCORDANCE WITH NATIONAL PLAN

(To be prepared in accordance with Sendai Framework for DRR, and recommendation of International SABO Symposium 2015 in Sendai, Japan)

Nepal is highly vulnerable to natural disasters. Globally, it is ranked 4th, 11th and 13th in terms of vulnerability to climate change, earthquake and flood and landslide risks respectively. An inventory of past disastrous events during 1971-2006 reveals that epidemics take the largest toll of life every year, and that landslide, flood (including the flash floods) and urban or rural fire are the principal hazards in terms of their extent, figure 4.1.

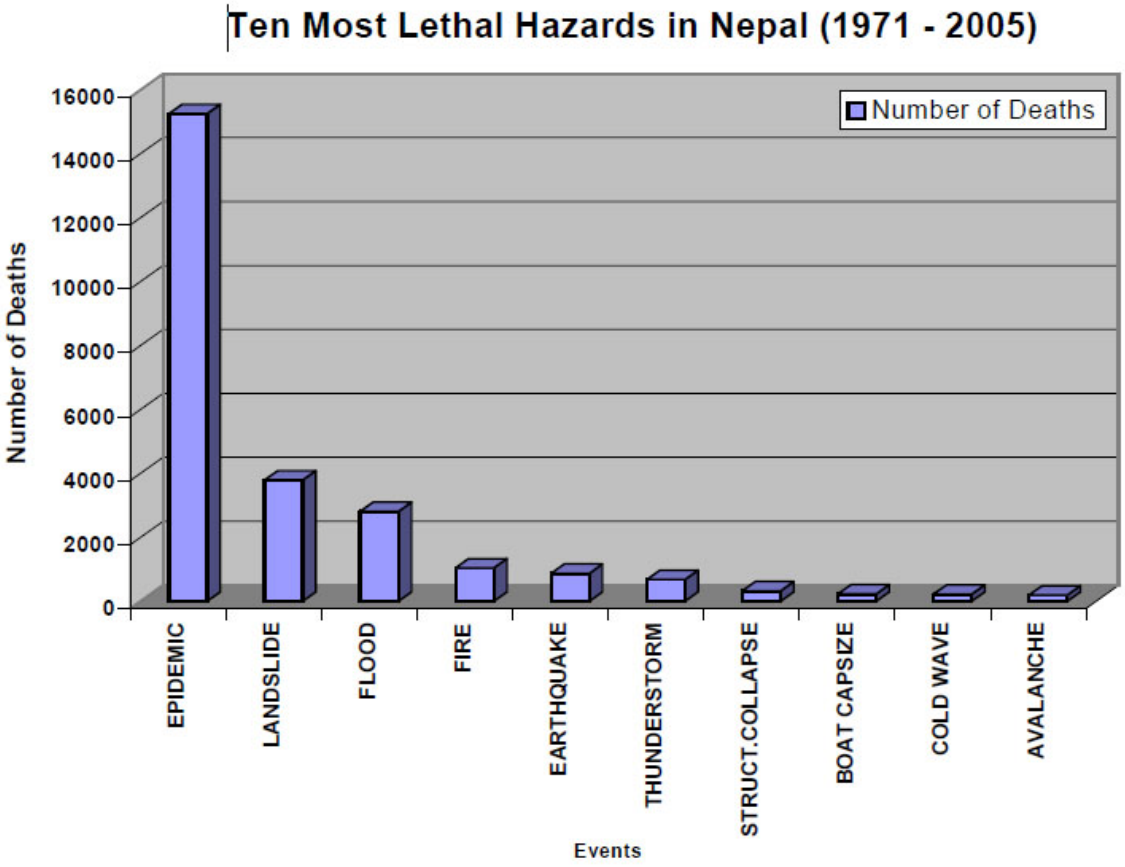


Figure4.1: Number of casualties due to different disasters in Nepal (Source: NSDRMN 2009)

Brief summary of expression mentioned in the National Plan of Nepal from 8th to recent 14th National Plan are as below.

8th Plan (1992-1997) is the first plan of the democratic government formed through popular elections following the restoration of democracy brought about by the historic people's movement of 1990. It explains a few words about DPTC time works under Irrigation heading as "Water Induced Hazard Control: Support will be provided to water induced hazard control works by organizing relevant training programmes and collecting the data relating to water induced hazard control. Besides, construction of the hydraulic laboratory, installation of equipment and various training programmes will be undertaken".

9th plan (1997-2002) did not mention about any hazard/disaster related works but few words about landslide and flood adaptation are mentioned under environment field heading.

10thPlan (2002-2007) spelled firstly about the Disaster Management in Nepal clearly under Water Induced Disaster Prevention heading of Irrigation Chapter with the objective "to control and manage water induced disasters, soil erosion, floods, landslides and flow of debris which cause damages to lives and property, arable land and development infrastructures every year – to contribute to poverty alleviation and sustainable development and to develop and expand appropriate and low cost technologies and to disseminate information and enhance the capacity of people to protect themselves from such disasters"

11th plan (2007/08-2009/10) clearly mentioned under Water Induced Disaster Prevention heading of Irrigation Chapter as to minimize the annual damage inflicted on settlements, agriculture lands and development infrastructure as well as the annual loss of lives and property caused by water induced disasters such as, floods, landslides, flow of debris, soil erosion and inundation. And also mentioned about the working area of Disaster Mitigation Support Program (DMSP).

12th plan (2010/11-2012/13) mentioned about Water Induced disaster management under Disaster management chapter with objective of to provide safety measures to settlement, farm land, infrastructures and establishing employment to help the poverty alleviation of the country. The target is mainly focused on construction works of river disaster management, and mentioned about the working area of Disaster Mitigation Support Program (DMSP).

13th Plan (FY 2013/14 – 2015/16) mentioned that the impact of Water Induced Disaster will be minimized to protect human settlements, arable land and built infrastructures by protection works of embankment, arable land, physical

infrastructure and human settlements, land reclamation, hazard map preparation of six watershed areas, and implementation of landslides and sediment-flow mitigation activities.

The 14th three year plan, Base paper (FY 2016/17-2018/19) mentioned that to mitigate the loss of life, property and damaged infrastructures due to different types of water induced disaster, the mitigation and management of water induced disaster will be implemented and help to establish the employment and poverty alleviation with the major Strategies like 1) Improvement of policy and institutional management to make effective Water induced Disaster management. 2) Identify, develop and extend the appropriate technology for effective Disaster control.

Apart from the National Plan of Nepal, the disaster risk reduction (DRR) has been discussed and challenged under global program. In this context, Nepal made commitments in various international conventions and forums about Disaster Risk Reduction (DRR). The NSDRMN was established by Government of Nepal (GON)on 2009 reflects the spirits and aspirations of the government and people of Nepal as embodied in the 10th Five-year Development Plan (2002-2007) and also the Interim National Development Plan (2008-2010) which aims to facilitate fulfillment of the commitments made by Nepal through various international conventions and forums towards DRR. Of particular relevance is the Hyogo Framework of Action (HFA) 2005-2015, which is a consensus document adopted at the UN World Conference on Disaster Reduction, Kobe in 2005, towards achieving the stated goals of DRR within the stipulated time frame. The NSDRMN is also guided by the UN "Cluster approach" principle and recommends creation of equivalent working groups drawing members from relevant Nepalese institutions for coordination of efforts (NSDRMN 2009). In the same way, Nepal has to consider the ***Sendai Framework for Disaster Risk Reduction 2015–2030*** visions and the ***Recommendation from the International SABO Symposium 2015 in Sendai (18 March 2015), Japan***, now onward towards the DRR in Nepal. The targets and Recommendations of them are mentioned below.

The Sendai Framework for Disaster Risk Reduction 2015–2030 explains the seven global targets of the outcome and goal of the present Framework and the priority area are:

Targets:

(a) Substantially reduce global disaster mortality by 2030, aiming to lower the average per 100,000 global mortality rate in the decade 2020–2030 compared to the period 2005– 2015;

(b) Substantially reduce the number of affected people globally by 2030, aiming to lower the average global figure per 100,000 in the decade 2020–2030 compared to the period 2005–2015

(c) Reduce direct disaster economic loss in relation to global gross domestic product (GDP) by 2030;

(d) Substantially reduce disaster damage to critical infrastructure and disruption of basic services, among them health and educational facilities, including through developing their resilience by 2030;

(e) Substantially increase the number of countries with national and local disaster risk reduction strategies by 2020;

(f) Substantially enhance international cooperation to developing countries through adequate and sustainable support to complement their national actions for implementation of the present Framework by 2030;

(g) Substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to people by 2030.

Priority areas:

Priority 1: Understanding disaster risk.

Priority 2: Strengthening disaster risk governance to manage disaster risk.

Priority 3: Investing in disaster risk reduction for resilience.

Priority4:Enhancing disaster preparedness for effective response and to "Build Back Better" in recovery, rehabilitation and reconstruction.

Recommendation from the International SABO Symposium 2015 in Sendai (18 March 2015), Japan.–The International SABO Symposium 2015 was held as a public forum of the 3rd WCDRR, with the subtitle: *"**Protect human lives and communities against sediment disasters for sustainable development**"* and the theme: *"**Challenges to reduce the risk of sediment disasters caused by climate change and urbanization".***Likewise, the sediment disaster should be regarded as an important part of DRR at national and international levels.

In this relation, the International SABO Symposium 2015 in Sendai recommends all the countries to promote sediment disaster risk reduction (SDRR) for sustainable development with priority on following actions.

1. Monitor the influence of global changes, including climate changes on sediment disasters and formulate national climate change adaptation strategies.

2. Prepare detailed documentation of sediment disasters, as far as feasible, shortly after the disasters have occurred, for hazard assessment, timely evacuation, effective emergency operation and smooth rehabilitation.

3. Prepare accurate sediment disaster hazard/risk maps to make people aware of the possible risks and monitor the changes in risk and land-use, making use of land observing technologies such as advanced sensing system and geo-referenced image technology. Restrict development in hazardous areas, incorporating the maps into land-use regulation and urban development planning.

4. Improve sediment disaster forecasting and warning systems at national and local levels and ensure information/communication to targeted stakeholders to prevent human casualties. Develop geo-hydrological observation systems and relevant technologies.

5. Promote training and education on sediment disaster risk reduction (SDRR) in communities and schools.

6. Increase investments in SDRR to save human lives and properties, and to foster sustainable development. Prepare technical guidelines and enact relevant laws and ordinances to facilitate investments.

7. Increase investments in advanced research for better understanding of triggering and process of sediment disasters, improved hazard mapping and monitoring and modeling of sediment disasters and effective disaster mitigation measures.

8. Prepare national and local SDRR plans as a part of the national disaster risk reduction plan to be prepared following the Post-2015 FDRR in each country.

9. Establish Global Sediment Disaster Statistics in association with the Global Disaster Statistics launched during the WCDRR and make data widely available.

10. Promote the exchange of knowledge and information among those concerned with SDRR through communication oriented official web sites such as the International SABO Network.

11. Provide engineers, research scientists and government officials with increased opportunities to exchange data, information, knowledge and experiences on SDRR such as regular international meetings including the International SABO Symposium.

12. Strengthen disaster risk governance through participation of relevant stakeholders, especially local residents in risk area for proper land-use, relocation, early warning and evacuation and implementation of structural measures.

Thus, as the Nepal is suffering from different types of disasters. Out of them the landslide lies on principal hazards of Nepal which has been affecting enormous losses of life and property and infrastructures and even affecting the national development, poverty alleviation and GDP. In this condition, the National Plan of Nepal pronounced about Disaster management firstly on 10thPlan (2002-2007) with clear objective which was continued up 11th Plan. After that the objective of National plan related to Water induced Disaster management is more focused on construction work of river disaster management and priority to the landslide disaster management is shrinking down in comparison to the river disaster management. The reflection of them can be seen in the budget distribution of DWIDM since its establishment in table 3.1 above. Nevertheless, the DWIDM is widening gradually its vision towards landslide disaster management in Nepal after establishment of the Landslide Study and Management Division on it.

In this context, the future plan and objective of landslide disaster management in Nepal have to be prepared addressing preparation and study of the landslide inventory map, landslide hazard map, land use map of landslide, analysis of the property of soil and rock for landslide, threshold value of rainfall for landslide, appropriate early warning systems for landslide, development of appropriate countermeasure technologies, and appropriate data management and so on which are very much preliminary stage at present in Nepal. During the preparation of the plan an objective of the landslide disaster management in Nepal, the ***Sendai Framework for Disaster Risk Reduction 2015–2030 and Recommendation from the International SABO Symposium 2015 in Sendai (18 March 2015), Japan*** would be necessarily considered. In this regard, the National Plan of Nepal needs to prioritize the Landslide disaster management in Nepal accordingly as a principal disaster.

4.1 Institutional Development

As the Landslide disaster is the principal disaster in Nepal but its management is in very much preliminary stage at present in Nepal, a well managed landslide disaster management authority should be established. At present, the Landslide disaster management is looking over by Landslide Study and Management Division (DDG) which was established recently in Fiscal year 2015/16 with limited facilities under

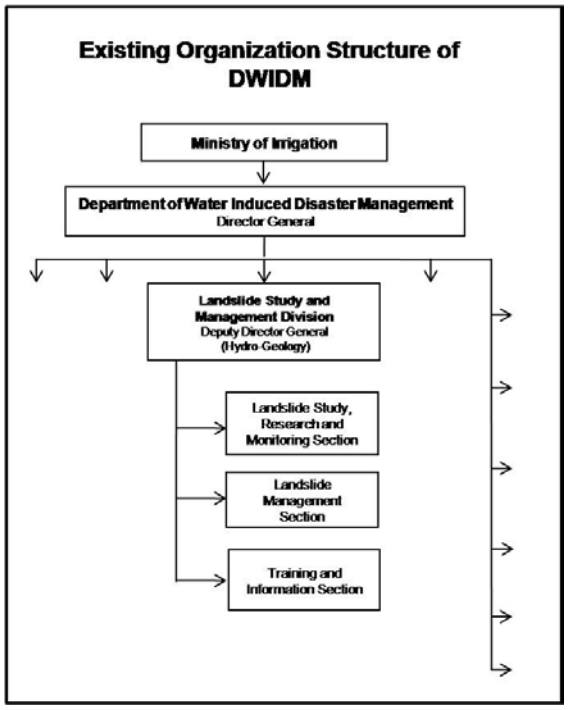


Figure4.2 Existing Organization of Landslide Wing, DWIDM (source DWIDM)

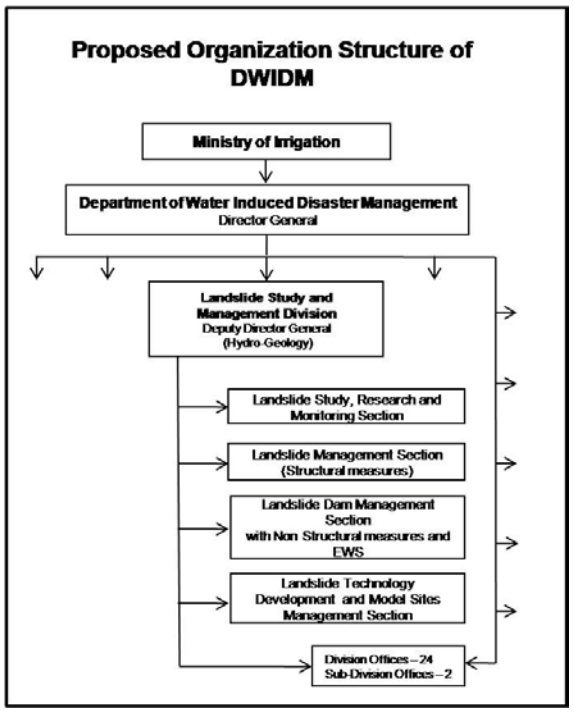


Figure4.3 Proposed Organization of landslide Wing, DWIDM

Department of Water Induced Disaster Management (DWIDM). The existing organization of Landslide disaster management wing under DWIDM is still needed to be updated in technical management, human resource management, linking with division and sub-division offices and so on to serve the people more user-friendly up to the community level, to facilitate development of the country and to achieve the target of poverty alleviation of the nation. Thus the existing and proposed organization chart of landslide disaster management wing is presented in Figure 4.2 and 4.3. Since the working area of all the 24 divisions and 2 subdivisions include the mountain and hilly area which are prone to landslide disaster, the landslide study and management division should be linked to all the division and subdivision offices for landslide disaster management work and man power related to the landslide disaster management should be recruited accordingly. To manage and plan the landslide disaster issues of Nepal very closely, the DWIDM have to formulate an individual landslide disaster management Project which could extend to necessary number

offield offices covering certain region of the landslide disaster areas.

4.2 Human resource development

As the Landslide Disaster management in Nepal is in very much preliminary stage, the Department has to establish landslide disaster data management with software development, prepare landslide inventory map of all over the country, prepare selected landslide hazard map, landslide zoning map, and land use map of landslide areas, train GIS and remote sensing experts to address the different types of landslide maps, analysis of the property of soil and rock for landslide, analysis of soil moisture content, threshold value of rainfall for landslide, develop appropriate early warning systems for landslide, develop appropriate countermeasure technologies, select and evaluate model sites of landslide disaster, appropriately use Hydraulic laboratory, develop technology and equipment for landslide dam management, develop appropriate non-structural measures, develop landslide disaster awareness education to local community and so on. During the landslide disaster management, not only the disaster related personnel but also the equipment management personnel and administrative management personnel must be involved. In this relation, Department has to develop and recruit human resources to address them including national and international capacity building opportunities.

4.3 Technological assistance

Since the nation is facing three major types of mass movements like slow moving landslide, slope failure and debris and mud flow and there are so many types of simple to sophisticated procedures to mitigate the impact of the landslides with structural and non-structural countermeasures, the Department has to manage appropriate technological assistance as per need from national and international sources. The mitigation measure technologies of those three types of mass movement are different from each other. So, DWIDM has to develop the landslides mitigation technologies as much as it can with technological assistance mainly in the following areas. From the past history, the use of SABO dam technology is popular and successful in context of Nepal. So, the different types of SABO Dam technology needs to be developed in Nepal for example, open type SABO dam, closed type SABO dam , frame structured SABO dam, gabion SABO dam, steel framed SABO dam, low cost SABO dam, net type SABO dam and so many other types of SABO dam.

1) The major cause of landslide is the increase of pore water pressure. So the DWIDM has to develop the different types of pore water pressure reducing technologies such as horizontal, inclined and vertical drilling technologies, development of drainage well, tunneling etc. to drain out ground water.

2) After identification of morphology of landslide body, the application of load removal at head part, counter weight management as toe wall at toe part and the anchoring and rock bolting technologies to mitigate the hanging landslides should be developed.

3) The different types of hill side works, bio-engineering works, different types of SABO dams, ground sill could be countermeasures of debris and mud flow disasters. Thus the DWIDM has to develop such technologies to manage the debris flow disasters in the country.

4) The nation faced the Jure landslide in August 2, 2014 which dammed the Sunkoshi. At that time the nation did not have any knowledge, experiences and preparedness for that type of disasters. So DWIDM has to develop countermeasure technologies to address that type of small to large landslide damming for example siphoning technology, blasting and excavation methods which were used in Jure landslide dam and other methods.

5) The early warning system(EWS) is the more economic, more effective, more applicable and reliable, easy to understand in community level countermeasure technology of non-structural countermeasures of landslide disaster. So DWIDM has to develop different types of technologies of EWS to save the life of people.

6) To develop the EWS, the landslide hazard maps with zoning of the landslide disaster area have to be prepared. So the DWIDM has to develop the different methods of preparation of hazard maps of landslide in the country.

7) Data management is the major part of landslide disaster management in Nepal. The MoHA collected the data of disaster as village name, type of disaster (eg. Fire, flood, landslide etc), death, injured, and losses (as land, cattle, cash and houses etc). but in addition, the coordinates (by GPS) of landslide event for location, area of landslide disaster, type of landslide disaster (debris flow, slope failure, slow moving landslide etc), accessibility and so on also are needed. For a good data management, particular software for database has to be developed. In this way, the DWIDM has to develop a well-managed data base and with appropriate software of landslide disaster in Nepal such as GIS which is strong for special data management and analysis.

8) In the same way, the most important part is the preparation of mapping of landslide of Nepal. The DWIDM has to prepare the inventory map of all over the country, preparation of selected hazard map of landslide of community level with zoning, land use map of landslide and development of GIS and Remote sensing technology. During the mapping of the landslides of Nepal, inventory mapping of

the landslide with polygon would be prepared in small scale which will have wide coverage but the selected landslide hazard map with zoning would be prepared in large scale mapping so that the community could understand easily. It can also be used for design of countermeasures.

4.4 Transfer of knowledge and technique to next generation

As per the government rules, the staff will be transferred from one position/section to another after certain time period and also in the cases of retirement, the concerned position could be vacant. The experiences and knowledge gained have to be transferred to new comer or next generation to keep continuity of the work. In this case, there should be a trend in government that a new staff should be deputed to work with the senior staff who is going to be transferred or retire at least one year before the event so that the experiences and knowledge and working technologies could be transferred to the new comer.

4.5 Important fields (subjects) in landslide disaster management in Nepal

As the landslide disaster management in Nepal is in initial stage, almost all fields related to the landslide disaster management are equally important and need to be developed. So following fields could be the major fields of landslide disaster management in Nepal with priority. Landslide study, Landslide mapping (inventory, hazard, zoning), landslide Structural countermeasure technology such as different types of SABO dams for different types of landslide disasters, landslide non-structural countermeasure technology such as awareness educations, Landslide dam management technology with different types of equipments, EWS technology, Landslide low cost counter measures technology and so on. The Important fields of landslide disaster management, Human resources development, and External Technological assistance required which are explained in sections 4.2, 4.3 and 4.5 are presented in Table A of Annex I. Similarly, the Progress of achievement of key elements of community disaster risk management: current status and future prospect as of 2016 is presented in the Table B of Annex I

REFERENCES:

NSDRMN 2009, National Strategy for Disaster Risk Management in Nepal 2009, Government of Nepal, UNDP, EU and NSET.

Sendai Framework for Disaster Risk Reduction 2015-2030, United Nations

Recommendation from the International SABO Symposium 2015 in Sendai (18 March 2015), Japan.

Eighth Plan of Nepal (1992-1997), Government of Nepal, National planning Commission , Kathmandu, Nepal

Ninth plan of Nepal (1997-2002), Government of Nepal, National planning Commission, Kathmandu, Nepal

Tenth Plan of Nepal (2002-2007),Government of Nepal, National planning Commission Nepal, March,2002

Eleventh Three Year Interim Plan(2007/08 – 2009/10), Government of Nepal, National Planning Commission, Singhadurbar, Kathmandu, Nepal, December 2007.

Twelfth Three Year Interim Plan(2010/11-2012/13), Government of Nepal, National Planning Commission, Singhadurbar, Kathmandu, Nepal, Asar 2068

An Approach Paper to the Thirteenth Plan (FY 2013/14 – 2015/16), Government of Nepal, National Planning Commission, Singha Durbar, Kathmandu, Nepal, July, 2013

Fourteenth Plan, Base Paper (2016/17-2018/19), Government of Nepal, National Planning Commission, Singha Durbar, Kathmandu, Nepal, 2073.

CHAPTER V

REQUIREMENTS FOR DWIDMTO CARRY OUT ACTIVITIES MENTIONED INCHAPTER IV ABOVE, IN TERMS OF:

5.1 Human resource (number of persons, expertise)

As per the organization Chart proposed in the Figure 4.2 above for the Landslide Disaster management (LDM) under DWIDM, the requirement of human resources is presented in Table 5.1 below.

Table 5.1: Requirement of Human Resources for Landslide Disaster Management

S.NO.	Discipline	Required Number for Department	Required Number for Division /sub-division offices	Required Number For projects +FO (pool)	Total	Remarks
1	Officer Class I Hydro-geologist	1	0	1	2	
2	Officer Class II Hydro-geologist / Engineering Geologist	4	12	2+5	23	for 12 Div. offices
3	Officer Class III Hydro-geologist / Engineering Geologist	4	26	4+10	44	for 12 Div. and 2 subdiv.
	Sub total	**9**	**38**	**7+15**	**69**	
4	Officer Class III Engineering	4	38	4+10	56	1 Eng. for each Dist.
5	Non-Officer I Sub-engineer	8	60	4+20	92	1 S.E. for each Dist.
	Sub total	**12**	**98**	**8+30**	**148**	
	Grand Total	**21**	**136**	**15+45**	**217**	

FO=Field Office for five regions/provinces

The four sections mentioned in the proposed organization chart in figure 4.2 under Deputy Director General(DDG) of DWIDM will look over the centrally controlled landslide management works all over the country. There are 24 division offices and 2

sub-division offices under DWIDM which will look over the local and community level disaster management in Nepal and each Division office will look over three to four districts and the sub-divisions will look over one each of the remote districts. The location of the Divisions and Sub-divisions of DWIDM with Districts are shown in

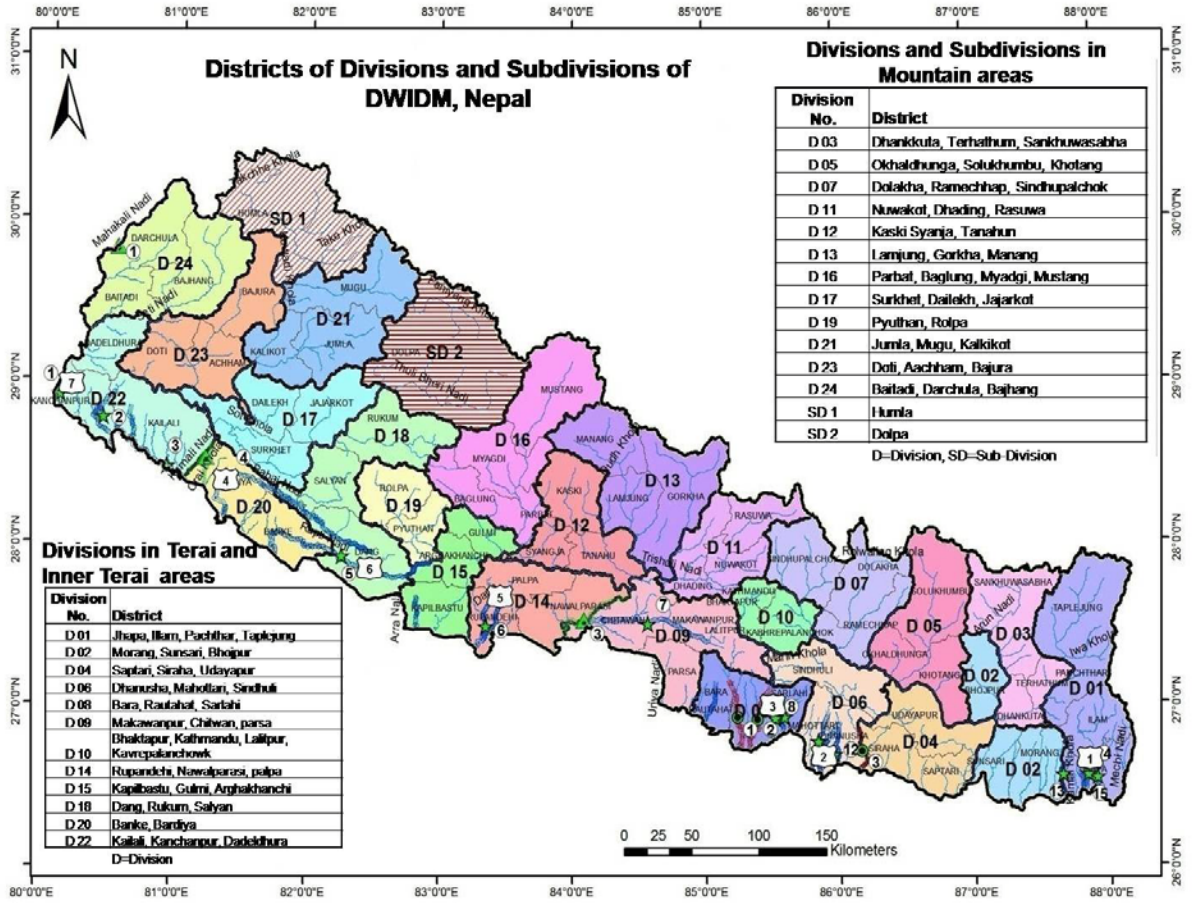


Figure 5.1 : Map of Nepal showing Districts of Divisions and Sub-divisions of DWIDM (source DWIDM)

Figure 5.1 and Table 5.2A.Thus most of the division offices consist of mountain and hilly areas which are landslide prone areas. So Division and sub-division offices of mountain area have to cover landslide disaster management as well. Thus, the Division and sub-division offices of mountain area should be looked over by landslide disaster related technical personnel i.e. Hydro-geologist /Engineering geologist but the division offices in Terai and inner Terai regions are mainly concentrated on river disaster management and should be looked over by river disaster related Engineers. In this regard, out of 24 division offices, 12 division offices (Table 5.2 C) have to be looked over by landslide disaster related technical personnel i.e. Hydro-geologist /Engineering geologist including the two sub-division offices and the remaining 12 division offices concentrated to Terai and inner Terai region (Table 5.2 B)have to be looked over by the river disaster related engineers where the mountain districts of

Do1 of Table 5.2B is needed to be adjusted towards Mountain Divisions for Landslide Disaster management. When the Landslide disaster management work in Nepal will run smoothly as per appropriate way, there will be need of establishment of individual landslide disaster management projects. In other hand, the individual

Table 5.2: Number of Divisions and Sub-divisions of DWIDM with districts

A. Total Divisions and Sub-divisions of DWIDM with Districts

Division No.	District
D 01	Jhapa, Illam, Pachthar, Taplejung
D 02	Morang, Sunsari, Bhojpur
D 03	Dhankkuta, Terhathum, Sankhuwasabha
D 04	Saptari, Siraha, Udayapur
D 05	Okhaldhunga, Solukhumbu, Khotang
D 06	Dhanusha, Mahottari, Sindhuli
D 07	Dolakha, Ramechhap, Sindhupalchok
D 08	Bara, Rautahat, Sarlahi
D 09	Makawanpur, Chitwan, parsa
D 10	Bhaktapur, Kathmandu, Lalitpur, Kavrepalanchowk
D 11	Nuwakot, Dhading, Rasuwa
D 12	Kaski Syanja, Tanahun
D 13	Lamjung, Gorkha, Manang
D 14	Rupandehi, Nawalparasi, palpa
D 15	Kapilbastu, Gulmi, Arghakhanchi
D 16	Parbat, Baglung, Myadgi, Mustang
D 17	Surkhet, Dailekh, Jajarkot
D 18	Dang, Rukum, Salyan
D 19	Pyuthan, Rolpa
D 20	Banke, Bardiya
D 21	Jumla, Mugu, Kalkikot
D 22	Kailali, Kanchanpur, Dadeldhura
D 23	Doti, Aachham, Bajura
D 24	Baitadi, Darchula, Bajhang
SD 1	Humla
SD 2	Dolpa

D=Division, SD=Sub-Division

B. Divisions in Terai and Inner Terai

Division No.	District
D 01	Jhapa, Illam, Pachthar, Taplejung
D 02	Morang, Sunsari, Bhojpur
D 04	Saptari, Siraha, Udayapur
D 06	Dhanusha, Mahottari, Sindhuli
D 08	Bara, Rautahat, Sarlahi
D 09	Makawanpur, Chitwan, parsa
D 10	Bhaktapur, Kathmandu, Lalitpur, Kavrepalanchowk
D 14	Rupandehi, Nawalparasi, palpa
D 15	Kapilbastu, Gulmi, Arghakhanchi
D 18	Dang, Rukum, Salyan
D 20	Banke, Bardiya
D 22	Kailali, Kanchanpur, Dadeldhura

D=Division

C. Divisions and Subdivisions in Moutain

Division No.	District
D 03	Dhankkuta, Terhathum, Sankhuwasabha
D 05	Okhaldhunga, Solukhumbu, Khotang
D 07	Dolakha, Ramechhap, Sindhupalchok
D 11	Nuwakot, Dhading, Rasuwa
D 12	Kaski Syanja, Tanahun
D 13	Lamjung, Gorkha, Manang
D 16	Parbat, Baglung, Myadgi, Mustang
D 17	Surkhet, Dailekh, Jajarkot
D 19	Pyuthan, Rolpa
D 21	Jumla, Mugu, Kalkikot
D 23	Doti, Aachham, Bajura
D 24	Baitadi, Darchula, Bajhang
SD 1	Humla
SD 2	Dolpa

D=Division, SD=Sub-Division

landslide disaster management Project could establish necessary number of field offices to work with more comfort which will cover certain region of the landslide disaster areas such as, five field offices to address the five regions of Nepal or five provinces of mountain regions Figure 5.2. In that case, additional human resource has to be established as mentioned in Table 5.1 (projects+FO). Thus DWIDM have to manage at present total 217 technical personnel to carry out the Landslide disaster management work in Nepal as mentioned in Chapter IV above.

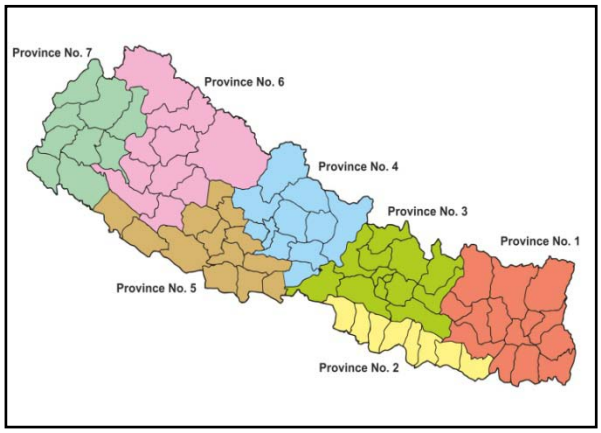


Figure 5.2: Provinces of Nepal

The landslide in Nepal is majorly caused due to impact of groundwater and the department will look over the water induced disaster under Ministry of Irrigation in Nepal. So the Hydro-geologist is the appropriate landslide disaster

management related technical personnel who will work all the hydro-geological works including landslide disaster management, geological works and engineering geological works as well related to landslide disaster management.

5.2 Technology

As mentioned in the section 4.3 above, the DWIDM requires experts through technological assistance in the following areas.

1. *SABO Dam technology experts:* different types of SABO dam e.g. open type SABO dam, closed type SABO dam, frame structured SABO dam, gabion SABO dam, steel framed SABO dam, low cost SABO dam, net type SABO dam and so many other type of SABO dams.
2. *Slow moving landslide treatment technology expert:* Pore water pressures release technologies as horizontal drilling drainage, drainage wells, surface and sub-surface drainage management, tunneling to drain out the collected ground water, anchoring and rock bolting technologies, load removal and counter-weight management, toe wall management and so on. These are especially effective for slow movement type landslides.
3. *Debris and mud flow treatment technology expert;* SABO Dam experts as in 1. Above, Ground sill management, Debris breaker and debris pool management, different types of hill side work technologies.
4. *Slope failure treatment technology expert:*
5. *Landslide Dam management technology experts:* Small to large landslide dam management, e.g. siphoning technology, blasting and excavation technology and so on.
6. *EWS technology expert:* Evacuation of the people to safe area on the base of early warning system (EWS) to protect from the impact of landslide disaster.
7. *Landslide Hazard mapping expert:* Analysis from high resolution of satellite imagery or aerial photos and also Lidar etc. hazard evaluation methodology such as AHP,
8. *GIS and Remote sensing expert:*
9. *Landslide data management expert:* Need to develop appropriate software for landslide data management.

5.3 Transfer of knowledge and technique to next generation

As mentioned in section 4.4 above, to transfer the knowledge and technology that was gained by the senior staffs to next generation, a trend should be developed in

government so that a new staff will be deputed to work with the senior staff who is going to be transferred or retired from his/her job at least one year before the event. Thus, the experiences and knowledge and working technologies could be transferred to the new comer without any losses.

5.4 Budget

The approximate Budget required for DWIDM to carry out the activities mentioned in the Chapter IV for the Landslide Disaster Management is summarized in the table 5.2 below. The required budget is broken down in nine different headings which are most import to manage the Landslide disaster in Nepal. The required budget for those nine activities of landslide disaster management each year is about 2.32 billion. This will be about 32.5 billion up to 2030 AD.

Table 5.3: Approximate Requirement of budget for Landslide Disaster Management in Nepal up to 2030AD.

S.No.	Activities	Necessary Budget per year in NRs. million	Necessary Budget needed up to 2030 (*14)
1	Central level LDM (countermeasures works)	1000	14000
2	District level LDM (countermeasure works)	250	3500
3	Study, research and mapping of Landslide Disaster and Laboratory development	100	1400
4	Equipments and Landslide Dam management works	150	2100
5	Rehabilitation works	100	1400
6	EWS development works	100	1400
7	Landslide Management Technology development and Model sites development works	100	1400
8	Data Management with LDM software development and purchase of soft wares	20	280
9	Landslide Management Projects	500	7000

	Approximate required Total Budget	**2320**	**32480**

The detailed activities of those nine headings are explained below.

Central level Landslide Disaster Management (LDM): To do countermeasure works in one large landslide (>100m toe width and >150m Length),it costs approximately 400 to 500 million Nepalese Rupees. If we allocate initially NRs50 million only for one landslide, the countermeasure works can be done just in 20 landslides each year from NRs.1000M. This amount will be approximately 20% of total annual Budget of DWIDM but there are so many medium and large deep seated landslides in Nepal. So it will be continued in following years.

District level Landslide Disaster Management (LDM): The Division and Subdivision offices will look over the medium and small landslide countermeasure works. If we can allocate initially NRs.20M for one Division and NRs. 5million only for one Subdivision each year (which is much small budget), then, at least some development could be observed in local community level. Each Division offices look over 3 to 4 districts. So it will be 250M for 12 Divisions and 2 Subdivisions of mountain areas. It will be continued to following years.

Study, research and mapping of Landslide Disaster and Laboratory development (100M): This time DWIDM do not have landslide inventory map, hazard maps of landslide, no research works were done yet, laboratory have to be updated and maintained. So, initially, NRs.100M is allocated to do those works in some districts in lump sum base and it will be continued to following years.

Equipments and Landslide Dam management works (150M): This time DWIDM do not have any equipment related to Landslide disaster management and landslide dam management and there are not any landslide monitoring equipment, apparatus and so on. So the landslide disaster management related equipment will be purchased from the allocated budget which is allocated on lump sum base.

Rehabilitation works (100M): Since the DPTC time (1991), the DWIDM constructed many countermeasure structures related to landslide disaster management. Those structures have to be rehabilitated. The amount is allocated as lump sum base.

EWS development work(100M): This time there are no any development of Landslide EWS in Nepal. So we have to establish landslide EWS from very beginning as study, development of appropriate technology, lab test, and hazard maps preparation and so on. To address those works NRs 100M budget is allocated in lump sum base.

Landslide Management Technology development and Model sites development works (100M): To develop a model site in large landslides, it will cost approximately 400 to 500M. So this will be an initial cost to develop landslide model sites with appropriate technology.

Data Management with LDM software development and purchase of software (20): DWIDM have to manage the Data bank of LDM. It has to purchase some necessary software related to the data management and have to develop appropriate software as well. The budget of NRs.20M is allocated initially in lump sum base for those works.

Landslide Management Projects: DWIDM established the Landslide Study and Management Division in Department, established the WIDM Policy 2072(BS) and the establishment of WIDM Act and Rule and Regulation are in process. In this context, the DWIDM will establish Landslide Disaster Management Projects in Nepal. More over the LDM Project could establish Field Offices in at least five development regions of Nepal or five mountainous provinces of Nepal to address the appropriate LDM technology in large and medium landslides of Nepal. Initially the budget NRs.500M is allocated to establish the project, study and management in lump sum basis.

There could be so many possible projects under the Landslide Disaster Management (LDM) in the country. Out of them few possible projects are mentioned below.

1. Climate change induced disasters in Landslide and River Disaster management in Narayani Watershed.

The DWIDM already submitted the project proposal to Government of Japan/JICA through diplomatic channel with necessary Japanese technical assistance in Fiscal Year 2016/17. The proposal was concerned to Climate change induced disasters in Landslide and River Disaster management in Narayani Watershed.

Objectives of the project proposal were

- To proceed Climate change Resilience all over the basin.
- Study of those disasters all over the basin, such as different types of Landslide and flood in the watershed base.
- Preparation of **Inventory, Hazard and vulnerable map** of Landslide and River Disaster areas.
- **Prepare Master Plan** of Selected Landslide Disaster and construct selected Model sites which will be supportive for future works.
- Demarcation of **Land use** in vulnerable areas
- Design of **structural mitigation** measures with **new technology and implement them**

- Develop and design **non-structural measure–early warning technology development and awareness programs.**
- **Design Manuals** of Landslide and River training management.

To address those DRM issues, DWIDM has to develop a well managed system, mechanism and capacity building.

Some Information of the Narayani River Watershed/Basin

The Narayani Basin covers 17 districts and 7 major rivers. The names are as follows.

- **Districts:**
  Chitwan, Makawanpur, Nawalparasi, Dhading, Nuwakot, Rasuwa
  Kaski, Syanja, Tanahu, Lamjung, Manang, Baglung, Parbat, Myagdi, Mustang, Gorkha and Gulmi
- **Related Rivers**
  - Narayani
  - Kaligandaki*(Tributaries-Ridhi khola, Badegadh, Rahughat, Mustang)*
  - Rapti (E)*(Tributaries- Riu, Lothar, Manahari, Karra)*
  - Seti (Tributaries-Madi)
  - Marsyandi
  - Budhi gandaki *(Tributaries- Ankhu)*
  - Trishuli*(Triobnutaries-Tadi, Malekhu, Likhiu, and Bhote)*

The Narayani Basin consists of rugged topography, unstable geological structures, soft and fragile rocks, along with heavy and concentrated rainfalls during monsoon periods collectively cause severe landsliding problems and related phenomena in the basin. **Parbat, Lamjung, Baglung and Makwanpur** districts are rated as the **very high** and **Syangja, Gorkha, Dhading, Nuwakot, Kaski, Myagdi and Tanahu** district as **high vulnerable** districts to **landslide**. The rainfall induced landslides in the hills and mountain area of these districts of basin extend tremendous damage to lives, property, infrastructure, and environment, particularly in the monsoon season.

National Adaption Programme of Action (NAPA) assessment in Water Induced Disaster Risk in the Basin: The basin receives high rainfall compared to other mega basins of Nepal. The topography of the basin is also very rugged. The most frequent disasters in the basin are **Flood and Landslide.** According to NAPA assessment four districts **Parbat, Lamjung, Makwanpur and Baglung** exposed to very high landslide vulnerable zone whereas, district with less rainfall and low lying are less vulnerable **Manang, Gulmi, Nawalparasi and Chitwan**. Similarly, districts as **Chitwan and Nawalparasi** were rated as **high and moderate** flood

exposed area. Further, NAPA separated GLOF Risk Area with reference to distance downstream. In Narayani Basin Lamjung, Gorkha, Manang and Mustang are high vulnerable area. The rest were rated low vulnerable district to Flood, (Ministry of environment 2010).

2. Landslide Disaster Management in National Road/Highways

Since more than 80% area of the country consists of mountain and hills with fragile geology which are prone to sediment related water induced disasters such as, slope failure, debris flow and landslide which are triggered due to torrential rainfall during the monsoon rainy season, and that causes the damage of Highways and infrastructures and loss of lives and properties and environmental degradation each year. More over the climate change induced disasters due to unscheduled torrential rainfall destructing towns, National Infrastructures like Bridges, Highways, Hydropower, Irrigation Canal, Agricultural land, giving threats to Development of the Country. To address those issues and their management, many projects have to be formulated in different sectors of the country. One of the sectors could be Landslide Disaster management in the National Highways such as, Sindhuli Road. The Sindhuli road (four sections) was constructed under grant assistance of Government of Japan which was completed all the four sections and opened to the public since March 2015. Even though the completion of the Sindhuli road, the landslides destructing the Sindhuli road each monsoon year and disturbing the traffic.

In this regard, a project have to be formulated which will address the important sites of landslide protection for roads both by hardware measures and software like detailed hazard mapping by using AW3D DEM which enables high resolution of topographical analysis and EWS for road traffic safety.

In the same way, those types of procedures could be used in Hetauda-Dakhinkali-Kathmandu road, Butwal-Palpa Road, Tulsipur-Salyan road, Kathmandu-Kodari road and so on which are much vulnerable.

3. Landslide Disaster Management in Large Landslides

To address the water induced disaster issues and their management; the next sector of project formulation area could be Landslide Disaster management in the individual large and deep seated Landslides where preparation of detail community hazard map, master plan of countermeasures, land use map and application of EWS has to be implemented such as,

- ***Kerunge Landslide and flood management****, Nawalparasi,*
  - *Affected settlements, East-West Highway and agricultural lands.*
- ***Jure Landslide*** *and* ***Natural Dam management,*** *Sindhupalchowk*

- *Affected Arniko Highway, Sunkoshi Hydropower and agricultural land.*

- ***Hangdewa and Hireba Landslide and Debris flow management,*** *Taplejung*
  - *Affected Airport, headquarter, residents and agricultural lands*
- ***Ramche Landslide management,*** *Rasuwa*
  - *Affected Pasang Lhamu Highway, settlement and agricultural land*
- ***Taprang Landslide management****, Kaski*
  - *Affected the Pokhara-Taprang highway, Sildujure settlement and agricultural land*
- ***Gyapche Landslide management,*** *Ramechhap,*
  - *Affected settlements and agricultural lands.*
- ***Kapurkot*** *Landslide management, Salyan and so on.*
  - *Affected settlements, agricultural lands and highway.*

4. Landslide Disaster Management in Community based approach for rehabilitation of earthquake and rain-induced disasters (for medium Landslides), such as,

- ***Sheri Landslide and Rara Lake area Landslide management****, Mugu*
  - *Affecting the Headquarter, settlement, agricultural land and environment*
- ***Subeda Landslide management****, Bajhang,* ***Baglung Landsdil****e, Baglung,* ***Myagdi landslide*** *and so on*
  - *Affecting the settlement, agricultural land and environment*

REFERENCES:

Ministry of Environment, 2010, National Adaptation Programme of Action to Climate Change, Government of Nepal, Kathmandu, Nepal

CHAPTER VI

CONCLUSION AND RECOMMENDATIONS
(as per TOR)

6.1 Conclusion

Nepal is the mountainous country covering more than 80% hills and mountain area which are most prone to disasters by various types of landslide such as slow movement type slides, slope failure, debris flow, and various erosion and sedimentation processes as well. The country is facing catastrophic landslides which are causing casualties more than 100 each year as per the MoHA data. An inventory of past disastrous events during 1971-2006 reveals that epidemics take the largest toll of life every year, then the landslide and flood take place in second and third position respectively (NSDRMN 2009). Thus, the landslide lies on the principal hazards of Nepal which have been affecting enormous losses of life and property and infrastructures and even affecting the national development, poverty alleviation and GDP of the country.

On the basis of the Natural Calamity (Relief) Act 1982, a framework of disaster management in Nepal is developed from central government level to local level such as, Central Natural Disaster Relief Committee, Regional Natural Disaster Relief Committee, and District Natural Disaster Relief Committee to coordinate the disaster preparedness and response activities in the country under the Ministry of Home Affairs (MoHA) which is the nodal body in the field of Disaster Management in Nepal. In this regards, the Government of Nepal has been following a trend of providing immediate response as rescue and relief work during a disaster, especially during the monsoon floods and landslides utilizing the armed police force and Nepalese army. Besides them the disaster data management and national and international disaster fund management is the responsible field of the Ministry of Home Affairs.

The landslide disaster management in Nepal was initiated authentically since the establishment of the Water Induced Disaster Prevention Technical Centre (DPTC) on 1991 which constructed different types of Model sites for countermeasures of mass movement like slowly moving landslide, slope failure, debris flow and Model sites for countermeasures of river disaster management like river training works, revetment works and embankment protection works and so on. The small scale landslide mitigation works as soil erosion control in watershed were executed by DSCWM and other NGOs like Nepal Red Cross Society and so on before DPTC which has been continuing to date.

The National Plan of Nepal express s few words about DPTC as "support will be provided to water induced hazard control works by organizing relevant training programmes and collecting the data relating to water induced hazard control" in 8th Plan (1992-1997)of Nepal. The 9th Plan (1997-2002)did not spell out about Disaster management in Nepal. The 10th Plan (2002-2007) explains first time about disaster management in Nepal. The water induced disaster management as flood, landslide, debris flow and inundation were addresses in this plan which was continued up to 11thPlan (2007/08-2009/10). In the mean time, the Water Resources Strategy of Nepal 2002 and the National Water Plan 2005 delegated the mandate to DWIDM for water induced disaster management in Nepal. After the 12th Plan (2010/11-2012/13), the objective of National plan related to Water induced Disaster management is more focused on construction work of river disaster management which is continued up to recent 14th Plan (2016/17-2018/19) and priority to the landslide disaster management is shrinking down in comparison to the river disaster management in Nepal.

This is reflected on the budget allocation of water induced disaster management where the average budget allocated for landslide disaster management is only about 4% of the total amount since Fiscal year 2001/02 to 2015/16 (source: DWIDM). Thus, although huge amount of fund has been investing by the government for disaster management field every year, the landslide disaster is not treated as one of the important parameters during the planning and designing stage. Even if treated, it is done without detailed study and investigation which further enhances the problem.

On the other hand, the landslide disaster is mostly created due to influence of groundwater which is strongly affected by geological condition. So the landslide disaster management has to be looked over by geo-scientist as Hydro-geologist or geological engineer. Since the National Plan is weak to address the Landslide disaster management in Nepal, the appropriate human resources became quite insufficient in the DWIDM. (The landslide study and management division looked over by DDG under DWIDM was established since last fiscal year 2015/16 but government has not recruited the landslide study and management division Chief, DDG post and Landslide Management Section Chief yet. This time there are only 3 geoscientists are present in the DWIDM during preparation of this report). And the budget allocation for landslide disaster management is also minimal. Thus appropriate managed data of landslide disaster, inventory of landslides in Nepal, landslide hazard map, study of soil and soil moisture for threshold value of rainfall for landslides, development of landslide EWS, awareness education programs to the community have been quite limited and so many other activities are in void in landslide disaster management of Nepal. This situation directly impacted to not only to the loss of life and property, .development, poverty alleviation and GDP of the country, it impacted to the donor institutions who are investing a lot of budget in Nepal as well and they could not

lunch any appropriate projects focusing on landslide disaster management in Nepal. The donor agencies like JICA, WB, DFID, and UNDP are spending billions of rupees in Nepal but there are no such projects that are related to landslide disaster management in Nepal with cooperation of DWIDM except a few under JICA. The UNDP generated so many disaster related projects through Flagship programs, but there is no such a project that is related to landslide disaster because there are only little data about landslide disaster management in Nepal except limited data of MoHA and some data established during DPTC time like Model site reports, photo monitoring data, bioengineering albums and so on which have to be analyzed, evaluated and published. So we have to study, generate data, prepare maps of landslide disaster management in Nepal as soon as possible to facilitate development, poverty alleviation and GDP of the country and to protect the life and property of the people.

Thus now onward the National Plan of Nepal has to keep the landslide disaster management in Nepal in priority as a principal disaster and the government has to allocate considerable budget to the landslide disaster management as well considering the ***Sendai Framework for Disaster Risk Reduction 2015–2030 and Recommendation from the International SABO Symposium 2015 in Sendai (18 March 2015), Japan.*** In this context the DWIDM have to play a lead role to establish them.

6.2 Recommendations

The landslide disaster management is the principal disaster in Nepal which has to be addressed by National Plan of Nepal and the Government has to put it in priority budgetary system. To bring these views to reality, the DWIDM has to play a lead role. In this context the recommendations are listed as below.

Related to the Activities for which DWIDM should be responsible in the future, considering 2,3,4 chapters :

- DWIDM's own Landslide Data bank should be established with development of software and the data established during DPTC time like Model site reports, photo monitoring data, bioengineering albums and so on have to be analyzed, evaluated and published.
- DWIDM has to deal with lead role for landslide disaster management in Nepal.
- National Plan has to prioritize the landslide disaster as principal disaster of Nepal and the DWIDM has to facilitate it considering the ***Sendai Framework for Disaster Risk Reduction 2015–2030 and***

Recommendation from the International SABO Symposium 2015 in Sendai (18 March 2015), Japan.

- National plan has to recruit a landslide management expert as a member which will help to landslide disaster management plan in Nepal.
- Although the landslide policy is developed under the Water Induced Disaster Management Policy 2072, still there are no Act and regulation of landslide disaster management. So those acts and regulation should be developed as soon as possible.
- DWIDM has to prepare the landslide inventory of Nepal with shallow and deep seated landslides, landslide hazard map with zoning as soon as possible,
- DWIDM has to prepare landslide EWS and landslide awareness education to the local community.
- DWIDM has to be prepared for landslide damming situation with necessary equipment, technologies and trained manpower.
- DWIDM has to keep continuity of rehabilitation works of landslide disaster.
- DWIDM has to pursue cost effective landslide countermeasures
- The Water Resources Strategy of Nepal 2002 and The National Water Plan 2005 delegates the mandate of water induced disaster management to DWIDM but their vision is so vague that there is no clear demarcation about landslide disaster management in Nepal. In this context DWIDP have to play lead role to establish the National strategy for landslide disaster management in Nepal.
- DWIDM have to prioritize the budget to landslide disaster management as much as it can.

Related to the Requirements for DWIDP to carry out activities mentioned in section 4-1～4-5

- DWIDM has to update its organization chart in landslide study and management wing as mentioned in figure 4.3
- DWIDM has to establish one central level individual landslide disaster management Project which will look over more closely the landslide issues of Nepal.
- Human resources have to be managed as mentioned in table 5.1. and the Landslide study and disaster management division chief (DDG) and the

Landslide management Section chief should be recruited as soon as possible which have been vacant.

- DWIDM has to prepare the expert on SABO DAM, Landslide treatment expert (which will look over the slow moving landslide treatment, Debris flow and mud flow treatment, and slope failure treatment), EWS technology expert, landslide Hazard mapping expert, Landslide data management expert and GIS and Remote sensing experts.
- DWIDM has to develop a trend to produce successor of senior staffs after his/her retirement/transfer to transfer the knowledge and techniques.
- DWIDM has to play lead role to manage the budget as mentioned in table 5.2.
- DWIDM has to play lead role to communicate with donor agencies who are involved in disaster field to implement landslide disaster management related projects.

6.3 Proposal on the use of input from NFAD to meet the requirements, in particular, for human resource development specifying technical field (scheme) which NFAD will focus on.

Since the establishment of DPTC on 1991, JICA/Government of Japan provided more than 50 training fellowships to date in sediment related disaster, river disaster management and masters course on hydrology, Sabo engineering and so on. Out of them a few fellows who had trainings on river disaster management are still working in DWIDM, a few were transferred to DHM but most of them retired by age and no more landslide experts are remained. And the DWIDM has no trend to prepare successor yet.

In this situation, DWIDM has to have trained manpower again in SABO dam technology, Landslide treatment technology, Sediment related disaster treatment technology, landslide EWS technology, landslide hazard map preparation technology, landslide data management technology and GIS and Remote sensing.

So, it is proposed to NFAD to provide opportunities to develop human resources on those technical fields to develop the landslide disaster management in Nepal. Besides, during the landslide disaster management work, the equipment management personnel and administrative management personnel also should be involved. So, opportunities of capacity building to them are also proposed in in-house and abroad

here. On the other hand, Government of Nepal facing climate related landslide disasters and earthquake related landslide disasters as well and many advanced and sophisticated technologies related to landslide disaster management are developed in Japan at present time. In this relation people and Government of Nepal would like to have that technology transfer with appropriate Model sites in deep-seated landslides and landslide dams which will help to develop human resources as well as technology transfer program to meet the Sendai Framework for DRR and the International SABO Symposium 2015 in Sendai.

ANNEX I

TABLES

Table A: Important fields of landslide disaster management, Human resources development, and External Technological assistance required

Important fields (subjects)of landslide disaster management in Nepal (4.5)	**Human resource development required to address (4.2)**	**External Technological Assistance required for Technology transfer (4.3)**
Landslide research and study	Geological and geomorphological study of pre-landslide forecasting, different landslide monitoring technologies, and landslide data management areas.	Geological, geomorphologic expert for study of pre-landslide forecasting; Different landslide monitoring technology expert; Landslide data management expert.
Landslide mapping (inventory, hazard, zoning)	Landslide hazard mapping, landslide mapping, landslide inventory mapping and GIS and remote sensing areas.	Landslide hazard mapping, landslide mapping and landslide inventory mapping expert; GIS and remote sensing expert.
Structural countermeasures technology	Different types of SABO Dam technology; Slow moving landslide treatment technology; Pore water pressure treatment technology; Debris and mud flow treatment technology; Slope failure treatment technology; and anchoring and rock bolting technology areas.	Different types of SABO Dam technology expert; Slow moving landslide treatment technology expert; Pore water pressure treatment technology expert; Debris and mud flow treatment technology expert; Slope failure treatment technology expert and anchoring and rock bolting technology expert.
Non-structural countermeasures technology	Disaster awareness education; and Community based disaster risk management areas.	Disaster awareness technology experts; Community based disaster risk management expert.
Landslide dam management technology	Landslide dam management technology areas.	Landslide dam management technology expert.
EWS technology	Different Types of EWS technology areas	Different types of EWS technology expert.
Low-cost countermeasures technology	Different types of Bioengineering technology areas.	Different types of Bioengineering technology experts.

Table B. Progress of achievement of key elements of community disaster risk management: current status and future prospect as of 2016

S.N.	**Name of community with Disaster type**	**Hazard map**	**EWS**	**CDRM Plan/ Construction**
1.	Kabilash village Landslide, Chitwan	○ (landslide)	○ (landslide)	○
2.	Danabari Landslide, Ilam (2002/03)	x	x	○
3.	Higuwapati Landslide, Kavre 2002/03 to 03/04)	x	x	○
4.	Lohendra Bank protection, Morang (2002/03 to 03/04)	x	x	○
5.	Okharpauwa Landslide, Nuwakot (2002/03-2006/07)	x	x	○
6.	Khandichaur Landslide, Sindhupalchowk (2003/04-2007/08)	x	x	○
7.	Bungmati Landslide, Lalitpur	x	x	○

	(2004/05-2005/06)			
8.	Champha Pani Landslide, Syanja (2004/005)	x	x	○
9.	Pirkun & Chundevi, Dharmasthali Landslide, Kathmandu (2004/05)	x	x	○
10.	Naubise Road Sector Landslide, Dhading (2004/005 to 2006/007)	x	x	○
11.	Attarpur Landslide,Sindhupalchowk (2004/05)	x	x	○
12.	Petku Landslide, Sindhupalchowk (2006/07-007/08)	x	x	○
13.	Maadtal khola Landslide, Chitwan(2006/07-008/09)	x	x	○
14.	Tatopani Landslide, Sindhupalchowk (2006/07-2009/10)	x	x	○
15.	Tallo Kuduletar Landslide, Sindhuli (2006/07-009/010)	x	x	○
16.	Jyamire Landslide, Sindhuli (2008/09)	x	x	○
17.	Amale Landslide, Dhading (2007/08)	x	x	○
18.	Besar danda Landslide, Dhading (2008/09)	x	x	○
19.	Aanpkhark Landslide , Dhading (009/010)	x	x	○
20.	Chapali Bhadrakali, Landslide, Kathmandu (2007/08-2010/11))	x	x	○
21.	Dube khola Landslide, Sindhupalchowk (2008/09)	x	x	○
22.	Looksing Landslide, Sindhupalchowk (2007/08-008/009)	x	x	○

23.	Kharidhunga Landslide, Dokkha (2009/010)	x	x	○
24.	Kapan Landslide, Kathmandu (2009/010)	x	x	○
25.	Kerunge LS (Large), Nawalparasi (2011/12 to date)	x	x	△
26.	Lyang Khola LS (large), Sindhupalchowk, 2011/12 to date)	x	x	△
27.	Handewa/Hireba LS (large) Taplejung (2011/12 to date)	x	x	△
28.	Dhaibung LS, Rasuwa (2011/12 to date)	x	x	△
29.	Thangpal Dhap LS, Sindhupalchow, 2011/12 – 12/13)	x	x	○
30.	Olangchungola LS, Taplejung (2013/14)	x	x	○
31.	Gyapche/gaire gau/keureni LS (large), Ramechhap, (2014/15 to date)	x	x	△
32.	Subeda/dhaulabagar LS, Bajhang, (2014/15 to date)	x	x	△
33.	Ramche LS (large), Rasuwa (2014/15 to date)	x	x	△
34.	Dhodeni LS, Bajhang (2015/16 to date)	x	x	△
35.	Majhifeda LS, Kavre (2013/14 to date)	x	x	△
36.	Kapurkot LS (large), Salyan (2015/16 to date)	x	x	△
37.	Sheri LS, Mugu, (2015/16 to date)	x	x	△
38.	Sildujure LS (large), Kaski (2015/16 to date)	x	x	△
	Total as of 2016 (Large and Medium Landslides)			38

	By 2017,2027,2030*	x	x	x

○ : completed △: under implementation ×: not yet

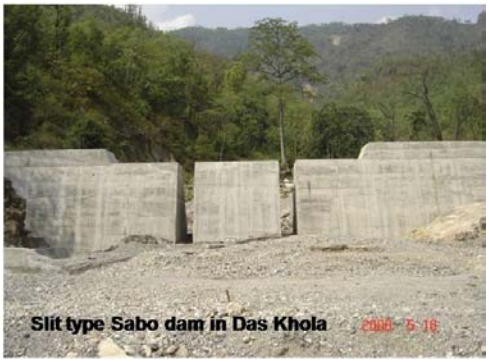
* Target year of National Water Plan, Water Resources Strategy, Sendai Framework for DRR

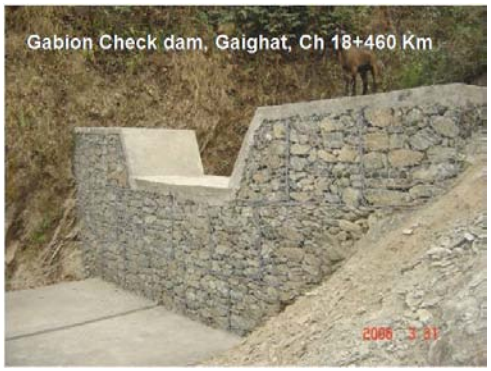
Note: The listed landslides are managed by landslide management section/DWIDM. The division and subdivision offices of DWIDM did many small landslide countermeasure works in their area which are not listed here.

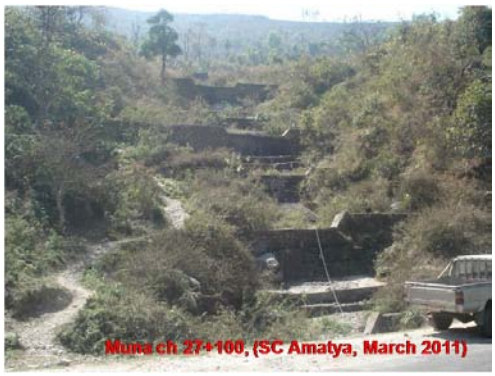
ANNEX II

PHOTOGRAPHS OF SUCCESSFUL EVIDENCES

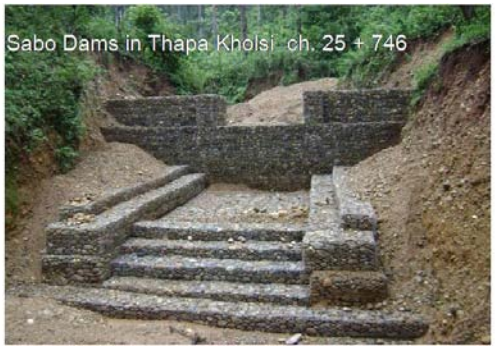
Photographs of Mugling Narayanghat WIDP project (source: DWIDM)



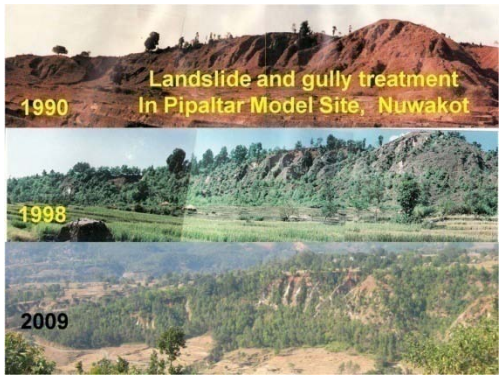


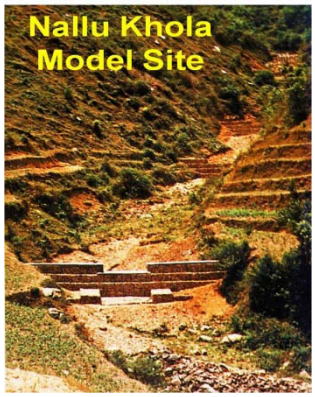


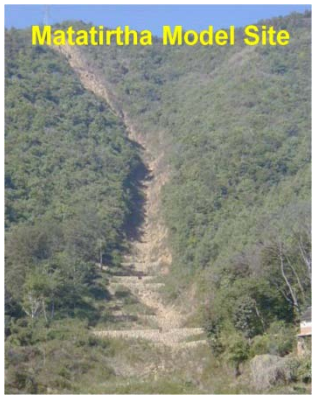
Photographs of Sindhuli Bardibas WIDP project (source: DWIDM)

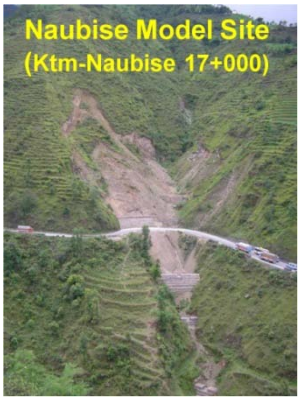


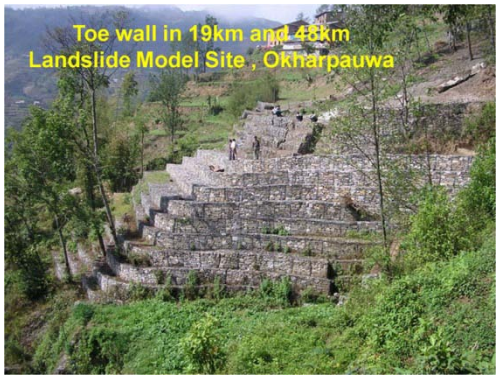
Photograph of DPTC/DWIDM Model Sites(source: DWIDM)

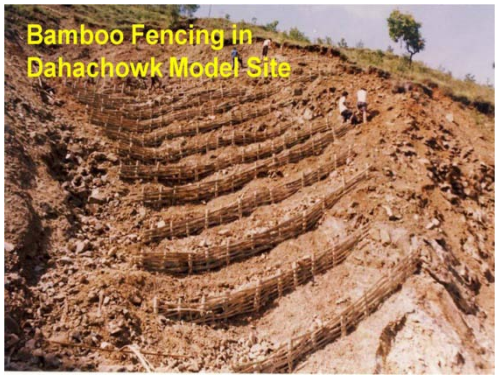


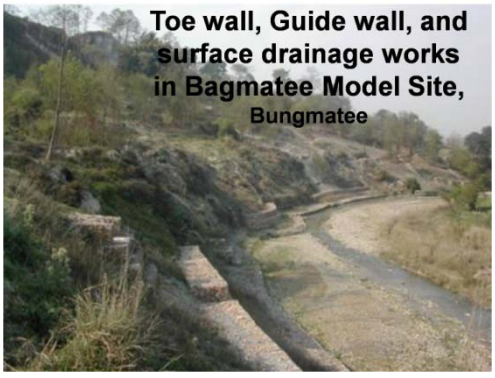




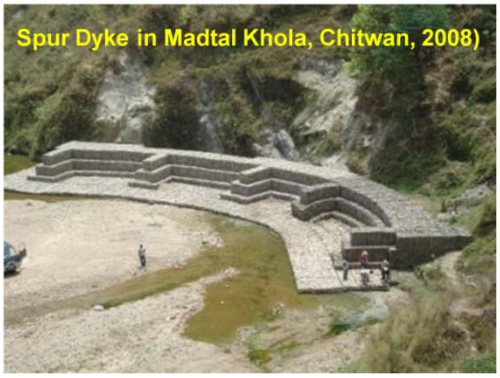


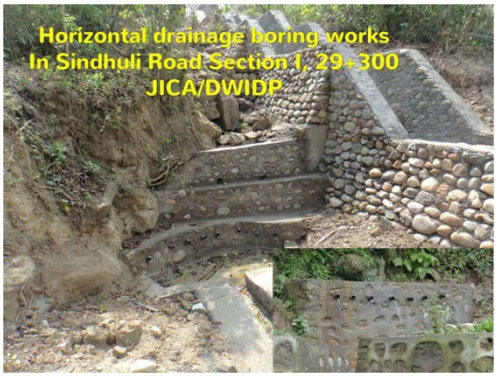


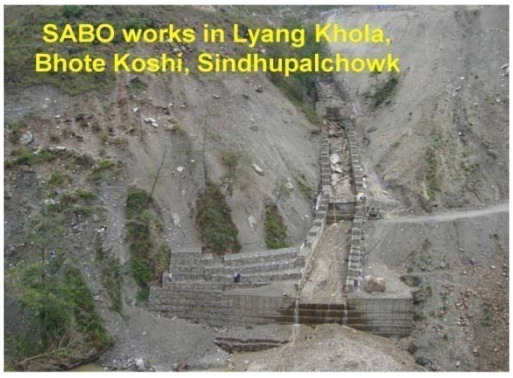


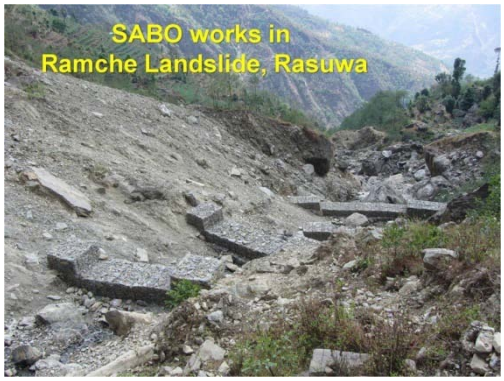


Photograph of DWIDM Sites in different districts (source: DWIDM)









ANNEX III

PHOTOGRAPHS OF RECENT OUTSTANDING WATER INDUCED DISASTERS IN NEPAL

ANNEX IV

PHOTOGRAPHS OF ANALYSIS OF THE SETI FLASH FLOOD DISASTER 2012(Oi et al, J.)

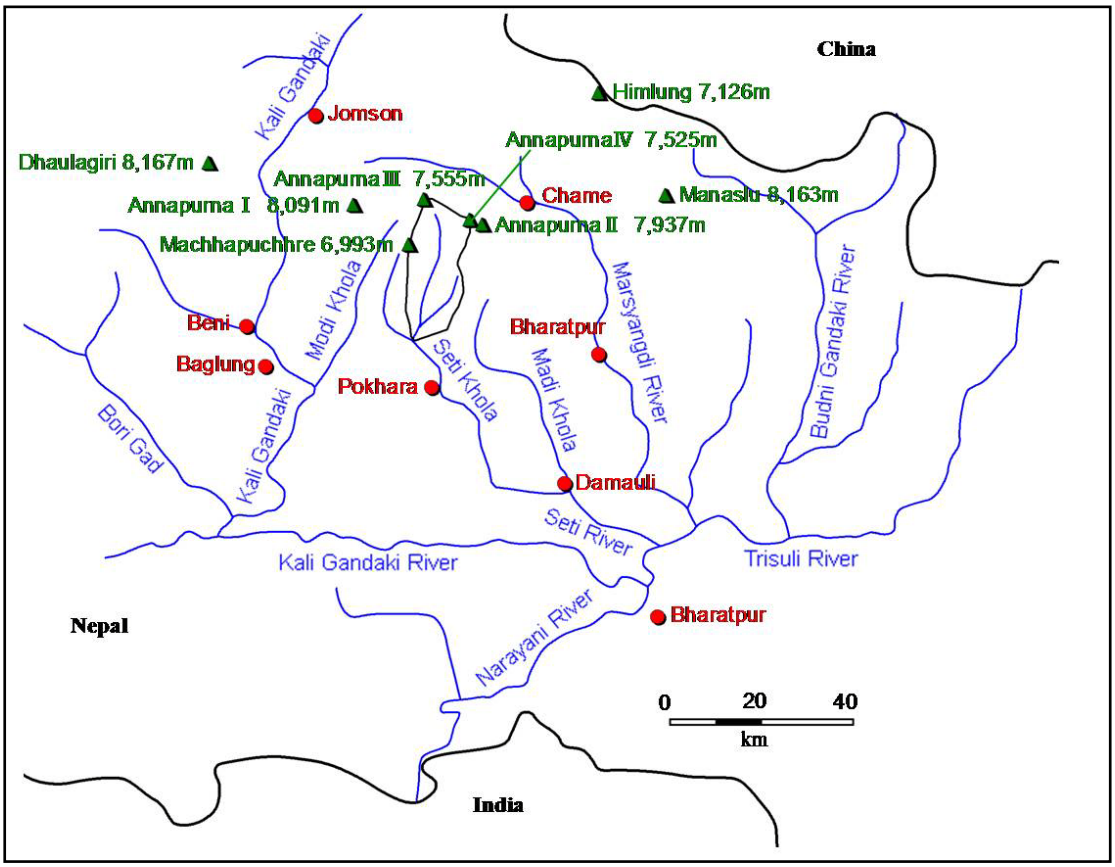


Plate 1: Bird's eye view of the Seti watershed (Modified from Google Earth)

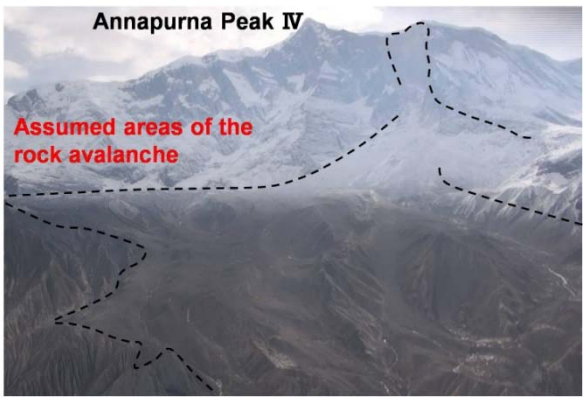


Plate 2: Panoramic view of the rock slide on the west-facing slopes of Annapurna Peak IV (Gentle foot slopes can be seen in the center.)

Plate 3: Earth pillars of lacustrine deposits (Rounded slopes appear in the right section.)

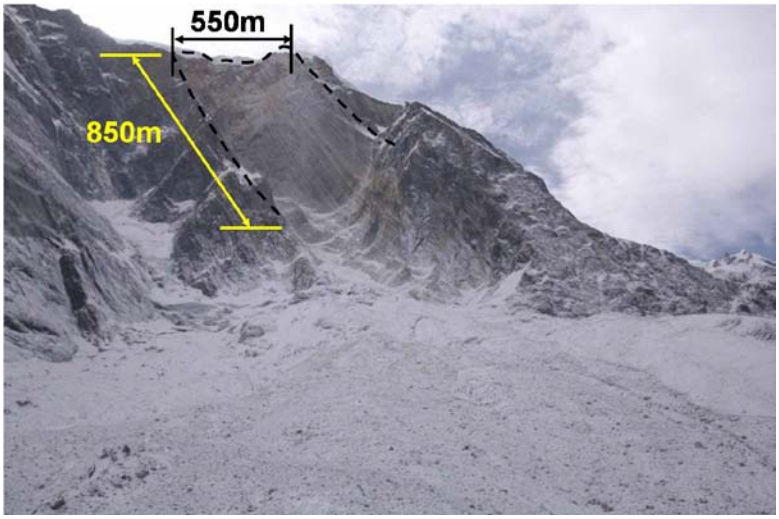


Plate 4: Rockslide on the west-facing slopes of Annapurna PeakIV (Collapsed slopes in the center right and fragmented debris can be seen on the foot slopes.)

Plate 5: The Seti Gorge formed in limestone (Mud originating from the rock avalanche can be seen at the lower part.)

Plate 6: Seti Gorge channel way

Plate 7: Third bending point of Seti River at Kapuche (It breached after the temporary blockage.)

Plate 8: Trees falling toward downstream (There is mud clinging to them.)

Plate 9: River channel just downstream of the third bending point at Baraudi

Plate 10: Temporary damming-up area near Kapuche (Two houses remain on the lower terrace at Yomo.)

Plate 11: Disaster area around the suspension bridge at Karapani

(The flood overtopped the left-bank river terrace due to the momentary river blockage.)

ANNEX V

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