Nepal Government

Ministry of Irrigation

Report on
Jure Landslide, Mankha VDC, Sindhupalchowk District

The Report based on the Study committee formulated by
Ministry of Irrigation (Minister Level) on August 24, 2014 AD (2071/05/08 BS)

(Translated and edited from Nepali to English by: Mr. Shanmukhesh Chandra Amatya, Sr. Div. Hydro-geologist, Landslide Management Section Chief, DWIDP)

September 21, 2014 AD
(2071/06/05 BS)

1. Background

A huge landslide disaster was occurred on August 2, 2014 (2071/04/17 BS) Saturday, at 2.36 Am in the Jure, Ward no 1 and 5 of Mankha Village Development Committee (VDC) and Ward no. 5 of Ramche VDC, Sindhupalchowk district. The gigantic landslide disaster affected huge losses of life and property in the area. The massive landslide dammed completely the Sunkoshi River forming a lake of about 3km long and 300 to 350 m width and the Natural dam.

In this regard a Study Committee was formulated by Government of Nepal (Minister Level decision) on August 24, 2014 AD (2071/05/08 BS). The Study Committee was given the mandates for technical study of the Jure landslide, to find out the cause of the landslide, possibility of losses of life and property due to occurring landslide in the same place in future, to find out the Mitigation measures of the Jure Landslide that the Ministry of Irrigation have to do, Suggestion and Proposition for policies that the Government of Nepal have to follow to mitigate the losses of life and properties from similar Landslides in the country. The Study committee started the work from August 27, 2014 (2071/05/11 BS) and visited the Landslide site two times for preliminary study.

The present report is based on the available maps, data and study reports, site investigation, site photographs, GPS survey, and interviews from the victims and so on.

2. Extraordinary Landslide

The landslide occurred in the Jure, Sindhupalchowk (Figure 1) is a unusual mass movement. This type of landslide can be found in the mountainous countries such as Switzerland, Japan, and Canada and periodically in Nepal. We can also find this type of massive landslides along the rivers which flow from Tibet to Nepal such as Karnali river, Gandaki river, Marsyangdi river and Tamakoshi river.

The Jure landslide is a typical rock avalanche or slope failure type of mass movement. The rock fragments were dropped from about 800m height to the base of the landslide where the speed could be from 60 to 70m per second. The air in the Sunkoshi narrow valley was trapped by the dropping of the huge mass of the landslide suddenly so that the rock fragments spread up to the opposite bank of the Sunkoshi river and due to surging of the Sunkoshi and the landslide material, the Dabi khola and surrounding villages with jungles were badly

damaged up 100m high. The dust of the landslide was reached up to 600m height which covered the Dabi Khola village area.

The landslide created about 13.5 million tons of rock debris and dust. The rock debris avalanche dammed the Sunkohsi river completely within approximately 2 -3 minutes. A local quake of 3.3 magnitudes was recorded on that day due to the landslide. The two gates of the Sunkoshi hydropower dam was damaged due to the pressurized surging of the mud and debris created in the Sunkoshi river. After few minutes of this event the flow of the Sunkoshi was stopped and it took about 12 hours to over top the Natural dam created by the landslide.

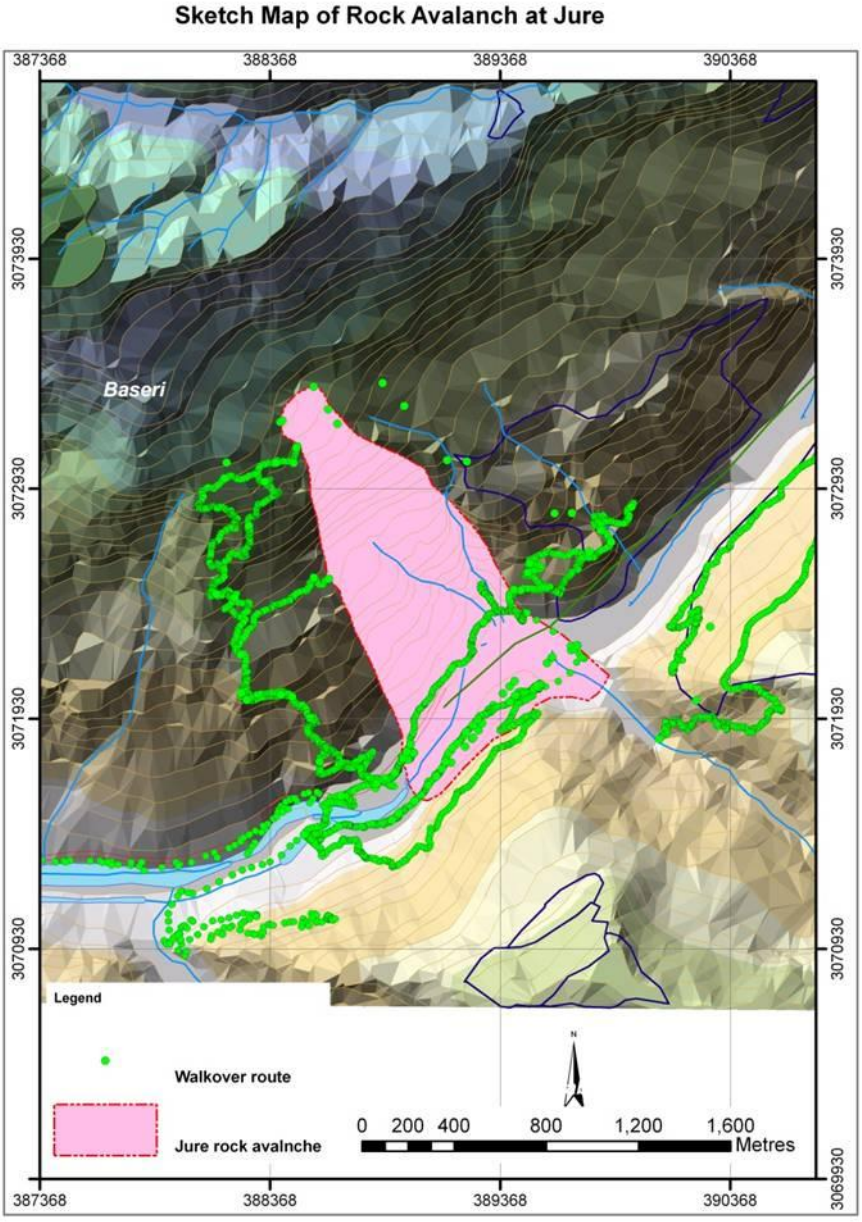


Figure 1: GIS map showing Tracks and Location of study points during the Jure Landslide study, Sindhupalchowk.

3. Physical Status

The rock type in the landslide area is phyllite, schist and quartzite. The Araniko Highway study in 1987 AD (2044 BS) also noticed the landslide in Jure area. Similarly the landslide was clearly seen in the Google Earth map since 3-4 years but it was difficult to assume such type of gigantic event will happen.

There are many studies of such type of landslides in other countries also. The Landslide of Alm in Switzerland and landslide of Randa were the examples of them. This type of mass movement weakens from the joints and cracks instead of from some particular surface, in the result, the mass will be moved down due to instability and gravity force.

Similar type of environment was created in the Jure landslide also. The comparatively thick 2-3 hard layers of rocks preventing the mass to move down but in the lapse of time, the rock mass continuously weakened due to the weathering activities and pore water pressure, in the result, the mass movement activated down suddenly.

Mainly four types of joint sets were identified in the Jure landslide area. First one is the joints along the foliation of the rock which dips about 20-30 degree toward NW. Second joint sets are nearly vertical from which most of the water falls of the area are flowing down. The third joint sets are parallel to the landslide slip surface or along the slope of the mountain and the fourth joint sets dipping about 40-50 degree toward West inside the landslide rock. The surface water entered inside of the mountain through those joints. In the time lapse of hundreds of year, the retaining force of the landslide decreased continuously and the mass movement was triggered by rainfall.

4. Present Status of the Landslide

The Jure landslide can be divided into 7 parts. Which are explained separately as follows.

4.1 Crown Part: The altitude of the crown part of the landslide is about 1650m msl. The land surface in the crown part is still in unstable condition. There are present of many cracks, spring water is coming out, different blocks are moving and toppling down from the cracks, trees are tilting down to different directions and about 300m width and about 15m depth body mass are in process to move or slip down slowly. (Figure 2,3,4,5 &6). It was noted that the surface water was flowing into the cracks developed in the crown area

near the Tate village since 2 years and the location was descended with some kind of sounds just two days before the disaster event. In the mean time, the villagers were shifted from that location to safe site before two days knowing such a hazardous condition of the site. The landslide in the crown part was initiated at about 5Am in that day as per the villagers. The village road near the Tate village also was damaged by the landslide event (fig.5) but it is now maintained by the villagers. The villagers of the Tate village mentioned that the crown part area of the landslide was in risky condition since long time ago.

Figure 2: Cracks and disturbed surface in the Crown part of the Jure Landslide

Figure 3: Disturbed and inclined trees in the crown part of the Landslide

Figure4: Cracks and ready to move mass in the Crown part of the Landslide

Figure 5: Subsided village road in the crown part of the Landslide

Figure 6: Streams flowing at the Crown part of the Landslide

4.2 Crown part to near the Iteni village: There is still existence of large cracks, huge rock boulders and fragments, springs in many places in this area. Debris is flowing down. The slope of this area is much steep (fig 7 &8). Still it can be observed the falling of the rocks from the crown part. The weathered rock bridge (shoulder of the landslide in centre part) about 200m thick is made up of black plyllite and quartzite but in the site it is seen as grey and yellowish in color. These conditions of the rocks are due to the interaction of water and chemical weathering since long time back. It is most probable to rock fall, topple and debris flow in this area in near future due to existence of sufficient spring water and fractured rock debris.

Figure 7: Hanging block at the upper boundary part of the Landslide

Figure 8: Big cracks near the border of Landslide

4.3 Nearby the Iteni village part: There is a comparatively hard rock bridge (shoulder) about 100m down from this area where debris fan is deposited about 20-25m span. There are some huge rock boulders/fragments of about 3m*3m*2m size which are in high hazardous condition that could be fell/roll down any time. In this place, the debris is still flowing down continuously. Here the part of the Iteny village is completely damaged (fig 9, 10, 11).

Figure 9: Landslide near the damaged village Iteni

Figure 10: Landslide block moving down near the Iteni Village

Figure 11: The vulnerable remaining part of the Iteni Village

4.4 Nearby the Thadechaur Village area: The status of this village area is also similar to the Iteni village. The rock fragments from this village area are falling down from time to time. The previous waterfalls existed in this area are the main source of water at present and due to which the debris are flowing down continuously. The landslide and debris flow damaged the Thadechaur Village completely i.e. about 21 houses.

4.5 Toe or debris fan deposit area: This area is the toe part of the Jure landslide. The debris and rock fragments fallen from the upper part are deposited in this area as fan deposit. This area is about 800m width, about 300m high and about 25-50m depth. The temporary road track is excavating from Eastern side of this area. This area is much more vulnerable due the continuous falling of rock fragments and the debris flow. New slope failures, sinking of surfaces and sink hole formations are increasing due the bank cutting along downstream by the Sunkoshi river. The disaster event damaged the houses existed in this area and Jure bazaar completely and damaged two gates of Sunkoshi powerhouse barrage including about 1km long Araniko Highway. At present, some electric poles are installing by Nepal Electricity Authority in this area.

Figure 12: Debris deposited at the toe part of the Landslide

4.6 Landslide Natural Dam in Sunkoshi: The length of the dam across the river was measured about 350m, the width of the dam along the river was measured about 700m and the height of the dam was about 55m. The primary channel for outlet of the trapped river was opened on August 2, 2014 at about 2pm by Nepal Army with the help of experts from Department of Water Induced Disaster Prevention DWIDP. The opening method of the channel was mainly blasting but the rock type of this area is mainly schiest and phyllite, due to which it was felt difficult to progress the deepening of the channel. In this stage the experts and decision makers in the special committee formulated by Ministry of Home Affairs decided to open secondary channel. The experts located the secondary channel at middle part of the dam to open. Thus the secondary channel was opened on August 30, 2014 in the morning at central part of the dam by Nepal Army with blasting and excavation by two numbers excavators. In the same way, Nepal Army excavated the approach road to the dam site. The Nepal Army continued to widen the inlet of the secondary channel upto 52m wide on September 6, 2014. Rainfall in the watershed was occurred in the night of September 6. Due to more widening of the inlet of the secondary channel and occurrence of rainfall in the watershed, the dam was pressurized by water and hit and scour in the weak part of the dam. In the result the dam was breached on

September 7, 2014 at 1am and continued up 4Am (Fig. 13 and 14). Since the breaching occurred slowly and it took about 4hrs, the damages by the breach were nominal and no causalities. The Department of Hydrology and Metrology recorded the discharge during the breaching of the dam at Pachuwaghat real time gauze station which was located at downstream from Khadichaur Bridge. As per the record, the normal flow was 300 cu.m/sec and the maximum discharge was 1350 cu.m/sec and the historic capacity of channel was 1700-1800 cu.m/sec. So the maximum flow was within the capacity. After the breaching of the dam, the water level in the reservoir was decreased by 20m. The study Report of Hazard Mitigation in the Northern Sunkoshi and Bhote Koshi Water Catchment Areas, Nepal (HMWA), 1996 reported that under the Natural dam, the River terrace of sand, clay and gravel boulders were existed.

Figure 13: Opening of Secondary Channel in the Landslide Dam

Figure 14: Damaged Sunkosi Hydropower Headwork and Araniko Highway
after breach of the Landslide Dam

4.7 Left bank area of Sunkosi Natural dam: During the Jure landslide and Natural damming in Sukoshi river event, it damaged the left bank of the Sukoshi area also. The Dabi khola area was completely damaged. The surging of the landslide material damaged the opposite bank upto 100m height. The utensils food grains from Jure landslide area were spread to the opposite bank up to the height of 100m. On the other hand the dust came out from the event were spread out and covered about five sq km area.

The temporary village road excavated by Nepal Army in the left bank of Sunkoshi River is still in operation (Fig 15). In this road, Nepal Army installed a belly bridge in Sukoshi River near the Barhabise Bazar.

Figure 15: The alternate temporary road to Barahbise constructing by Nepal Army

5. Loses of Life and Property

The losses of life and property data as per the Ministry of Home Affairs in the disaster area are given below.

Migrated family number due to the Jure Landslide

Group A **Date: Sept 07,2014 (2071/05/22BS)**

S.N.	V.D.C.	House Family	Total population	Total death	Migrated No	Remarks
1.	Mankha	36	181	116	65	
2.	Ramche	3	11	8	3	
3.	Tekanpur	3	32	21	11	
4.	Dhuskun	-	-	-	-	
	Total	42	224	145	79	

Group B

S.N.	V.D.C.	House Family	Migrated No	Remarks
1.	Mankha	58	300	
2.	Ramche	27	153	
3.	Tekanpur	19	112	
4.	Dhuskun	9	36	
	Total	113	601	

Group C

S.N.	V.D.C.	House Family	population	Remarks
1.	Mankha	25	115	
2.	Ramche	39	216	
	Total	64	331	

Rescue and Relief data in Sunkoshi Jure Landslide Disaster

1. Total number of death and lost	156
2. Number of Names identified death and lost	145
3. Number of Names not identified death and lost	11
4. Total dead body found	33
5. Total number of live rescued	27
6. Total Migrated House number A= 42 B= 113 C= 64 Total	219
7. Total Migrated population A= 79 B= 601 C= 331 Total	1011
8. Number of people received the amount for Funeral management	144
9. Number of people received the house damaged cost	36
10. People getting relief card A= 33 B	89
11. Number of people received the relief material	384
12. Number of institutes and personnel who had donated	366
13. The total collected Cash by donation NRs	16,204,105

6. Immediate steps to be done to mitigate the Landslide Disaster

It is clear from the above mentioned data that the Landslide is not yet stabled. The Iteni village is in Hazardous zone. The debris flow and rock debris falling from upside on the newly opened track road is still continuing and the bank cutting by the Sunkoshi river is not yet stopped. In this regard the following attempts are recommended to implement.

a) The landslide and debris flow in the Head part of the Jure landslide is still active. So first of all the water available in the crown part should be managed by diverting to another safe side. The landslide and debris flow countermeasure work should be done.

b) About 100m from the Landside boundary should be warned as Hazardous area. Any type of land uses as Residence, Irrigation and so on should be stopped at the moment.

c) The unstable part in the Crown part of the landslide should be removed and water management should be done in this area.

d) The weathered and unstable cliffs with cracks in the shoulder should be trimmed.

e) The newly track road is aligned through the toe part of the landslide where the probability of rock falling and debris flow is high. So the protection wall in upper part of the road and scouring by Sunkoshi in the lower part of the road should be protected.

f) Geophysical and Geotechnical study of the Jure Landslide is recommended. As per the study report the mitigation measures of the landslide should be done.

7. Lesson Learned from the Jure Landslide

The unexpected gigantic Jure Landslide gave us the following lessons.

a) Such type of landslide can damage multiple infrastructures at once. It damaged not only the life and property of the villages rather damaged the hydropower such as Sanima and Sunkoshi, dammed the Sunkoshi River which created the threats upto Koshi River Barrage, inundated many villages, the Arniko highway was destructed which braked the national daily revenue about NRs. 30 million.

b) The rescue and relief done by the government was found not so effective. In this connection we felt the need of coordination between the different government institutions also.

c) We felt deficit of capable machineries and trained man power to fight such type of gigantic events and also the shortage of related experts such as geologists, engineer, and social coordinator to tackle such type of events.

d) The information dissemination was not satisfactory and managed. The media published information which was deviated from real data and created havoc in the public. Similar cases were happened in 1993 disaster in central Nepal also. These cases are due to the lack of practices of field study and investigation and authentication of information.

e) Financial and physical relief provided from Nepalese people, Nepal government, and different national and international institutions are more appreciable in the time of such type of disasters.

8. Policy making

1. To manage a holistic disaster, an autonomous, powerful and capable institute should be established which should have sound financial resources, technical experts including with the related equipments, technology and well managed laboratory.

2. Although, the existing line institutions such as Department of Water Induced Disaster Prevention, Department of Mines and Geology, Department of Soil Conservation and Watershed Management, Department of Hydrology and Meteorology, and National Disaster Relief Committee of Ministry of Home Affairs are involving in Disaster Mitigation field, it is found that there is a lack of coordination, data sharing and communication to each other. The available disaster experts in different institutes can be identified/listed out which will be useful for the responsible authorized Disaster Institute that will be established in near future.

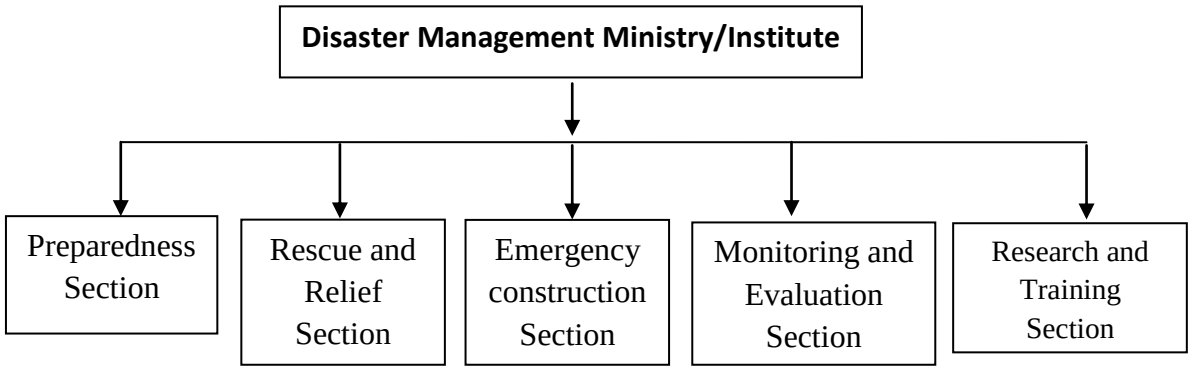
3. Instead of providing the authority about disaster mitigation related works to different institutions, rather it is needed to study the disasters, preparedness for pre-disaster, Rescue and relief during the disaster, categorization of disaster and hazard mapping, development of early warning system, awareness training to the people living in the hazardous areas, to provide disaster mitigation technology and so on which should be authorized to a single institute.

4. The topographical maps, satellite images, aerial photos, digital maps, hydrological and meteorological data and maps of the disaster area, and landslide disaster reports should be collected to study the natural disasters like landslide, flood, soil erosion, and earthquake and so on. To keep those materials in managed way, a well management library is needed under the newly formulated institute.

5. In relation to the study and investigation of disasters, it is needed to bring universities also in study and investigation scope with financial and technical aspects.

6. In the case of residence in flood plain areas, it should be categorized first the flood hazard zone and the people staying in the high hazard zone should be shifted to other safe site immediately.

7. The disaster management structure for the central level institute is needed to be as follows.



8. The under mentioned officials should be managed as per the above mentioned structure.

a. Disaster Management Ministry/Institute

Here the following officials should be nominated as members with the Prime Minister as coordinator.

i.	Prime Minister	Chair Person/Coordinator
ii.	Home Minister	Member
iii.	Defense Minister	Member
iv.	Finance Minister	Member
v.	Chief Secretary	Member

iv. The chief of the all sections mentioned in the structure will be secretary level and all of them will be member of the Disaster Management Ministry/Institute.

b. Preparedness Section

This Section will do

i. Improvement of the people's awareness

ii. Hazard Mapping

iii. Risk Mapping

iv. Early Warning System Development

v. Technology Development

The related experts to this section will be geologist, engineer, GIS experts, and social workers and so on.

c. Rescue and Relief Section

This section will do

i. Emergency information communication/dissemination,

ii. Rescue of the victims immediately in the disaster area,

iii. Mobilization of emergency materials for relief of the disaster victims,

This section should have the trained manpower from police, armed police, army, Red Cross society with availability of trained dogs including materials (tents, utensils, food etc), equipments and transportation vehicles for rescue and relief purpose.

This section should have the experts like Geologist, Civil Engineer, Seismologist, and Hydrologist, social workers and so on.

d. Emergency construction Section

This Section will do

i. Emergency survey, maintenance and construction works in the disaster areas

Equipments and materials needed for this section are Heavy Machineries and equipments, gabion wires boxes, construction materials and so on.

Man power and experts needed for this section are Civil Engineer, Engineering Geologist, GIS Expert, and Mechanical Engineer and so on.

e. Monitoring and Evaluation Section

Regular monitoring and evaluation of the disasters all over the country have to be done and report it.

This section should have a well managed Data centre and a well equipped library.

The related manpower and experts for this section will be Engineering Geologist, Civil Engineer, GIS Expert, and Mechanical Engineer.

f. Research and Training Section

This section will do study and research of the disaster area and prepare reports with important recommendations. Different types of awareness trainings including audio-visual, disaster information dissemination to the people of disaster area and other disaster prone areas will be organized. Publications of output of research and study

This section should have well equipped and well managed laboratory with related technicians. The laboratory should have facilities to analysis and study different types of disasters with models for flood, different types of landslides, earthquakes and other disasters.

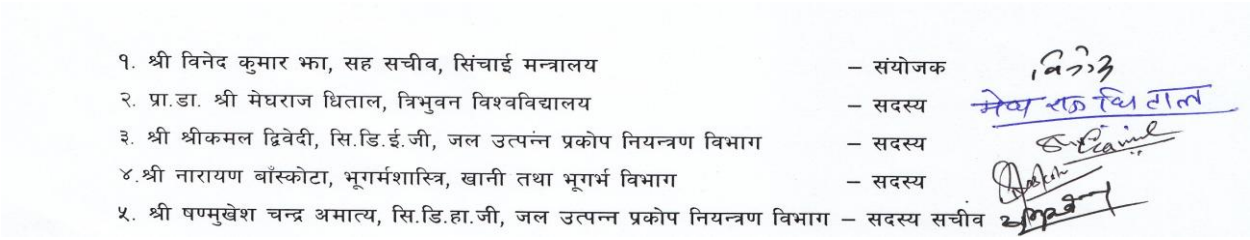
This section should have equipments as equipments related to early warning system, accelerometer, seismograph, hydrometer, drilling machine system, GIS and remote sensing Imaginaries, and other latest technologies.

The manpower and experts for this section will be Civil Engineer, Engineering Geologist, GIS Expert, and Mechanical Engineer.

Appendices

Structure of the Study Committee

Having the mandates of Mitigation measures of the Jure Landslide, Suggestion and Proposition for Policies that the Government of Nepal have to follow to mitigate the losses of life and properties from similar type of Landslides in the country

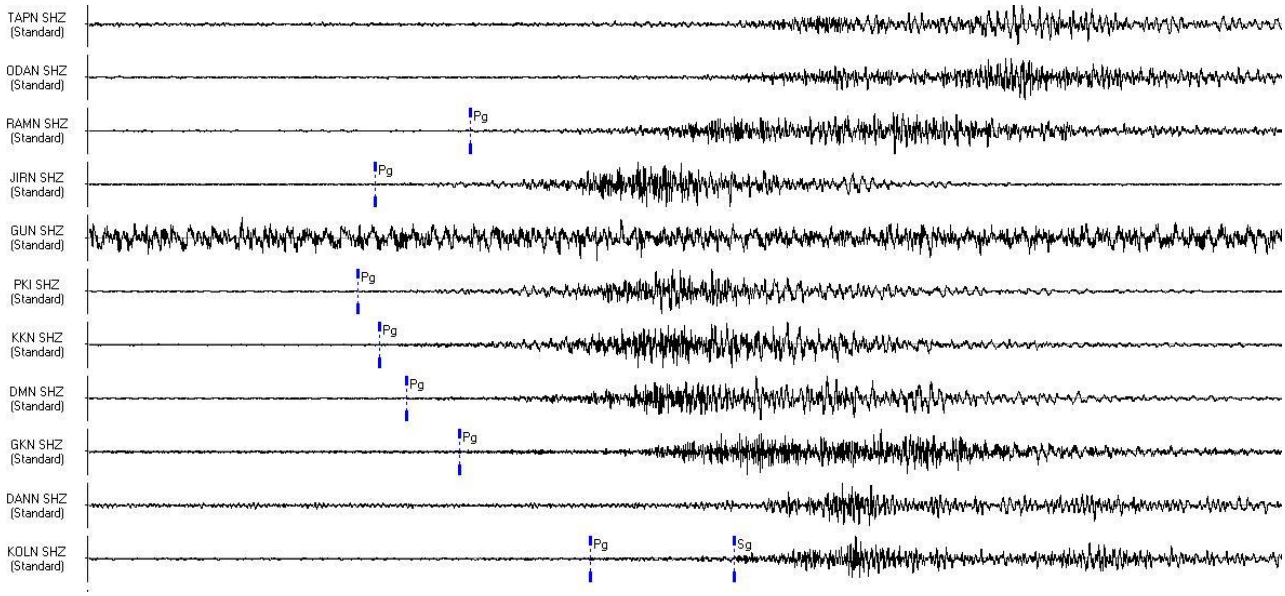

१. श्री विनेद कुमार झा, सह सचीव, सिंचाई मन्त्रालय – संयोजक
२. प्रा.डा. श्री मेघराज धिताल, त्रिभुवन विश्वविद्यालय – सदस्य
३. श्री श्रीकमल द्विवेदी, सि.डि.ई.जी, जल उत्पन्न प्रकोप नियन्त्रण विभाग – सदस्य
४.श्री नारायण बाँस्कोटा, भूगर्मशास्त्रि, खानी तथा भूगर्भ विभाग – सदस्य
५. श्री षण्मुखेश चन्द्र अमात्य, सि.डि.हा.जी, जल उत्पन्न प्रकोप नियन्त्रण विभाग – सदस्य सचीव

1.	Mr. Binod Kumar Jha, Co-Secretary, Ministry of Irrigation	Coordinator
2.	Prof. Dr. Megh Raj Dhital, Expert, Tribhuvan University	Member
3.	Mr. Shreekamal Dwibedi, Sr.Div.Engg.Geologist, DWIDP	Member
4.	Mr. Narayan Banskota, Geologist, Dept. of Mines and Geology	Member
5.	Mr. Shanmukhesh Chandra Amatya, Sr. Div. Hydro-geologist, DWIDP	Member-Secretary

Members of the Study Committee

Appendix A

SEISMIC RECORD



Seismic data recorded from Taplejung to Pyuthan District stations on August 2, 2014 AD morning (2071/04/17BS)

GMT Time	Local Time	Intensity (ml)
20:46	02:31	
20:47	02:32	
20:48	02:33	
20:51	02:36	3.3
21:04	02:49	
22:56	04:41	

Source: National Earthquake Centre, Department of Mines and Geology, Lainchaur, Kathmandu, Nepal.

Appendix B

Volume of the Lake formed by Jure Landslide Damming

Approximately 8million cubic meter volume of water was dammed by the Landslide and other details are presented as follows.

Length of Lake formed by Natural Dam	3.1 km
Width of the Lake (Max.)	390m
Width of the lake (Ave.)	195m
Area covered by lake	453,500 Sq.m.
Depth of the lake (max.)	47m
Depth of the lake (ave)	21m
Input to the lake from upstream	200 cu.m.
Duration of Damming of the river (full)	11 hours
Duration of Damming of the river (partial)	1 hour
Volume of the water in the lake (about)	8.0 million cu.m

Appendix C

Rainfall Data recorded at Barhabise station of DHM before and after the Disaster

Days	Rainfall (mm)	Days	Rainfall (mm)
July 17	30.2	29	12.0
18	40.2	**30**	**70.2**
19	17.2	**31**	**70.4**
20	62.3	Aug 1	12.4
21	10.3	**2**	**11.2**
22	14.1	3	25.4
23	7.3	4	21.8
24	12.0	5	0.0
25	25.0	6	30.2
26	10.6	7	26.8
27	31.4	8	40.4
28	0.4	9	21.2

Appendix D

Landslide photographs in Ramche and Mankha VDCs

Photo 1: Temporary Araniko Highway track at toe of the Landslide

Photo 2: Big rock boulders fallen from the Landslide

Photo 3: Rock fragments fallen from the Landslide

Photo 4: Damaged houses due to the Landslide

Photo 5: Relief to the affected people from the Landslide

Photo 6: Landslide occurred at left bank of Sunkoshi after breach of Dam