

THE SUSTAINABLE DEVELOPMENT GOALS AND DISASTER RISK REDUCTION (SDGs):  
REDUCING THE ECONOMIC LOSS OF DISASTERS

“विपद जोखिम न्यूनिकरणमा लगानी बढाऔं, आर्थिक क्षति घटाऔं”

#IDDR2018

#ResilienceForAll

International Day for Disaster Reduction (IDDR)  
Symposium - 2018

Called by



Ministry of Home Affairs

Organized by



Nepal Geological Society

Co-ordinated by



DPNet Nepal

Supported By:



UNDP Nepal



Dept. of Water Resource & Irrigation

**In Association With:** Department of Mines and Geology, Department of Irrigation, Tribhuvan University, President Chure Tarai Madhes Conservation and Development Board, Nepal Electricity Authority, National Society for Earthquake Technology-Nepal, Nepal Tourism Board, Nepal Red-Cross Society, DiMANN, Association of International NGOs, Task Group of Disaster Management, ICIMOD, Stratigraphic Association of Nepal, Nepal Hydrogeological Association, National Reconstruction Authority, Municipal Association of Nepal, CBM International, Save the Children

October 13, 2018 (27 Ashoj, 2075)

**Nepal Tourism Board, Bhrikutimandap, Kathmandu, Nepal**  
**IDDR 2018**

The Nepal Geological Society (NGS) has organized one-day symposium to observe the International Day for Disaster Reduction (IDDR) on October 13, 2018 (Saturday, 27 Ashwin, 2075) at the conference hall of Nepal Tourism Board, Bhrikutimandap, Kathmandu. The one-day symposium was organized upon the call from Ministry of Home Affairs, Government of Nepal in collaboration with UNDP Nepal, Department of Water Resource and Irrigation and National Society for Earthquake Technology along with several other associated partners (Nineteen governmental and non-governmental organizations). The program was financially supported by UNDP Nepal, Department of Water Resource and Irrigation and National Society for Earthquake Technology along with the relevant presentations. Honorable Home Minister of Nepal Government Mr. Ram Bahadur Thapa inaugurated the program as the chief guest. The NGS has been observing IDDR Day regularly each year by organizing different programs. This year, the society organized a one-day symposium with ten presentations on related theme (Theme of IDDR 2018 is THE SUSTAINABLE DEVELOPMENT GOALS AND DISASTER RISK REDUCTION (SDGs): REDUCING THE ECONOMIC LOSS OF DISASTERS “विपद जोखिम न्युनिकरणमा लगानी बढाऔं, आर्थिक क्षति घटाऔं”)

The geological hazards (earthquake, landslide, flood etc) are the major challenges to the national development and poverty alleviation in Nepal. Therefore, Nepal Geological Society initiated the advocacy in the area that included awareness campaign through the regular celebration of the International Day for Natural Disaster Reduction (UN/IDNDR) since 1990s. After the establishment of UNISDR (United Nation International Strategy for Disaster Reduction), the society has carried out its activities in line with the UNISDR aims of building disaster resilient communities by promoting increased awareness of the importance of disaster reduction for reducing human, social, economic and environmental losses due to natural hazards and related technological and environmental disasters. The activities of NGS towards disaster prevention was acknowledged by UN Humanitarian and Emergency Relief Coordination office of IDNDR Secretariat in Geneva, by awarding UN-Sasakawa Disaster Prevention Award in 1998 for its efforts in disseminating the scientific knowledge and spreading the awareness to the general public, concerned authority as well as to the stakeholders to prevent the natural disaster. The society is committed to advocate for disaster risk reduction and mitigation activities in the country.

The Symposium was divided into Inaugural and technical sessions. Dr. Kabi Raj Paudyal, President of the NGS chaired the Inaugural session and delivered the welcome speech. Chief Guest, Honorable Minister of Home Affairs Mr. Ram Bahadur Thapa inaugurated the program by lightening the lamp. Mr. Churna Bahadur Wali, Convener of the IDDR Day Organizing Committee highlighted the program. Mr. Surya Bahadur Thapa, Chairman, DPNet, Nepal; Mr. Bijay Singh, Assistant Country Director, UNDP Nepal; Mr. Birendra Yadav, Chairman,

President Chure-Tarai Madhesh Conservation Development Board; Mr. Kalanidhi Devkota, Executive Director, Municipal Association of Nepal; Mr. Sushil Gyewali, Chief Executive Officer, National Reconstruction Authority; and Mr. Prem Kumar Rai, Secretary, Ministry of Home Affairs, Government of Nepal delivered their speech as the guest of the program. Honorable Minister Mr. Ram Bahadur Thapa mentioned the threat of different natural disasters in Nepal and government's activities to minimize these disasters. He also mentioned there is an urgent need to unite all the stakeholders with the government to overcome these problems. At the end of the session, Dr. Ganesh Nath Tripathi, Vice President of the NGS extended concluding remarks and vote of thanks. The program was conducted by Dr. Kamala Kant Acharya, General Secretary of the NGS.

Head and/or representatives from all associated organizations, Government officials, members of the Nepal Geological Society, media persons from different media houses and students from different disciplines have actively participated in the program. Altogether 220 participants were present both in the inaugural and technical session.

Following the inaugural session two technical sessions were conducted. The first Technical session was chaired by Prof. Dr. Tara Nidhi Bhattarai and Dr. Ashok Sigdel and Ms. Sunu Dawadi served as rapporteurs. Five technical papers were presented in this session. The second technical session was chaired by Mr. Samjwal Ratna Bajracharya and Mr. Bharat Bhandari and Ms. Sabina Khatri served as rapporteurs. Five technical papers were presented in this session with lively discussions and comments on each presentation.

The one-day symposium was organized in association with the following organizations:

S.N.	Organizations
1	Department of Mines and Geology
2	Tribhuvan University
3	President Chure Terai Madhesh Conservation and Development Board
4	Nepal Electricity Authority
5	Nepal Tourism Board
6	Nepal Red-Cross Society
7	DiMANN
8	Association of International NGOs
9	Task Group of Disaster Management
10	ICIMOD
11	Stratigraphic Association of Nepal
12	Nepal Hydrogeological Association
13	National Reconstruction Authority
14	Municipal Association of Nepal
15	CBM International
16	Save the Children
17	Kathmandu Metropolitan City
18	Lalitpur Metropolitan City

19	Bhaktapur Sub-Metropolitan City
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## IDDR one-day Symposium-2018

### Program

<b>Inaugural Session</b>	
<b>Time</b>	<b>Activities</b>
8:00 – 8:30	Registration, Tea/Coffee
8:30 - 8:40	Dignitaries call on the dias
8:40 - 8:50	Welcome speech by Dr. Kabi Raj Paudyal, President, NGS
8:50 -8:55	Inauguration of the Symposium by the Chief Guest, Hon'ble Minister, Ram Bahadur Thapa, Ministry of Home Affairs
8:55 - 9:00	Program Highlight by Mr. Churna Bahadur Wali, Convener
9:00 - 9:05	Speech by Surya Bahadur Thapa, Chairman, DPNNet-Nepal
9:05 - 9:10	Remarks by Bijaya Singh, Assistant Country director, UNDP-Nepal
9:10 – 9:15	Remarks by Mr. Birendra Yadav, Chairman, President Chure-Terai Madhesh Conservation Development Board
9:15 – 9:20	Remarks by Mr. Kalanidhi Devkota, EM, Municipal Association Nepal
9:20 - 9:25	Remarks by Mr. Sushil Gyawali, CEO, NRA
9:25 - 9:30	Remarks by Mr. Prem Kumar Rai, Secretary, Ministry of Home Affairs
9:30-9:45	Address from Chief Guest: Hon'ble Minister of Home Affairs
9:45 - 9:50	Vote of thanks and closing of Session: Dr. Ganesh N. Tripathi, Vice-President, NGS
9:50 -10:00	Group Photo
High Tea	
<b>Technical Session</b>	
<b>Chairperson: Prof. Dr. Tara Nidhi Bhattarai</b>	
<b>Rapporteurs: Dr. Ashok Sigdel, Ms. Sunu Dawadi</b>	
10:30 - 10:40	Status of Regulatory Framework for Disaster Risk Reduction and Awareness- <b>Indu Ghimire</b> , Ministry of Home Affairs
10:40 - 10:50	Invited Lecture: Role of Nepal Geological Society in Disaster Risk Reduction - <b>Ramesh Man Tuladhar</b> , DDR, National Coordinator, NGS
10:50 - 11:00	Probabilistic Seismic Hazard Analysis for Nepal - <b>Dilliram Thapa</b> , Tribhuvan University
11:00 – 11:10	Initial Step in Understanding Potential Glacial Lakes Outburst Flood, one of the Main Cryospheric Hazards in the Hindu Kush Himalaya - <b>Sudan B. Maharjan, Finu Shrestha and Rajendra B. Shrestha</b> , ICIMOD
11:10 – 11:20	Efforts of DPNNet-Nepal in DRR&M - <b>Raju Thapa</b> , DPNNet/AINTGDM
11:20 – 11:35	Discussion
Tea Break (15 minutes)	
<b>Chairperson: Mr. Samjwal Ratna Bajracharya</b>	
<b>Rapporteurs: Mr. Bharat Bhandari, Ms. Sabina Khatri</b>	
11:50 - 12:00	Role of President Chure Tarai Madhesh Conservation Program in Water Induced Disaster Risk Reduction in Chure-Tarai Madhesh Areas of Nepal - <b>Pem Narayan Kandel and Prem Nath Paudel</b> , PCTMCDB
12:00 - 12:10	Investment aiding Preparedness: An economic analysis of Gorkha Earthquake housing reconstruction - <b>Ranjan Dhungel</b> , NSET
12:10 - 12:20	Rapid Geological Assessment of Landslides by Department of Mines and Geology in the western parts of the Lesser Himalaya - <b>Monika Jha and Sunita Bhattarai</b> , DMG
12:20 - 12:30	Intervention for safer construction after 2015 Barpak – Gorkha Earthquake - <b>Parajuli H. R., Pradhan S., Bogati K. &amp; Paudel N.</b> , NRA

12:30 -12:40	Transforming Glacier Hazard into a Economic Opportunity for the Development of Nepal - <b>Dhananjaya Regmi</b> , Himalayan Research Centre
12:40 - 13:00	Discussions and Closing of the Program
Lunch	

## ABSTRACTS OF PRESENTATION

### Status of Regulatory Framework for Disaster Risk Reduction and Awareness

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Nepal is a young geological but diverse geographical developing country with multi hazards natural risk and various types of human induced disaster. DRR lens is overshadowed and is not effective in development activities, construction of infrastructures and uplifting people's lifestyle. DRR provision is unable to obtain the importance legally and organizationally. As a result, DRR mainstreaming is lacking in a development framework. Due to lack of awareness of general people and low prioritize of media, civil society and academic forum, DRR provision is not sufficient to establish its importance. To incorporate the primary importance of DRR in development activities and lifestyle, skilled manpower is needed to be developed. To develop a disaster resilient society it is very important and can be a great challenge in the present scenario.

Increasing people's awareness regarding DRR and to mainstream it in various development activities DRR policy formulation is required. It is very essential to tie up between the existing policy and DRR to work hand in hand as it helps to set up the institution and increase the effectiveness through collaboration and support of with various government departments, NGOs, INGOs and humanitarian agencies. DRR risk mapping is very essential with its in-depth analysis. Till now there has been no comprehensive disaster risk management plan developed in Nepal due to lack of research-oriented organization. To develop this plan and implement it effectively skilled manpower with dedicated institution and concerned stakeholders are required to cooperate with each other to formulate the required policy.

Regarding DRR, Nepal has endorsed the constitutional provision in its guiding principle and allocation of power among federal, provincial and local government respectively. Likewise, we have recently formed the Disaster Risk Reduction and Management (DRRM) Act, 2017 and the Local Governance Operation Act, 2017. According to the DRRM Act, National Disaster Risk Reduction & Management Authority is being established soon for the purpose of a high performing agency on Disaster Risk Management. We have also formulated the guiding policy documents called DRR National Policy, 2018 and DRR National Strategic Action Plan, 2018 based on Sendai Declaration and Sustainable Development Goals, are being newly introduced. According to the new policy and national period plan for development process should include DDR mainstreaming. Recently due to transformation into the Federal structure, the central government has provided guidelines to provincial and local governments for DRR streaming. Various academic, media and communication and humanitarian sectors are also actively participating in it.

*Keywords:* hazards, risk, DRRM, awareness, policy.

# **Role of Nepal Geological Society in Disaster Risk Reduction**

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The United Nations General Assembly “proclaims the International Decade for Natural Disaster Reduction, beginning on 1 January 1990; decided to designate second Wednesday of October International Day for Natural Disaster Reduction, to be observed annually during the Decade by international community; adopts the International Framework of Action for the International Decade for Natural Disaster Reduction”. Inspired by this, the Nepal Geological Society decided to make a NGS culture to observe IDNDR every year since 1991 to date without interruption. This untiring journey encompassing key phases of DRR namely IDNDR, ISDR, HFA and SFDRR has created a history of its own in DRR in Nepal.

Recognizing the contribution of NGS towards DRR that include commitment to observe IDNDR day and DRR visionary in 1990s, policy advisory to the government, initiatives toward awareness campaign, training to media personnel and school teachers on natural disasters and generating research-based platform for DRR through organization of national and international seminars with emphasis in Asia, NGS was conferred upon by “Sasakawa Disaster Prevention Award” in 1998.

UN ISDR announced the theme for the International Day for Disaster Reduction -2018 as **SDGs and Disaster Risk Reduction: Meeting Target C of the Sendai Framework (Reducing the economic loss of disasters)**. The IDDR 2018 (27<sup>th</sup> DRR event of NGS) is being organized on 13 October. Current NGS vision in line with UN ISDR is towards achieving the SDGs together with DRR, is largely governed by the effective implementation of DRR and Management Act 2017 through integrated approach in terms of technological, sociological, economical and management perspectives in order to reduce economic loss due to disasters.

*Keywords:* natural disaster, reduction, framework, IDNDR, sasakawa

## **Probabilistic Seismic Hazard Analysis for Nepal**

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Nepal is an earthquake-prone country in the world; hence the reliable seismic hazard assessment is a critical element for the aseismic design of structures and disaster mitigation and reduction planning in the country. In this study, seismic hazard assessment in Nepal has been performed using a probabilistic approach. Twenty three seismic source zones has been defined based on the available seismological, geological, and tectonic information as well as quantitative evaluation of intersections of morphostructural lineaments using the pattern recognition method and a selected ground motion prediction relationship has been used to estimate the peak ground accelerations (PGAs) at bedrock level with 63%, 10%, and 2% probability of exceedance in 50 years. The resulting maps indicate the significant spatial variation in seismic hazard with distinctly higher hazard in the eastern and far-western parts of the country than in southern Nepal. The hazard maps provide basic and important information to the engineers for designing and evaluating the seismic performance of key engineering structures (e.g.,

buildings, dams, hospitals, long-span bridges, pipelines, powerhouses, schools, tunnels), and to the government for making future city development plans, as well as effective earthquake disaster mitigation, and prevention planning in the country.

*Keywords:* seismic hazard, earthquake, peak ground acceleration, Nepal

## **Initial Step in Understanding Potential Glacial Lakes Outburst Flood, one of the Main Cryospheric Hazards in the Hindu Kush Himalaya**

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The Hindu Kush Himalaya with the largest accumulation of glaciers and snow outside the Polar Regions is the source of countless perennial rivers that originate from glaciers. But it is also the source of various natural disasters such as snow avalanche, glacial lake outburst floods (GLOF). The Hindu Kush Himalaya (HKH) is characterized by the widespread presence of glacial lakes and many of them are potential source of floods. To deal with such floods, it is necessary to understand the occurrences and distribution of glacial lakes and as such a mapping process has been conducted at various stages. A total of 25,614 glacial lakes greater than or equal to 0.003 km<sup>2</sup> were mapped with a total area of 1,444 km<sup>2</sup> in five major river basins including Mansarovar Basin within the HKH from Landsat images (Maharjan et al. 2018). This has provided the comprehensive picture of glacial lake distribution in the HKH. This basin wise approach of compilation of a standardized glacial lake inventory of the entire HKH is found to be meaningful in a way that it provides scientific information for transboundary cooperation, for water resources and hazard management. Because the flood disaster or GLOF do not limit to geographical boundaries and thus needs to be looked from basin perspectives.

In the context of Nepal, GLOFs have caused significant damage to life and property. More than 20 GLOF events have impacted various parts of Nepal since 1935 causing loss of lives and property. So, it is desirable to have information upon occurrence and distribution of glacial lakes such that the planning and implementation of disaster management activities can be carried out effectively. In this regard, ICIMOD has undertaken a glacial lakes study in 2009-10. It has led to mapping of 1466 glacial lakes covering an area of 64.75 km<sup>2</sup> using Landsat images taken in 2005 and 2006. Among them 21 lakes were identified as critical with six lakes defined as high priority requiring extensive field investigation and mapping (ICIMOD 2011).

It is emphasized here that ranking of glacial lakes objectively in terms of their potential to breach is not an easy task. Most important aspect is that once we have the information upon distribution of glacial lakes, a list of the moraine dammed and most rapidly expanding lakes that are also situated above areas of intensive human utilization is necessarily a first step. A more complete assessment and eventual ranking will require intensive fieldwork, including the application of sophisticated geophysical techniques. It will also require to identify the vulnerable human assets (life and property) in the downstream area. Thus, a mechanism for continuous monitoring of critical lakes has to be developed and established initially for effective GLOF hazard management.

*Keywords:* glaciers, outburst, Hindu Kush Himalaya, GLOF, disasters.

# **Efforts of DpNet-Nepal in Disaster Risk Reduction and Management**

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DPNet-Nepal, as an umbrella network of various stakeholders working in the field of DRR&M, coordinates with wider stakeholders in the field of knowledge management, capacity building and policy advocacy in an inclusive way. With the technical and financial support of AINTGDM and other stakeholders, DPNet-Nepal as a secretariat of National Platform for DRR has been supporting the government of Nepal to represent single Nepal delegation in International forums, formulate policy and action plan and to mark the national/international days in remarkable way.

DPNet-Nepal's member organizations have been working in the field of inclusive DRR, emergency response and humanitarian assistance and climate change in joint collaboration with private sectors.

*Keywords:* DpNet, stakeholder, DRR&M, emergency response

## **Role of President Chure Tarai Madesh Conservation Program in Water Induced Disaster Risk Reduction in Chure-Tarai Madhesh Areas of Nepal**

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The Chure also known as Siwalik is the youngest and fragile mountain of the outer Himalayas formed by fluvial sedimentary rocks such as sandstone, mudstone, shale and conglomerate. Siwalik terrain which comprises 13% land of Nepal extends in a narrow east-west belt located between the main boundary thrust at the southern boundary of the Mahabharat range and the main frontal thrust at the northern boundary of the Tarai- Madhesh. Chure Mountain is naturally vulnerable to landslides and soil erosion due to fragile topography. Intensity of rain fall is high in the area and impact of climate change is apparent. The fragility has further accelerated due to illegal human settlements, deforestation, inappropriate agriculture practice, open grazing, exploitation of river-bed materials and unsustainable infrastructural developmental. All types of rivers of Nepal flow through Chure range towards Tarai Madesh and beyond. Landslides, flood, sedimentation and expansion of river width have become phenomenon in Bhabar and Terai-Madhesh which have resulted loss of human lives, livestock and agriculture land every year. Government of Nepal declared the "Chure Conservation area" in 2014 under the environment Act. Since then a symbolic National pride "President Chure Conservation Program is being implemented to conserve and manage Chure-Tarai Madesh which comprises 27% land of the country and reliant 60% population of Nepal for their livelihoods. Chure Tarai- Madesh Conservation Development Board has been formed with mandate to formulate sectorial integrated policy, legal instrument, plan and program; coordinate to implement the program and develop monitoring system; and generate resources for conservation and ensure sustainable livelihood of people of Chure, Bhabar and Tarai Madesh areas of Nepal. Many studies reveal that the program has made remarkable achievements in

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water induced disaster risk reduction. This paper analyses the roles and impacts of President Chure-Tarai Madesh conservation program in water induced disaster risk reduction in the area of Nepal.

*Keywords:* Chure, Siwaliks, water induced, disaster, risk.

## **Investment aiding Preparedness: An economic analysis of Gorkha Earthquake housing reconstruction**

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Nepal, being one of the most susceptible country in terms of hazards, has faced many disastrous events since past many centuries. The delicate topography, young & fragile geology exposes country to multitude of catastrophic events, causing huge loss of life and properties. Having said that, the Gorkha Earthquake on April 2015 had shattering effects to the country claiming lives of more than 8790 people and damaging infrastructures worth billions, of which private housing was one of the severely affected sectors accompanying almost half of the total loss. The rural areas of Nepal, where most of the houses were load bearing type with mud mortar, shared the major fragment of damage. Post Disaster Needs Assessment- that was conducted just aftermath of earthquake estimated the recovery and reconstruction cost of housing to be about **2.74 billion USD**- that has now however deviated.

The private housing reconstruction can be considered as an ample opportunity to invest, which will prevent loss of life and economic losses due to the disasters in future. The cost analysis part also illustrates that investment made today in incorporating the seismic resistant components, will help to mitigate the loss of lives and cumbersome forfeiture in terms of monetary value.

Disasters themselves do not, but the ravaged infrastructures claim our life and cause colossal damage to our fortunes. In this regard, the extra cost being invested by people and government in order to reconstruct and retrofit the existing buildings (*which were partially damaged*) can also be considered as an investment, which may not be directly interpreted to benefit in monetary values but in longer term will help reduce the disaster losses to a much extent and make our country resilient.

*keywords:* preparedness, resilient, damage, reconstruction, economic.

## **Rapid Geological Assessment of Landslides by Department of Mines and Geology in the western parts of the Lesser Himalaya**

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Department of Mines and Geology (DMG) has been conducting various preliminary and detailed investigations regarding landslides and also published more than ten landslide hazard zonation maps in

last few years. After 2015 Gorkha Earthquake, DMG has played lead role in conduction of both rapid and detailed geological assessment to assess the vulnerabilities of earthquake affected settlements with proper recommendation for relocation. Realizing the need of national level research centre for landslide, DMG has established a Landslide Research Section under Geo-science Division with the aim to reduce losses from landslide hazard by improving our knowledge for understanding the causes of landslide and suggesting the possible mitigation measures and strategies.

On the request of Ministry of Home Affairs (MOHA), a team from DMG has conducted an immediate survey for some parts of Baglung and Lamjung districts of western Nepal. In Baglung district, three vulnerable sites including Kathekhola, Huldi and Bahungau Villages were surveyed while in Lamjung district, Khinchok- Jalgeni road section was visited. The rocks of the region belongs to the Lesser Himalayan unit and these sites were either located near to the major geological structures (e.g. thrust or shear zones or axis of the folds) or over weak lithology which includes low-grade metamorphic rocks like phyllite and slate intercalated with quartzites. The main objective of the study was to assess the engineering geological condition of the landslide affected area and to identify the causes of landslides with the proper mitigation measures.

Landslides of Kathekhola, Bahungau and the Khinchokbesi are examples of rainfall induced Landslides. Intense rainfall is the key factor for these types of problems. The Huldi Landslide is one of the thrust controlled landslide that has been started since last two decades and reactivating in each monsoon. Main causes of landslides were intense rainfall, weak lithology, and steep slope gradient, haphazard construction of road and improper management of surface and subsurface water.

For the reduction of pore water pressure, surface and ground water drainage is very crucial. So, it is recommended to construct appropriate surface and shallow subsurface drainage. To minimize the infiltration of surface run-off, ground seal and filling up the cracks is recommended. Slope reformation works is also required for the slope correction at some places of the road section. Similarly, check dams, retaining walls and revetment are recommended for the erosional protection. Non-structural countermeasures like bioengineering methods can also be applied to stabilize the hazardous slopes in conjunction with civil engineering structures. The regular monitoring of the displacement of the tensional cracks is essential in those vulnerable sites. So, it is recommended to establish a committee at local level for regular inspection of landslide affected areas. For detail assessment, topographical, geophysical and hydrogeological survey are further recommended.

*Keywords:* rapid assessment, landslide, geological structures, weak lithology, sub-surface water

## **Intervention for safer construction after 2015 Barpak – Gorkha Earthquake**

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The collision of Indian and Eurasian plates results high seismicity in Himalayan. Consequently, this region including Nepal is one of the earthquake prone zone on Earth. Nepal has a long history of catastrophic earthquakes and the recent M7.8 Gorkha, Nepal earthquake on April 25, 2015 have severely

affected many sectors of nation's claiming many lives and loss of million dollars, primarily private houses are the most affected sectors. After the establishment of National Reconstruction Authority (NRA), there are numerous activities regarding technical interventions being formulated and implemented to achieve build back safer for houses that have been built under the housing reconstruction program. Reconstruction works are being speeding up through many ways such as implementing National Building Code, producing and endorsing typical building drawing – design catalogues for engineers addressing traditional and alternative construction methodology, formulating technical manual for engineer's covering diverse building typologies. While developing these working manuals, there are scientific researchers are conducted on different building materials and building typologies. Engineering tests are also carried out for different materials predominantly found in local construction. Additionally, the several cyclic tests at walls to full building shake table tests were carried. This paper covers the seismic damage and technical endeavors undertaken in Nepal for reconstruction and retrofitting of damaged houses by Gorkha Earthquake.

*Keywords:* Barpak-Gorkha earthquake, intervention, low strength masonry, reconstruction, retrofitting.

## **Transforming Glacier Hazard into a Economic Opportunity for the Development of Nepal**

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Because of the High relief, very rugged topography (65-8848 m in 160 km), active tectonics (5000 local and regional events of earthquake in a year), highly concentrated precipitation (80% in summer, 37 % in 24 hours), global warming and lake formation (more than 1500 Glacier lakes), highly dynamic environment vulnerable to hazards and disasters, Nepal is Known as global hotspots for natural disasters and ranked 11<sup>th</sup> for earthquake, 30<sup>th</sup> for flood and 5<sup>th</sup> for climate change risk.

Every year there are thousands of fatality, damage of infrastructure, loss of agriculture land, that cost millions of dollars as a result of natural hazard, i.e., landslide, floods including GLOF's. The major instigate of natural disaster and consecutive losses in Nepal are the lack of identification of the problem and perseverance action to resolve it. Natural disaster cannot be predicted, but with the use of available science knowledge including the use of remote sensing and modeling, the probable losses can be predicted and actions can be taken to minimize the possible damages.

Nepal Himalaya is known for its enlarging glacier lakes and the frequent GLOF's due to the warming temperature. Not alike other natural disaster, the threat of GLOF can be forecast and it is increasing everyday, but there is no clear actions or policy formed to minimize the possible losses in downstream areas. Past initiatives (Tso-Rolpa, Imja lowering projects) are very small considering the ambiguous threat of it. So, at this time when government is trying to develop the multimillion-dollar hydropower projects and other infrastructures in downstream areas, they should increase the investment on identifying the economic losses, and recognizing the better use of natural lakes water using cost effective approach.

*Keywords:* relief, topography, infrastructure, GLOF, forecast.