CLIMATE CHANGE: PROJECT CLIMATE RISK ASSESSMENT AND MANAGEMENT REPORT

I. Basic Project Information

Project Title: Nepal: Earthquake Emergency Assistance Project

Project Budget: US$ 232 million with ADB $200 million and Government $32 million

Location: Earthquake affected districts

Sector: Infrastructure, Education

Theme: Environmentally sustainable and inclusive economic growth; Climate Change Adaptation; capacity development. Disaster risk resilience

Brief Description

The Earthquake Emergency Assistance Project will support the government of Nepal to accelerate recovery and reconstruction following the devastating earthquake of 25 April and major aftershocks. Key elements of investment will be in schools, roads and reconstruction of settlements and in strengthening resilience to withstand future disasters. The project will seek to ensure schools are rebuilt and upgraded to disaster resilient standards. Similarly, roads and bridges will be rehabilitated and reconstructed to higher standards to strengthen disaster and climate resilience. In terms of project coverage, priority will be given to the 14 most affected districts[1].

An underlying feature of this project will be to incorporate key lessons into project design and implementation from ADB's recent experience in responding to disasters in India, Pakistan and the Philippines and in particular focusing on strengthening resilience to future disasters incorporating 'build back better' design features for strengthening both disaster and climate resilience.

II. Summary of Climate Risk Screening and Assessment

A. Sensitivity of project component(s) to climate/weather conditions and sea level

The predicted impacts of climate change for Nepal[2] indicate consistent warming and a rise in maximum temperatures at an annual rate of 0.04 - 0.06°C. Additional Screening Reports conducted by ADB South Asia Regional Department (SARD) for the project, which use Regional Circulation Models (RCP8), indicate annual mean temperatures to increase by 3°C by 2050. Studies[3] conducted as part of the National Adaptation Programme (NAPA) indicate that the observed warming trend is not uniform across the country and is found to be more pronounced in high altitude regions (such as the project area), as compared to the Terai and Siwalik regions. Similarly, annual precipitation data shows a general decline in pre-monsoon precipitation in far and mid western Nepal, with a few pockets of declining rainfall in the western, central and eastern regions. In contrast, there is a general trend of increasing pre-monsoon precipitation in the rest of the country. In the rest of the country, monsoon precipitation has generally increased. Post monsoon precipitation shows increasing trends in most of the mid western and the southern parts of eastern and central/western Nepal. A declining trend in precipitation is observed in most of the far western and northern parts of the western, central and eastern Nepal. The winter precipitation trends show an overall increase except the northern part of mid-western, western and eastern Nepal.

General circulation models run with the SRES B2 scenario show the mean annual temperature to increase by an average of 1.2°C by 2030, 1.7 by 2050 and 3°C by 2100 compared to a pre-2000 baseline. Recent studies cited in the NAPA documentation that used GRCM models, project the mean annual temperature to increase by 1.4°C by 2030, 2.8°C by 2060 and 4.7°C by 2090. The projections show higher temperature increments during winter as compared to the monsoon seasons. Higher increments in temperature are projected over western and central Nepal as compared to eastern Nepal for the years 2030, 2060 and 2090. Similar trends are projected for the frequency of hot days and nights for 2060 and 2090.

[1] The majority of the affected districts fall within the Central region with the exception of Okhaldhunga (Eastern Region) and Gorkha (Far Western Region). All project affected districts are ecologically classified as hills and based on the major physiographical regions presented in the country all except two (Rasuwa and Sindhupalchok – classified as high mountain) are classified as 'middle mountain'.

[2] Nepal National Adaptation Programme of Action (NAPA). 2010. Ministry of Science, Technology and Environment. Government of Nepal, Kathmandu, Nepal.

[3] Ministry of Science, Technology and Environment. 2012. Climate Change Risk Assessment and Mapping. Government of Nepal, Kathmandu, Nepal.

Precipitation projections are noted to increase for the whole country in the range of 15-20%. Further, the projections indicate an increase in monsoon and post-monsoon rainfall as well as an increase in the intensity of rainfall and a decrease in winter precipitation. The 2007 Intergovernmental Panel on Climate Change report projects that there will be a general increase in the intensity of heavy rainfall events in the future and an overall decrease by up to 15 days in the annual number of rainy days over a large part of South Asia. The projections indicate that the key impacts for Nepal are likely to include: significant warming, particularly at higher elevations, leading to reductions in snow and ice coverage; increased frequency of extreme events, including droughts and floods and an overall increase in precipitation during the wet season.

More recent in-depth studies for Kathmandu which covers three of the affected project districts and where detailed climate threats analysis have been conducted[1] conclude the following: (i) **Increasing maximum temperatures** - increase in average maximum temperature of up to 1.85°C; (ii) **Increasing intensity of rainfall events**; (iii) **Increasing number of extreme rainfall events** – events that now occur every 5 years are projected to occur every 2 years; (iv) **Increasing wet season flow on the Bagmati River** – peak monthly average flow in wet season will increase by up to 68%; (v) **Greater likelihood of pooling;** (vi) **Increase in irrigation demand** – irrigation demand will increase by up to 980mm, and (vii) **Increasing risk and severity of flash floods during the wet season.**

Nepal has as part of the NAPA process and using a variety of climate risk/exposure and sensitivity maps (see Annex 1) conducted a series of climate change vulnerability assessments at the district level. This exercise has highlighted those areas that are the most vulnerable to climate change impacts in Nepal. From a climate change vulnerability perspective the earthquake impacted areas are listed as being of medium – high risk and with the exception of Rasuwa and Sindhupalchok districts (classified as high mountains), fall within the middle mountain range which is noted to be the first great barrier to the monsoon winds which produces the highest precipitation on its southern slopes due to orographic effects.

Collectively, the background presented above underscores the impact climate change will have on Nepal as a whole with several implications on the project area. In particular it is noted that the project area is likely to experience increases in precipitation and particularly where the topography is broken, cracked and eroded, there are increased chances of experiencing a higher level of vulnerability to flooding and landslide risks imposing serious threats to planned infrastructure works. As a whole the climate impacts in the investment programme area are found to be potentially more vulnerable to increased incidence of severe flooding, drought and rising temperatures. In these circumstances an integrated approach in dealing with the engineering aspects of the "building back better" is recommended as a means to help increase overall resilience.

In addition, ADB has provided considerable assistance to the climate change agenda in Nepal through grant assistance programmes and through its participation in the Pilot Programme of Climate Change Resilience. The Project Team will seek to draw on the screening reports and knowledge products which also cover key infrastructure areas proposed under the emergency assistance project.[2]

Project component(s)	**Sensitivity to climate/weather conditions and sea level**
Output 1: Schools are rebuilt and upgraded 1. Construction of schools and rehabilitation of destroyed structures;	1. Specific sites to be determined on assessment of propensity to be affected by potential landslides in the aftermath of the quake;
2. Emergency restoration and strengthening of drainage channels	2. Increased storm surge and riverine flooding impacts causing possible flash floods and debris floods ;

[1] TA 7984 Component 3 (Mainstreaming Climate Change Risk Management in Development) - Pilot Programme on Climate Change Resilience (PPCR).

[2] (i) DOR & MoSTE. 2014. *Strategic Road Network: Synthesis Report on Adaptation to Climate Change*. Ministry of Science, Technology and Environment (MoSTE) and Department of Roads (DOR) as part of TA –7984 NEP: Mainstreaming Climate Change Risk Management in Development Project supported by ADB with funding from the Climate Investment Fund (CIF). Kathmandu, Nepal; (ii) DOLIDAR & MoSTE. 2014. *Local and Rural Roads Sector: Synthesis Report on Adaptation to Climate Change*. Ministry of Science, Technology and Environment (MoSTE) and Department of Local Infrastructure Development and Agricultural Roads (DOLIDAR) as part of TA – 7984 NEP: Mainstreaming Climate Change Risk Management in Development Project supported by ADB with funding from the Climate Investment Fund (CIF). Kathmandu, Nepal.

Output 2: Roads and Bridges are rehabilitated and reconstructed	
3. Construction of roads and pavements	3. Winter and summer temperature contrast;
4. Construction of a new river-crossing bridge and rehabilitation of destroyed structures	4. Intensity and frequency of heavy rainfall events;
5. Emergency restoration and strengthening of drainage channels	5. Increased storm surge and riverine flooding impacts causing possible flash floods and debris floods ;
Output 3: District-level government facilities constructed and/or rebuilt:	
6. Construction of public buildings and rehabilitation of destroyed structures;	6. Specific sites to be determined on assessment of propensity to be affected by potential landslides in the aftermath of the quake;
7. Emergency restoration and strengthening of associated drainage channels	7. Increased storm surge and riverine flooding impacts causing possible flash floods and debris floods.

B. Climate Risk Screening

Risk topic	**Description of the risk**
1. Flood	1. Flooding caused by the combination of torrential rains commonly experienced during the monsoon period in the foothills and rapid snow and ice melt in the mountains are likely to seriously affect the project implementation activities. Features such as inundation, bank cutting and sediment deposition - are all likely impacts to roads built in the middle hill region.
2. Rainfall increase	2. High in the project area and likely to affect drainage structures, bridges, road pavements. May also result in increase in scouring of bridge foundations and also trigger increase in frequency of land and mud slides.
3. Earthquake	3. Project located on a high hazard earthquake zone
4. Temperature	4. Can cause pavement deterioration due to liquidation of bitumen
5. Landslides	5. The threat of landslides across Nepal and in particular in the project affected districts is serious in the aftermath of the earthquake, surrounding lands are noted to be cracked and eroded and landscapes in this fragile state have an added propensity to experience landslides triggered by precipitation.
6. Glacial lake outburst flood (GLOF)	6. GLOF events – particularly in the project affected districts of Gorkha and Dolakha are a potential risk. Recent surveys have shown that many glacial lakes in Nepal are expanding at a considerable rate so that the danger they pose appears to be increasing.[1] Nepal has experienced 24 GLOF events in the recent past, several of which have caused considerable damage and loss of life. Scientists predict that the frequency of GLOF events will increase with climate change and variability and thus the need to factor this risk into project design and planning.

Climate Risk Classification
High

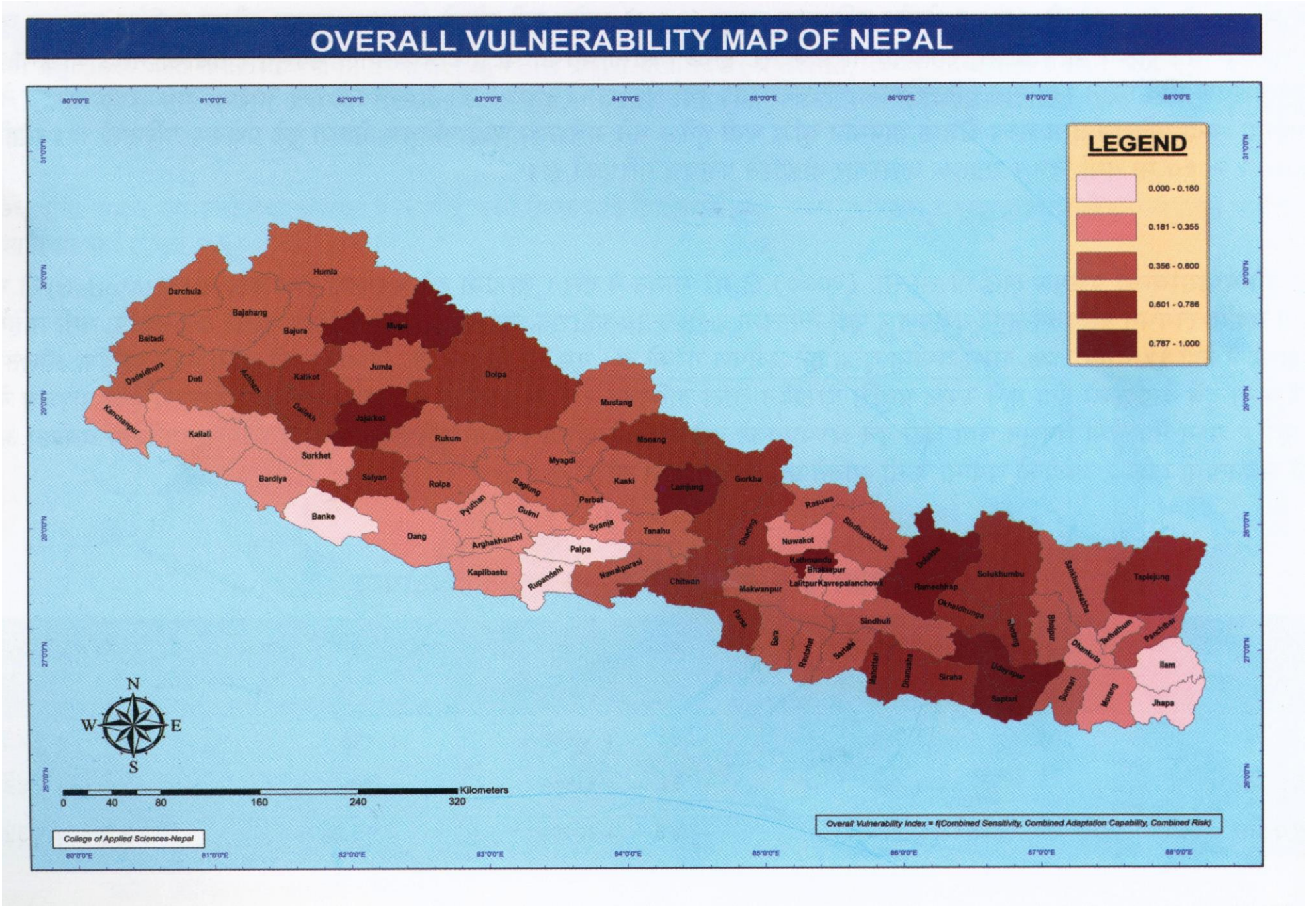
C. Climate risk assessment

The climate change risk assessment was based on a variety of secondary sources/ data sets and screening tools including AWARE: (i) a Nepal's National Adaptation Programme of Action (NAPA) 2010; (ii) TA 7984 (Mainstreaming Climate Change Risk Management in Development - Component 3 of the Pilot Programme of Climate Change Resilience); (iii) Recent published peer reviewed journal articles and (iv) climate change relevant ADB assisted TA programmes (2013 onwards).

In addition, the Project Team will use the AWARE tool further and in more detail when preparing individual subprojects and will incorporate additional climate risk screening elements at that time for a more thorough and detailed incorporation of risk elements in project design.

[1] International Centre for Integrated Mountain Development, Kathmandu, March 2011. Glacial Lakes and Glacial Lake Outburst Floods in Nepal

III.	Climate Risk Management Response within the Project
1.	Improved preparedness for climate variability and change through the incorporation of resilient designs for all infrastructure works (including rehabilitation). The Project Team will ensure consistency between the EARF and EMP.
2.	Capacity building of district environmental officers and project staff in undertaking safeguards due diligence to also incorporate climate change resilience procedures. To be incorporated into the EMP;
3.	For roads component the project will help better cope with climate variability and change through activities focused on rehabilitation and will use stiff bitumen to withstand projected rise in temperature. Additionally it will include clauses in the specifications to ensure that design and construction standards are raised to appropriate levels;
4.	For areas within low-lying flood prone areas which cannot be relocated, flood defense and mitigation measures will be implemented, including raising infrastructure works to be above the maximum projected flood level (taking into account maximum recorded levels and future flood level projections)
5.	Installation of stronger more climate resilient buildings - to include but not restricted to installation of pre-stressed, spun concrete poles for reinforcement purposes. In addition it will be important that good quality materials and cement are used for ground cover, given the additional wear and tear and potential damage from future storms.
6.	Considering the project areas vulnerability to extreme weather events, regular operations and maintenance activities and equipment inspections should be carried out to help mitigate damage and ensure continuous operations and /or faster restoration after natural disaster events.
7.	Due to high costs involved in disaster insurance – recommend a study on available options for future disasters, including self-insurance and strengthening early warning systems to enhance disaster preparedness.
8.	Review (and revise if required) the current practice of: calculating return periods, design discharge, high flood levels, length of waterways etc. Include slope protection works (both retaining and breast walls), subsurface drains and catch drains;
9.	Increase frequency of periodic maintenance.
10.	Increase capacity of side drains, cross drains and embankment height. Involve Department of Hydrology and Meteorology DHM hydrologists to input into design structures based on probable increases in rainfall.
11.	Review of set design life periods to accommodate for increased flood volumes. Bridges will also be built with drainage structures designed for higher return periods. Bridge design will endeavor to make structures more resilient to over topping by high floods. Increasing invert levels of bridges/culverts to accommodate for high flood levels will be investigated as part of the project.
12.	Roads built in low land and in close proximity to adjacent rivers will include additional protection works to resist erosion and scour.
13.	Specifications for materials and mixes used for all construction works will be reviewed to increase their resilience to the impacts of increased rainfall, increased flows and fluctuations in temperature variations.
14.	Design engineers will undertake multi-hazard identification exercise for the project. This exercise may recommend rerouting or relocation during project site identification and ensure that infrastructure must withstand future climate and disaster impacts. The Project Team will ensure that findings of this exercise are made consistent between the EARF and EMP.


OVERALL VULNERABILITY MAP OF NEPAL
LEGEND
0.000 - 0.180
0.181 - 0.355
0.356 - 0.600
0.601 - 0.786
0.787 - 1.000
Humla
Darchula
Bajahang
Bajura
Mugu
Baitadi
Dadeldhura
Doti
Achham
Kalikot
Jumla
Dolpa
Mustang
Kanchanpur
Dailekh
Jajarkot
Kailali
Rukum
Manang
Surkhet
Myagdi
Bardiya
Salyan
Rolpa
Baglung
Kaski
Lamjung
Gorkha
Banke
Pyuthan
Gulmi
Parbat
Rasuwa
Dang
Syanja
Tanahu
Dhading
Sindhupalchok
Arghakhanchi
Palpa
Nuwakot
Kapilbastu
Rupandehi
Nawalparasi
Chitwan
Kathmandu
Bhaktapur
Dolakha
Solukhumbu
Makwanpur
LalitpurKavrepalanchowk
Ramechhap
Sanhuwasabha
Taplejung
Okhaldhunga
Parsa
Sindhuli
Khotang
Bhojpur
Bara
Tarhathum
Panchthar
Rautahat
Sarlahi
Dhankuta
Ilam
Mahottari
Dhanusha
Siraha
Udayapur
Saptari
Sunsari
Morang
Jhapa
N
W
E
S
0
40
80
160
240
320
Kilometers
College of Applied Sciences-Nepal
Overall Vulnerability Index = f(Combined Sensitivity, Combined Adaptation Capability, Combined Risk)