CLIMATE CHANGE ASSESSMENT

I. Basic Project Information[1]

A. Project Name: NEP (51190-001): Disaster Resilience of Schools Project

B. Project Budget:

Source	Amount ($ million)	Share of Total (%)
Asian Development Bank	158.9	79.9
Concessional ordinary capital resources[a]	148.9	74.9
Asian Development Fund DRR grant	10.0	5.0
Clean Energy Fund[b]	5.0	2.5
Government of Nepal	35.0	17.6
Total	198.9	100.0

DRR = Disaster Risk Reduction. Source: Asian Development Bank estimates.

[a] Includes $20 million of Disaster Risk Reduction concessional ordinary capital resources.

[b] Clean Energy Fund is under the Clean Energy Financing Partnership Facility; financing partners: the governments of Australia, Norway, Spain, Sweden, and the United Kingdom. Administered by the Asian Development Bank.

C. Location: Schools in earthquake-affected areas in these districts in Nepal: Bhaktapur, Dhading, Dolakha, Gorkha, Kathmandu, Kavrepalanchok, Lalitpur, Nuwakot, Okhaldunga, Ramechhap, Sindhuli, Sindhupalchok, Rasuwa and Makwanpur.

D. Sector/Sub-Sector: Education/Education Sector Development

E. Brief Description:

The project will improve disaster resilience of schools in three provinces of Nepal. It will reconstruct heavily damaged buildings of 174 schools in 14 districts most affected by the earthquake of 2015. The project will support school infrastructure investments, disaster risk management (DRM) and institutional strengthening. It builds on and expands ADB's on-going emergency reconstruction support.[2]

The project focuses on school infrastructure rehabilitation and will also complement efforts of an on-going education program to improve quality of school education, access to education, and school management.[3] The preparation of gender sensitive and inclusive DRM planning will supplement the retrofitting and reconstruction efforts. The DRM action plan will be informed by the Comprehensive School Safety Framework (CSSF) and a gap assessment of activities to be undertaken by other development partners and through interagency coordination.[4]

Output 1: Heavily damaged schools reconstructed and improved. The project will reconstruct heavily damaged buildings of 163 schools in 14 districts most affected by the earthquake.[5] The schools will be reconstructed to earthquake resilient standards. Reconstruction will include improved classrooms and facilities comprising of science laboratories, computer-equipped ICT rooms, libraries, water supply and sanitation and hygiene compliant gender responsive segregated and disabled friendly toilets, and solar power supply or back up for 90% of the reconstructed schools. Construction works will be designed to mitigate potential weather-related hazard to schools and to ensure provision of a safe learning environment.[6], Off-grid and on-grid solar power systems will be installed in 130 schools.[7] The schools are selected based on size of enrollment, scale of damage, and equity (gender and historically disadvantaged group) considerations.[8]

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[1] ADB. 2018. *Report and Recommendation of the President to the Board of Directors*: NEP Disaster Resilience of Public School Infrastructure and Community Project

[2] ADB. 2015. *Report and Recommendation of the President to the Board of Directors: Earthquake Emergency Assistance Project*. Manila.

[3] ADB. 2016. *Report and Recommendation of the President to the Board of Directors: Proposed Results-Based Loan and Technical Assistance Grant to Nepal for Supporting School Sector Development Plan.* Manila.

[4] These development partners include National Society for Earthquake Technology, United Nations Children's Fund, United Nations Educational, Scientific and Cultural Organization, and other relevant sector and cluster groups. Such objective is reflected in Ministry of Education. 2016. *School Sector Development Plan*. Kathmandu (Objective No. 6).

[5] These districts include Bhaktapur, Dhading, Dolakha, Gorkha, Kathmandu, Kavrepalanchok, Lalitpur, Nuwakot, Okhaldunga, Ramechhap, Sindhuli, Sindhupalchok, Rasuwa and Makwanpur.

[6] Reconstruction of schools is designed to meet Indian Standards, Criteria for Earthquake Resistant Design for Structures, 2002 for Importance Factor 1 (highest: Service, Community and Emergency Buildings).

[7] Renewable energy generation capacity will be about one megawatt, resulting in 1500 gigawatt hour energy per year.

[8] Gender and Social Inclusion Action Plan; and School Selection for Reconstruction and Retrofitting (accessible from the list of linked documents in Appendix 2).

Of the schools targeted, 36 schools include buildings with reconstruction needs only, and 127 schools include buildings with reconstruction and retrofitting needs. The targeted schools are mainly secondary schools and some feeder basic schools that will help achieve the SSDP goal of 85% enrollment in secondary schools. **Output 2: Unsafe schools retrofitted and disaster risk reduced.** The project is targeting 138 schools that include buildings with retrofitting needs. Of these schools, 127 schools are also targeted under output 1, as these schools include buildings with reconstruction needs, and the remaining 11 schools include buildings with only retrofitting needs. The retrofitting works will be complemented by construction of improved facilities to reach comparable learning environment sought for the schools reconstructed under Output 1. The schools targeted for retrofitting will also be selected based on size of enrollment, scale of damage, and equity (gender and historically disadvantaged group) considerations. The project will also support development of a DRM action plan and relevant training for school management committees (SMC), students and communities, and field-test the risk management action plans in selected reconstructed and retrofitted schools in the 14 affected districts. **Output 3: Institutional capacity for disaster resilience strengthened.** This output will strengthen (i) the education management information system (EMIS) to improve school building inventory, condition status and local level SMC reporting to the EMIS system;[9] (ii) an implementation unit and municipalities' capacity to design and build disaster resilient structures; and (iii) SMCs to operate and adequately maintain schools, utilizing local government funding.[10] Considering the widespread retrofitting needs that will remain, a toolbox will be developed to pilot in three schools and support community retrofitting of schools and utilization of local government funding.

II. Summary of Climate Risk Screening and Assessment

A. Current Hazards/Exposure Profile (see Appendix 1)	
Earthquakes, landslides, and floods are the most severe hazards in Nepal. The frequency and intensity of weather-related hazards, notably rainfall-induced landslides, floods, and droughts, are expected to increase in the years to come due to climate change. Seismic events have the potential to trigger secondary hazards including landslides, floods, and fires. Although massive earthquakes happen infrequently, they cause significant casualties, physical damage, and losses to the economy.[11]	
B. Climate Projections (by the end of the 21st century)[12]	
Studies for Kathmandu covering detailed climate threats analysis concluded the following[13] : (i) increasing maximum temperatures; (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; and (vi) increasing severity of flash floods during the wet season.	
Change in temperature	Seasonal maximum temperature increase of 4.5˚C in spring and 3.3˚C in summer. Seasonal minimum temperature increase of 5.4˚C in winter and 3.4˚C in summer.
Changes in rainfall	Overall annual precipitation decreases by 2% of the baseline amount by 2020s. However, it increases by 6% and 12% of the baseline by 2050s and 2080s, respectively.
Extreme weather	It is likely that climate change in Nepal will increase the frequency and magnitude of extreme weather events.
C. Project Components	
i. Heavily damaged schools reconstructed and improved ii. Unsafe schools and disaster risk reduction reduced iii. Institutional capacity for disaster resilience strengthened.	

[9] EMIS is the Department of Education's main database for reporting on schools, students and teachers based on data collected twice a year.
[10] SMC capacity strengthening target 3(c) is detailed under Design and Monitoring Framework (Appendix 1).
[11] Documented earthquakes in 1934 (8.4 magnitude), 1980, 1988, 2011, and 2015.
[12] MOSTE. 2014. *Nepal Second National Communications to the UNFCCC*. http://unfccc.int/resource/docs/natc/nplnc2.pdf
[13] TA7984 Component 3 (Mainstreaming Climate Change Risk Management in Development) - Pilot Programme on Climate Change Resilience (PPCR).

D. **Sensitivity to Climate/Weather Conditions and Geophysical Events** (e.g., earthquakes, landslides, floods) ─ **High**
Nepal is among the most vulnerable countries in the world in terms of disasters and climate events. It is prone to floods, landslides, avalanches, glacial lake outburst floods, and earthquakes, causing loss of lives, livelihoods, properties, and infrastructures. Nepal is physically vulnerable due to its steep, rugged and fragile terrain. Sensitivity to hazards also resulted from unsustainable land use practices and low coping and adaptive capacity. Buildings in general have varying sensitivity. For example, wood can be more sensitive to moisture and wind than cement. As a result, wooden buildings are more vulnerable to floods and strong winds than cement-based structures. Cement-based structures however could cause more harm to people if these collapse, say due to strong winds and/or earthquake. Sensitivity and exposure determine the degree of impacts. Exposed structures could be affected more than the unexposed structures with the same sensitivity (as a function of materials and design).
E. Adaptive Capacity ─ Medium
<u>Positive:</u> • The Ministry of Home Affairs integrated school safety in its National Disaster Risk Reduction Policy and Strategic Action Plan (2017-2030).[14] • The preparation of gender sensitive and inclusive DRM planning will supplement the retrofitting and reconstruction efforts. • The project is aligned with Nepal's Post Disaster Recovery Framework and comprehensive 2016-2023 School Sector Development Plan (SSDP), which focuses on school safety as an explicit objective to develop human capital. • The project incorporates the lessons learned from ADB's previous reconstruction activities in Nepal and other countries. • Added value of the presence of ADB to support the Project and provide technical assistance. • Low carbon initiatives applied to the school buildings (use of solar energy) **<u>Negative:</u>** • No explicit adaptive capacity to future climate regime.
F. Climate and Disaster Risks Screening Key climate and disaster risks for the project school infrastructure result from exposure to hazards that include flooding, landslides, and earthquake and GLOF events. The changes in climate/weather will increase the sensitivity of the project components, which may already exist under normal conditions. 1. Flooding, caused by the combination of extreme precipitation 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 will likely affect adversely the built areas in the middle hill region. We also note that flood is the second highest cause of damage and losses in Nepal, after earthquake (see Appendix 1-f). 2. GLOF events particularly in the project affected districts of Gorkha and Dolakha are potential risks. 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.[15] Scientists expect 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. 3. Earthquake induced landslides across Nepal and in particular in the project affected districts are noted to result to cracked and eroded landscapes. Landslides during intense precipitation episodes will further aggravate this fragile state.

[14] Government of Nepal. 2017. *The National Disaster Risk Reduction Policy and Strategic Action Plan (2017-2030). Kathmandu* has been developed in line with United Nations Office for Risk Reduction. 2015. *Sendai Framework for Disaster Risk Reduction 2015-2030*. Geneva

[15] ICIMOD. 2011*. Glacial Lakes and Glacial Lake Outburst Floods in Nepal*. GFDRR, World Bank, 99 pp.

G. Risk Assessment

1. Increase in precipitation may result in: seepage and flooding in building interiors; physical changes to building materials (e.g., corrosion of metals) and finishes; and washout of temporary or poorly-constructed housing structures.
2. Decreased precipitation may result in: increased soil cracking and subsidence in areas with clay soils and reduced soil moisture; and damage to building foundation and facade from ground movement and subsidence.
3. Extreme weather/climate events could lead to structural damage and reduced durability of exterior surfaces due to erosion and weathering.
4. With the positive adaptive capacity present in the project management, the high exposure to current hazards could reduce the risks of disasters. However, additional efforts have to be made to address future climate risks (see Section III below).
5. According to an extensive survey of the 5,760 damaged schools in the project area (the Structural Integrity and Damage Assessment - SIDA) conducted under the auspices of the Global Facility for Disaster Reduction and Recovery (GFDRR) and the World Bank, only about 5% of these schools are exposed to flood risk.
6. The vulnerability to landslides has been assessed under the SIDA program for 60% of these schools. About 50% of them have been found vulnerable to landslides.
7. The project will essentially reconstruct and retrofit to earthquake resilient standard the buildings of about 163 and 138 schools respectively among the 5,670 damaged schools. On average, but to be confirmed by the final list of schools, 5% will be vulnerable to flooding and 50% to landslides. A much smaller percentage to GLOF events. Each school survey will assess the risk of flooding, landslide and GLOF – the earthquake risk being prevalent – and propose specific construction design to mitigate the school vulnerability

H. Climate Risk Classification — MEDIUM

On the basis of the above findings, the project risk is Medium for floods and landslides (both from extreme rainfall events and earthquake), including possible GLOFs in the upper areas. From the SIDA base that includes a survey of schools affected by the earthquake, 5% by flooding and 50% are affected by landslides.

III. Climate Risk Management Response within the Project

While the proposed project details measures that will address current disaster risks (earthquakes and landslides), it has yet to consider the risks due to changing climate conditions, including variability and extremes. Climate projections indicate generally, warming trend while changes in the distribution and pattern of rainfall could result in either flooding or prolonged dry conditions. These can affect the integrity of the school buildings if not factored into the design planning.

Some specific measures for climate change adaptation are recommended as follows:

- Design engineers need to 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. Review and revise calculated return periods using more recent climate rainfall projections as inputs into design of structures and specifications for materials and mixes used for all construction works.
- Reduce the degree of exposure by relocating assets and systems away from exposed locations, such as floodplains, and areas at risk of landslides, mudflows, floods, or fire.
- Improve preparedness for climate variability and change through the incorporation of resilient designs for all infrastructure works (including rehabilitation/retrofitting). For areas within low-lying flood prone areas which cannot be relocated, flood defense and prevention measures need to be implemented, including raising infrastructure works well above the maximum projected flood level (taking into account maximum recorded levels and **future** flood level projections).
- Regular operations and maintenance activities and equipment inspections should be carried out to help lessen damage and ensure continuous operations and/or faster restoration after natural disaster events. On some instances, increased frequency of periodic maintenance may be necessary.
- Capacity building of district environmental officers, engineers, and project staff in undertaking safeguards due diligence to also incorporate climate change and disaster risk resilience procedures.
- Strengthen coordination with authorities in charge of early warning to enhance disaster preparedness.

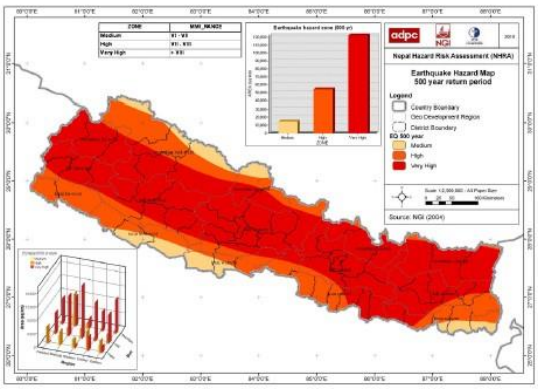
- For schools within low-lying flood prone areas which cannot be relocated, flood defense and prevention measures will be implemented, including raising infrastructure works above the maximum projected flood level.
- Installation of stronger and more climate resilient buildings - to include but not restricted to installation of pre-stressed, spun concrete poles for reinforcement purposes. In addition, good quality materials and cement will be used for ground cover, given the additional wear and tear and potential damage from future storms and floods.
- Considering the project areas vulnerability to extreme weather and related geophysical events, regular operations and maintenance activities and equipment inspections should be carried out to help lessen damage and ensure continuous operations and /or faster restoration after natural disaster events.

Climate mitigation is estimated to cost $6.8 million and climate adaptation is estimated to cost $7.2 million. ADB and the CEF will finance 100% of both mitigation and adaptation costs.

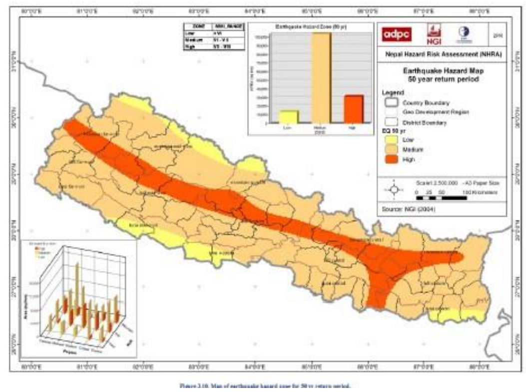
Appendixes: Information Used for the Climate Risk Screening

Appendix 1: Current Hazards

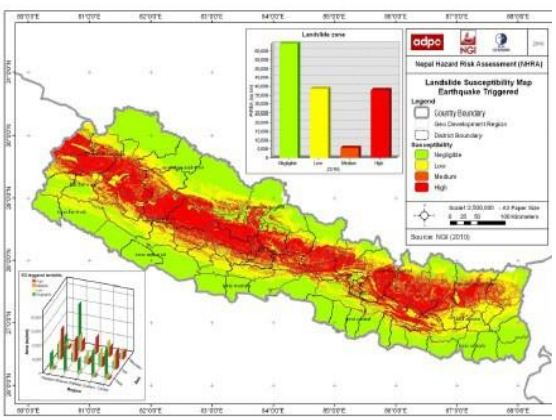
a. Earthquake: 1: 500 year earthquake



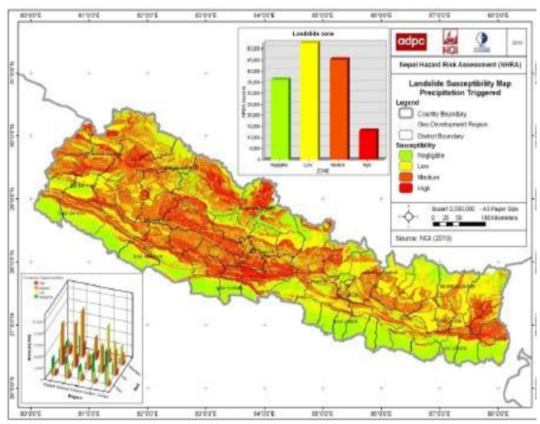
b. Earthquake: 1: 50 year earthquake



c. Earthquake-induced landslides



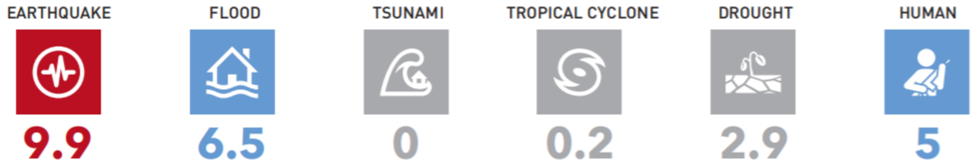
d. Precipitation-induced landslides



e. Glacial lake outburst floods (GLOFs)

GLOF events have been occurring in Nepal for many decades. However, it was only in 1985 after the Dig Cho glacial lake outburst that a detailed study of this phenomenon was initiated. In 1996, the Water and Energy Commission Secretariat (WECS) of Nepal reported that five lakes were potentially dangerous. These are Stu Dig Tsho, Imja, Lower Barun, Tsho Rolpa, and Thulagi, which are all above 4,100 m. A study done by ICIMOD in 201112 reported 20 potentially dangerous lakes in Nepal. In ten of them GLOF events have occurred in the past few years and some have been regenerating after the event. Additional dangerous glacial lakes may exist in parts of Tibet Autonomous Region of the People's Republic of China that are drained by streams crossing into Nepal, raising the possibility of outburst incidents in Tibet Autonomous Region of the People's Republic of China causing downstream damage in Nepal.

f. 2017 Disaster Risk Index in Nepal[16] - include earthquakes and floods as the top two major concerns.



Appendix 2: Observed Climate and Trends

a. Annual average temperature trend: The Terai region has maximum temperature of more than 24°C and the northern high mountainous region has lowest minimum temperature of less than 4°C. The country's annual mean maximum temperature is 23.6 °C and that of minimum is 11.6°C. With the exception of small isolated areas, most of Nepal has an increasing trend of 0.55° C per decade.

b. Precipitation Trend: The annual distribution of precipitation is observed to be highest at above 5,000 mm centered over southern part of Annapurna range and the driest part with about 500 mm on the lee side of the same range. This manifests the role of topography on the spatial variations of precipitation distribution in Nepal. The eastern high altitude regions have two pockets of about 3,000 mm annual precipitations. The rest of the country has approximately 1,000-2,000 mm, increasing towards the northern mountains from the east and decreasing towards the north in the western part. Overall, the average annual precipitation in Nepal is 1,683 mm of which 1,330 mm falls during summer monsoon.

Appendix 3a: Nepal Observed (1981-2010) Temperature Values and Projected Baseline and Changes in Seasonal and Annual Values during time slices 2020s, 2050s, and 2080s[17]

Season	Observed (˚C)	Baseline (˚C)	2020s (˚C)	2050s (˚C)	2080s (˚C)
Maximum Temperature					
DJF	17.8	9.5	1.5	2.8	4.4
MAM	26.0	21.7	1.1	2.6	4.5
JJA	27.3	21.6	1.0	2.1	3.3
SON	23.3	14.7	1.2	2.7	3.8
Annual	23.6	16.9	1.2	2.6	4.0
Minimum Temperature					
DJF	4.7	-5.6	2.3	3.9	5.4
MAM	12.5	7.0	1.2	2.9	4.2
JJA	18.5	15.3	1.2	2.4	3.4
SON	10.8	2.9	2.5	3.8	5.0
Annual	11.6	4.9	1.8	3.3	4.5

Appendix 3b: Nepal Observed Seasonal and Annual Precipitation (1981-2010) and their Downscaled Projected B aseline values and % changes during 2020s, 2050s and 2080s timelines[18]

Season	Observed, mm	Baseline , mm	2020s, %	2050s, %	2080s, %
DJF	71	163	-15	3	-12
MAM	211	319	4	10	-3
JJA	1330	1190	-1	8	20
SON	72	220	-4	-5	3
Annual	1683	1892	-2	6	12

Notes: Time slices are the middle of the 30–year period: 2020s: 2011-2040; 2050s: 2041-2070; and 2080s: 2071-2098. DJF = December-January-February; MAM = March-April-May, JJA = June-July-August, SON = September-October-November

[16] https://reliefweb.int/sites/reliefweb.int/files/resources/CP_Nepal_250117.pdf
[17] ICIMOD. 2011. *Glacial Lakes and Glacial Lake Outburst Floods in Nepal*. GFDRR, World Bank, 99 pp.
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