DISASTER RISK ASSESSMENT AND MANAGEMENT

A. Overview

1. **Disaster Risks and Impacts in Nepal.** Nepal is at risk to disasters triggered by natural hazards including earthquakes, flood, landslide, glacial lake outburst flood, and drought. Between 1980 and 2017, disasters in Nepal have caused about 21,000 deaths, affected the lives and livelihoods of almost 13 million people, and resulted to approximately $5.9 billion in direct physical losses.[1] The 2015 Nepal Earthquake caused damage and loss estimated at $7.1 billion, equivalent to 35.7% of 2014 Gross Domestic Product (GDP); with 8,790 casualties, 22,300 injuries, and overall 8 million people affected that represents almost 29% of the population.[2] The GDP growth fell to only 0.2% in fiscal year FY2016 from 5.7% in FY2014 and 3% in FY2015.[3] In August, 2017, widespread floods affected 35 of the country's 77 districts, inundating about 80 percent of the land in the Terai region and recovery need is estimated at $705.1 million. Probabilistic analysis estimates that Nepal experiences an average annual loss of $173 million (equivalent to 0.88% of 2014 GDP) as a consequence of natural hazards. The 100-year probable maximum loss is estimated at $1.4 billion for earthquake.[4]

2. Climate change is expected to worsen Nepal's climatic conditions and bring about changing hazard patterns (e.g. more frequent occurrences of extreme events) that lead to the increase in disaster risk. Based on Government of Nepal estimates, 1.9 million people are highly vulnerable, and an additional 10 million are increasingly at risk to potential climate change impacts.

B. Government Strategy on Disaster Risk Reduction

3. **Disaster Risk Reduction Policy and Action Plan.** The Constitution of Nepal 2015 identifies disaster risk reduction (DRR) as a priority and gives responsibility of reducing risk and advancing disaster risk management (DRM) to all levels of government. The Fourteenth Plan 2016/17-2018/19 focuses on risk reduction from water-induced disasters, and environmental and climate changes; and post-earthquake reconstruction and rehabilitation.[5] Following the 2015 earthquake that has exposed Nepal's vulnerability and also highlighted the need to enhance DRM. The Nepal Earthquake Post Disaster Recovery Framework 2016-2020 was approved in 2016.[6] In 2017, the Disaster Risk Reduction and Management Act was passed and the National Disaster Risk Reduction Policy and Strategic Action Plan 2017-2030 was finalized.[7,8]

4. **DRR Institutional Arrangements.** The Disaster Risk Reduction and Management Act provides for the establishment of a Disaster Risk Reduction and Management National Council that will provide directives and policy guidelines on DRM. A National Disaster Risk

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[1] D. Guha-Sapir, R. Below, Ph. Hoyois, EM-DAT: The CRED/OFDA International Disaster Database, Universite' Catholique de Louvain, Brussels, Belgium.
[2] National Planning Commission. 2015. *Nepal Earthquake 2015: Preliminary Damage and Needs Assessment*. Kathmandu; National Reconstruction Authority. 2016. Post Disaster Recovery Framework (2016-2020), Kathmandu.
[3] ADB. 2016. *Asian Development Outlook 2016: Asia's Potential Growth*. Manila.
[4] United Nations Office for Disaster Risk Reduction, 2015. Making Development Sustainable: The Future of Disaster Risk Management. Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland.
[5] National Planning Commission. 2016. *Fourteenth Plan 2016/17-2018/19*. Kathmandu.
[6] National Reconstruction Authority, Government of Nepal. 2016. *Nepal Earthquake 2015 Post Disaster Recovery Framework 2016-2020*. Kathmandu.
[7] Government of Nepal. 2017. *Disaster Risk Reduction and Management Act 2017*. Kathmandu.
[8] Ministry of Home Affairs, Government of Nepal. 2017. *National Strategic Action Plan for Disaster Risk Reduction 2017-2030*. Kathmandu.

Reduction and Management Authority is expected to be created that will implement and manage DRM activities. The law proposes a multi-tier institutional structure of disaster risk reduction and management at the national, provincial, district and local levels. The creation of this new institutional set up is a priority for the effective implementation of the country's DRM policy. In support of mainstreaming efforts, disaster risk reduction and climate change adaptation focal points have been placed in key ministries and agencies.

5. Challenges remain on (i) mainstreaming DRM in development planning, policies, and programs due to inadequate technical and functional capacities, and siloed approaches to DRM that does not recognize the intersections and interconnectedness of strategies and actions to build resilience; (ii) financing challenges to invest adequately on DRM; (iii) poor DRM information, including early warning systems; and (iv) lack of appropriate risk assessments to support planning, among others.[9,10,11]

C. Key Natural Hazards in Nepal

6. Nepal's topography makes it extremely vulnerable to disasters triggered by natural and man made hazards, including climate change. Factors that increase the exposure and vulnerability of population and assets to these hazards include rapid population growth and rapid unsafe urbanization; lack of land use planning and enforcement of building regulations; and limited awareness within the population of the possibilities and means to reduce disaster risk through improved planning, design, construction/retrofitting and maintenance of assets.

7. **Earthquakes.** The Himalayas is a hotspot for geological activity, leading to frequent large earthquakes. Nepal lies in a seismic active zone: almost the whole country falls in high seismic intensity scale of MMI IX and X (for the generally accepted recurrence period). Seismic hazard zoning map of Nepal divides the country into three zones along an elongated section that runs across the northwest-southeast direction forming a central belt along which the seismic risk is highest (Annex-1). Nepal has been ranked high 11th for earthquake hazards.[12] Recent devastating disasters in Nepal include the earthquakes of 1833,1934, 1980, 1988, and 2015. They not only caused heavy loss of human life and physical property, but they also adversely affected the development process of the country as a whole.

8. **Landslides.** Nepal's topography is known for its steep, rugged mountains, high-angle slopes, and complex geology; these conditions are impacted by very high intensity rainfall during the monsoon season, resulting in landslides, which are some of the most destructive natural disasters in Nepal. Three quarter of the total land area of Nepal is hilly and many villages are situated on, or adjacent to, unstable hill slopes, resulting in many landslides that cause severe damage. There are several pertinent aggravating factors, mainly unplanned settlements and physical constructions, built without due consideration to natural hazards. These structures considerably aggravate the dangers posed by the mountain environment. The middle hills and the higher mountains are highly susceptible to landslides, including seismic induced landslides.

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[9] Ministry of Home Affairs, Government of Nepal. 2016. *Disaster Management in Nepal: Status, Achievements, Challenges and Ways Forward. National Position Paper for the Global Platform on Disaster Risk Reduction, 22-26 May 2017, Cancun, Mexico*. Kathmandu.

[10] Ministry of Home Affairs, Government of Nepal. 2017. *Nepal Disaster Report 2017: The Road to Sendai (Draft).* Kathmandu.

[11] Practical Action. 2017. *Developing National Disaster Risk Reduction Policy and Strategic Action Plan in Nepal 2016-2030: Lessons Learned from Implementation of National Strategy for Disaster Risk Management (NSDRM) 2009*. Kathmandu.

[12] United National Development Programme, 2004. *A Global Report Reducing Disaster Risk-A Challenge for Development. and Recovery*, Geneva.

9. **Floods.** Nepal is also highly exposed to flood hazards and rated 30th in the world for flood hazards.[12] While flash floods are concentrated in the mountain and hilly regions, the southern part of the country, the flat Terai lies in the area with highest susceptible to flood hazard. While Nepal always experienced floods, particularly during monsoon season, in recent years, melting ice as a result of climate change is exacerbating this risk. In addition, landslides add significant load to streams and rivers, causing additional flooding. These are characterized by debris flows, which add the problem of injury from debris and contamination by petrol, chemicals, and other liquid spills. Floods cause loss of human life and immense damage to agricultural land, crops, human settlements, and other physical properties.

D. Disaster Risks, Vulnerability and Exposure

10. While natural hazards trigger disasters, the risks and the consequences of such events are determined by the vulnerability and exposure of assets and communities. The degree of **vulnerability** of assets is affected by their design, quality of materials, construction and maintenance of structural and non-structural elements; as well institutional capacity to pursue resilience. The level of **exposure** is affected by proximity of the asset to hazard zones, physical characteristics of location; its age, occupancy, and usage; and communities' level of awareness of disaster risk and preparedness. Reducing the vulnerability and exposure of communities and physical assets to natural hazards and enhancing the capacity of communities at risk are critical to protect people, safeguard investments and promote sustainable development.

11. **Structural vulnerabilities.** Elements that affect vulnerability of a building include: (i) typography (ii) building configuration, (iii) building modifications, (iii) structural capacity, (iv) construction materials and construction quality, (vi) age, and (vii) maintenance and repairs.[13]

12. **Non-structural vulnerabilities**. Non-structural elements include signage, pipes and ducts of water pipes, water tanks inadequately fixed to the structure, windows, doors, non-structural partition walls, and equipment (electrical, mechanical, and plumbing equipment for instance), installations such as book shelves and cabinets. Nonstructural walls are required to have some strength or designed to resist a minimum lateral force. Earthquake-induce damage to the non-structural elements of a building generally does not undermine the capability of the structural elements to support the building. Structural elements such as beams, columns, floor, walls, and foundation are designed to resist the expected pushes and pulls of gravity, wind, earthquakes, and other types of loads, thus preventing structural collapse. A building can remain standing after a disaster but still be unserviceable due to non-structural damage; for instance, it may have no windows or roof. Moreover, the non-structural damage to a building can cause physical injury to those inside or near it.

E. Schools and Disaster Risks in Nepal

13. More than 72% of the school buildings of the country's 35,000 schools require seismic retrofitting.[14] Studies dating back to 1997 and 2000 highlighted similar risks and needs for school safety.[15] Although massive earthquakes happen infrequently, they cause significant casualties, physical damage and losses to the economy. The total value of the damages and losses suffered by the education sector from 2015 earthquake was estimated at NPR 31,317.9 million (US$ 313.2 million). Of this, the damage to infrastructure and physical assets is

[13] Global Facility for Disaster Risk Reduction and Recovery. 2013. Global Program for School Safety: Characteristics of Safer Schools, Washington, DC.

[14] Vishokarma, J.S., Dahal, R.H., Acharya, S.P. Guragain, R. and A.M. Dixit. 2012. Implementing School Retrofitting Program in Nepal: Experiences and Lessons Learned, 15th World Conference on Earthquake Engineering, Lisbon.

[15] National Society of Earthquake Technology, Nepal and GeoHazards International, 2000. Seismic vulnerability of public school buildings of Kathmandu Valley and methods for reducing it, Kathmandu.

estimated at NPR 28,063.8 million (US$ 280.6 million), thus highlighting the physical vulnerability of education-related infrastructure. The extent of damages and losses was the highest in school education, with the subsector accounting for 88.8 percent of the total damages and losses faced by the entire sector. More specifically, 8,242 community (public) schools were affected by the earthquake: 25,134 classrooms were fully destroyed and another 22,097 were partially damaged. Institutional (private) schools also experienced significant infrastructure damage: 956 classrooms were fully destroyed and 3,983 classrooms were partially damaged. In addition, 4,416 toilets, and water, sanitation and hygiene (WASH) facilities, and 1,791 compound walls were damaged. The damage to ECD centers, furniture, libraries and laboratories, computers and other equipment was proportional to the damage faced by the schools. School safety has been given much attention in policy since this devastating 2015 event. The School Sector Development Plan (SSDP), the government's major education initiative for 2016-2023, aims to strengthen the school education sector across core dimensions including resilience by mainstreaming comprehensive school safety and disaster risk reduction in the education sector through enhancement of school-level disaster management and resilience among schools, students and communities.[16]

14. The government's SSDP, developed to ensure equitable access to quality education for all through a participatory process led by the Ministry of Education, is considered an important mechanism to enable the achievement of the Sustainable Development Goals (SDGs) and reach the goal of becoming a middle-income country by 2030. Comprehensive School Safety Framework (CSSF) guidelines were also developed, supported by ADB and other international agencies to provide safe learning facilities, school disaster risk management, and risk reduction and resilience education.[17]

15. **Safe School Facilities**. For new schools, school safety is achieved by determining performance objective, and hazard assessment at a macro and local site level; designing and constructing buildings to minimize exposure based on site selection and physical characteristics, and reducing structural and non-structural vulnerability.[18] For existing schools, it needs is to be determined whether they are is safe, require retrofit, repair or reconstruction and reduce risks to an acceptable level. The following factors are critical to ensuring safe and improved schools: (i) structural elements, use of disaster resilient design standards to meet performance objective, tested materials, skilled labor during construction, and strong construction supervision so design standards are maintained during implementation for structural elements; (ii) non-structural building elements, interior layout, and furnishings properly anchored to structures; people with special needs and disabilities considered regarding potential evacuation; schools as emergency community shelters designed to meet this performance standard; (iii) access to schools to be open, including along pedestrian paths, roads, and river crossings; for safe evacuation and/or access if a school is to be used as a temporary shelter; (iv) water and sanitation facilities to source adequate clean water and toilet facilities to meet needs of girls and boys; (v) climate-smart interventions (e.g. solar panels, renewable energy, rain water harvesting and school gardens); and (vi) financing operations and maintenance of schools to keep them in good condition for normal school operations as well as during or after a hazard event.

16. **School Disaster Risk Management**. Key considerations for school DRM are with education authorities and local school communities (including students) to: (i) provide policies and guidance for ongoing site-based assessment, planning, risk reduction, and disaster

[16] Ministry of Education, Government of Nepal. 2016. *School Sector Development Plan, Nepal, 2016–2023*. Kathmandu.

[17] United Nations Office for Disaster Risk Reduction. 2017. *Comprehensive School Safety Framework*. Kathmandu.

[18] Performance objective is the maximum level of risk that can be tolerated in terms of damage and disruption; and can be PO4-collapse prevention, PO3-life safety, PO2-immediate occupancy/operational continuity and PO1-continuous occupancy by FEMA-US, Eurocode, Indian Standard or others.

preparedness as part of normal school management and improvement[19]; (ii) develop, roll-out, institutionalize, monitor, and empower school-site DRM committees, involving staff, teachers, students, parents, and community stakeholders; (iii) adapt standard operating procedures including: drop-cover-hold, building evacuation, evacuation to safe haven, shelter-in-place, shelter via lockdown, and safe family reunification; (iv) practice response preparedness with regular school-wide, community-linked simulation drills; (v) establish national and sub-national contingency plans to support educational continuity, including limiting the use of schools as temporary shelters so children can get back to school; and (vi) incorporate the needs of girls and boys, and children with special needs.

17. **Risk Reduction and Resilience Education**. Key needs for a culture of safety and resilient communities is to have in schools (i) consensus-based key messages for reducing household and community vulnerabilities, preparing for disasters, and responding to them, as both formal and non-formal education; these materials must generate a problem-solving mind-set to reduce risk; (ii) risk reduction in school curriculum and integrate DRR into tertiary education; (iii) teacher training for teachers and teacher trainees on risk reduction curriculum materials; and (iv) strategies to scale-up teacher involvement for effective integration of these topics into the formal curriculum, non-formal teaching, and extra-curricular activities in local communities.

F. Proposed Project for Disaster Resilience of Schools

18. **Assessments.** A Structural Integrity Damage Assessment (SIDA) estimated that 2,234 schools are heavily damaged and not in use in 14 districts that were severely affected by the 2015 earthquake.[20] The SIDA survey also shows that all (100%) of these schools are vulnerable to seismic hazards, 30-50% of the schools are vulnerable to both precipitation and earthquake triggered landslides, and 5% of them are susceptible to flooding. Detailed appraisal of individual schools was conducted during project preparation to assess exposure based on site location, physical characteristics of the location; and vulnerability of schools based on detailed survey of damage of school buildings.

19. **Needs and Targeting.** The schools in the earthquake affected districts are functioning under temporary makeshift shelters and lack adequate facilities for learning, such as laboratories, libraries and information and communication technologies (ICT). They also possess very limited basic facilities, such as water supply and sanitation, and electricity. About 25% will be reconstructed under planned and on-going projects that are supported by various development partners.[21] Government efforts are also underway to finance reconstruction of additional schools. However, a significant funding gap for school reconstruction remains. Additional 3,569 partially damaged and functioning schools, with identified retrofitting or repair needs, remain in use. These schools include 17,688 school buildings and 45,111 classrooms, representing approximately 67.4% of school buildings and 66.7% of classrooms that were damaged.

20. **Proposed Project Scope**. The project is aligned with the following impact: disaster risk management for human resource development enhanced. The project will have the

[19] In addition to Comprehensive School Safety, Inter-Agency Network for Education in Emergencies (INEE) standards (http://www.ineesite.org/en/minimum-standards) and Sphere standards will guide preparedness efforts (http://www.sphereproject.org/).

[20] Department of Education and the World Bank. 2016. *Structural Integrity and Damage Assessment*. Kathmandu.

[21] ADB-funded Emergency Earthquake Assistance Project and Japan Fund for Poverty Reduction-funded Disaster Risk Reduction and Livelihood Restoration for Earthquake Affected Areas for $78m are reconstructing 160 schools. Japan International Cooperation Agency provided $112 million to reconstruct and retrofit 282 schools. The Government of India allocated $50 million to reconstruct 75 schools. There are also contributions from the United States Agency for International Development, and United Kingdom Agency for International Development. These contributions represent less than 25% of the needs identified.

following outcome: disaster resilience of schools and communities increased and learning environment improved. The project outputs include: (i) heavily damaged schools reconstructed and improved; (ii) unsafe public schools retrofitted and disaster risk reduced; and (iii) institutional capacity for disaster resilience strengthened. The proposed project is to focus on school infrastructure, build on and expand the ADB's on-going emergency reconstruction support that will be completed in June 2019.[22]

21. **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.[23] 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.[24], Off-grid and on-grid solar power systems will be installed in 130 schools.[25] The schools are selected based on size of enrollment, scale of damage, and equity (gender and historically disadvantaged group) considerations.[26] 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.

22. **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.

23. **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;[27] (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.[28] Considering the widespread retrofitting needs that will remain, a

[22] ADB 2015, *Report and Recommendation of the President to the Board of Directors: Earthquake Emergency Assistance Project*. Manila.
[23] These districts include Bhaktapur, Dhading, Dolakha, Gorkha, Kathmandu, Kavrepalanchok, Lalitpur, Nuwakot, Okhaldunga, Ramechhap, Sindhuli, Sindhupalchok, Rasuwa and Makwanpur.
[24] 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).
[25] Renewable energy generation capacity will be about one megawatt, resulting in 1300 gigawatt hour energy per year.
[26] Gender and Social Inclusion Action Plan; and School Selection for Reconstruction and Retrofitting (accessible from the list of linked documents in Appendix 2).
[27] EMIS is the Department of Education's main database for reporting on schools, students and teachers based on data collected twice a year.
[28] SMC capacity strengthening target 3(c) is detailed under Design and Monitoring Framework (Appendix 1).

toolbox will be developed to pilot in three schools and support community retrofitting of schools and utilization of local government funding.

24. The project will primarily focus on the two CSSF pillars of developing safe school facilities and disaster risk management based on ADB's comparative advantage of supporting school infrastructure reconstruction and retrofitting and targeted interventions in disaster risk management.

25. The project incorporates the following lessons learned from ADB's previous reconstruction and retrofitting activities in Nepal and other countries: (i) support investment in mainly secondary schools in both urban and rural areas that will have significant impact on education targets; (ii) focus on improved design of infrastructure for resilience and strengthened decentralized supervision to enhance implementation quality; (iii) carefully plan contract packaging and develop bidding documents to encourage wider response and competition for scaling up reconstruction and retrofitting; (iii) utilize reliable building condition assessment of moderately damaged buildings to target for their retrofitting; (iv) establish capable and experienced implementation team from the start of a project; (v) maintain on-going project's implementation arrangements that have been proven to work well; and (vi) enforce readiness criteria so project can be implemented within the planned implementation period and budget. Some additional lessons for retrofitting schools are to: (i) increase qualified engineers and masons to build capacity on vulnerability assessment and design and construction; (ii) apply structural and non-structural interventions to comprehensively address school safety; (iii) apply community-based approaches to ensure ownership and quality of construction; and (iv) implement efforts beyond Kathmandu valley to scale up efforts as the retrofitting needs are greater than reconstruction needs.[14]

26. The ADF 12 disaster risk reduction loan and grant financing of $30 million is expected to finance output 2 and 3 to support retrofitting of schools, reducing disaster risks and strengthening capacity of local government, implementing unit, engineers and masons, and school management committees for design, supervision, and operation and maintenance of safe schools. Details on project result and targets, cost estimates, financing plan, implementation arrangements are outlined in the project design and monitoring framework and the project administration manual. [29]

[29] DMF and PAM (accessible from the list of linked documents in Appendix 2).