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THE KATHMANDU VALLEY EARTHQUAKE RISK MANAGEMENT PROJECT: AN EVALUATION

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SUMMARY

The Kathmandu Valley Earthquake Risk Management Project (KVERMP) had four objectives: 1) evaluate Kathmandu Valley's earthquake risk and prescribe an action plan for managing that risk; 2) reduce the public schools' earthquake vulnerability; 3) raise awareness among the public, government officials, the international community resident in Kathmandu Valley, and international organizations about Kathmandu Valley's earthquake risk; and 4) build local institutions that can sustain the work launched in this project. The project was implemented by the National Society for Earthquake Technology – Nepal and GeoHazards International, as a part of Asian Urban Disaster Mitigation Program of the Asian Disaster Preparedness Center with core funding from the Office of Foreign Disaster Assistance of USAID.

Generally, the stated objectives of the projects have been achieved very successfully, but many lessons, both positive and negative, were learned in the process. The lessons learned include the following: (1) flexibility of funding agency is critical to project success, (2) awareness raising became part of all project components, (3) low-tech approach was optimal, (4) emphasis on community level work is important, (5) focus on school earthquake safety drew criticism, (6) NGO status both helped and hindered project implementation, (7) efforts at transparency were difficult but valuable, (8) institutional development is a long-term process, and (9) a successful new model for national-international project partner relationships was developed.

SEISMIC RISK OF NEPAL AND KATHMANDU VALLEY

Nepal is located within the Himalayan range, a product of the continental collision of the Eurasian and Indian plates, initiated about 40-55 Ma ago. The collision was followed by subduction of the Indian plate underneath Tibet, which continues today at an estimated rate of about 3 cm per year. The subduction results in tectonic stresses along the Himalayan frontal fault system (HFF), the Main Boundary Thrust Fault System (MBT), the Main Central Thrust Fault System (MCT), and the Indus Suture Zone (ISZ), all parallel to the Himalayan arc. Numerous earthquakes have occurred in this region, including four major earthquakes of magnitude greater than M8 within the last 100 years (Seeber et al., 1981; Molnar, 1984; and Chandra, 1992). Table 1 shows the frequency of earthquakes instrumentally recorded since 1911 within 150 km of Nepal's border.

In this century alone over 11,000 people have lost their lives due to earthquakes in Nepal. The 1934 AD Bihar-Nepal Earthquake produced strong shaking in Kathmandu Valley, the country's political, economic and cultural capital, and destroyed 20 percent and damaged 40 percent of the valley's building stock. In Kathmandu itself, one quarter of all homes was destroyed along with many historic sites. This earthquake was not an isolated event. Three earthquakes of similar size occurred in Kathmandu Valley in the 19th Century: in 1810, 1833, and 1866 AD. The seismic record of the region, which extends back to 1255 AD, suggests that earthquakes of this size occur approximately every 75 years, indicating that a devastating earthquake is inevitable in the long term and likely in the near future.

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Table 1: Magnitude-Frequency Data on Earthquakes in Nepal and the Surrounding Region (1911-1991)

	Earthquakes of Magnitudes in Richter Scale				
	5 to 6	6 to 7	7 to 7.5	7.5 to 8	>8
No. of Events	41	17	10	2	1
Approximate Recurrence Interval, yr.	2	5	8	40	81

Source: Earthquake Catalogue in BCDP, 1994

Like many urban areas in developing countries, Kathmandu Valley's risk has increased significantly since the last major earthquake. The Valley has a burgeoning population of almost 2 million people, uncontrolled development, and a construction practice that has actually degraded over this century. Nepal is among the poorest and least developed countries in the world. It has a per capita GDP of US$ 145 making it one of Asia's poorest countries. Approximately 14% of the GDP are derived from foreign development aid. A weak economy and abundant poverty affect earthquake risk management in many ways: a lack of government funds to support earthquake hazard mitigation programs, inexpensive and poorly constructed dwellings that often fail even in the absence of earthquakes, a tendency in the general population to ignore the earthquake hazard due to more immediate needs, and a lack of awareness about the earthquake hazard. Kathmandu Valley has an urban growth rate of 6.5% and one of the highest urban densities in the world. Nepal currently has no official building code[1,] and practically all construction is built without the input of an engineer and without considering seismic forces. The technical information about earthquake risk in Kathmandu Valley is incomplete and scattered among several governmental agencies. However, a more important contributor to the region's lack of earthquake preparedness was that the available technical information was synthesized, was not been applied to the infrastructure of modern day Kathmandu Valley, and not been presented in a form that the public and government officials could digest.

It is clear that a large earthquake near the Kathmandu Valley today would cause significantly greater human loss, physical damage, and economic crisis than caused by past earthquakes. The Kathmandu Valley Earthquake Risk Management Project aimed to improve this situation, and start a process towards managing the earthquake risk in the Valley.

PROJECT OVERVIEW

The Kathmandu Valley Earthquake Risk Management Project (KVERMP) was implemented from 1 September 1997 to 30 December 1999 jointly by the National Society for Earthquake Technology – Nepal (NSET-Nepal) and GeoHazards International (GHI), as a part of the Asian Urban Disaster Mitigation Program (AUDMP) of the Asian Disaster Preparedness Center (ADPC), with core funding by the Office of Foreign Disaster Assistance of USAID.

A project design workshop in March 1997, attended by representatives of most of the government and non-governmental institutions in Kathmandu Valley related to disaster management helped to define KVERMP's objectives as follows: 1) to evaluate Kathmandu Valley's earthquake risk and prescribe an action plan for managing that risk; 2) to reduce the public schools' earthquake vulnerability; 3) to raise awareness among the public, government officials, the international community resident in Kathmandu Valley, and international organizations about Kathmandu Valley's earthquake risk; and 4) to build local institutions that can sustain the work launched in this project.

KVERMP included a wide variety of activities aimed at beginning a self-sustaining earthquake risk management program for Kathmandu Valley. Project components included the following: 1) development of an earthquake scenario and an action plan for earthquake risk management in the Kathmandu Valley, 2) a school earthquake safety program, and 3) awareness raising and institutional strengthening.

The project was implemented with strong participation by national government agencies, municipal governments, professional societies, academic institutions, schools, and international agencies present in Kathmandu Valley in advisory committees and various workshops, seminars, and interviews.

[1] The United Nations Development Program sponsored the development of a building code, which was approved by the national Parliament in 1998. The building code still needs to be legalized and enforced.

The project was implemented with a core funding of US$ 290,000. An additional US$ 300,000, mostly provided as in-kind contribution was received from various institutions during the project implementation.

PROJECT ACHIEVEMENTS

Simplified Earthquake Scenario and Action Plan

This component of the project consisted of three parts: a simple loss estimation study, a written scenario which translated the findings and consequences of the loss estimation study into layman's language, and an action plan which presented the key mitigation activities, which should follow the completion of this project.

The Loss estimation

A simple loss estimation study was conducted for a repeat of the 1934 earthquake in modern day Kathmandu Valley. The location and vulnerability of Kathmandu Valley's infrastructure was determined through interviews with about thirty institutions. The information collected in these interviews was combined with previously conducted studies, and then a loss estimation study was conducted using earthquake loss models designed for use in Japan and the US such as ATC-13 (ATC, 1985). Although construction and maintenance of structures in Nepal vary considerably from those in Japan and the US, it was agreed that these readily available models produced useful, conservative results at a sensible cost, considering that the main aim of the project was to promote mitigation action rather than conduct detailed scientific or technical research. Loss estimates were conducted for the road system, the water system, the electricity system, the telephone system, and typical structures. In addition, possible death and injury figures were determined by looking at statistics from previous comparable earthquakes from around the world.

The 1934 Bihar-Nepal Earthquake produced shaking of intensity X, IX and VIII (Modified Mercalli Intensity scale) within the Kathmandu Valley. It is believed that this shaking was primarily due to amplification of the local soil, lacustrine sediments several hundred meters thick and therefore, a similar distribution of shaking can be expected from all major, distant earthquakes affecting the Valley. In addition, there is a high probability of liquefaction in many of the Valley's urban areas, especially near rivers.

A brief summary of the loss estimates for a possible repeat of the 1934 level of shaking follows:

- As many as 60 percent of all buildings in Kathmandu Valley are likely to be damaged heavily, many beyond repair.
- Almost half of the bridges in the valley could be impassable, and 10 percent of paved roads will have moderate damage, such as deep cracks or subsidence. The country's only international airport may be inaccessible. The prevalence of extremely narrow roads, which could easily be blocked by debris, will exacerbate the problem.
- Approximately 95 percent of water pipes and 50 percent of other water system components (pumping stations, treatment plants, etc.) could be damaged seriously. Almost all telephone exchange buildings and 60 percent of telephone lines are likely to be damaged, requiring significant to moderate repair to be operational. Approximately 40 percent of electric lines and all electric substations are likely to be damaged.
- Simply applying the percentage of the population killed or injured in the 1934 earthquake to the population of the valley today results in an estimate of 22,000 deaths and 25,000 injuries requiring hospitalization. Applying more recent earthquake casualty figures from cities comparable to Kathmandu Valley results in an estimate of 40,000 deaths and 95,000 injuries in Kathmandu Valley's next major quake.

The Earthquake Scenario

A scenario document that explains the results of the earthquake loss estimation study in layman's terms has been written and published in English and Nepali languages (NSET-1, 1999). This document includes a description of possible damages to various vital systems in Kathmandu, and an explanation of the repercussions of this damage on life in Kathmandu Valley. It also presents the story of one common man, "Bhaicha", for up to one

year after the scenario earthquake, and illustrates how this imaginary character's life is impacted. This document, published in large quantities, is being widely distributed along with information on how to prepare for an earthquake and where to get more information about earthquake safety. It is expected that this document will provide emotional understanding of the earthquake phenomenon to complement the technical information in the loss estimation study.

The Kathmandu Valley Earthquake Risk Management Action Plan

As a response to the extreme risk identified in the loss estimation, the project with over 80 government and non-government institutions developed a plan (NSET-2, 1999) to systematically reduce this risk over time. The Prime Minister of Nepal officially released and endorsed this plan in January of 1999.

The purpose of the plan is to assist His Majesty's Government of Nepal, concerned agencies, and the municipalities in Kathmandu Valley to reduce Kathmandu Valley's earthquake risk over time by coordinating and focusing risk management activities. The specific objectives that this plan will focus on to achieve that purpose are to improve emergency response planning and capability, improve awareness of issues relating to earthquake risk, integrate seismic resistance into the process of new construction, improve the safety of school children and school buildings, improve the seismic performance of existing buildings, improve the seismic performance of utility and transportation systems, increase experts' knowledge of the earthquake phenomenon, vulnerability, consequences and mitigation techniques and prepare for long-term community recovery following damaging earthquakes.

Ten specific initiatives were defined as urgent to implement in the next two years. NSET will actively aid and promote the implementation of these initiatives. These initiatives are:

1. NSET will request HMG/N Government to (1) constitute the National Disaster Management Council headed by the Prime Minister; and (2) direct the NDMC to define an integrated national disaster management system.

2. Once constituted, the National Disaster Management Council should (1) provide guidance for the preparation of new (or revision of existing) integrated emergency response plans and (2) direct these organizations to prepare plans.

3. NSET will work with the Ministry of Science and Technology to develop a comprehensive program to raise awareness about earthquake risk and mitigation options.

4. NSET will work with the municipalities and districts in the valley to create Disaster Management Committees, and to design a program of activities, including public awareness programs, for these committees.

5. NSET will request the Ministry of Housing and Physical Planning to constitute the Building Council and direct it to draft the rules and procedures for implementing and enforcing the building code, and formally adopt requirements to implement and enforce the building Code.

6. NSET will work with the Ministry of Housing and Physical Planning and others to prepare training materials and provide training for building inspectors, masons and engineers on applied aspects of design and construction of buildings to conform to the Building Code.

7. NSET will manage and co-ordinate the "School Earthquake Safety Project" which will (1) inform selected communities about the vulnerability of their schools and what can be done to reduce the risk; (2) prepare school-specific plans for improvements in seismic safety; and (3) mobilize support to improve the safety of the school buildings.

8. NSET will create information products to explain what non-structural hazards are how to mitigate them in typical Nepali homes and offices.

9. NSET will encourage the Nepal Telecommunications Corporation to assess the vulnerability of its system to earthquakes, identify the most vulnerable elements, and develop a program to improve its performance after earthquakes.

10. NSET will encourage engineering institutes to develop and offer short courses for practicing engineers on earthquake engineering principles and procedures.

School Earthquake Safety

The project included a vulnerability assessment of Kathmandu Valley's public schools as an example of how to conduct earthquake risk mitigation projects in Nepal. The purpose of this assessment is not to identify individual schools as vulnerable, but to quantify the risk faced by the entire system. First, the project team created a questionnaire that could be filled out by school headmasters. This questionnaire included topics such as size of buildings, density of students, year(s) of construction, whether or not an engineer was involved in the building design or construction, etc. Additionally, simple questions were asked about structural characteristics, presented through illustrations and descriptions. The project conducted 16 seminars with school headmasters from 65% of the total 645 public schools in the Valley to teach them about earthquake risk, about the necessity of planning for earthquakes in their school, and how to fill out the project questionnaire. Subsequently, the survey was conducted by the headmasters and data on 430 schools were returned to the project.

Following the completion of the surveys by the headmasters, engineers visited approximately 20% of all schools in the survey sample to assess the reliability of the data collected and to complete the survey form whenever necessary. Investigations were made into potential methods for retrofitting these existing buildings, and possible costs of retrofitting. A detailed retrofit design and cost estimate has been made for one typical school building. The safety of this school was improved through a simple seismic retrofit and other measures in a very cost-effective way.

There has been a very high level of cooperation and interest from the Kathmandu Valley schools and school officials in this project.

Public Awareness

Prior to this project, public awareness about earthquakes was very low. The publicity of this project has greatly increased that awareness. The project and its findings have appeared frequently in newspaper stories, have been featured on television, and have been presented in a wide variety of other forums.

At NSET's request, the government has designated January 15 as the Earthquake Safety Day, in recognition of the occurrence of the last earthquake tragedy to strike the valley on January 15, 1934. An Earthquake Safety Day National Committee has been constituted with the Minister of Science and Technology as the Chair, and 22 representatives of various organizations, including NSET, as committee members. The Committee is responsible for organizing the Earthquake Safety Day events annually.

The first Earthquake Safety Day was organized during 12-18 January with the Prime Minister releasing the Kathmandu Valley Earthquake Risk Management Action Plan and the Earthquake Scenario of Kathmandu Valley, and the Minister for Science and Technology vowing to work towards implementing the Kathmandu Valley Earthquake Risk Management Action Plan. An Earthquake Safety exhibition was organized by NSET/KVERMP in cooperation with private, public and non-government sectors of Nepalese society. In addition, NSET-Nepal organized interactive activities, including discussions on radio and television, a technical seminar for professionals of the building industry, earthquake-theme essay writing and painting contests for school children, and a street performance depicting what to do in case of an earthquake. A high point of the event was a simulation of how different building types, both with and without seismic reinforcement, would react to a high-intensity earthquake like that of 1934, demonstrated using a simple shaking table and one-tenth scale models of typical Nepalese buildings.

Institution Building

An important component of this project was to institutionalize the earthquake risk management processes started in this project. In order to reduce Kathmandu Valley's earthquake risk, the processes started by this project need to continue for many years. The project's institutionalization efforts have focused on two areas: first, establishing NSET-Nepal as a neutral seismic safety advocate for Nepal; second, to incorporate earthquake risk management and other disaster management activities into local government. This project has given NSET-Nepal an opportunity to establish an office, train its staff, gain experience in earthquake risk management, and develop a positive reputation through its actions. It has also provided an opportunity, through the development of the Earthquake Risk Management Action Plan and other activities, for NSET-Nepal to plan its long-term

strategy in tackling Kathmandu Valley's earthquake risk. Progress has been made in establishing local government earthquake risk management institutions, as well. The Kathmandu Metropolis created a Disaster Management Unit as part of the city government, which has been included in project activities and was trained in organizing disaster management activities by a KVERMP consultant. Other municipalities in the valley have also considered establishing Disaster Management Units, and are working with NSET-Nepal to get the process started. NSET-Nepal has also been active in educating ward-level officials (a ward is a subset of a municipality, the legal equivalent of a neighborhood), and at this time two wards have created their own Disaster Management Committees made up of neighborhood residents and community-based organizations.

EVALUATION OF ACHIEVEMENT

Generally, the stated objectives of the projects have been achieved very successfully, but many lessons, both positive and negative, were learned in the process. These lessons are described below. The experience gained from examining these lessons will benefit all types of mitigation projects in Nepal.

Flexibility of funding agency is critical to success

The project funding agency (the Asian Disaster Preparedness Center, with funds from USAID) allowed considerable flexibility in distribution of funds and schedule. This was critically important because, despite the best efforts, the original project concept, schedule and budget proved to be inadequate in many ways once work was underway. The implementation of KVERMP was an evolutionary process, and the flexibility of ADPC allowed the project to pursue the best results, regardless of whether or not they fit the project contract exactly.

As an example, the level of effort required for developing the earthquake scenario increased greatly from what was originally anticipated. The number of institutions interviewed increased from 15, the originally planned number, to 29, and required 3 to 4 visits for each institution lasting 1 to 3 hours per visit. The project proposal assumed these visits would require 1 hour apiece. The increased effort placed on these interviews allowed us to get better information from the organizations and secured their interest, involvement and ownership of project results.

The scenario interviews are only one of many activities that required greater resources than anticipated and, therefore, necessitated shifts in schedule and budget. Several project activities that were originally planned were never completed as a consequence. By allowing us to learn from our experiences as we worked, we believe that our final project achievements are much more significant than they would have been if we had strictly followed the project contract.

Awareness raising became part of all project components

Raising awareness was originally stated as a project objective, but as we worked it became clear that raising awareness was, in fact, a crucial component of everything we were doing. Every activity we undertook was shaped to raise the awareness of different groups - government officials, media, international agencies, etc.

Specifically, our emphasis in developing the earthquake scenario was not in producing precise, technically sophisticated results, but in involving all key institutions in developing and understanding simple technical results. The action plan development was not focused on identifying the activities that made the most sense to experts, but to educate policy makers that actions can and must take place. The action plan was developed by querying policy makers about which activities were most feasible to undertake given Nepal's current political climate. Similarly, the school earthquake safety program emphasized educating headmasters about their risk and their ability to reduce it. Low-tech methods were used to classify the structural safety of each school so that headmasters could participate in and learn from the process. One result of this outreach is that project workshops were actually working sessions, not platforms for various individuals to display their wisdom, which happens frequently in Nepal.

As an additional note, we were surprised to find that release of the results of loss estimates did not create any panic in the population. It rather made a larger part of the society wanting to improve the situation. This leads us to believe that the traditional belief of possible generation of panic should not be used as an excuse for not releasing information on risk.

Low-tech approach was optimal

The project consistently adopted simple technical approaches, which made the project cost-effective and understandable to the lay persons. It also helped to focus the project on implementation of risk reducing actions, our major aim. In Nepal, people are tired of seeing millions of dollars spent on studies without any implementation of actions.

Unlike many projects, KVERMP put greater emphasis on the use of past research rather than conducting new technical or scientific studies. The decisions to use a repeat of the 1934 earthquake shaking and simple, existing methods to produce loss estimates was very important. These loss estimates were cost-effective and produced a significant impact on the community without causing undue panic. This approach built upon the works of GeoHazards International and Escuela Politecnica National (GHI, 1994) in Quito, Ecuador. Similarly, the low-tech approach adopted for screening the seismic safety of schools produced useful results affordably and in a timely way. Both of these efforts should someday be followed by more detailed technical studies, but out low-tech work has given quick and strong motivation and direction to the mitigation efforts which are desperately needed to save lives in Nepal.

Emphasis on community level work is important

Implementation of the action plan and earthquake risk reduction as such can not be achieved unless consideration for earthquake safety starts becoming a part of the society's culture. Common people started taking interest in earthquake issues and raising questions shortly after the project began. This prompted the project to work on an experimental basis with two of the wards of Kathmandu municipality. The residents of these wards have, on their own initiative, taken several actions to try to assess and decrease the risk of their neighborhoods. The enthusiasm and potential of these groups has been exciting and such community work should be a part of future efforts of NSET.

Focus on School Earthquake Safety drew criticism

KVERMP was criticized for focusing only on public schools. Many people questioned why hospitals, a critical facility for post-earthquake response, was not chosen. Additionally, people asked why cinemas, private schools and colleges were not examined. The project team continued explanation for its focus on school did not quell the criticism. However, given the limited resources available, KVERMP continued the focus on schools, noting that the work on schools was building NSET's capacity to evaluate the vulnerability of other systems in the future. The school survey examined many previously unknown attempted activities: the costs of conducting a survey of building vulnerability, the technical expertise required for this type of survey, the costs involved in strengthening existing vulnerable buildings, the types of techniques to use for strengthening typical Nepalese structures, the interest of the community in strengthening buildings, the ability to attract funds (local and international) to this type of work, and the levels of earthquake risk acceptable in Nepalese society.

NGO status both helped and hindered project implementation

NSET faced problems from both local and international institutions due to its NGO status. Locally, NGOs have a tarnished reputation as corrupt and ineffective. Internationally, many agencies are not able to work with NGOs, requiring direct relationships with governments. This limited funding opportunities.

Ultimately, NSET's NGO status was extremely beneficial to the project. The flexibility of the non-government group allowed fast and cost-effective work. Its staff and programs remained stable throughout the project duration, whereas Nepal's government, and therefore bureaucrats throughout the system, changed several times. Last, NSET's non-political status allowed it to work effectively among all groups, despite the highly politicized atmosphere in Nepal.

Efforts at transparency difficult but valuable

The project made many efforts to be transparent, most significantly, the creation of an advisory committee to oversee all project work. This committee helped to draw in many influential people in the process of project implementation. The dialogue of this committee and other groups helped to build an environment of trust. The approach adopted by the project to keep people abreast about ongoing activities and interim findings, supported by maps, and documents helped establish the authority of NSET.

Frequent changes of people in the government positions during the project implementation period at time hindered the institutional interaction between the project and the different organizations. However, due to the massive outreach efforts of this project, project results will be openly available for all those who wish to use them, unlike many previous studies which have become inaccessible after a project is completed.

Institutional development is a long-term process

The project helped NSET to strengthen and establish itself as a leader in earthquake disaster management activities in Nepal. However, NSET still requires a great deal of institutional help before it can be a self-sustaining and fully effective organization. In particular, NSET needs to improve its management capabilities, reduce its dependence on a few key-people and improve authority delegation. It needs to broaden its ability to attract funds, and increase its ability to plan long-term strategy and day-to-day activities. This project has increased the interest and concern of Kathmandu Valley citizens about earthquake so significantly that NSET is overwhelmed by requests for help. In order to effectively meet all of these demands, NSET needs to address the aforementioned issues.

As a side note, a lack of regional experience in scenario and action plan development caused many to doubt NSET's capability to implement KVERMP. For example, "Why should we have in Nepal an earthquake scenario prepared, when even India does not have it for its cities?" was a comment made by some institutions. General thinking that Nepal is not a leader in technical areas could inhibit NSET's future work.

A new model for national-international project partner relationship developed

The co-operation between OFDA (core funding agency), ADPC (AUDMP co-ordinator), GHI (technical assistance and oversight provider) and NSET was extremely successful and significantly different than previous projects conducted in Nepal. This new model was extremely cost-efficient, helped to build local institutions, and produced successful results.

First, primary control of the project and a majority of project funds went to NSET. This contrasts strongly with many previous development projects in which nearly all funds are spent on foreign consultants, and local specialists play a secondary role. Second, significant international support and guidance were given to NSET through GHI, ADPC and OFDA. The involvement of these groups helped to strengthen NSET's abilities and added confidence to NSET's staff. These groups worked as true partners with NSET, accepting that local specialists knew the best methods to address local problems.

The success of this project caused it to be a model for the United Nations RADIUS project, implemented in nine cities around the world.

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