



## EARTHQUAKE RISK MANAGEMENT IN RAPIDLY URBANIZING AREAS OF NEPAL

Surya Narayan SHRESTHA<sup>1</sup> and Amod Mani DIXIT<sup>2</sup>

### SUMMARY

High population growth, rapid urbanization, low level of earthquake awareness, and poor construction practices are characteristic features of all municipalities in Nepal. Many of these settlements already face very high levels of earthquake risk, which is increasing continuously. Prevailing building permit process at the municipalities does require compliance to planning bylaws, although compliance to earthquake code is not mandatory. Even then, most buildings are constructed without any advice from qualified engineers. Such affair limits the desired benefits to be derived from the inclusion of seismic code into the building permits process. Erroneous juxtaposition of disaster risk reduction efforts against other developmental priorities, instead of mainstreaming them together with good governance, continue to dominate the prevailing national policies. Such conditions render earthquake considerations to occupy the least important place in municipal governance and developmental planning. As a result, earthquake risk is growing asymptotically. As an effort to contain the growing earthquake risk in urban areas, the National Society for Earthquake Technology-Nepal (NSET) has developed, implemented and tested a comprehensive program of Municipal Earthquake Risk Management (MERMP). The program consists of a) earthquake damage assessment using RADIUS tool, b) action planning with wider participation of all stakeholders (with emphasis on participation of women groups), c) School Earthquake Safety Program (SESP) as a demonstration of feasible mitigation effort, d) training of masons and technicians, e) awareness-raising activities that target a wide audience, and f) creation of municipal-level Program Advisory Committees as platforms for facilitating transparency and buy-in from the stakeholders. The concept of MERMP was developed based on the successes and lessons learned from the Kathmandu Valley Earthquake Risk Management Project (KVERMP), and the ongoing Kathmandu Valley Earthquake Risk Management Action Plan Implementation Project. The program demonstrates how it is possible to reduce earthquake risk considerably even in a country of weak economy if it adheres to and propagates bottom-up approach, community participation, use of indigenous wisdom, incremental safety approach, and creates synergy among government, businesses and non-governmental organizations.

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<sup>1</sup> Structural Engineer, National Society for Earthquake Technology-Nepal, Nepal, [sshrestha@nset.org.np](mailto:sshrestha@nset.org.np)

<sup>2</sup> General Secretary, National Society for Earthquake Technology-Nepal, Nepal, [adixit@nset.org.np](mailto:adixit@nset.org.np)

## **INTRODUCTION**

Nepal has a long history of destructive earthquakes. In this century alone, over 11,000 people have lost their lives in four major earthquakes. Study of the seismic record of the region suggests that earthquakes producing shaking of MMI IX or more occur approximately every 75 years and the smaller ones more frequently. Earthquakes are, thus, unavoidable part of Nepal's history, and a major earthquake is likely in the near future. Since the last major earthquake of 1934 the earthquake risk of Kathmandu valley has increased significantly mainly due to uncontrolled development, use of poor construction practices with no earthquake safety consideration, and lack of awareness among the general population and authorities.

The risk is growing not only to Kathmandu valley, but also to the 58 municipalities and other urbanizing centers of Nepal. These settlements experience very high rate of migration from rural areas, uncontrolled urbanization, and the resulting increase in seismic vulnerabilities mainly due to poor construction practices. Likewise, infrastructure development initiatives in the rapidly growing urban centers have not been able to adequately address the earthquake risk. In many cases, even development activities have inadvertently contributed to increasing the risk.

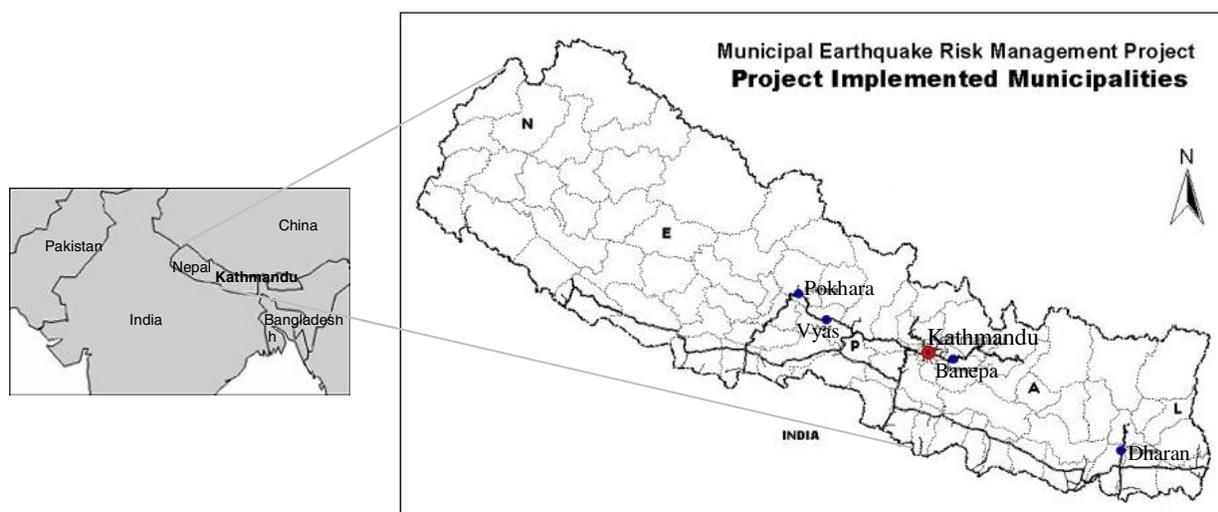
Cities outside the Kathmandu valley are also the centers that mobilize the resources of surrounding large hinterlands. Since most of the 58 municipalities of Nepal are also headquarters of administrative districts, the importance of earthquake risk management at that level becomes very important because of the likely participation of all district level development authorities and donor agencies in the process. Also, any awareness program for earthquake risk mitigation or preparedness in these municipalities spills over to the surrounding villages. As the masons and labors involved in construction of buildings or other development works in urban areas mostly come from the surrounding villages, training of masons in aseismic construction directly affects the construction culture of rural areas as well.

In this context, the National Society for Earthquake Technology – Nepal (NSET) implemented the Municipal Earthquake Risk Management Project (MERMP) as the consolidation process of the experiences, achievements and lessons learned from the Kathmandu Valley Earthquake Risk Management Project (KVERMP). MERMP benefited from the successful achievements of KVERMP, Dixit et al. [1]; and similar experiences of earthquake risk assessment and mitigation in other cities of the developing world in the past decade, ADPC [2].

NSET implemented MERMP on experimental basis in four municipalities of Nepal during 2003 in collaboration with the Asian Urban Disaster Mitigation Program (AUDMP) of the Asian Disaster Preparedness Center (ADPC), Thailand, Bangkok. This paper describes the methodology, scope, outcomes and lessons learned of this model program for earthquake risk reduction.

## **THE PROJECT AREA**

Three representative municipalities of the country were selected for implementing the model program: Banepa, Dharan and Vyas. Banepa is representative of smaller old settlements; Vyas represents the rapidly developing urban centers, and Dharan municipality represents medium sized urban centers of Nepal. Pokhara Sub-metropolitan City, in which one can see a very high level of investment on urban dwelling, is the fourth project city where several training programs were conducted in the initial phases of the program. In each of the four municipalities, the project was implemented in close partnership with the municipal authorities and other key role players of the society. The location of MERMP municipalities is shown in Figure 1 and their general description is given in Table 1.



**Figure 1: Location of MERMP municipalities**

**Table 1: Brief Description of MERMP Municipalities**

Description	Municipality			
	Banepa	Dharan	Vyas	Pokhara
<b>Location</b>				
Region:	Central Region	Eastern Region	Western Region	Western Region
Zone:	Bagmati	Koshi	Gandaki	Gandaki
District:	Kavrepalanchok	Sunsari	Tanahun	Kaski
Topography	Hill	Foothill	Hill	Valley
Climate	Temperate	Tropical	Temperate	Temperate
Area (sq. km.)	5.56	21.12	60.02	55.22
Establishment	1981	1960	1992	1962
No. of Wards	11	19	11	18
Population	15,822	96,365	28,245	156,312
Population Growth	2.35%	3.67%	4.55%	5.07%
No. of households	3,015	20,930	6,511	37,305
Bldg. Construction	100-200/year	200-300/year	100-200/year	400-500/year

### **Selection of municipalities**

Experiences of KVERMP showed that earthquake vulnerability reduction could be successfully implemented in any municipal area of developing world. However, MERMP used the following criteria for selecting the project municipalities:

- High level of potential local buy-in
- Moderate size of the municipality area
- Even geographical distribution in the country: adequate representation of different geographic conditions, and
- Wider capture of urban processes such as construction practices, population growth, ethnic diversity etc.

The possibility of achieving sustainability of the replication process and its wider application in the entire country was also considered during the selection of municipalities. Most importantly, the level of enthusiasm of the city government was the main selection criteria.

## **IMPLEMENTATION APPROACH**

### **Local groups as local champions**

Prior to launching the project, NSET professionals made several visits to the selected municipalities. During the visits, meetings and consultations were made with local community organizations, professional bodies, institutions and influential individuals, and the municipal authorities to shape the project as their need and to get the buy-in. The objective of such consultations was to identify the local champions who can help implement the project and similar initiatives in future in a sustainable way. Aim was also to identify the prospective individuals and groups as candidates for further training programs on earthquake vulnerability reduction to be imparted by the project. The process created conducive environment for widening stakeholders' participation and helped generate local human resources for implementing the project.

In Banepa, municipal engineers and other professionals were the key role players. A local educational institution, namely the "Chaitanya Multiple Campus" supported the project and implemented earthquake-resistant construction of its educational building as an earthquake vulnerability reduction demonstration project. Local chapter of the Chambers of Commerce and Industry and the local contractors group were also involved in conceptualizing and supporting the training and awareness programs implemented under the project. The ownership of the project was entirely with the municipality itself.

Representatives of the local government, non-government organizations, teachers from engineering campuses, and the media people were involved alongwith the municipality machinery to implement the project in Dharan in various capacities: advisors, engineers, project partners etc. Local contractors and NGOs contributed in carrying out the training and awareness program like shake table demonstration.

Dedicated professional staff of Vyas municipality presented themselves as the local champions for enhancing earthquake safety. The municipal engineers conducted a series of training programs on earthquake-resistant construction involving communities from the surrounding villages and nearby urban centers. They did it in partnership with NSET. Earlier, these local champions were the participants of NSET/ADPC implemented EVRC (Earthquake Vulnerability Reduction for Cities) training programs. Business groups and Community-based organizations (CBOs) were deeply involved in the MERMP process. Special mention is to be made of the neighborhood organizations, consisting largely of women groups, locally called *Tole lane Organization*, which discussed aspects of earthquake safety periodically and organized special lecture programs from specialists. Students from the local engineering college were involved in conducting building inventory survey and risk mapping for Vyas city.

Professional societies and media agencies took a leading role in propagating earthquake safety message through awareness programs in Pokhara. The local chapter of the Nepal Engineers' Association facilitated conducting training programs for engineers, and also organized workshops and seminars on earthquake-resistant construction that were implemented in coordination with Pokhara Sub-Metropolitan City.

These local groups and champions are expected to continue such activities in the cities in the spirit of MERMP in future also.

### **Municipality professionals were the key project execution team members**

Project team was constituted in each project cities. The team consisted of professionals from NSET and municipal staff. The focal point for project implementation was the municipality; the engineering professionals formed the core.

At the onset, MERMP organized a number of orientation programs for the benefit of local champions and municipal professionals. These programs explained the basics of earthquake hazard and vulnerabilities, and the vulnerability reduction measures. The importance of education, awareness, self-help and cooperation for earthquake vulnerability reduction was emphasized. Lessons drawn from recent earthquake in Turkey, India and Iran were discussed in detail. The rationale and need for earthquake vulnerability reduction, its potential impact and ultimate vulnerability reduction was reiterated repeatedly. At the same time, community meetings were organized in each city to make people aware on the project activity and earthquake safety in general. The objective of the early awareness programs was to create an environment in which municipalities received the support of the elected representatives in implementation of project and, thus, to create a demand for earthquake vulnerability reduction actions for municipalities to implement.

At the start of the project, technical training programs were organized also for the local professionals. These training programs focused on vulnerability assessment of built structures using RADIUS tool for earthquake damage estimation, RADIUS [3]. Training programs were also organized for contractors and masons with the aim to train them on aspects of earthquake-resistant construction techniques. These training programs developed necessary skills and capacity to implement the project components. Basically, municipal engineers carried out vulnerability assessment of the city under NSET's guidance. Interactions with local stakeholders were made in the action planning process.

The approach adopted in the training programs was to enhance existing capabilities and to address the local needs. Hands-on training to masons and contractors on earthquake-resistant construction was imparted as per the needs of the cities. Implementation of earthquake vulnerability reduction demonstration project such as the School Earthquake Safety Program (SESP) proved to be equivalent to learning laboratories. SESP also served as the case study and demonstration field exercise area for the training programs.

### **Generation and use of local resources**

High priority was given in generating and using local resources in order to ensure sustainability of the program. Significant volume of resources was generated in terms of voluntary labor. Many private businesses, including local contractors, donated cash and construction materials and sponsored training programs.

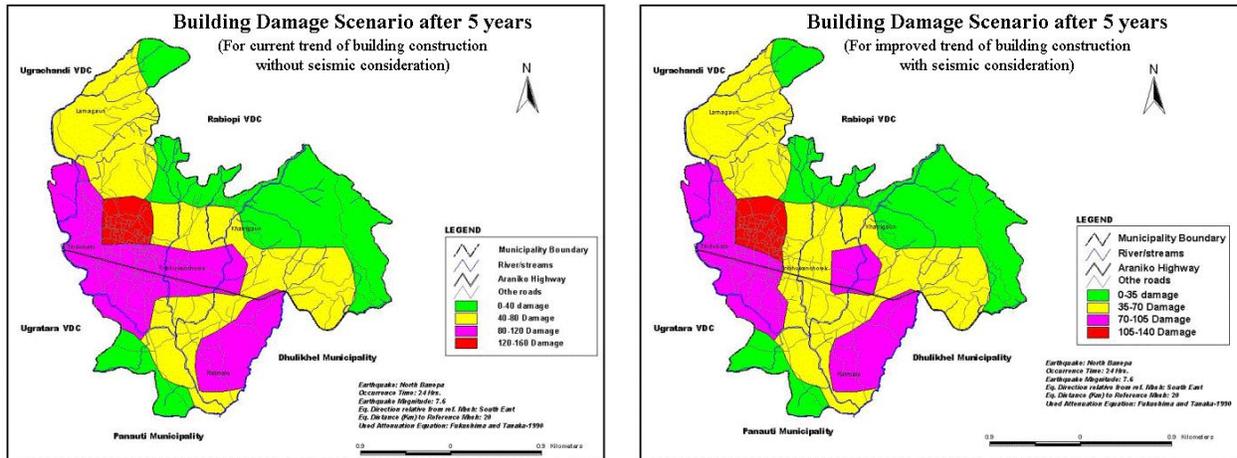
## **PROJECT COMPONENTS**

### **Development of Earthquake Loss Scenario and Action Planning**

The earthquake damage scenario, which described possible consequences of future likely earthquake, was proven to be a strong awareness-raising tool during the implementation of KVERMP. It tremendously helped to sensitize the common people and also the high level authorities on urban earthquake risk, NSET [4, 5]. Following the successes of KVERMP, the current project made development of earthquake loss scenario one of the main components of the project.

All available information pertaining to earthquake hazard and vulnerability of the municipal area were collected and analyzed to develop the risk scenarios of the cities. Additional surveys were carried out

wherever necessary. The data, thus collected, included earthquake catalogue, active fault map, present-day city infrastructure, and soil profiles. A building inventory survey was conducted which provided the key data for vulnerability analysis of the project cities. Loss estimates were carried out and risk maps were prepared for each of the municipalities using RADIUS tool. This methodology allowed showing the expected level of damage and casualty (Figure 2) for the scenario earthquake.



**Figure 2: Sample risk map showing building damage scenario in Banepa after 5 years**

In order to identify the current capability of cities, interviews were conducted with operators of critical facilities and emergency response systems. While trying to assess the capability of the facilities and the systems to respond to the disaster situation, the interviewers also explained to the interviewee the overall earthquake risk of the municipality and the urgency to act. Part of the interview was used for explaining the municipal earthquake risk map.

Following the interviews, workshops were organized to finalize the earthquake scenario for the city. Representatives of local and central government agencies, donor agencies working at local level, business leaders, and the civil society were the participants of the workshops. The loss estimate originally prepared was modified as per the suggestions and comments received in the workshops. Final earthquake scenarios for each of the cities were then prepared based on these consensus loss estimates. Risk maps were prepared for the present and future times, for two possible development trends: 1) no improvement in the current building construction practices and 2) improved situation. The comparison of those cases showed that incorporation of building codes into the building design and construction process would significantly reduce the existing as well as the growing seismic risk of the future.

Based on the earthquake scenario, action plans were developed for each of the municipalities. The action planning process involved all the main stakeholders in developing the mitigation and preparedness plan and also for designing the programs in detail. A consensus action plan for earthquake risk management was the major outcome of the project for each municipality. In all cases, the action plan was prepared considering the accepted priorities, approaches and the agreed short-list of initiatives. The entire cycle of disaster management – from disaster risk reduction and response planning, to rehabilitation and reconstruction were considered while developing the plan.

## Public Awareness and Capacity Building

One of the aims of the program was to enhance the level of knowledge and skills of the people and municipal authorities on earthquake risk reduction. Every activity carried out during the project, hence, was shaped to raise the awareness of municipal residents and the governing authorities.

Organization of Earthquake Safety Day (ESD) has proven to be a strong and effective method for earthquake awareness-raising in Nepal, Dixit et al. [1]. The ESD program in MERMP typically included various awareness-raising activities such as earthquake safety rally, shake table demonstration, earthquake safety exhibition, earthquake awareness seminars etc. These activities helped to change the perception and attitude of citizens on earthquake risk and its management. Festivals and other religious and special occasions were also utilized as awareness-raising occasions, which were participated by large section of the community (Figure 3, 4).



**Figure 3: Folklore competition, an awareness-raising event**



**Figure 4: Public commitment from district authorities during Earthquake Safety Day celebration in Vyas municipality**

MERMP also targeted at capacity enhancement of local engineers, technicians, contractors, masons and the municipality staff. Series of training programs were organized in each of the municipalities. These training programs helped to enhance the knowledge and skills of the groups to adapt the appropriate technology of earthquake-resistant construction. While KVERMP emphasized on on-the-job training of local masons, MERMP expanded it to cover local masons and petty contractors, and also the engineers and technicians. In the project municipalities, about 100 local masons and petty contractors were trained on earthquake-resistant construction. On-the-job training was provided to the local masons, under the School Earthquake Safety Program (SESP) of MERMP. These on-the-job training programs produced a group of qualified masons who can not only construct earthquake-resistant buildings but also can train other masons on the technology. Likewise, local engineers can now serve as the resource persons and instructors in future training programs.

Municipal staff and professionals were provided with opportunities to participate in national, regional and international training programs, conferences, workshops and seminars. Such national, regional and international exposure of municipal staff contributed in improving their skill and capability to start earthquake risk management initiatives in their respective municipalities. A change in mindset, from passive observation to proactive action, has been very obvious.

Awareness-raising effort has achieved visible success in all the project municipalities. There is a marked improvement in construction practices: the stirrups are closely spaced and configured properly; the

reinforcement details are getting better, and quality consciousness has grown remarkably. The number of requests from many communities and institutions to NSET for conducting orientation lectures and training programs is continuously increasing. Several urbanizing settlements adjacent to the project municipalities have also requested NSET to provide technical assistance in managing their earthquake risk.

### **School Earthquake Safety Program (SESP)**

Among different earthquake vulnerability reduction measures implemented under KVERMP and MERMP, the School Earthquake Safety Program (SESP) was found to be the most effective as a pilot work, Dixit et al. [6]. The demonstration effect of the program was always phenomenal.

Despite the fact that public schools are the center of social activity in every community and that the public school buildings can serve as emergency shelters during earthquake emergencies, both the buildings and the occupants of public schools face extreme risk from earthquakes. This is because of the fact that the majority of the school buildings, even those constructed in recent years, are generally constructed without the input of trained engineers in design and construction works.

Realizing these facts, the School Earthquake Safety Program (SESP) was implemented under MERMP in each of the municipalities. SESP included a) vulnerability assessment of public school buildings b) selection of one or two target schools for seismic performance improvement, c) design of structural interventions, seismic retrofitting or aseismic re-construction after demolition, d) implementation of the construction works, e) on-the-job training of local masons and f) training and awareness of teachers, students, parents and the people.

Tremendous community participation was achieved in every activity. Significant local resources were generated for the program in the municipalities, Shrestha et al. [7].

### **Implementation of other earthquake vulnerability reduction measures**

Besides implementing SESP, other earthquake vulnerability reduction measures as prescribed by the action plan were also implemented as pilot works. Based on the past experiences and lessons learned from KVERMP, the MERMP focused on the following activities:

- Setting up municipality-level disaster management unit – some municipalities have already established the disaster management unit in their organizational structure and they are in the process of forming municipal level disaster management committee drawing representatives from a wide sector of the society.
- Setting up building code implementation mechanism in the municipality

## **ACHIEVEMENTS**

### **MERMP helped start the process of incorporating disaster risk reduction in development programs of municipalities**

The project municipalities have started to incorporate disaster risk mitigation and management in their development programs. Specific vulnerability reduction programs especially those spelt out in the action plan have started being included in the annual plan with budgetary allocation. They have also started to incorporate disasters into their infrastructure development planning and implementation. One such example is the case of Dharan municipality where they incorporated earthquake-resistant elements in the construction of a clock tower - the design lacked such consideration. In Banepa municipality, construction of a public campus building initially was designed without any consideration of earthquake resistance, but

due to the influence of the project, they requested the project to assist them to incorporate earthquake-resistant features into their building design. Now the building has been constructed earthquake-safe, incorporating all earthquake-resistant features. The municipalities have not only been incorporating disaster consideration into their own programs, but they are also encouraging other institutions and individuals to follow suit.

The Ministry of Local Development, which is the concerned ministry for all local governments, has endorsed the new approach and has approved all programs, incorporated and performed by the municipalities on earthquake risk management. This endorsement will help to ensure sustainability of disaster risk management efforts incorporated by the municipalities. This is one of the unprecedented achievements of MERMP.

### **Building code implementation**

Raised earthquake awareness has started showing the positive results – as an initial step towards building code implementation, the municipalities have started certification process for builders and contractors. Construction of residential buildings in a developing country like Nepal is mostly carried out as informal construction. However, the certification process will gradually turn it into a formal one. In this process importance is also given to capacity enhancement of the contractors, builders and the masons as well as monitoring and evaluation of the works carried out by them. Incorporation of seismic provisions into the bylaws and the pertinent regulations for making the buildings earthquake-resistant has been started. Gradual incorporation of required provisions into bylaws and regulations will finally lead to a mandatory implementation of the building code.

### **Capacity enhancement of municipality staff**

Every activity under the program was shaped to enhance the local capability of the municipality. This helped to enhance the sustainability of the efforts. For this, all the activities were carried out under the leadership of municipality staff; NSET played subordinate role and provided technical assistance. Participation of municipality engineers, technicians and other staff was made mandatory in all the activities. Due to this, the knowledge of earthquake risk management, skills for effective implementation of risk reduction initiatives and the confidence level of the municipality staff have significantly increased. They are now considered as the local champions for earthquake risk reduction and management. These champions influence enhancement of earthquake safety not only in their own municipality, but also nearby cities and urban centers.

### **Attitudinal Change**

Every activity under the program targeted awareness-raising of general people and also of the authorities who are responsible for local development, disaster risk reduction, and response and relief. Increased awareness has contributed to changed perception and attitude of the people in understanding the earthquake risk. Many communities are requesting the municipality and NSET for organizing training and orientation programs in their communities, and assist with formation of disaster management committees. Many positive changes can be seen in the construction practices for private residential buildings. People have started to consult technicians and engineers while they are in early planning stages of building construction. Contractors and builders themselves have started to make their own code of conduct to establish and promote good construction practice and culture.

### **Strong influence in the satellite settlements**

The activities and programs performed in the project municipalities have not only influenced the people of that municipality, but have influenced also the nearby municipalities, urbanizing centers and the villages. This could be achieved because MERMP promoted participation from other villages and municipalities for observing the program. NSET has received many requests from other municipalities and villages for

implementing the program in their communities. Some municipalities have already taken initiatives to implement earthquake risk management initiatives in their own way.

Many other schools near to the project schools have shown their interest for implementing the program in their schools by replicating what has been proven as success. They have requested NSET and the municipalities for technical and financial assistance. Earthquake-resistant construction technology is gradually becoming popular. Many other institutions have requested NSET to provide technical assistance in their building construction. This is very encouraging as it shows high replicability potential.

### **Influencing the district level officials**

The program has also influenced the district level authorities. In one of the project municipalities, the District Administration Office has shown interest to work jointly with the municipality and NSET for planning and implementing disaster risk reduction, response, and relief activities. In Nepal, the District Administration Office is the responsible institution for disaster response and relief. In that particular district, formation of district level disaster management committee and the advisory committee is in the process.

## **LESSONS LEARNED**

### **Holistic Approach works**

MERMP is a comprehensive program of seismic risk management that includes risk assessment, action planning, implementation of mitigation measures, training and awareness activities. Simplicity of the project concept and use of a participatory approach provided better understanding of risk and it encouraged stakeholders to be engaged in the entire process of MERMP. The School Earthquake Safety Program (SESP) served as a convincing mitigation initiative. Public awareness on earthquake safety created a demand for and support to political will to implement risk reduction program. Conduction of training programs at municipality level helped in capacity building of institutions. This ensured increased sustainability potential. It has become obvious that any individual component in isolation may not produce the result like the way a comprehensive program could achieve.

### **MERMP helped new municipalities to avoid common mistakes of larger cities**

The project municipalities were relatively small but rapidly expanding settlements. Therefore, the project initiatives could influence all concerned sectors, and cover the entire development and administrative processes. In Vyas municipality almost of all government bodies, academic institutions, non-government organizations, business and private sector took part in the process of risk mapping, action planning, implementation of selected demonstration measure i.e. school seismic intervention, and the training programs. As a result, disaster risk management entered into the development mainstream of the city - Municipal Board allocated separate fund for seismic reduction programs in its annual budget and started certification system for contractors with due consideration of their capability in earthquake-resistant construction. District Development Committee (DDC) and other government agencies adopted a policy that required all new infrastructure projects under their jurisdiction and control to incorporate seismic risk consideration in all phases starting from the project design stage. Similar process is evolving in other MERMP municipalities.

All these actions will surely have far reaching consequences in making the cities safer from earthquakes. This is the start of creating a culture of prevention, and that is what we all aspire!

### **Cities have internal hidden resources**

The municipalities did not have enough resources for implementing MERMP at the start. Hence financial support was sought from the regional program AUDMP of ADPC. However, during the course of project

implementation, a significant proportion of resources were generated from local institutions, business communities and the general public. Later, additional programs and activities were carried out by cities mobilizing their own resources. It is observed that the initial external support act as a 'seed', which helped to generate local resources, once the program was accepted and owned by local institutions.

#### **Appropriate technology suited to maximum utilization of local resources is key for acceptability**

RADIUS tool was used for the seismic risk assessment of the cities. As it is simple and easy yet effective, local municipal professionals could be easily involved in earthquake risk mapping and assessment. The acceptability of project outcomes was very high. Similarly, focus was given to simple technical solutions in training and demonstration projects. The replicability of earthquake-resistant construction observed in household level and other public structures was possible, actually, because of the understanding, acceptance and ownership of the technology by local champions.

### **CONCLUSIONS**

The effectiveness of the program was so dramatic that it could not only influence a wider section of the community and involve many individuals and institutions within the municipality, but it could also influence the nearby municipalities and the villages on aspects of earthquake safety. Many municipalities and villages adjacent to the project areas are requesting NSET to implement similar programs of earthquake risk management in their settlements. The approach, methodology and experiences of MERMP process and greater realization of the urgent need to implement earthquake risk management initiatives in all the 58 urban centers of the country implies that a consolidated program of urban earthquake risk management should be continued to cover the whole country in the shortest possible time.

MERMP has, thus, proved that municipalities do have internal capabilities in terms of human and other local resources. However, they lack the initial financial resources to start the process of risk management. Once disaster risk management is perceived to be important, and consequently integrated into development activities, the financial constraints would not be any major problem as the required resources could be generated locally. However, small technical and financial support from outside the municipality is regarded absolutely necessary for sustaining earthquake risk management process in such municipalities and urban centers of Nepal.

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