PROVENTION CONSORTIUM

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Asian Disaster Preparedness Center

Applied Research Grants Program for Disaster Risk Reduction

Rounds I and II (2003-2006)

Innovative Initiatives in Disaster Risk Reduction

Applied Research by Young Practitioners in South, South East, and East Asia

Applied Research Grants for Disaster Risk Reduction Rounds I and II (2003-2006). Innovative Initiatives in Disaster Risk Reduction-Applied Research by Young Practitioners in South, South East, and East Asia. 144 pages

ProVention Consortium
The ProVention Consortium aims to reduce the risk and social, economic and environmental impacts of natural hazards on vulnerable populations in developing countries in order to alleviate poverty and contribute to sustainable development. This is achieved through: forging partnerships and promoting multi-stakeholder networking; promoting policy as an informal forum for dialogue and agenda-setting; improving practice through more effective problem-solving; managing knowledge through combining knowledge advancement, gathering and sharing. All ProVention project activities are intended to contribute to these four overarching and interconnected objectives and to the Hyogo Framework for Action (HFA). For more information, please visit *www.proventionconsortium.org*.

Asian Disaster Preparedness Center (ADPC)
Established in 1986, ADPC is a leading regional resource center based in Thailand dedicated to create safer communities and sustainable development through disaster risk reduction. ADPC's programs demonstrate a wide diversity in application, address all types of disasters, and covers all aspects of the disaster management spectrum-from prevention and mitigation through preparedness and response, to damage and needs assessment, rehabilitation and reconstruction endeavors. ADPC's activities are implemented by five teams: Climate Risk Management (CRM), Disaster Management Systems (DMS), Early Warning Systems (EWS), Public Health in Emergencies (PHE), and Urban Disaster Risk Management (UDRM). For more information, please visit *www.adpc.net*.

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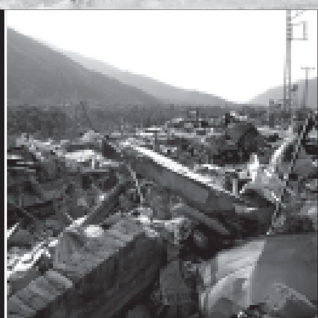
Innovative Initiatives in Disaster Risk Reduction

Applied Research by Young Practitioners in South, South East, and East Asia

Applied Research Grants for Disaster Risk Reduction
Rounds I and II (2003-2006)



Preface by ADPC

Asian Disaster Preparedness Center

Applied research is used to find solutions to everyday problems and innovative approaches to address the problem. Such research is extremely important for the field of disaster risk management, which looks at reducing the daily risk of communities facing disasters. At ADPC, we have been working for more than 20 years with national governments and communities to respond to their needs and assist them to build capacity for reducing risk and preparing better for disasters. In the process, we have been learning from practices in countries from the region, and sharing those experiences and lessons learned to the other countries in the region, thus facilitating dissemination and management of knowledge. Results of such research would add to the palette of information and would be of extreme importance to the countries of the region in taking forward the agenda of disaster risk reduction (DRR).

ADPC has been energized and encouraged by the hard work and innovation of the young emerging professionals and researchers. With small amounts of money compared to normal amounts spent in internationally funded projects, many grantees have worked closely with local communities and governments and some impact on the ground; while raising and stirring-up interests, concerns, and questions for all of us in the field of DRR. In both rounds, ADPC has handled the largest numbers of grantees in the program, reflective of the range and complexity of issues faced in the region; and the large number of university-based institutions, NGOs, and governments interested in acting on it.

It is a privilege for us at ADPC to be a regional partner with the ProVention Consortium initiated Applied Research Grants for Disaster Risk Reduction Program. It gives us the great opportunity to collaborate and work with World Bank and IFRC, the two key members of the ProVention Consortium, as well as other university partners at the University of Wisconsin-Madison, the Cranfield Disaster Management Center, and the University of Cape Town.

ADPC is most grateful to the grantees, the mentors, host organizations, local governments and community-based organizations in their respective areas of study; their rich experiences in the field of disaster risk management are great value to the young grantees for interactive learning and networking and looks forward to continuing this work in future forums.

This publication contains 15 edited research grants primarily from round two, who presented at the Bangkok December 2006 Workshop. Through this diverse range of critical thinking, action and reflective writing that these grantees' work represent; we hope that this publication captures the diversity and complexity of issues being addressed and the range of actors involved; while inspiring more than the young practitioners to enter this complex work and stay engaged.

Dr. Bhichit Rattakul
Executive Director a.i.
Asian Disaster Preparedness Center (ADPC)
Bangkok, April 2007

Preface by ProVention

Exploring ways to encourage a new generation of actors to lead disaster risk reduction initiatives in developing countries, the ProVention Consortium launched a Programme of Applied Research Grants for Disaster Risk Reduction in 2002 and conducted a second round of grants in 2005. Globally, more than 100 small grants (USD 5000 or less) have been awarded for 6-9 months of applied research on disaster risk reduction.

In 2005, 264 grant applications were screened by an independent panel of disaster risk management specialists from around the world. Fifty-two awards were granted to students and young professionals from the following 34 countries: Algeria, Argentina, Armenia, Bangladesh, Burundi, Cameroon, China, Colombia, Costa Rica, Haiti, Honduras, India, Indonesia, Jamaica, Kenya, Kyrgyzstan, Lebanon, Mexico, Mongolia, Namibia, Nepal, Pakistan, Philippines, Russia, South Africa, Sri Lanka, Tajikistan, Tanzania, Thailand, Turkey, Uganda, Uzbekistan, Vietnam, and Westbank/ Gaza. This second round of the Programme was managed by the ProVention Secretariat and the University of Wisconsin-Disaster Management Center (UWDMC) in close collaboration with the Asian Disaster Preparedness Center (ADPC) and the University of Cape Town - Disaster Mitigation for Sustainable Livelihoods Programme (DiMP). ADPC managed grants for East Asia & the Pacific and South Asia, DiMP worked with sub-Saharan Africa and the Middle East & North Africa and UWDMC was responsible for Europe & Central Asia and Latin America & the Caribbean.

This publication presents information and results of select projects from the East Asia & Pacific and South Asia regions supported during both rounds of grants. It is clearly evident from the findings that emerging risk researchers are a critical human resource for promoting risk reduction in disaster-prone regions. The Programme also demonstrates the value of acculturating the next generation of researchers and practitioners to cross-disciplinary practice, participatory action research and problem-solving. Growth in risk reduction research over the past years has generated a great deal of information, but whether this translates into more action on the ground is not always clear. Coherent integrated action is constrained by the wide professional diversity in the field and by limited collaboration between scientists and practitioners. The Programme seeks to address these issues as it encourages participants from various academic and professional backgrounds to cross barriers between technical and local knowledge; knowledge and action; and research and practice.

The ProVention Consortium Secretariat is very grateful to its regional partners for their high level of commitment to the Programme, and to all the grantees for their hard work. We look forward to taking this initiative forward in 2007 and beyond.

Margaret Arnold
Head of ProVention Consortium Secretariat
Geneva, March 2007

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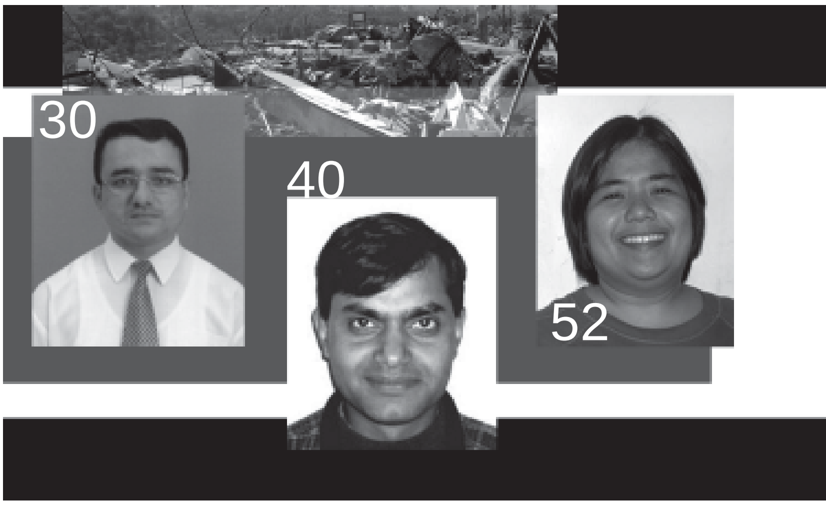

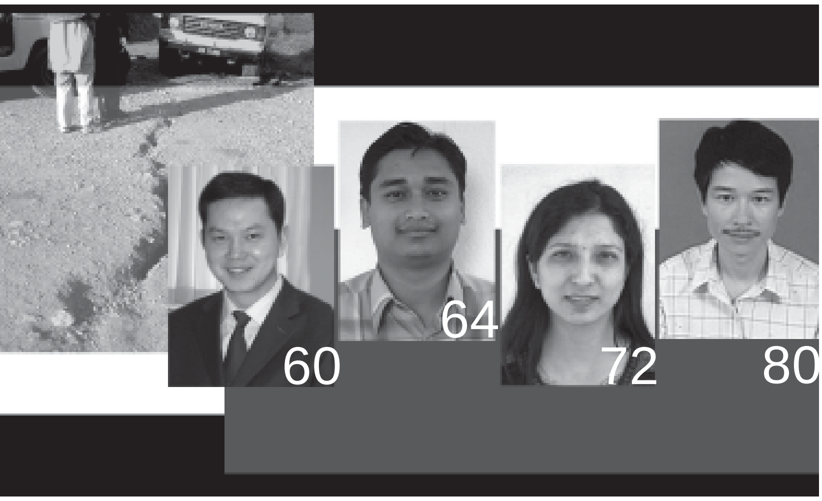

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PHOTO BY ADPC/TSF. Flashflood Quezon, Philippines Dec 2004

Introduction to this publication

The ProVention Consortium initiated the Applied Research Grants Program for Disaster Risk Reduction to support innovative action research by young professionals from developing countries. Researchers under the age of 35 years are invited to submit applications with proposals. The award of grants is made following a review of applications by and independent panel and a competitive selection of the most relevant, deserving and innovative. The selected grantees then undertake their respective work over a nine-month period under the supervision of a mentor.

In the first round, 65 grants were awarded globally; of which 35 were from South, South East and East Asia. In the second round, 52 were selected worldwide; 21 of whom were from South, South East and East Asia. In both rounds, ADPC was responsible for grantees from these Asian sub-regions. At the end of the first round, a global symposium was held in Washington in July 2004 and, grantees from this Asian region were among the 15 who made presentations.

With the completion of the second round of grants, ProVention Consortium and ADPC organized a workshop on “Innovative Initiatives in Disaster Risk Reduction” in Bangkok from 6-8 December 2006. The main purpose of the event was to provide the 11 selected grantees from six countries an opportunity to meet and share among themselves and interested audiences the experience of conducting research work in their countries and present the results. Moreover, the event was a forum for discussing further work by grantees, possible ways in which ProVention and ADPC could assist with dissemination of results and follow up actions, and provided feedback on the operation of the grants program to suggest improvements in the future rounds.

This publication is an affectionate documentation of the grantees’ drive and commitment to develop innovative initiatives towards disaster risk reduction for safer communities. Derived from a rich dialogue during the Bangkok Workshop December 2006, it aims to showcase not only the achievements, but also the constraints, and challenges of the grantees in implementing their respective researches and the determination to continue their professional engagement with these issues. It contains 15 papers selected from first and second round grantees in South, South East and East Asia, including the 11 second round papers presented at the workshop.

Overview of the Applied Research Grants Program for Disaster Risk Reduction (Rounds I and II)

The ProVention Consortium is a global partnership of governments, international organizations, academic institutions, the private sector, and civil society organizations aimed at reducing disaster impacts in developing countries. The Consortium functions as a network to share knowledge, connect, and leverage resources to reduce disaster risk.

Research in the field of disaster risk reduction remains dominated and influenced by academic institutions and international scientific organizations from the industrialized world. The advances made by these institutions during the last decades in natural science, engineering, social science, and technology development have substantially contributed to reducing disaster casualties in both the developed and developing world. However, efforts by Northern academic and scientific institutions to transfer existing technical and scientific knowledge to high-risk countries in the developing world have often been confronted with a wide range of obstacles such as a lack of technological absorption capacity, limited institutional capacity, insufficient qualified staff, and absence of linkages and networks to successfully implement the concerned programs. Furthermore, as disaster vulnerability in these countries is strongly determined by developmental and socio-economic processes, more research on risk, vulnerability, and capacity issues is urgently required. Overall, disaster risk management expertise in most developing countries is often scattered across different disciplines and sectors. Networking between disaster risk management professionals in the South is limited. Financial, material, and human resources allocated by national governments and donors to disaster risk reduction research is largely inadequate.

To support innovative disaster risk management projects in developing countries, build up local research capacity, and encourage young professionals (under 35 years of age) to become more involved in disaster risk reduction, the ProVention Consortium, in collaboration with the World Bank's Hazard Management Unit (HMU), launched on December 2002 an "Applied Research Grants Programme for Disaster Risk Reduction." Young researchers were invited to propose creative projects in three categories: risk identification and analysis, risk reduction, and risk sharing/transfer.

1. **Risk Identification and Analysis.** Any effective strategy to manage disaster risk must begin with an identification and analysis of the nature and extent of risk that characterizes a particular location. This includes information on the frequency, magnitude, severity of past hazards, data on the degree of exposure of a population and its built environment to such hazards, and identification of local capacities and resources to withstand shock and stress. The process also includes analysis of the underlying causes of why these elements are at risk.

   Risk identification and analysis informs decision makers on where to prioritize risk-management efforts, and how to design projects that will effectively reduce the impacts of potential disaster events. A more comprehensive analysis of disaster data and understanding of the economic, financial, and social impacts of disasters on a country or community can help demonstrate the importance of including risk reduction in development plans and programs. Assessing risk is also a key component of the process of measuring the potential and actual benefits of disaster reduction. Risk monitoring is critical in ensuring that risk reduction programs effectively reduce risk.

2. **Risk Reduction.** Risk reduction involves measures to avoid (prevention), limit (mitigation), or take precautions against (preparedness) the destructive and disruptive effects of hazards, thus lessening potential impacts. The implicit focus of risk reduction is vulnerability reduction, which includes a wide range of social, economic, environmental, and technical issues. Risk reduction includes a range of structural measures, such as flood defenses or safe building design, as well as non-structural measures, such as development of early warning systems, regulation of land use, or sensitization of populations at risk. To be truly effective, risk reduction cannot be limited to the realm of disaster risk management but has to be fully integrated in development policies and planning, climate change adaptation efforts, and post-disaster recovery processes.

3. **Risk Sharing/Transfer.** The financial and economic impacts of disasters can be reduced through risk transfer. While these risks can never be completely eliminated, they can be shared. Individuals and groups can transfer the financial risk that they are unable or unwilling to absorb to a larger collective with greater economic means—for instance, from an individual household to a community or company, or from a national government or company to global markets. The most obvious risk transfer tool is insurance, which for low-income households in developing countries is often called micro-insurance. Further arrangements such as informal community pools, social protection funds, and innovative schemes based on weather indices are similarly useful for transferring and thus, managing the financial impacts of disasters. Risk transfer must also be used to promote risk and vulnerability reduction activities.

In the first round (2003-2004), the program was managed by the World Bank's Hazard Management Unit (HMU) in collaboration with the University of Wisconsin-Disaster Management Center (UW-DMC), the Asian Disaster Preparedness Center (ADPC) and Cranfield Disaster Management Center (CDMC). After the first successful round, a second round was launched (June 2005-December 2006), which was managed by the ProVention Secretariat based at the International Federation of Red Cross and Red Crescent Societies (IFRC) in a continuing and more decentralized collaboration with University of Wisconsin-Disaster Management Center (UW-DMC), the Asian Disaster Preparedness Center (ADPC) and the Disaster Mitigation for Sustainable Livelihoods Programme - University of Cape Town (DiMP). The table below shows the number of grantees under Rounds I and II.

***Round I Grantees from Asia**

During the first round, 65 grants were awarded worldwide. Of this, 35 were from the East Asia, and South Asia. Below is the countrywide distribution of grantees:

East Asia and Pacific		South Asia	
China	4	Bangladesh	2
Indonesia	1	Bhutan	1
Philippines	1	India	17
Vietnam	2	Nepal	5
		Pakistan	2

***Round II Grantees from Asia**

In round two, out of the 52 grants awarded world wide, 21 were from the South, South East, and East Asia regions. Below is the countrywide distribution of grantees:

South Asia		South East Asia		East Asia	
India	5	Indonesia	1	China	2
Nepal	6	Philippines	1	Mongolia	1
Pakistan	1	Thailand	1		
Sri Lanka	2	Vietnam	1		

Range of Backgrounds and Institutional Affiliations of Grantees

The grantees during the first and second rounds came from an interesting mix of institutional affiliations as follows:

Institutional Affiliations	Round I	Round II
National university	14	2
University outside home country	6	1
Government	4	4
Local NGO	8	7
International NGO	1	1
Professional in association/firm	2	6
TOTAL	**35**	**21**

Note: A complete list of grantees and mentors is given in Annex A pages 136-142 of this publication.

Grantees in rounds I and II were drawn from those doing research as part of or complementary to their academic programs and those engaged in program implementation from NGOs and government. Many of the grantees led teams or had research assistants with complementary expertise. Several grantees made an active effort to move beyond their narrow academic or disciplinary boundaries.

Round III entitled: Reserach and Action Grants for Disaster Risk Reduction was announced in June 2007. Proposals in this round are encouraged in, *but not limited to*, the following thematic focus areas: 1. Identifying enabling factors and incentives for disaster risk reduction; 2. Developing mechanisms to strengthen community resistance and resilience; 3. Applying local risk analysis and risk management (especially for schools and hospitals); 4. Improving education materials and curricula; 5. Promoting risk reduction in response and recovery activities; 6. Engaging the private sector in disaster risk reduction (especially micro-enterprises); 7. Linking climate adaptation and disaster risk reduction efforts.

The upcoming round will be administered in association with the University of Wisconsin Disaster Management Center with regional partners: Asian Disaster Preparedness Center; University of Capetown Disaster Mitigation for Sustainable Livelihoods Programme; Secretariate General Facultad Latinoamericana de Ciencias Sociales; and Bogaziçi University Center for Disaster Management.

ADPC Commentary on Applied Reserach Grants for Disaster Risk Reduction (Rounds I and II)

During Round I, the majority of projects dealt with natural hazards and their consequences: floods, earthquakes, cyclones, landslides, coastal, and river erosion. A few focused on industrial hazards, urban fires, and pesticide residues. One project covered internally displaced populations. While some projects used of techniques of hazard assessment, an equal number sought to assess and map social vulnerability with the aim of reducing it.

A number of projects tested development or enhancement of tools and techniques for specific aspects of the disaster risk management process. This included development of indicators for disaster preparedness, improved methodologies for damage and loss assessment, risk communication and information dissemination strategies, and planning for increased risk resilience at community, urban, and district levels. Several projects tracked and identified issues arising during recovery processes following significant disasters in India, Pakistan, Bangladesh, and China.

During Round II, the topics ranged from community based risk reduction in a watershed area in rural Nepal to flood risk analysis in urban areas of Mongolia; earthquake resistant housing using bamboo in China; developing building design standards and seismic retrofitting scheme for non-engineered construction in Nepal; and seismic hazard assessment in hydropower dams in Vietnam.

A large number of topics also included various community led planning approaches to reduce disaster risk—community driven disaster management plan; community risk index toolkit for conducting community wide vulnerability assessment in Pakistan; and child oriented participatory risk assessment and planning in the Philippines. Topics also included risk reduction of tsunami by strengthening environmental laws in Sri Lanka and modeling of coastal protection from vegetation in Indonesia. Other topics covered included institutional and capacity building for disaster management and interagency coordination in emergency response operations.

Linkages with Community and Follow-up Actions

Many of the researchers undertook data collection through intensive interaction with communities affected by a specific disaster or those under threat from disasters. This interaction led to the establishment of links with local governmental authorities and local NGOs and community based organizations. Grantees presented the results/ findings to the community directly or shared the results with a local NGO.

Lixin's project on "Social Forestry Based Disaster Preparedness in Yunnan, China" used mountain agroforestry as a strategy for landslide and erosion control that helped establish local farmers associations for resource conservation and disaster preparedness. Based on project outputs, there are plans to extend this to other upland communities within the province with resources from an international NGO.

Rawat's project on "Disaster Mitigating Developmental Planning" focused on incorporating results of risk assessment in watershed based community development planning in four villages of Rudraprayag District of Uttaranchal State, India. Under the project, watershed development committees prepared action plans. Implementation of the plan will be undertaken through a three-year follow up project being funded by a national foundation.

Jojo's project on "Community Based Advance Risk Sharing Program" covered six vulnerable communities in the coastal regions of Guntur District in Andhra Pradesh State, India. After a participatory risk assessment, the project established risk management committees and built their capacity. It initiated two specific protective measures. Through a "one fist full of rice" campaign, the project set up community food security reserves and established a Community Informal Insurance Fund.

Jalaluddin Shah's project—"Ghariat Potential Landslide: Demonstrating Hazard Risk Assessment Tools in Mountain Environments"—in Hunza Valley in Northern Pakistan conducted a seismological and geological assessment of one of the 400 high-risk potential landslides. It also established a community monitoring mechanism and conducted a participatory assessment of vulnerability and potential impact. Working closely with the CBO in the village, mitigation action planning will be done in a follow up phase likely to be supported by an international NGO.

In Nepal, Krishna Prasad Sharma used community mapping procedures to complement Geographical Information Systems/Remote Sensing (GIS/RS) tools to make a landslide risk assessment in a mountainous region in Nepal. Bhoj Raj Khanal worked closely with community forest users' group to document their existing forest fire risk reduction techniques. Suresh Marahatta used local knowledge to understand and mitigate community risks from climate changes.

In the Philippines, Mayfourth Luneta conducted child-oriented participatory risk assessment and planning processes in a disaster-prone urban poor community that resulted in the implementation of community-initiated risk-reduction measures.

Brief Profile of Projects Selected for Presentation at Washington Symposium Held on July 2004

Seven projects from the Asian region were selected for presentation at the grants symposium.

Dash's project, "Indicators for Disaster Preparedness," studied six hazard prone communities in diverse settings and developed a series of 10 indicators to rate the current state of preparedness of a community and its ability to deal with hazards. The results of the study were presented to the communities studied.

Prabhir's project on "Action Advocacy to Ensure the Right to Livelihood Risk Reduction and Beyond" looked at recovery processes among a group of urban slum dwellers in Bhuj affected by the 2001 Gujarat earthquake. Some of the factors it probed were age, gender, literacy, educational levels, and functioning of local markets. The research was conducted with the active involvement of the affected persons. The project did advocacy based on key findings by sharing the results in state level workshops, newsletters, and internationals journals.

Berdin's project on "Coastal Erosion Vulnerability Mapping in the Philippines" mapped out short and long term changes in the 60 km long coastline of southern La Union in Luzon Island. The study looked at human interventions in the destruction of natural resources and protective actions taken by local communities. In particular, the study highlighted the uncontrolled occupation of accreted coastal lands as a serious issue and initiated a dialogue with the city and provincial governments.

Kumar's project on "Testing Communication Strategies for Industrial Disaster Risk Reduction" involved establishing a dialogue on industrial hazards and community preparedness among an industrial estate in Gujarat India, neighboring schools, and related regulatory and responsible government departments. The project successfully piloted interaction among Grade 9 high school students and their teachers and five industrial units using or producing hazardous chemicals. Through consensus, they enhanced hazard awareness and preparedness.

Paudel's project on "Mapping and Assessing Risk and Vulnerability of Water Induced Disaster in the Tinau Watershed of Western Nepal" prepared landslide and flood hazard maps integrated with vulnerability maps using three parameters. It held a seminar with the local Village Development Council (VDC) and other local community development organizations to share the results.

Pradhan's study on "GIS and Remote Sensing for Flood Disaster Identification in the Koshi River Basin of Nepal" utilized a participatory approach of data gathering and interpretation to supplement the use of GIS and remote sensing technology. Through interaction with the VDC, they started using flood maps as basis for flood preparedness.

Warsa's study on "Multidimensional SNMR Modeling for Groundwater Exploration" aimed to increase the use of Surface Nuclear Magnetic Resonance (SNMR) modeling as a new method for ground water exploration and determination of characteristics of ground water aquifers.

ADPC Contributions

As an implementing partner, ADPC played a key support role in the grants program:

ADPC widely disseminated the announcement of the grant awards scheme and invited applications from young professionals through an announcement in its newsletter and on its website. It sent the call for applications to over 300 partner organizations in universities, technical institutions, government departments, Red Cross and Red Crescent Societies, NGOs, research institutions, and UN regional and country offices, requested all the addressees to publicize the scheme among their partners.

An international panel of reviewers rated the quality of the proposals submitted from South, South East, and East Asia. Afterwards, ADPC reviewed all applications for relevance, significance, institutional and community linkages, and innovativeness in terms of the subject and approach. It also considered the background of the applicants and institutional affiliation. Based on this, ADPC short-listed 25 applications during the second round. Given the limited budget available, ADPC proposed that the grant amount be reduced to between USD 3,000 to USD 4,500, instead of the indicated RFP limit of USD 5,000, which was the cost of most grant applications. This meant grantees needed to limit the proposed scope of work and expected results. Thus, instead of awarding only 16 grants of USD 5,000 each as was done in other regions, ADPC, in consultation with ProVention and other partners, UN-DMC and DiMP, was able to award 23 grants without any increase in budget.

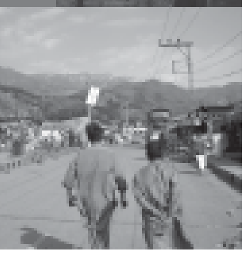
ADPC established direct communication with all the grantees and their mentors/guides and conveyed the terms of the grant, proposed budget limit, reporting requirements, communication details within ADPC, and requested confirmation and revision of budget. It gave greater attention and planning to dissemination of grant results.

In addition, ADPC offered each grantee a disaster management (DM) information kit based on a selection of reading materials, and information support in terms of access to specific documents in the ADPC library, to be identified by the grantee through an online search.

ADPC also linked each grantee with DM organizations in country in the government and NGO sector, academics, and ADPC staff interested in their area of study.

Based on receipt and review of the initial and mid term reports, ADPC provided some input and guidance to maximize the impact of the study being undertaken. This was primarily in the form of encouraging establishment of links with the local government and community based organizations in the area of study, undertaking a suitable form of communication with the community being studied through preparation of a communication product (e.g., booklet, poster), and giving feedback on the results of research.

When ADPC staff visited the countries on regular missions, they made an effort to have face-to-face meetings with researchers in country and discussed with them the progress of their work, including providing feedback on their study. These face-to-face meetings were followed up by the communication through email and Web CT. It also facilitated communication between grantees in country.



ADPC coordinated the disbursement of grant payments in three installments and undertook scrutiny of receipts and the compliance of expenditure with grant norms. It also provided guidance on the format of final reporting and reviewed the final reports.

With the support and encouragement of ADPC, the Round I grantees in India decided to organize a national meeting of grantees to share the results of their research. This took place on February 2004 in Ahmedabad.

ADPC also participated in the web conferences held on May 2004 for Round I grantees to present the results of their research. These proved to be an exciting and interesting interactive learning opportunity for grantees to share the results of their work.

Round II grantees in Nepal likewise held a national meeting to share the results of their researches in Kathmandu on 30 November 2006. The grantees also planned for follow up activities that included drafting a proposal for publication in Nepali and seeking more collaboration from respective authorities, partners, and stakeholders for effective implementation of the research output. Grantees in India scheduled a similar national meeting.

<< Grantees and special guest from ProVention Consortium, UNDP (Bangkok), and USAID; participating in the Bangkok December 2006 workshop.

Lessons Learned

The Applied Research Grants Program was extremely successful, harnessing the enthusiasm of a large number of motivated young researchers. The program enabled them to undertake meaningful research/study/documentation on aspects beyond their normal academic work. Through direct engagement with practical issues on the ground, the grantees were introduced to different aspects of disaster risk management.

Studies of significant scale and scope and reasonable quality were undertaken at very reasonable costs. They made useful contributions knowledge and practice of disaster management to agencies and local government departments aiming to address hazard related concerns.

The grantees, their guides, institutions, and the managing regional centers contributed significant complementary funding. The grant did not provide professional fees to the grantees and only granted limited honoraria to the mentors.

In Round I, the scheme involved selection of grantees through a competitive process by a panel of independent reviewers. This did not involve the regional centers. No review was provided to the grantee of the scope or content of the proposed work. Neither was feedback to the area, organization, or community under study made an explicit part of the project scope. It is felt that future grants should receive feedback based on the review and suggestions on dissemination of results so that the project could be revised at an early stage. This was represented to a greater extent in Round II; and will be further developed in Round III.

In several cases, ambitious conclusions were made about the significance of the models developed or their applicability in a field situation. Perhaps this was due to the implied pressure on grantees to identify the significance and sustainability of their work. Future guidelines should focus on direct application of findings in the area under study rather than encourage an inflated claim of wider applicability.

In future rounds, a network of country based mentors/partners to whom the grantee could report at the middle and end of the project should be set up. In cases where this happened, the projects and results achieved benefited from this interaction.

Opening Ceremony of the ProVention Consortium-ADPC Workshop on “Innovative Initiaves in Disaster Risk Reduction” Applied Research by Young Professionals in South, South East and East Asia featuring grantees and distinguished guests (6 December 2006, Thailand)

Bangkok Workshop
6-8 December 2006

The first day of the workshop (6 December 2006) was a dry-run presentation by the grantees to AIT faculty members and students and ADPC staff. This was followed by a question and answer session. The grantees received feedback, comments, and suggestions from the audience on how their presentation could be improved so that it can effectively highlight the significance of their research work. The grantees revised their oral and PowerPoint presentations based on the comments.

On the morning of the second day (7 December 2006), grantees and the grant program managing staff had an open discussion of the impact of the program. Grantees pointed out that the program helped them personally and professionally by broadening their knowledge on disaster risk reduction and giving them an opportunity to widen and strengthen their network with local people and relevant organizations. They were able to translate their research successfully into practice at the community level—contributing alternative and innovative approaches to lessen the impact of disaster on people’s livelihood and living condition. The grantees also reported that the concerned parties welcomed their work. They not only received supportive collaboration from their organizations and active participation of community people; but also additional funding from stakeholder agencies.

The outputs of the morning session would be considered for the planning, monitoring, and managing of the next round.

In the afternoon of the second day, the grantees presented their research to a wider audience composed of Bangkok-based international and local organizations working on disaster risk reduction, representatives from Thai Red Cross, Department of Disaster Prevention and Mitigation (DDPM), Stockholm Environment Institute, USAID, DIPECHO, UN/ISDR, and UNDP.

On the last day of the workshop (8 December 2006), the grantees attended a short workshop to develop and sharpen their writing skills. They did an exercise that helped them summarize the main ideas of their study and gave them pointers on how to communicate their ideas better and rewrite their research paper for final publication. The grantees received guidelines on how to write for a wider audience in a simple and non-technical manner.

Ms. Joana Merlin-Scholtes (center), UN Resident Coordinator, UNDP Bangkok, delivering the closing remarks. On the left is Mr. Thomas Dolan, USAID and on the right is Dr. Luis Jorge Perez-Calderon, ADPC Deputy Executive Director.

Grantees participating in a writeshop to improve their writing skills, a side-event during the Bangkok Workshop December 2006

Reflections by Grantees, Mentors, and Reviewers on the Applied Research Grants Program for Disaster Risk Reduction (Rounds I and II)

The Applied Research Grants Program for Disaster Risk Reduction was launched by the ProVention Secretariat at the World Bank Hazards Management Unit in 2002, due to concerns that "research in the field of disaster risk reduction remains dominated and influenced by academic institutions and international scientific organizations from the industrialized world". This grants program invites applications from young professionals in wide-scope of disciplines- from the high academic scholar, government research body, local and international NGOs and professional affiliations. It encourages and supports young practitioners technically and financially, who are passionate to work in the field of disaster risk reduction.

Over the first two rounds, the program has grown from a modest experiment to a significant experience in the acculturation and professional development of a new generation of young disaster risk reduction champions in developing countries. This section of this publication reflects the strengths, constraints, and challenges of the program in Rounds I and II drawn from a review of Risk Red (February 2007), workshop discussions, and final reports of the grantees in this region.

STRENGTHS

Strengths of the program relies upon the generosity and spirit of voluntarism of both institutional and individual partners, as well as the ability to provide financial support for individual projects and for professional development guidance and capacity building at both global and regional levels.

The program supports the work in cross-disciplines and trans-boundary as well as encourages multi-interaction beyond the scope of conducting researches. The grantees from the same region and from different regions are offered the opportunity, through various channels such as web board communication, meeting and workshops, to share innovative ideas among themselves and with the grant managing staff. This increases level of coordination, knowledge sharing and expanding networks.

Moreover, the program offered the grantees better opportunities to experience more community work and transfer of knowledge into practice, which leads to a wider advocacy for disaster risk reduction (DRR) and to a higher degree of partnership by seeking and involving multi-disciplinary expertise from fellow researchers, local knowledge as well as international and renown organizations working on the subject.

The program is a catalyst to identify hazards in specific areas and impose alternative ways to tackle the problems. Certain research went beyond a piece of research and encompassed the broader scope of DRR with assertiveness by articulating the pitfalls of current practices, raising local and international awareness, offering an innovative approach, and highlighting the need to increase collaboration and committed actions of all who are involved or affected by certain hazards.

CONSTRAINTS AND CHALLENGES

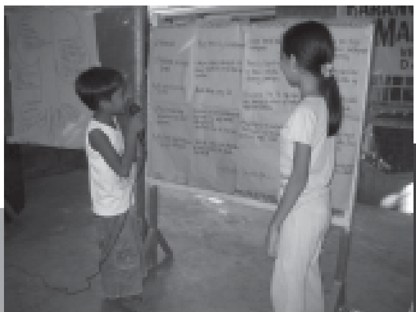
Grantees from academic and scientific institutions tend to be strong on technical research methods but weak in area of community linkages, participatory involvement, shared ownership, reporting back to stakeholders and have been almost unable to conceptualize or report on participatory process and dissemination.

The projects originating from the field are strong on community involvement but weak on awareness of existing research, developing and evidence-base for their actions, applying scientific methods, sampling and therefore reporting on replicable and scalable models.

Even when young people from academic settings have bridged the gap and experimented with "implementation technologies" and a variety of stakeholder involvement, they find this extremely difficult to document and to discuss.

Grantees have not yet thought through their facilitative role in action plans that flow from their projects, including shared ownership of desired outcomes, implementation costs, and division of labor.

Some community-based researches faced the challenge of encouraging the community to be available and participate. The grantees had to adjust their schedules and be more flexible in organizing community activities. Participation of local government agencies was another concern because local officials were busy with their own work. They had to balance the demands of their job and voluntary work under the research. In addition, the lack of skilled persons (team members, surveyors, community trainers, and facilitators) highlighted the difficulty of advocating for disaster risk reduction in remote areas...



Ms. Mayfourth Luneta
"Child-Oriented Participatory Risk Assessment and Planning-"

Planning activities with the community and research partners proved to be a challenge. We had to consider the schedules of everyone involved, including community celebrations and holidays like Christmas. We handled this challenge by postponing the activities and scheduling them at the time when everybody was available.

Another challenge was to have all the trained facilitators carry out the fieldwork. During the training, the 18 participants expressed their willingness to participate in the actual Child-Oriented Participatory Risk Assessment and Planning (COPRAP). The original plan was to launch the COPRAP in different puroks (i.e. a village sub-unit) at the same time. Another option was to have seven different groups handle seven different areas. However, some of the trained facilitators had work commitments and some were studying. To carry out the fieldwork, the 12 available participants decided to go as one group and do the assessment one day at a time in each purok. In addition, we combined the low risk areas of Purok 3, 4, and 5 to save time.

The local government research partner also had difficulty attending the fieldwork because of the huge responsibilities and work in the whole community. The Core Group decided to seek advice from the Barangay Captain on what they can do to help. They later agreed that the representatives would be the ones to organize the participants for the combined fieldwork of Purok 3, 4, and 5. This was a major positive step in reviving the partnership with government because the next phase of the project—community validation and implementation of a doable risk reduction measure—needed the support of the local government unit.

All the grantees had full time jobs. They had to balance their work responsibilities with their commitment to the research project...

Ms. Sweta Byahut & Mr. Darshan Parikh
"Integrating Disaster Mitigation in Urban Planning Practices in India"

Availability of key persons is always an issue. It is difficult to match schedules of both the resource persons in different cities and the research team as both team members are professionals with demanding full-time jobs.

Grantees had to be sensitive to local concerns. Some of them faced the challenge of convincing local people of the value of the research and getting their cooperation to participate in the survey.

Some key documents were not readily available because they are not in the public domain. For instance, the report of the Chitale Fact Finding Committee on the post-Mumbai floods had not yet been submitted to the government and thus, was not available. This document was crucial to our understanding of the issues involved, especially those relating to urban planning and governance. Fortunately, this report was made available to the research team towards the end of the project.

Adequate maps showing the natural drainage patterns and topographical details of the cities being studied could not be obtained from the planning authorities, who never incorporate these maps in urban development plans.

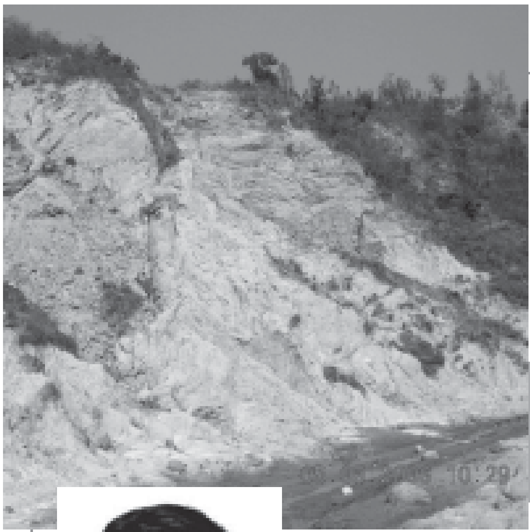
Mr. Binod Shrestha
"Sets of Standard Building Designs: A Supportive Step to Reduce Earthquake Risk"

During the survey, a few house owners were reluctant to accommodate the survey team because their building structures deviated from the plan in their building permit. They were also hesitant to show their houses because of fear of losing their tenants if their houses were found to be vulnerable to earthquakes. Some house owners were also concerned about security and did not want to provide information to the survey team. Data collection outside Kathmandu valley was constrained by travel and technical difficulties.

There is a need to exert more efforts to promote research outcomes so that affected populations could benefit from the findings and adopt the appropriate risk reduction practices...

Dr. Hongzhou Lai
"Using Bamboo to Build Houses in Earthquake Prone Rural Areas in Yunnan Province, P. R. China"

There were some constraints in the construction of bamboo houses, such as preservation, joints design, and fireproofing. Bamboo houses could provide villagers with a safer dwelling, but could not cater to people's desire to have concrete brick houses that they could show as a measure of their improved living conditions. We should provide adequate reasons to persuade local governments and residents to build more bamboo houses and carry out further technical research to resolve these issues.



Local hazards, harsh weather, and political unrest hindered some of the projects in the study areas...

Mr. Suresh Marahatta
"Using Local Knowledge to Understand and Mitigate Community Risks from Climate Change in Nepal"

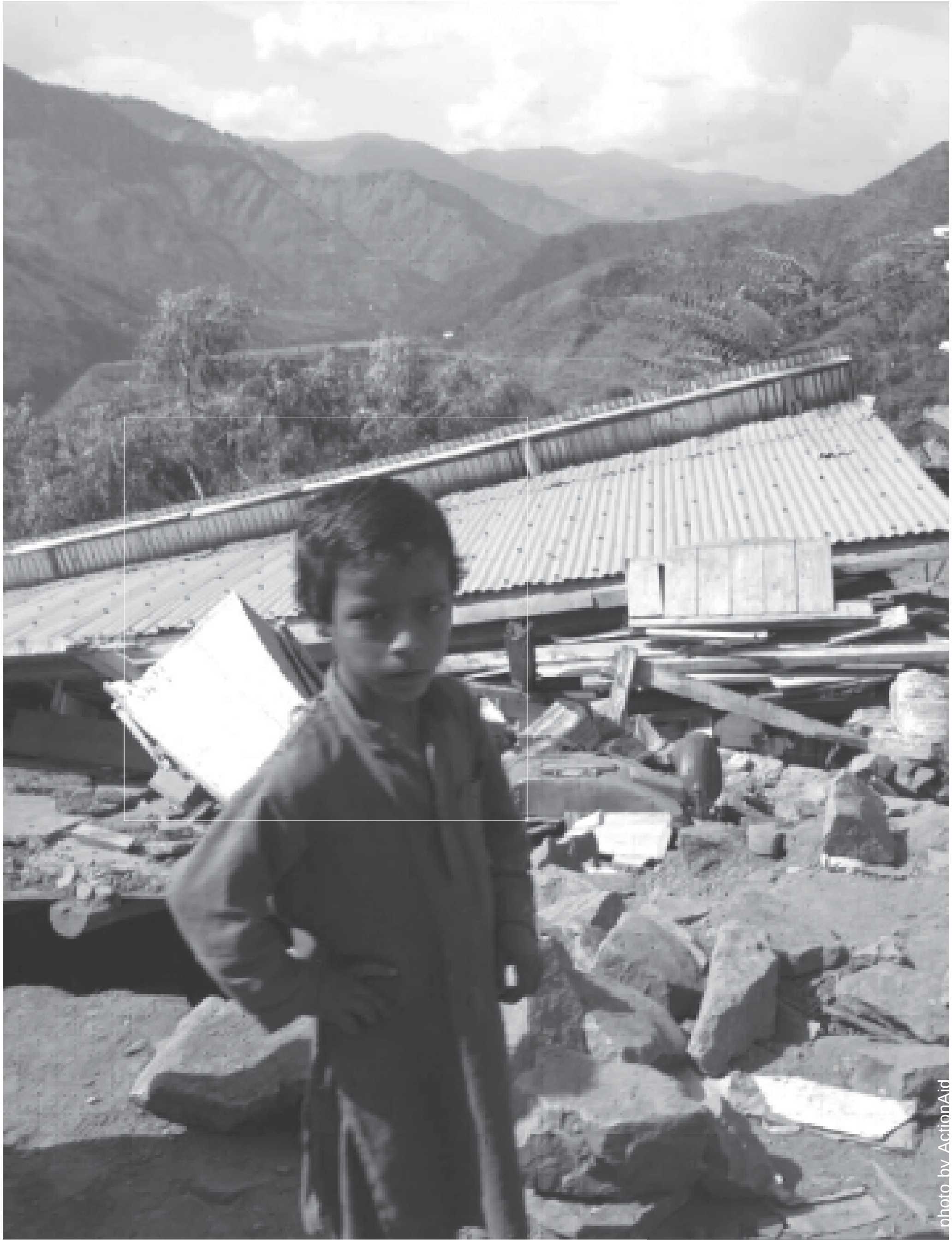
Low elevation characterizes the Siwalik area. The parameters used in the climate change study included precipitation, temperature, vegetation, and water resources. However, during the study period, political insurgency and armed conflict limited the coverage of our study to the Bidhuwa and Bukuwa Khola watershed area, which is only one part of the Siwalik area of Ilam District. As a result, the study does not represent the whole Siwalik area of Ilam.

Mr. Mujeeb Alam
"Toolkit to Conduct Community-Wide Vulnerability and Hazard Assessment in the Northern Mountainous Regions of Pakistan"

Many unforeseen events seriously affected our project. In the summer of 2005, heavy flooding in the target area forced us to stop our survey temporarily as we participated in the relief work. During the South Asian earthquake of October 8, 2005 that killed more than 80,000 people, we again had to stop our work and help the survivors. Our organization, Focus Humanitarian Assistance, actively participated in the relief efforts. The ruthless winter made it difficult to carry out any outdoor activity. During this period, we did some analysis work instead. Again, during the summer of 2006, many incidents of flooding and debris flow derailed our research work. We had to limit the scope of our work.

Mr. Bhoj Raj Kanal
"Forest Fire Risk Reduction Techniques in the Community Forests of Nepal"

During our first and third visits to the study sites, the strikes and political unrest in the country hampered our data collection to some extent because there was no available transportation to bring us to the study sites. For 21 days, there was political blockade in the country and intermittent strikes in Chitwan District.



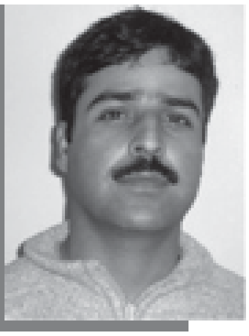
Surviving children in front of their destroyed home near the Line of Control (LoC) in Indian Administered Kashmir (IAK) in Uri after the October 8, 2006 earthquake.

It helped me integrate disaster management work into ActionAid's interventions in Kashmir, reaching about 100,000 people. The project enabled me to give wings to some of my dreams...

-Arjimand Hussain Wani

Grant No. 2051

Cross-border Collaborative Disaster Management in Kashmir



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Background

Owing to its complex geographical and political position, Kashmir is one region of the world that is beset with a number of natural hazards like earthquakes, floods, flash floods, landslides, avalanches, and snowstorms. These vulnerabilities are compounded by restrictions on communications and closure of road links with the outside world due to political reasons. Experience has shown that damage from many of these hazards can be minimized if there are institutionalized mechanisms for early warnings and information sharing on severe weather conditions across the Line of Control (LoC) that divides Kashmir between India and Pakistan.

The Kashmir region had an independent status until the Indo-Pakistani War of 1947, which established the rough boundaries of present day Kashmir. The part of Kashmir under Pakistani control is called Pakistan Administered Kashmir (PAK); while the part under Indian control is called Indian Administered Kashmir (IAK).

This project looked into the possible inter- and intra-governmental mechanisms for disaster risk reduction in this region and the areas of NGO/ community participation in operationalizing a community-based early warning and disaster risk reduction system in both parts of Kashmir. This system would be unique because no such mechanism of information sharing is currently in place. It would also help foster cooperation between the antagonistic states of India and Pakistan over Kashmir.

The project also identified the existing vulnerabilities, institutional weaknesses, capacity building issues, and new possible collaborative schemes for enlarging the scope of the Indus Water Commission (established by the 1960 Indus Waters Treaty) to help build greater cooperation across the LoC.

Every year, hundreds of people lose their lives. Common people face economic losses worth millions of dollars because early warnings about severe weather conditions do not reach them on time. This project aims to address this problem. It is ironical that most of the time, civilian governments and military agencies have information about severe weather conditions but this does not reach people across the divided frontier.

The project identified specific institutions, mechanisms, and collaborative systems in the two parts of Kashmir and between India and Pakistan. It also undertook a pilot early warning activity based on information sharing across the LoC on severe weather—in close collaboration, through informal communication systems, with the communities living close to the Line of Control (LoC) on the Indian side and with three community-based organizations, namely J&K Yateem Trust; People's Development Trust; and Himalayan Mission for Advocacy, Youth Awareness, and Training. This helped a vast population to prepare ahead of a snowstorm on December 2005.

The October 8, 2005 earthquake devastated most parts of the Kashmir region. This has proven that the LoC compounds the region's existing vulnerabilities to multiple hazards because it prevents the free movement of people and ideas and restricts communication exchange. The study identified the important players of an innovative disaster risk reduction set up: the Indian Meteorological Department (IMD), Pakistan Meteorological Department (PMD), disaster management authorities of both sides, governments of Indian and Pakistani administered parts of Kashmir, military, NGOs, and community-based organizations (CBOs).

The project also achieved some key goals on disaster risk reduction through its partner organizations—ActionAid International (India) and its local support organizations in Indian Administered Kashmir (IAK).

Teachers posing for a picture at the launch of the National Service Scheme (NSS)-ActionAid School/College Disaster Preparedness Program in Srinagar, IAK
(photo by Mudasir Wani, ActionAid).

Methodology

The project used the following techniques: community-based research and analysis, collection of secondary sources of information (e.g., government data and Internet), focus group discussions, and interviews with government officials, common people, community leaders, and army officials.

A sharing workshop involving local NGOs, CBOs, and community members from remote areas of IAK was held at Srinagar to learn about people's perceptions on disaster preparedness, existing and traditional knowledge about cross-LoC coping, and management mechanisms for disasters. One of the key learnings from the workshop was that prior to the creation of LoC that divided Kashmir, natural routes, safety, and community coping mechanisms provided vital support systems.

Applied Research Activity

Under the project, a community-based severe weather early warning activity was piloted that confirmed the usefulness of an early warning system. ActionAid and its local partner organizations implemented the following:

- Issued an early warning through newspapers on snowfall that was about to hit both parts of Kashmir based on satellite images analysis and information received from Pakistan Administered Kashmir (PAK), which is the first to receive such precipitation because of the easterly direction of western disturbance (i.e., a cloud system that brings snow and rain on this region). No government agency has ever issued such warnings.

- Disseminated information through print media, NGOs, and CBOs.

- Helped operationalize the early warning concept at the community level. This pilot exercise could be replicated at larger geographical levels.

Key Results

The different project accomplishments formed important components that helped operationalize the larger concept of collaborative cross-border disaster management. They included the following:

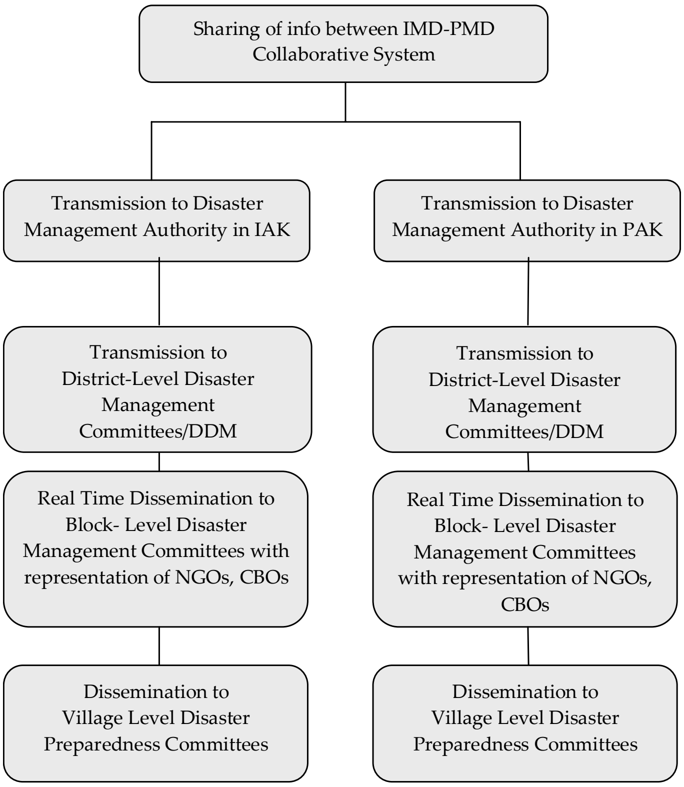
- Initiation of the School/College Disaster Preparedness Program—a joint initiative of the National Service Scheme (NSS) and ActionAid. In the program, 5,000 students and 500 teachers participated in a training of trainers (TOT) so they could reach 80,000 students. This helped transform post-disaster based discourse to preparedness and prognosis for the first time in this part of Kashmir.

- Establishment of the Disaster Information Center in Kashmir University. This integrated participatory vulnerability assessment (PVA) into students' disaster research. The center has issued severe weather warnings. It has also started publishing a disaster newsletter—a first in Kashmir—that is helping highlight the need for collaborative disaster management in Kashmir and influence decision makers.

- Implementation of community-based disaster preparedness training that reached the 31 most vulnerable villages and 120,000 people.

- Joint publication of ActionAid and Kashmir University of the feedback to the Disaster Management Authority (DMA) based on the project's findings. This was acknowledged by the government.

Below is a pictorial representation of the proposed institutionalized early warning system between India and Pakistan and the governments in IAK and PAK:



IMD-PMD Collaborative System: An Institutionalized Framework for a Preparedness and Early Warning System

A collaborative institutionalized system involving the Indian Meteorological Department (IMD) and the Pakistan Meteorological Department (PMD) could help in forecasting weather-induced hazards like floods, snowstorms, and landslides; share and disseminate information. They could also share knowledge and information on the seismic activities in the region. Such collaborative mechanism already exists in the form of the Permanent Indus Commission of India and Pakistan, which shares information on water discharge and flooding under the provisions of the 1960 India-Pakistan Indus Waters Treaty. However, this system does not share real time information and is limited to the waters of the six rivers, namely, Indus, Jhelum, Chenab, Ravi, Beas, and Satluj. The information that the Commission has does not include natural hazards and the forecasting of their occurrence. The proposed IMD-PMD Collaborative System could cover all seismic and weather induced hazards.

Specifically, the two departments could collaborate in the following areas:

1. Sharing of meteorological, geophysical, and phonological data of the region from the network of observing stations in the Kashmir region separately administered by the IMD and the PMD.

2. Creation of a dedicated telecommunication system between the two entities based in Srinagar and Muzaffarabad for speedy dissemination of data, especially to the Disaster Management Authority (DMAs) of the two sides. This telecommunication system could be similar to the pattern of hotlines used by the Directorate Generals of Military Operations (DGMOs).

3. Analysis of data based on information by the two meteorological offices based in Srinagar and Muzaffarabad for issuing forecasts and warnings across the political borders of the region.

4. Setting up of a processing unit for scrutinizing, comparing, and publishing data for appraisal of long-term weather trends and earthquakes within the IMD-PMD Collaborative System and its linkage with the DMAs of the two sides for an integrated analysis of relevant climatological and seismic data.

Institutional System of Early Warning with the Traffic Department

The Traffic Police Department in IAK regulates traffic on the 300 km Srinagar-Jammu and 400 km Srinagar-Leh highways—*the former being the only surface link of Kashmir Valley and Ladakh sub-regions with the rest of the world*. The Department has never predicted any weather-induced disaster on the road and stopped traffic based on any available early warnings. The passage of dozens of large military convoys and paramilitary vehicles on the road carrying men and materials creates a situation of anarchy. When a disaster occurs on the road, the Divisional Commissioner's office is responsible for initiating disaster management measures for relief and rescue. It is also responsible for looking after routine administrative issues and coordination among government departments in IAK.

Landslides and avalanches due to snow and rainfall along the Srinagar-Jammu highway frequently occur. They not only cause the death of civilians stranded in snow but also snap the vital communication link of the vast population of Kashmir. This creates economic instability and endangers people's lives because of the shortage of food and other essential supplies. As such, an early warning system involving the IMD-PMD Collaborative System, DMA (IAK), and the Traffic Police Department is proposed. This would regulate traffic on the road according to weather warnings. Such a system would also enable government and military agencies to plan logistical operations involving supplies of essential food and other supplies.

Role of NGOs

The scope and importance of the work of NGOs and CBOs in IAK have been very limited because of the overarching role of the State in all domains of public life. The high level of dependence of people on the State, lack of capacity among the local NGOs in undertaking professionally managed activities, and limited knowledge of the disaster preparedness paradigm have relegated them to the role of providing relief in post-disaster situations.

The tragedy of the October 8, 2006 earthquake in Kashmir attracted tremendous humanitarian response at many levels. Despite the remoteness of the affected areas and security concerns, assistance from local Kashmiri individuals and organizations has been unprecedented. Despite criticism of the largely uncoordinated and unplanned rescue and relief efforts undertaken by local NGOs, the outpouring of assistance underlined the importance of local social and cultural support systems crucial in the event of a disaster.

Their efforts have proven that if NGOs are woven into an integrated disaster preparedness and response system, they constitute an important and sustainable resource in disaster management in Kashmir. Capacity building through trainings in disaster management for local NGOs would prove extremely helpful, as the continued presence of international agencies in the politically volatile region of Kashmir is not guaranteed.

Decades of political instability and violent conflict in IAK have suspended the development of grassroots level democratic institutions. Under this project, however, ActionAid created the Village Disaster Management Committees (VDMCs) that have been implementing early warning and disaster preparedness activities. The VDMCs present a unique grassroots development model.

Because of this grassroots experience, residents of a village have organized themselves and set development and preparedness goals through a process of consensus that included women's participation. As part of a larger rehabilitation process, they have implemented activities that put pressure on the government and local political representatives to create transparent and accountable democratic systems at the grassroots level. Such grassroots approaches have also been helpful in reducing the high dependence on government to manage disasters in these areas. Fortunately, armed rebel groups have not obstructed this process perhaps because they do not see grassroots democratic processes hindering their larger political objectives.

An institutionalized community-based disaster management system enables people's voices to be heard. This democratic approach is inclusive and empowers people to be active players in development process—in effect, reducing their vulnerability. That disaster preparedness and management should be a function of the overall development and poverty eradication process in the Kashmir region is a key learning of the project.

NGOs and CBOs could play a key role in linking the government and the people. They could also supplement government efforts to put disaster management policies into practice.

More specifically, the role of NGOs can be envisaged as follows:

1. Be institutionally represented in the Disaster Management Authority (DMA) where there is a mechanism for sharing information and expertise between both government and NGOs.

2. Share information to the DDM at the district levels for dissemination on the ground. Presently, most of the valuable information and analyses available with NGOs and government are lost in the absence of an institutionalized system. Actions that are guided by a wider base of knowledge and information are likely to have much greater impact.

3. Regularly share activities concerning relief, rehabilitation, and disaster preparedness activities with the Disaster Management Authority. Quite often, government is totally unaware of the work carried out by NGOs, resulting in duplication.

4. Use the network of NGOs to disseminate early warnings issued by a potential IMP-PMD Collaborative System to the vulnerable communities, especially in areas where other modes of communications do not work as early warning systems.

5. Integrate NGO-implemented vulnerability assessment studies in the larger vulnerability map of government. This would help bring other perspectives and ideas into the system.

6. Ensure optimum utilization of resources of both government and NGOs and create systems of greater transparency and accountability through an integrated approach.

Planned Activities

Depending on availability of funding support, the grantee plans to enlarge the scope of cooperative mechanisms for disaster risk reduction in the region through the application of satellite remote sensing and GIS. As this could not be covered in the project, the application of technology would make a robust contribution to disaster management in the region.

Further research activities will be oriented towards building public and government opinion and bringing about policy changes. The specific focus areas are the following:

- Interaction for knowledge sharing between NGO and academic institutions between the two parts of Kashmir like AJK University and Kashmir University.

- Collaboration with the grantee of PAK for the dissemination of information in their side of the Kashmir region.

- Workshop with IMD and IAK government to be facilitated by ActionAid and its local partners.

- Dissemination of information brochures that highlight the merits of early warnings in vulnerable areas close to the Line of Control in both parts of the Kashmir region.

- Bringing together of government, military, NGOs, and CBOs to build an information sharing alliance. The same model can be considered on the Pakistani side. Such models will provide the basis for operationalizing a community-based disaster risk reduction program in both parts of the region.

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http://www.saarc-sec.org
http://www.southasianfloods.org
http://www.un.org.pk/undp/crises_p/crises_overview.html
http://www.worldbank.org

The grant provided opportunities to widen my horizon and understand development issues in other parts of the world. It has allowed my organization to further strengthen the agenda that we have been promoting for years...

-Darshan Parikh

Grant No. 2017

Integrating Disaster Mitigation in Urban Planning Practices in India

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Abstract

Urban planning in India has traditionally been the bastion of statutory bodies across India. While Indian cities have burgeoned, the planning regime, unfortunately, has been plagued with sluggishness. It has not been able to deliver plans that aid the growth of cities in a structured fashion. Increasing incidences of natural hazards further compound the problem. However, there is nothing irreversible about the planning lacunae in Indian urban areas. Experience has shown that if available opportunities are judiciously utilized, urban centers can be made more hazard resistant.

Planning mechanisms in India remain deeply political in nature. Mitigation is sidelined since its results are only probablistic and not readily visible. Preparing development/master plans to include the hazard and vulnerability profiles of the area does not take much of an effort. Incorporating mitigation measures (e.g. rubber joints for water supply lines) in infrastructure projects raises the costs by only 2% to 3%. Yet, most project executioners or decision makers are unwilling to spend that extra amount of money.

Structural weakness of building stock was the key reason why thousands of people were killed during the 2001 Gujarat earthquake. A robust and functioning regulation system that sets standards for the construction of safe buildings is required to reduce disaster vulnerability. Any policy for long-term risk reduction must improve the development regulation system.

Background

Vulnerability to natural hazards the world over is aggravated by several interacting factors. The disaster losses recorded in the last 50 years are enormous, showing an upward trend. Developing countries are particularly vulnerable because disasters introduce huge setbacks in their development. Recent studies in climate change have indicated that incidences of natural hazards will only increase with global warming and significant changes in weather patterns.

The world is rapidly urbanizing. With more and more people desiring gainful employment and better quality of life, the influx of people into the cities has risen significantly. Urban areas are rapidly expanding, albeit in a very haphazard manner.

Growth and Vulnerability of Indian Cities

During the last few decades, India has witnessed tremendous urban growth. In 1961, about 79 million people lived in urban areas of the country. By 2001, this number has gone up to over 285 million, an increase of over 350% in the last four decades. This number is projected to increase to 400 million by the year 2011 and to 533 million by the year 2021.

The Indian sub-continent is highly prone to natural disasters. Floods, droughts, cyclones, and earthquakes are a recurrent phenomena in India. The changing topography due to environmental degradation has increased the vulnerability of the country. In 1988, 11.2% of the total land area was flood-prone. However, floods in 1998 inundated 37% of the country. Presently, more than 38 million Indian cities fall under Seismic Zones III, IV, and V. The two major disasters that India experienced in the recent past are the 1999 super cyclone in Orissa and the 2001 earthquake in Gujarat—threatening the physical safety of vulnerable groups. These two major disasters have clearly illustrated the need for multi-hazard prevention, including response and recovery plans for natural hazards to minimize the threat to human life and property.

In the latest seismic zoning map from the Bureau of Indian Standards (BIS), over 65% of the country is prone to earthquakes of intensity MSK[1] VII or more. India has 38 cities in Seismic Zones III, IV, and V where more than half a million people reside. Some of the most intense earthquakes of the world have occurred in India. Fortunately, none of these have occurred in any of the major cities. India's most populous cities—including the capital, New Delhi—are located in Zone IV of high seismic risk.

Besides earthquakes, Indian cities are increasingly facing other hazards like floods. The 2005 Mumbai deluge and the very recent August 2006 Surat deluge have once again reiterated the need to incorporate hazard-mitigation in all aspects of development.

The Research Problem

As cities continue to grow, it is imperative to manage and guide their growth. The problems of unregulated growth, illegal construction, and poor building stock interact with other social factors that make the Indian populace increasingly vulnerable to natural hazards.

The existing Urban Planning Framework is unable to regulate growth in the cities. Flaws in urban planning and poor quality of existing building stock accentuate the impact of disasters. Disaster risk reduction requires improvement in the quality of building stock. This entails high levels of compliance to standards of safety and spatial planning that incorporates hazard mitigation measures.

This paper aims to present an approach that integrates disaster mitigation into mainstream urban planning and implementation—in land use planning and urban development policy.

Defunct urban planning in India. In India, growth of cities is managed by Master Development Plans, usually revised every 10 years. Typically, they determine the city's structural road network, land use zoning pattern, and development control regulations. Being regulatory and policy-oriented in nature, Master Development Plans are often not implemented. Most cities have outdated plans that do not respond to the demands of the real estate market. They stipulate uniform low densities across the city that lead to land scarcity, and force unauthorized development on the periphery.

Ineffective development control regulations. Building regulations are intended to ensure the safety of buildings. However, the current development regulation system is irrational, complex, and ineffective—leading to abysmally low levels of compliance as substantial development happens outside the ambit of regulated development. This creates unsafe living conditions and increases vulnerability. Rationalizing and simplifying development control regulations and effective enforcement will improve compliance to regulations.

Inadequate database and institutional capacities for planning. Urban local bodies have grossly inadequate capacities for planning. Moreover, there is no vibrant private sector that can provide basic urban planning services. Accurate maps and spatial databases are critical for decision-making, risk identification, and mitigation. While various authorities build and maintain infrastructure and databases, there is no inter-agency coordination or sharing of databases. Vulnerability maps of urban areas are not readily available. Mapping of inundation areas, hazard-prone areas, and vulnerable areas are rarely undertaken during city planning processes.

Planning does not address disaster mitigation issues. The survival of social and physical infrastructure systems is critical in the event of a disaster. However, in most cities, urban infrastructure is not designed to withstand hazards. Major infrastructure and construction projects also do not factor in the cost of disaster mitigation. During the Gujarat earthquake, urban infrastructure suffered significant damage. Replacement costs were far higher than what it would have cost to make them seismically safe.

Methodology

The research methodology included the following:

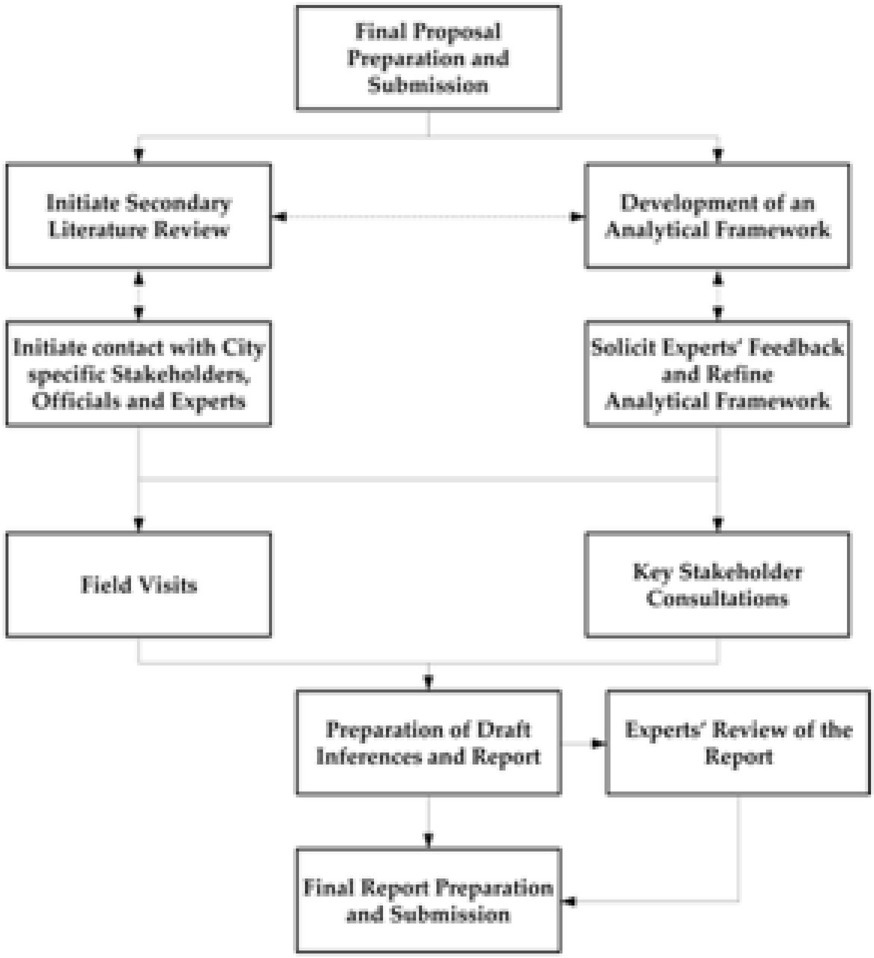
1. **Understanding the Legal and Administrative Framework for Urban Planning in India.** This study analyzed the adequacy and effectiveness of legal and administrative provisions for disaster mitigation in the state of Gujarat. It also analyzed building by-laws, frameworks, and enforcement mechanisms, including the capacities of enforcement agencies in development regulation.

2. **Case Studies of Three Major Cities of India and learning from the Post-disaster Reconstruction of Bhuj.** This study analyzed the use of urban planning as a tool for reconstruction, methods employed, and lessons learned in the post-disaster reconstruction of the town of Bhuj. It documented the existing urban planning legislation to redevelop the devastated city of Bhuj—studying the integration of disaster mitigation aspects in urban planning and reconstruction. The project undertook case studies of Master Development Plans of the three major Indian cities: Ahmedabad (it has a revised Development Plan in force), Mumbai, and Delhi. The project examined the integration of disaster mitigation initiatives in these plans—in land use planning and urban development policy.

[1] The Medvedev-Sponheuer-Karnik scale, also known as the MSK or MSK-64, is a macroseismic intensity scale used to evaluate the severity of ground shaking on the basis of observed effects in an area of the earthquake occurrence.

The overall methodology of the research is illustrated below:

Figure 1. Research Methodology



Key Findings and Recommendations for Stakeholders

1. **Improve Urban Planning Framework.** By and large, the traditional planning framework has not been able to address holistically the issues related to the growth of cities. This is primarily because it has subscribed solely to the "physical growth alone" perspective. Hence, it has not been able to address issues related to safety and disaster management. Factoring in the cost of disaster mitigation in urban and infrastructure planning in vulnerable areas is necessary to reduce the vulnerability of urban areas. A paradigm shift from response to mitigation is urgently needed. These changes should include mitigation into the overall planning context. Tools like risk profiling, vulnerability assessments, and hazard maps would be very useful.

   Disaster management should not be viewed as a separate sector because hazards turn into disasters through a complex mix of environmental and social factors—affecting various sectors. For instance, over half of Mumbai and Delhi live in unauthorized areas and buildings because the available land is not able to meet the burgeoning demand. Moreover, land supply is largely controlled by a few powerful builders. City planners should look at the overall city environment, strategically plan its growth according to its many needs, and build mitigation measures into city plans.

2. **Realize the Importance of Mapping and Database.** Accurate maps and spatial databases are critical for decision-making, risk identification, mitigation, and site specific interventions. There should be inter-agency coordination or sharing of databases among various agencies. They should make vulnerability maps readily available. During city planning processes, they should map hazard-prone and vulnerable areas.

3. **Build a Culture of Mitigation at Local Levels.** Being closest to a disaster, local governments have the highest stake in mitigating risks. However, local governments in Indian cities do not generally perceive disaster mitigation as their responsibility. Urban local bodies must be made legally responsible and empowered to undertake long-term disaster mitigation measures.

"Earthquakes don't kill people but the buildings do," so goes the popular saying. The quality of construction in an urban area largely determines its vulnerability. A substantial portion of building construction happens outside the ambit of regulated development—creating unsafe living conditions and increasing vulnerability to disasters. As the aims of disaster mitigation are consistent with the objective of improving the quality of the urban environment, local governments should take responsibility for disaster mitigation.

4. **Improve and Enforce Development Regulations.** Long term measures to mitigate the impact of disasters in an urban area must include systemic improvements in urban planning, development, and management. Urban planning and development regulation processes influence the quality of construction in the urban environment. In countries like India, these processes need to be radically revamped, which involves reforms in the technical and legal regime.

   The current enforcement regime does not involve professionals such as architects, structural engineers, and construction engineers. Compliance cannot be ensured without making these professionals responsible. However, the lack of clarity in roles and responsibility in the regulations accounts for the lack of accountability and the resultant non-compliance.

   Relying on the private sector is not without risk—which could include professional incompetence, human error, and fraudulent conduct. Thus, it is important to introduce an appropriate enforcement model (techno-legal regime) that clarifies the roles, responsibilities, and liabilities of professionals involved in construction in the development regulation system. Tools like deemed approvals for simple buildings and third party verification of complex buildings must be introduced.

Dissemination Strategy

Web-based Course on Disaster Risk Management. The Environmental Planning Collaborative (EPC), in association with the World Bank, has been offering a web- based course on Natural Disaster Risk Management that includes a specific module on "Safe Cities." The research conducted under this grant would become a part of the course materials provided to the participants consisting of private professionals, researchers, and government officials.

Take the Work Forward. EPC as an institution has been advocating reforms with national, state, and local level authorities in the planning processes for over a decade. For five years, EPC has been advocating for mitigation to be built into the urban planning framework. This study enables EPC to present a stronger case to the authorities.

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Annex A

Research Implementation

A systematic review of the existing urban planning framework was carried out for three different cities to clearly pinpoint a broader pattern and the intricate differences in practices across the country.

Existing Statutory Planning Framework

In India, the growth of cities is expected to be managed by Master Plans or Development Plans. Typically, these are land use plans laying out the growth pattern, showing proposed road network, and development control regulations. In most Indian cities these plans are outdated (for example, the development plan in Bhuj was 25 years old in 2001 when the earthquake struck). They neither respond to the realities of the real estate market nor do they supply urban serviced land for the ever increasing demand. These plans usually propose uniform low densities across the city and fail to release sufficient land for urban uses, thus, forcing illegal and unauthorized development to come up in risk prone areas without adequate services.

Strategic Long Term Planning

The urban planning framework in India has disappointingly not kept pace with the growth of cities and with the various changes in the way that planning is understood and carried out. However, it is increasingly being acknowledged that the typical development plan framework is no longer able to cater to the varied needs of the urban habitat. There is a strong impetus to take the framework forward by including strategic planning components. These components have been deemed unimportant because the local bodies lack the capacity to carry out normal development responsibilities. As such, they are unable to come up with innovations to improve service delivery and the overall urban environment.

Mapping and Databases

Most cities in India do not have accurate maps that can depict the extent of urban growth, road network, and infrastructure networks. Also, property databases are inaccurate and outdated, particularly in old cities. With complex ownership patterns, property records are a complete mess. This creates considerable problems for planning, sidelining mitigation initiatives. In a post-disaster situation, the lack of accurate information results in large numbers of people getting displaced, and creates complexities in the dispensation of compensation and assistance.

Local Level Incapacity

Planning frameworks for cities hardly recognize the dynamism of the city's social fabric and its multiple and complex vulnerabilities. Strategic planning has almost never been a part of a conventional planning exercise. For instance, the informal sector, which contributes about Rs. 4 crore daily to the productivity of Ahmedabad, hardly finds any plans that cater to their needs. This is largely because of the incapacity of local authorities to undertake strategic planning alongside physical planning.

Local level governments are the closest to any disaster and have a very high stake when it comes to mitigation. However, they are constrained by their own incapacity and the unavailability of resources.

Development Regulations

India largely suffers from a culture of avoidance of statutory controls within the construction and development industry, coupled with ineffective enforcement of these controls by the responsible local authorities. Poor understanding of seismic risk among many design and planning professionals, poorly drafted regulations, an outdated regulatory system, and ineffective bureaucracy needlessly compound these weaknesses. Poor building regulation and lax enforcement of building controls, particularly in relation to seismic hazard, have been identified as the major factors contributing to widespread building collapse, property damage, and loss of life.

FOCUS-trained volunteer Community Emergency Response Team (CERT) in action

This research provided us with new avenues and ideas for further exploration of different components of disaster risk management.

-Mujeeb Alam

Grant No. 2157

Toolkit to Conduct Community-Wide Vulnerability and Hazard Assessment in the Northern Mountainous Regions of Pakistan

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Abstract

Hazard, vulnerability, and capacity assessments are critical steps in the overall disaster management cycle. Sadly, such tools and techniques are not available in Pakistan. This research developed a toolkit for the assessment of natural hazards and community vulnerability. Its outputs could be used as planning tool for disaster risk management. This toolkit was piloted in the Ghizer District of northern Pakistan, which is a hazard-prone area.

With the participation of the local community and through ground surveys, the assessment teams identified over 300 hazard sites of different types, like debris flows, floods, rock falls, and even remote hazards like glacier lake outburst floods (GLOFs) that endanger the local population.

Enabling local communities to be resilient in the face of disaster would involve a detailed assessment of the most hazardous sites, simulation of scenarios based on ground data, development of land use management plan, and developing their capacity to mitigate hazards.

Context

Hazards are inevitable. It is important to prepare for them by identifying hazards in specific areas and their potential impacts on the inhabitants. It is also essential to upgrade the capacities of the community to cope with and recover from any disaster.

However, risk assessment tools and techniques are non-existent in Pakistan. There is a dearth of experts knowledgeable about environmental processes, natural hazards that affect the human population, and the measures to mitigate these hazards.

This study developed a toolkit for hazard risk identification and analysis that could be used anywhere in a mountain environment. The process would help relevant organizations to identify and understand natural hazards, their characteristics, causes, geographical distribution, frequency, magnitude, and the damage they inflict. Subsequently, this would enable these organizations to devise different disaster management programs that reduce losses to life and property, create awareness, and enhance people's capacity.

Debris flow hazards increase the vulnerability of the community

Methodology

The following steps were undertaken:

1. **Collection of secondary data and analysis.** The research team collected secondary data on past disaster events and their impacts in the target area to understand the community's vulnerability to prevalent hazards. Secondary data was collected from government, relevant institutions, and through review of related literature.

2. **Development of the toolkit.** The toolkit includes data collection forms, analysis sheets, metadata, legend, and data dictionary.

   The research team identified different indicators. They prepared special data forms to capture technical and scientific data on six main hazards: debris-flow/mud-flow, rock-fall, landslides, snow avalanche, bank erosion, and floods.

   The team considered earthquake but did not prepare any specific data collection form for it. Instead, they digitized a seismic map and faults from different maps and earthquake catalogue downloaded from the US Geological Survey website.

   A scoring system ranging from 1 to 3 was developed to assess the vulnerability of elements at risk. Level 1 means low risk, Level 2 means moderate risk; and Level 3 means elevated risk.

3. **Community workshops.** Local representatives and community gathered in village level workshops to share and discuss prevailing hazards and indigenous coping mechanisms. The research team used Participatory Rural Appraisal (i.e. focus group interviews, historical timeline, community mapping) and other tools to collect various datasets.

4. **Assessment of local hazards.** The assessment team visited every village in the target area and used specially designed forms to collect information on potential hazards. They used simple tools and modelling techniques to assess the hazards.

5. **Inventory of remote hazards.** Remote hazards have the potential of inflicting colossal damages. Some of these remote hazards are glacier lake outburst floods (GLOFs) and lake outbursts. Using Google Earth and reports from the local community, the research team made an inventory of lakes.

Key Findings

The research project identified and documented over 300 hazards of different types. These include the following: debris flows, mudflows, rock falls, snow avalanches, bank erosions, landslides, and floods. Over 60% of hazard sites and stations are unstable—which means they are active. The analysis showed that the debris-flow phenomenon is the predominant hazard, comprising about 30% of all the hazards in the area. This was followed by rock falls phenomenon (over 25%). With most of the villages located along the main river valley, flooding is also a concern.

Research results indicated that there are at least three potential hazard sites in every village and a minimum of five houses are at risk per hazard (i.e., affecting at least 15 houses). As the average family size is 10 members per household, about 150 persons are vulnerable in every village At least one critical facility (e.g., school, health post, and prayer hall) is at risk in every village.

Many villages are isolated for two to three months each year from the district due to frequent occurrence of hazards. In the summer (June to August), most of the channels produce floods and debris flows due to the melting snow in the mountains—cutting off villages for months. In the winter season (December to March), roads remain blocked due to heavy snowfall and subsequent snow avalanches. These hazards create serious mobility and accessibility problems for the community. To cope, people store edibles and other necessary items in their homes in preparation for the rainy season and other unforeseen situations.

Remote hazards have the potential for creating huge destruction, especially in the downstream settlements. The most common hazards are lake outbursts and GLOFs. Knowing very little about these hazards, which occur infrequently, many people ignore them. However, a GLOF at Karumber Glacier in June 1905 broke and washed away many villages along the riverbank in Ghizer and Gilgit districts.

Most of the critical facilities and other infrastructure are at risk to different hazards. However, no land use management system and standards for the construction of critical infrastructure are in place. A recent debris flow event washed away seven houses and one prayer facility, killing nine persons. In a similar incident, debris flow destroyed eight houses and a girl's hostel. Luckily, no one was hurt because it occurred during the day and the girls were able to escape.

The research results indicated that the community would face serious health problems in the event of a disaster because of the health sector's lack of preparedness and the lack of facilities to ensure mobility and accessibility. Only 70 health centers serve a population of over 120,000 in the target area. This includes 47 First Aid Points, 17 Mother and Child Health Care Centers, and 6 small hospitals. Only three health facilities have x-ray machines and operation theatres for minor surgeries. There are only 162 beds—one bed for 750 persons. There is no blood bank and no facility to provide untainted blood for the injured. There are only two ambulances for a population spread over 11,500 square kilometres in a steep mountain environment.

Most of the houses and buildings are non-engineered. Basic housing construction type is of mud and stone. Local masons construct over 70% of the houses. Most of the households have access to electricity but they use firewood for heating and cooking purposes.

The rapid population growth of the community has increased their social and physical vulnerability.

Increasingly more people are dependent on limited land areas and livestock.

People living in these harsh areas are mentally tough and hard working. Their cohesiveness as a community helps them to cope with various hazards and disasters.

FOCUS Humanitarian Assistance Pakistan is very active in this region. It has been providing training at the community level for many years. Under its Community Based Disaster Risk Management (CBDRM) Project, FOCUS has trained thousands of community volunteers in first aid, search and rescue operations, mobilization, logistics, and general disaster management. It has also formed Community Emergency Response Teams (CERTs) and stockpiled emergency supplies. With better awareness, skills, and resources, the local community is now more prepared to face any disaster situation. They are more vigilant of potential hazards and less dependent on external help. In fact, they have effectively responded to a number of disasters recently.

Recommendations

Risk identification and evaluation must be taken as a preliminary but necessary pre-condition to any effective crisis response.

To mitigate the risks of natural hazards, detailed site assessment should be carried out before the construction of critical facilities. In addition, existing critical facilities should be moved to safer locations. Where possible, risk mitigation work must be undertaken on the most hazardous sites.

For proper planning and land-use management, hazard mapping at the village level should be carried out in rapidly growing towns and villages to minimize risks of future disasters.

Detailed assessments of remote hazards, particularly GLOFs, lakes, and sites of possible valley blockages should be made. Based on the assessment results, suitable early warning systems should be established.

Both technical and non-technical staff in hospitals must be trained in emergency response like suturing, bandaging, and cardiopulmonary resuscitation (CPR). The main hospitals must be equipped with critical equipment (with backups) and standard operating procedures should be developed for an effective and coordinated response during disasters.

Drivers of public transport and private institutions should be trained in first aid, preferably as first responders.

A survey should be undertaken to investigate the physical vulnerability of critical buildings (i.e., schools, hospitals, and prayer halls) to seismic hazards because this region has many active faults. Weak buildings should be retrofitted to withstand earthquakes.

Historic natural events at the community and cluster levels should be documented and tracked by maintaining event registers. Each hazard site and station should be assigned a unique code for future reference (i.e., tracking and monitoring of the hazard site). This will be helpful for hazard mapping, disaster management planning, and land use management.

Community emergency response teams must be strengthened in emergency responses and in building the capacity of fellow community members in responding to disasters. The community must also participate in risk reduction activities.

The government should establish a disaster management authority in each district. It should also formulate and implement building and land use codes to mitigate the impact of disasters.

Dissemination Strategy and Action Plan

The project results have already been disseminated to the relevant stakeholders and the local community. Community level workshops were organized at every village cluster to inform the residents about the prevalent hazards in their areas and what can be done to prepare for them.

FOCUS has started a risk assessment project to reduce risks and facilitate land use planning. It has prepared village level hazard and risk maps for the community to enable them to implement disaster preparedness and mitigation activities.

The grantee plans to assess remote hazards in the project area using satellite images and modeling. This assessment would identify settlements that could be inundated by lake outbursts. It could help devise early warning systems and identify safe havens. The community could be trained and mobilized in the event of a lake or glacier lake outburst.

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Annex A
Records from Published Reports about Glacier Lakes and Floods in the Target Area

Year	Date/ Season	Supposed Source area of the flood	Remarks	Sources
1844		Ishkoman	Glacier lake outburst	Drew (1875)
1860 or 1861		Karamber	Glacier lake outburst	Hayward (1871)
1865	June/July	Karamber, Sokther Rabot	Lake at Karamber Glacier	Drew (1875)
1870		Karamber	Ice dam, no outburst	Hewitt (1982)
1891-1892		Ishkoman	Ice dam, no outburst	Hewitt (1982)
1893	6/7 July	Karamber	Water rose up to 23 feet above high flood level at Gilgit	Todd (1930)
1895		Karamber	Glacial flood	Kreutzman (1994)
1905	17/18 June	Karamber	Glacier dam broke at midnight. 20 feet above high flood level. Considerable damage to villages along the river banks above Gilgit	Todd (1930)
1905		Sokther Rabot		Kreutzman (1994)
1905		Warghut		Tilman (1951)
1909		Warghut	Periodic and disastrous floods	Longstaff (1951)
1911-1913		Saklei Shuyinj(?)	Ice dam; subglacial drainage	Stein (1928)
1916		Karamber	Ice dam	Hewitt (1982)
1955		Karamber	Ice dam	Hewitt (1982)
1972		Chateboi	Small lake	Iturrizaga (2005a)
1977-1978		Darkot	Landslide/debris flow	Raschid (1995), Whiteman (1985)
1980	July 27	Khalti		David Archer (2001)
1984	August 4	Gulogh		David Archer (2001
1990		Warghut	Lake	Iturrizaga (2005a)
1993		Karamber	Ice dam	Hewitt (1998)
1993		Chateboi	Very small lake	Hewitt (1998)
1995	July 25	Sosat		David Archer (2001
2004		Chateboi	Very small lake	Iturrizaga (2004)

Annex B
Elements at Risk and Risk Level to a Debris Flow Hazard

No.	Elements at Risk	Risk Level		
		Low	Medium	High
1	Houses (#)			12
2	Educational Facility (#)			
3	Medical Facility (#)			
4	Prayer Facility (#)	2		1
5	Office (Police Station, #)	1		
6	Public Building (Rest House, #)	1		
7	Water Channel (#)		1	
8	Road (meters)	30	20	
9	Productive Land			
10	Other (please specify)			

Annex C
Vulnerability and Capacity Assessment of a Village in the Project Area

Community Vulnerability & Capacity Assessment

Village Name: Immit — District Name: Ghizer

Assessor: Mujeeb/Ejaz — Date: 20-March-06

Category	S#	Indicators	Answer Yes	Answer No
Social / Economical/ Organizational	1	Is the average household size of the village less than 5?		√
	2	Does the community have diverse livelihood options?	√	
	3	Is agriculture not important to the community's economy?		√
	4	Are there savings and credit systems in the community?		√
	5	Does the community do internal lending?		√
	6	Is the community well organized?		√
	7	Is the health sector ready to withstand any disaster or emergency situation?	√	
	8	Does the community have access to basic services	√	
Preparedness & planning	9	Does the community have emergency response resources available?		√
	10	Has the community received emergency management training?	√	
	11	Is there any emergency response team established in the village?	√	
	12	Does the community have access to stockpile of emergency supplies?	√	
Sustenance	13	Does the community reserve food for emergency?		√
	14	Does the community have easy access to the local market for food?		√
	15	Does the community have easy access to a government food depot?		√
	16	Can the community support itself without external food supply for a specific period of time?	√	
Setting	17	Is the community located in the area affected by any glacier lakes or reservoirs?	√	
	18	Is the community living in harsh climatic conditions?	√	
	19	Are most buildings non-engineered?	√	
Communication	20	Does the community have access to telephone or other communication facilities?	√	
	21	Is the village accessible by road?	√	
	22	Is the village accessible by all-weather road?	√	
	23	Does the community have sufficient means of transportation?	√	
Physical Vulnerability	24	Is the village located on a hazardous site or vulnerable to a specific hazard?	√	
	25	Has the community suffered from acute or chronic food shortage?		√
	26	Has the community suffered from an emergency situation in the past?	√	
	27	Is the community directly or indirectly impacted by a disaster that was not common to this village?	√	

Timber is main source of income of villagers. They are haphazardly compiled near the forest area, which can lead to a big forest fire near villages.

The study was able to present some policy recommendations to reduce forest fire risks to the forestry organizations in Nepal. The grant added to my professional experiences and increased my confidence to search for other opportunities...

-Bhoj Raj Khanal

Grant No. 2184

Forest Fire Risk Reduction Techniques in the Community Forests of Nepal

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Abstract

Forest fires occur annually in all the major climatic regions of Nepal, including the Terai[1] and inner Terai. By destroying natural vegetation, forest fires are degrading Nepal's biological diversity. There are several causes of community forest fires: hunting and poaching of wild animals (23%); throwing cigarettes (19%); intentional fires to hasten the growth of grass fed to livestock (18%); collection of herb and honey (8%); children playing (8%); security from armed groups (6%); and collection of charcoal (5%). Unknown reasons comprised 4% of the causes of forest fires.

Community people are knowledgeable about the hazards and causes of forest fires. Therefore, their involvement is necessary for fire hazard reduction. Community-based organizations can provide solutions to the problem of forest fires. Community level fire control groups should be formed and trained on fire prevention and provided with fire fighting equipment. The top-down approaches adopted by government have failed to address the specific needs of vulnerable communities and ignored indigenous capacities and mechanisms. A fire forecasting system can help community forest users' group and other stakeholders to manage and conserve the fire prone areas more effectively and efficiently. Both community-based and scientific knowledge and technology should be embraced and applied.

The results of this study will be disseminated through workshops at the national and district levels. The research outputs will also be published in English and Nepalese languages (in booklet and leaflet forms) and will be distributed to the stakeholders of the community forests.

Background

Forest resources enable people, especially rural households in mid-hills and inner Terai, to earn their daily living in Nepal. One million hectares of forest have already been handed over to 14,000 community forest users' groups (CFUG) in Nepal (DoF, 2004). The District Forest Office (DFO) in Chitwan has formed 47 FUGs and has handed over forests at the community level until 2004 (DFO Chitwan, 2004).

Nepal does not have actual data about the number of fires, severity, and amount of loss. Nonetheless, forest fires occur annually in all major climatic regions of the country, including the Terai and inner Terai regions, during the dry season from February to May. Once the monsoon season starts in the middle of June, the forest fire problem disappears in the country.

Forest fires degrade the soil, inducing floods and landslides. The risk of forest fires from state owned forests is high and destroys community forests (CFs). However, there is no systematic plan to reduce and prevent fire hazards. With difficult topographical conditions, hot and dry climate, low level of education, lack of property, dependency on forest resources, and lack of proper extension activities, CFs have difficulties coping with forest fires. Illegal logging, accidental burning, carelessness, intentional fires, and encroachment on forest land for cropping and infrastructure development have destroyed the forest cover. Cattle grazing, smokers, and accidental burning comprise 54% of the known causes of forest fires; while 32% are of unknown causes (Sharma, 1996).

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[1] The Terai region is composed of a 26 to 32 km wide broad belt of alluvial and fertile plain in the southern part of Nepal. This belt extends from the westernmost part of the country to the eastern limit and covers about 17% of the total land area

The latest forest inventory has indicated that from 1978 to 1994, Nepal's forest cover decreased from 38% of the land area to 29%. Another 10.6% of the land area is under shrub cover and about 45% had been covered with forest until 1966. The annual deforestation rate is estimated at 1.7%, of which forest fire is a major cause (The Kathmandu Post, April 3 2001). Forest fires cause the movement of dry air with smoke and pollutant gases that affect the health of people. Sharma (1996) observed that about 90% of the Terai forests were burned in 1995. Earlier observations [Goldammer (1993) cited in Sharma (1996)] confirm this. The estimated burned area of forest is more than 400,000 hectares, with fires burning at least 100 villages annually. In 1998, 20 reported incidents of fires in 15,140 hectares of forest area resulted in huge losses to life, property, and endangered species of flora and fauna. The estimated cost was USD 127,500.

The specific objectives of the research are the following:

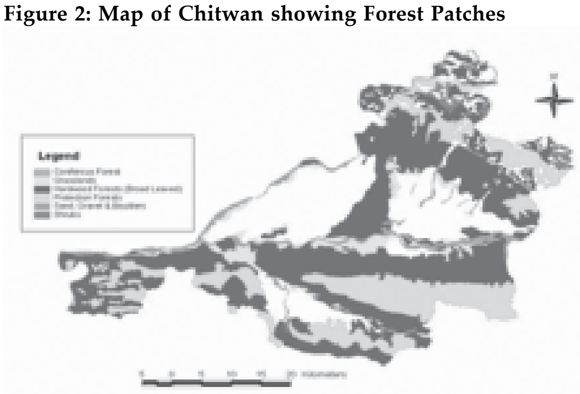
1. To document existing forest fire risk reduction techniques in CFs.
2. To find out the causes and effects of forest fire in CFs.
3. To outline the role of stakeholders to reduce the risk of forest fire in CFs.
4. To promote policies and appropriate mechanisms on forest fire risk reduction in the CFs.

Study Area

Chitwan district was selected as the study site because it is one of the fire-prone districts located in the central part of the country. The CFs were selected from the buffer zone and non-buffer zone forests where fires occur annually. The CFs from the buffer zones were: Chitrasen Buffer Zone CF, Daksin Kali Buffer Zone CF, and Milijuli Buffer Zone CF. The CFs from the non-buffer zones were: Panchakanya CF, Satanchuli CF, and Jaladevi CF. The following two maps show the Chitwan District (Figure 1) and its forest patches (Figure 2):

Figure 1: Map of Nepal showing Chitwan District

Figure 2: Map of Chitwan showing Forest Patches



Methodology

Both primary and secondary data were collected. Secondary data was obtained from the Department of Forest (DoF), DFO-Chitwan, Chitwan National Park (CNP), National Trust for Nature Conservation (NTNC), Department of National Park and Wildlife Conservation, Forestry Research Division, NGOs working in the CF management, and concerned FUGs from buffer zones and non-buffer zones. Primary data was collected from the institutional survey of selected FUGs and members' household survey. The data gathered included causes of fire, effects of fire, fire types, duration of forest fires, and monthly distribution of forest fire incidents throughout the year. The following risk reduction mechanisms for forest fires were considered: extension programs, workshops, enforcement of laws and regulations, fuel management-fire line construction, control burning along the fire lines and construction forest tracks and roads, and clear demarcation of forests. Round table discussions were held with forestry professionals (DFO, NTNC, and CNP) and community people to compile their knowledge and experiences on forest fire risk reduction. Six focus group discussions (three each in buffer zone and non-buffer zone) were held to find the causes, effects, and indigenous techniques that CFs were using. During the dry season (February to May), the research team observed the damage caused by forest fires in the study area.

Key Findings

Causes of Forest Fires. According to Sharma (1996), the fuels in the forest areas are highly combustible. Fuels found in the layers of Sal *(Shorea robusta)* leaves and other species comprise about 90%. Other surface fuels are from twigs and grasses. Some 10.7 tons of fuel can be found over dry areas.

There are two categories of the causes of forest fires: intended and unintended. In the former category, people deliberately start a fire in the forest to collect herbs, to hunt, and to hasten the growth of new grasses to feed livestock and use for roof cover in their village. The latter category consists of unextinguished cigarettes carelessly thrown away, burning of agricultural products, children playing, control burning that later becomes unmanageable, and careless travelers.

The following are the observed causes of forest fires in the selected six FUGs in the buffer zone and non-buffer zone.

Table 1. Causes of Forest Fires in the Buffer Zone CFs and Non-buffer Zone CFs

Causes of Forest Fire	Buffer Zone CFs			Non-buffer Zone CFs			Average (%)
	CBZCF	DKBZCF	MJBZCF	PCF	SCCF	JDCF	
To hasten growth of new grass	10	10	45	10	10	20	17.5
Cigarettes	20	20	10	20	20	20	18.33
Collection of herb/honey	5	-	5	10	25	5	8.33
Collection of charcoal	10	10	-		-	10	5
Hunting/poaching of wild animals (wild boar and others)	30	20	20	15	25	30	23.33
Playing children and cattle herders	5	20	-	10	10	-	7.5
Security reasons (from state and rebel groups)	-	10	-	15		10	6.0
To get rid of wild animals	10	10	15	10	10	5	10
Unknown reasons	10	-	5	10	-	-	4.0

Acronyms: CBZCF: Chitrasen Buffer Zone Community Forest, DKBZCF: Daksin Kali Buffer Zone Community Forest, MJBZCF: Milijuli Buffer Zone Community Forest, PCF: Panchakanya Community Forest, SCCF: Satanchuli Community Forest, JDCF: Jaladevi Community Forest

The observed causes of fires in CFs are largely anthropogenic. They are as follows: hunting and poaching of wild animals (23%); throwing of cigarettes (19%); intentional fires to hasten the growth of grass fed to livestock (18%); collection of herb and honey (8%); children playing (8%); security from armed groups (6%); and collection of charcoal (5%). Unknown reasons comprised 4% of the causes of forest fires.

The effects of seasonal forest fires can be very destructive, resulting in the loss of human lives, timber and non-timber forest products, livestock, and wild animals. With burned trees, stumps, flowers, grains, and seed, and damage to natural resources such as watersheds, the environment's recovery from forest fires may take several years. The destruction of animal and insect habitat causes imbalance in the ecosystem. The change in soil texture affects its capacity to hold water, kills microorganisms, and reduces organic matter in the soil. Smoke from forest fires causes haze in the villages, diminishing air quality.

In regions affected by forest fires, climate patterns become irregular because of the heat that rises to the atmosphere, contributing to global warming.

Forest fires in the community forest near the East West Highway in Barandhabhar Corridor Forest, which is very close to the Chitwan National Park in Chitwan District.

Community Based Forest Fire Management and Risk Reduction Techniques. Community people have developed their own methods and traditional ways of forest fire management. These include: worshiping the forest goddess; planting evergreen trees along the trails; collecting forest litter for animal bedding and making compost; patrolling within their CFs; penalty and reward system for the villages; construction of small ponds, forest tract and fire lines inside the forest; and early and controlled burning in the fire prone areas.

CF members are making a canal to conserve water and reduce the risk of forest fires

Water reservoirs are constructed in some of the CFs to reduce fire risk

The problems that CFs are facing include the following: insufficient plans and programs to control fire with DFO and NTNC; inadequate human and financial resources; insufficient extension programs for community people, especially cattle herders, school children, and collectors of non-timber forest products (NTFPs); lack of strong policy or fire control rules and regulations; and lack of specific fire control organization as DFO; and NTNC not prioritizing the forest fire risk reduction program.

The top-down approaches adopted by government have failed to address the specific needs of vulnerable communities and ignored indigenous capacities and mechanisms. Community people are knowledgeable about the hazards and causes of forest fires. Therefore, their involvement is necessary for fire hazard reduction. Community-based organizations can provide solutions to the problem of forest fires. Sharing responsibilities, raising awareness, building capacity of FUGs, early warning and monitoring are the key aspects to strengthen fire risk reduction measures. In addition, community level fire control groups should be formed and trained on fire prevention and provided with fire fighting equipment. **Existing Forest Fire Regulations and Organizations.** Clause B, Section 49 of the 1993 Forest Act, states that "starting a fire or doing anything that may cause a fire accident in natural forest is prohibited." Clause 50 of the Act stipulates that "any person who commits such an offensive shall be punished with a fine of not more than 10,000 Nepalese Rupees (approximately USD 140) or with imprisonment for a term not exceeding one year or both." As the only legal provision for fire control, it is ineffective because it is extremely difficult to identify the offender. Every CF, however, has its own Operational Plan (OP) in forest fire management.

During the season of forest fires, Nepal Radio and Nepal Television broadcast clips on forest fire prevention and fire fighting. The Community Forestry Division of DoF also publishes and distributes leaflets, booklets, posters in the fire-prone areas to make people aware of the risks. The DFO used to hire temporary fire watchmen to help CFs in preventing and fighting fires. However, the lack of training, resources, appropriate skills, and specific organizations made this initiative ineffective.

Government support in the enactment of laws and policies for community based fire risk reduction and management is vital. DFO and NTNC have been ineffective because of the lack of resources; insufficient fire control and extension programs; inadequate fire control rules and regulations; absence of organizations responsible for preventing and fighting forest fires; and lack of proper risk reduction mechanisms. Preparedness consists of measures that enable governments, organizations, communities and individuals to respond rapidly and effectively to disaster situations (Carter, 1991). In the case of forest fires, it is important to formulate effective and updated counter disaster plans, provide a warning system, and implement public education, awareness, and training programs to FUG members.

Recommendations

Since the people are the main cause of fires in community forests, prevention and control must involve communities. Fire management includes monitoring, early warning, prevention, preparation, suppression, and restoration activities that the community can take part. Investing in fire education and training programs will substantially reduce the number of fires and the cost of fire management. The cost of fire education campaigns is very low compared to costs entailed in controlling fires and recovering from fire-inflicted damages. It is strongly recommended that a significant portion of the budget be allocated to forest fire prevention.

National Level Stakeholders are the DoF, Department of National Park and Wildlife Conservation, Community Forestry Division, NTNC, and Forest Research Division. Below are the recommendations for them:

- Include forest fire education in the school curriculum.
- Use satellite imagery (GIS technology) in government offices to monitor forest cover change and fire extent throughout the country and disseminate the information to CFs in fire-prone areas.
- Develop training curriculum for "community-based forest fires risk reduction program." This program should impart skills for FUG members on forest fires risk reduction and effective use of indigenous knowledge.
- Conduct regular researches on forest fire to eliminate the repetition of previous mistakes, improve ongoing forest fire risk reduction capability, assist in reducing vulnerability to forest fire disasters, and stimulate forward-looking concepts for the future.
- Form specific institutions to deal with fire prevention extension activities, human resources development, law enforcement, fire suppression, and fire research.
- Prepare sufficient booklets, leaflets, and other educational materials (in local language with pictures) and distribute in the communities living in fire-prone forest areas.
- Formulate policies based on forest fire researches.

District Level Stakeholders are the DFO, CNP, District Development Committee (DDC), NTNC-District Office, and Federation of Community Forest Users' Group. Below are the recommendations for them:

- Provide appropriate training and distribute materials among FUG members, school children, cow herders, and school teachers.
- Identify a key partner institution to deliver training programs (including NGOs) and to enhance FUG members' response and preparedness capacity.
- Mobilize NGO resources to provide trainings to community leaders, teachers, and personnel on preventive measures of fires.
- Set up an early warning and communication system among community forests for possible outbreak of forest fires, and coordinate with other CFs.
- Enforce laws, regulations, and restrictions on community forests regarding fires.
- Authorities and communities should work as partners. Authorities should refrain from adopting top-down approaches with communities.
- Assist CFs to formulate effective and updated fire disaster plans.
- Prepare a detailed report about the occurrence, damage, and impact of fire and disseminate to all stakeholders.
- Conduct researches on local people's use of fire, yearly number of fires and burned areas, number of fires, fire distribution and direction, duration, monthly distribution of fire incidents throughout the season, and impact on the different ecosystems.

Community Level Stakeholders are the CFUGs, Community People, Village Development Committee (VDC), Range Posts, and SAHARA—a local NGO. Below are the recommendations for them:

- Clear demarcation and fencing of forest areas to prevent children and travelers from entering.
- Raise awareness on the proper use of flammable materials among FUG members, school children, cow herders, and school teachers.
- Form teams of fire fighting volunteers in fire prone areas
- Construct fire lines, forest track, ponds, and canals according to the forest operational plan.
- Practice fuel management and control burning before fire season.
- Regularly organize fire prevention and suppression campaigns.
- Raise community people's awareness on safe forest fire risk reduction techniques.
- Train FUG members and other community people on the techniques to extinguish fires.
- Promptly detect fires through observation points, patrolling, communication network, fire forecasting (early warning system), and coordinating with nearby CFs.
- During fire incidents, clean fire lines and forest tracks if there are forest areas nearby so that fire would not spread from villages to the forest areas and vice versa.
- Conduct research to find the causes of fire and plan for future.

Dissemination Strategy and Action Plan

In February and March 2007, a national-level workshop in Kathmandu involving all national level stakeholders and other ProVention grantees will be organized to disseminate the research findings.

After the national workshop, a mini-workshop that will present the research findings will also be organized in Chitwan District (study area), with the help of DFO-Chitwan, NTNC Sauraha, and CFs. All district and community level stakeholders will be invited.

After the workshops, the research outputs will be published in booklet and leaflet forms filled with pictures in Nepalese language and distributed to all stakeholders. Below is the work plan:

Activity Time Table

S. N.	Description	2007				
		Jan	Feb	Mar	Apr	May
1.	Refine the final report					
2.	Organize joint workshop in Kathmandu					
3.	Organize mini-workshop at community level					
4.	Translate report in Nepalese language					
5.	Publish booklet in Nepalese language					
6.	Publish leaflet in Nepalese language					
7.	Distribute leaflets and booklets					

Acknowledgement

The author expresses his sincere appreciation to the ProVention Consortium and the Asian Disaster Preparedness Center (ADPC) for providing the research grant, invaluable support, and guidance throughout the study period.

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Annex A

List of Acronyms

ADPC	Asian Disaster Preparedness Center
BCF	Barandhabhar Corridor Forest
BZCFUG	Buffer Zone Community Forest Users' Group
CBS	Central Bureau of Statistics
CF	Community Forest
CFD	Community Forestry Division
CFUG	Community Forest Users' Group
CNP	Chitwan National Park
DDC	District Development Committee
DFO	District Forest Office
DoF	Department of Forest
DNPWC	Department of National Parks and Wildlife Conservation
EC	Executive Committee
FAO	Food and Agriculture Organization of the United Nations
FUG	Forest Users' Group
GIS	Geographical Information System
Ha	Hectare
NTNC	National Trust for Nature Conservation
NPC	National Planning Commission
NTFP	Non-timber Forest Product
OP	Operational Plan
VDC	Village Development Committee

Annex B

List of Community Forests in Chitwan District

N	Name of FUGs	Address	Total HH	Area (Ha)	Population
1	Parameshowi	Piple 6	406	938.25	3000
2	Baghamara	Bachauli	532	400	3380
3	Kankali	Chainpur, Birendranagar	1318	737	8557
4	Bandevi	Bharatpur 8 and 9	1075	200	9000
5	Kumroj	Kumroj	1177	1050	7238
6	Janakauli	Bachauli 5,6 and 7	312	97	2908
7	Bhramasthani	Piple 4	194	75	1117
8	Surdevi	Piple 5	244	201.56	1437
9	Shivashakti	Piple 7	402	NA	2211
10	Bandevi	Piple 7	208	200	1200
11	Kushana Gathauli	Kathar 1	112	NA	731
12	Ajingare	Chainpur 1, 2 and 3	605	290	3727
13	Pashupati	Piple 7	203	200	1453
14	Shivapuri	Piple 7	333	300	1726
15	Nawajyoti	Bhandara 7	47	NA	278
16	Chitrasen	Ratnanagar 4, 5 and 6	664	500	4200
17	Amrit Dhara	Chainpur 9	501	1088	3950
18	Dudhakoshi	Birendranagar, Khairahani	782	1005	5330
19	Indreni	Shiddi, Shaktikhor	401	NA	2994
20	Baghadevi	Birendranagar 1	665	700	4219
21	Dhulewatar	Kabilas 2	77	NA	475
22	Bhagawan Sthal	Shivanagar 1	93	NA	473
23	Nawa Jagriti	Bharatpur 11	1149	NA	10000
24	Kalika	Shaktikhor 9	125	NA	900
25	Chturmukhi	Jutapani 8 and 9	220	NA	1300
26	Gyaneshwor	Mangalpur 1,2,3,4,5, 6	1660	NA	9380
27	Kalika	Birendranagar, Khairahani	1776	987.5	13000
28	Rambel	Bharatpur 12	558	NA	3427
29	Danglo	Korak 3,4 and 6	93	60	609
30	Deujar	Shiddi 7	47	42	287
31	Panchakanya	Ratanagar	1019	NA	6506
32	Satanchuli	Bharatpur 1	402	NA	1927
33	Sat Kanya	Pithuwa 1	305	300	1566
34	Jaladevi	Bharatpur 2	251	NA	1634
35	Jana Pragati	Shaktikhor 1 and 5	180	NA	1009
36	Jamuna	Kuwapani, Shaktikhor	126	NA	1200
37	Jay Shri Brahasthani	Piple 9	186	NA	1080
38	Shikhar Hariyali	Bhandara 7,8, 9, Korak 7,	862	NA	5809
39	Thakal Tar Sal	Korak 1	161	NA	1421

Source: District Forest Office, 2004.
Note: NA = Not Available

Annex C

The Use of GIS Technology for Forest Fire Prediction: The Simulation Model
(Saidi Ahmed, Center National des Techniques Spatiales, CNTS, Algeria) http://www.ing.unitn.it/

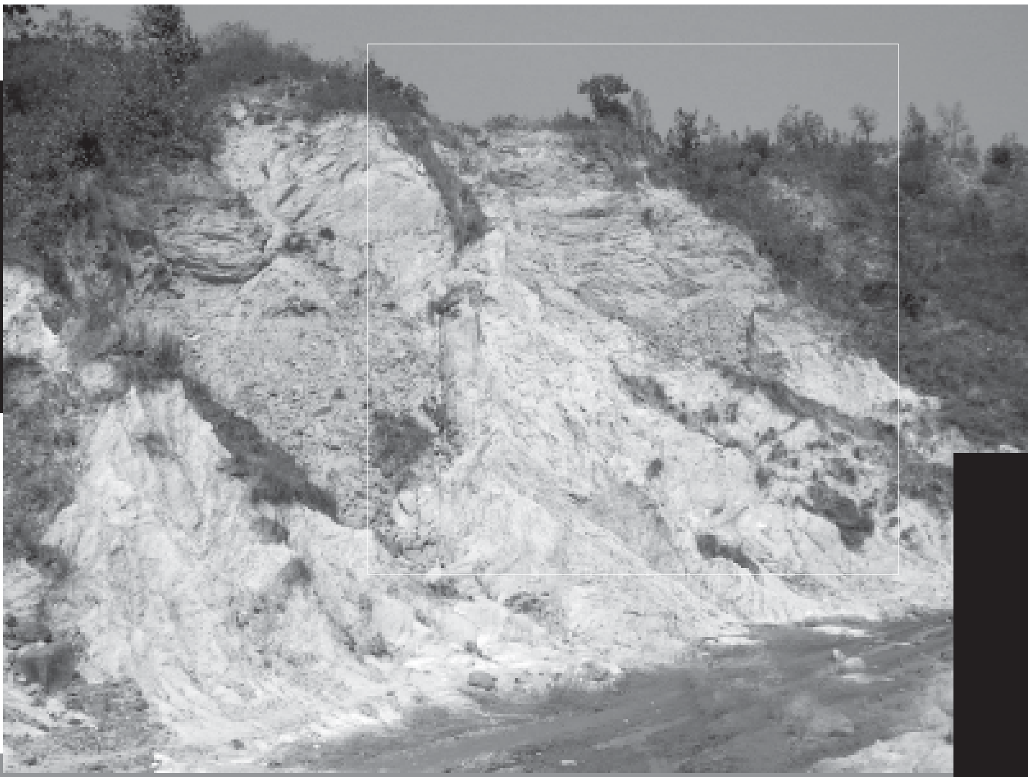
One of the best ways to understand forest fires is to have a tool that informs us about the beginning of a fire according to given environmental and climatic conditions. In this context, fire modeling and simulation is an efficient tool predicting and managing forest fires. Such a model allows a determination of zones susceptible to fires in a specific time interval with some degree of confidence. The study elaborates on the development of a tool that is able to represent suitably the parameters of forest fires and behavior in a given region. To characterize these mechanisms adequately with spatially distributed propagation parameters, the use of GIS is unavoidable. GIS—in combination with simulation techniques—provides a sound basis for appreciating and understanding problematical forest fires. GIS has the power to represent all phenomena within a geographical area. Such fire simulation models have two main attractions to operators in charge of managing forest fire (firefighters, forests services, local collectives, etc.). First, they allow the consideration and verification of various forest control and management action without having to suffer the disaster of a real fire. Hence, they allow operators to define a long-term coherent and homogeneous policy of forest fires prevention. Such models also make it obviously clear that the co-ordination of the intervention teams in the early stages of a fire is of paramount importance in developing an effective strategy for controlling forest fires.

Annex D: Pictures of Forest Fires in the area

Picture 1: Left over forest trees after a big fire in the community forests.

Picture 2: Forest fire near the Baradhabhar Corridor Forest near Chitwan National Park.

Picture D: There is still fire in the forest after a week long of fire in Chitrasen Buffer Zone Community Forest, where fires occur twice a year.



Landslide upstream of Biduwa and Tirtire Confluence increased soil erosion

The community is adapting to climate change. They have a lot of indigenous knowledge. The project helped me establish the link between community knowledge and hydro-meteorological data. The research was able to identify areas that are safe from hydrological accidents and other water-induced disasters.

-Suresh Marahatta

Grant No. 2085

Using Local Knowledge to Understand and Mitigate Community Risks from Climate Change in Nepal

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Abstract

Climate change has significantly affected the natural resources and livelihoods of communities. Through local knowledge and indigenous adaptation mechanisms, communities have been continuously mitigating the adverse impacts of climate change.

To know more about the impacts of climate change, vulnerability, and community adaptation on agriculture, water resources, forestry, and socio-economy, an exploratory case study was carried out in the Chulachuli Village Development Committee (VDC) of Ilam Siwalik in Nepal. The study collected primary information through structured interviews with randomly selected households in two micro watersheds. It likewise obtained secondary information on temperature and precipitation data from the Department of Hydrology and Meteorology (DHM), Government of Nepal.

The present study revealed that climate changes, in general, and changes in rainfall pattern, in particular, have affected the farming systems and water resources at the local level. The major risks in the study area consisted of unpredictable floods, landslides, heavy soil erosion, river cutting, and drought. These changes have greatly reduced water availability and agricultural productivity. Under these circumstances, communities have adapted through some mitigation measures based on local knowledge and traditional practices. Some of them have modified cropping patterns and changed crop types, varieties, and cultural practices for agriculture. Other communities have started digging wells and harvesting rainwater during the monsoon season to minimize the water scarcity risks during the dry season. However, these indigenous coping mechanisms have not been well documented.

Background

The past few decades have seen significant increases in global temperatures resulting in climate changes and frequent occurrence of extreme weather conditions mainly due to human induced factors. The IPCC (2001) reported that global temperatures are expected to rise between 1.4ºC and 5.8ºC by 2100. The impacts on the natural environment would be dire if strenuous efforts are not taken to limit emissions of greenhouse gases (GHG), especially carbon dioxide.

As a member of the global community, Nepal has suffered from the consequences of these aberrant climate changes—retreating glaciers, increasing glacial lake outburst flood (GLOF), frequent occurrence of extreme floods, and droughts. A collective effort is required from all the stakeholders, decision makers, and professionals to mitigate the impacts of this global threat.

Analysis of observed temperature and precipitation data in Nepal is limited. One of the reasons is the relatively short length of time—about 30 years—that data has been recorded. Available studies have shown that temperatures in Nepal are increasing at a rather high rate. Shrestha et al. (1999) analyzed 49 stations in Nepal and found that there was consistent warming since the mid-1970s that continues today. They found that the average increase in annual temperatures between 1977 and 1994 was 0.06 ºC. Warming is more pronounced in the higher altitude regions of Nepal, such as middle-mountain and the Himalayas; while it is significantly lower or even absent in the Terai and Siwalik regions. Further, warming in the winter is more pronounced compared to other seasons. Compatible with projections made in climate models, the two warmest years in Nepal were 1998 and 1999.

Similar analysis on precipitation data in Nepal did not indicate significant trends but is correlated with several large-scale climatological phenomena, including El Niño (Shrestha et al., 2000). Warming observed in Nepal is also observed in the Tibetan Plateau.

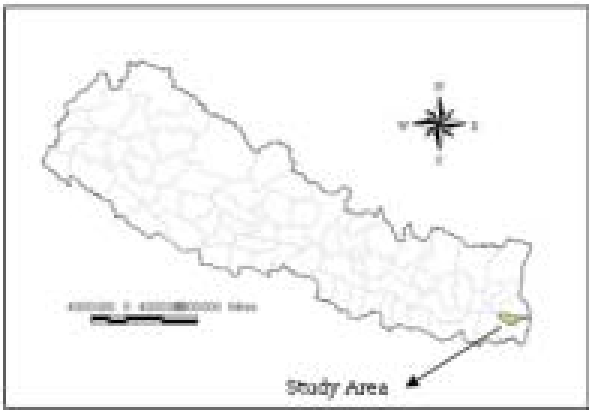
In the Tibetan Plateau, warming is more pronounced in higher altitude stations than in lower ones (Liu et al., 2002). In contrast, the widespread lowland areas of India do not show significant warming. It is inferred that the Himalayan and Tibetan Plateau, being elevated regions of the globe, are more affected by climate change.

The MOPE (2004) reported that the observed trend of temperature rise per decade was 0.41°C. Seasonal rising trends all over the country during pre-monsoon, monsoon, and winter were 0.43°C, 0.43°C, and 0.37°C per decade, respectively. Studies related to vulnerability and adaptation to climate change in Nepal has just began with a focus on four sectors: forestry, agriculture, water resources, and health.

Methodology

The study areas were: Bukuwa Khola (Stream) watershed, Biduwa Khola watershed, east of Ratuwa Khola covering Thapa holi watershed, and Dudhe Khola watershed in the Chulachuli VDC in the Siwalik region of the Ilam District, Eastern Nepal. Chulachuli VDC lies in the northern boarder of Jhapa District and consists of flat, denuded land with large spans of riverbed. The study area is elevated from 160 to 532 m amsl at 26° 42' to 26° 47' N and 87° 40' to 87° 45' E. The study area is shown in Figure 1 below.

Figure 1: Map of Study Area



The study covers only part of the Siwalik area of Ilam district that is Bidhuwa and Bukuwa Khola watersheds. Glaciers are excellent indicators of climate change in the Himalayan region (Oerlemans, 1989 and 1994). Siwalik is a low elevation area and the parameters used in the climate change study included precipitation, temperature, vegetation, and water resources.

Secondary sources of information of the population and households were collected from the Election Commission (EC). Monthly rainfall and temperature data (1972-2001) used in the study were obtained from the Department of Hydrology and Meteorology (DHM). Altogether, data from five meteorological stations were used in the analysis. Missing data in some stations were computed by normal ratio method and the arithmetic average method. The measured and simulated rainfall data predicted by normal ratio method and double mass technique was also checked. Precipitation, temperature, and natural disasters were the key indicators of this study.

Field reconnaissance was carried out from January 3 to 7, 2006 in the Ratuwa Khola and Bidhuwa Khola area of Ilam Siwalik region. Descriptive cross sectional study was carried out. The structured household questionnaire was tested to explore the suitable community to carry out the study on the impacts of climate-induced hazards. Through random sampling, 52 households were selected for the survey. Detailed field surveys were carried out two times from January 27 to February 3, 2006 and March 3 to 12, 2006. The information obtained using the survey questionnaire was analyzed using SPSS software.

The field study aimed to verify the secondary data collected, seek additional on-the-spot data, physically survey the river, and undertake a socio-economic survey of the local communities. To collect the primary information, walkover surveys along the river course were done using a structured questionnaire. Impacts of climate change in different sectors like agriculture, water, forest, and the extent of natural disasters were found during the field visits.

The research plotted and analyzed trends and temporal variations of annual rainfall at each station, including the rainy days and the mean monthly rainfall during the monsoon months. It also prepared isohyetal and isothermal maps for comparison in the study area.

Key Findings

Rainfall Analysis

The rainfall distribution in the study area showed an increasing trend of 31 mm/decade. Precipitation trends increased during the monsoon and pre-monsoon seasons and decreased during the winter and post-monsoon seasons. The isohyetal map (Figure 2) shows increasing precipitation trends (0 to 100 mm per decade). The analysis of MOPE (2004) indicates negative trends during all seasons in most parts of the Terai belt except in the eastern region. The study area likewise has no distinct spatial variation of rainfall.

Figure 2. Isohyetal map of monsoon precipitation trends

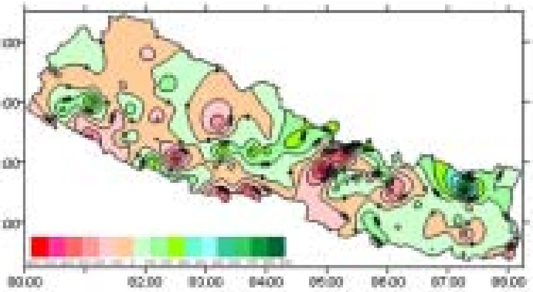


Figure 3. Isohyetal map of annual precipitation trends

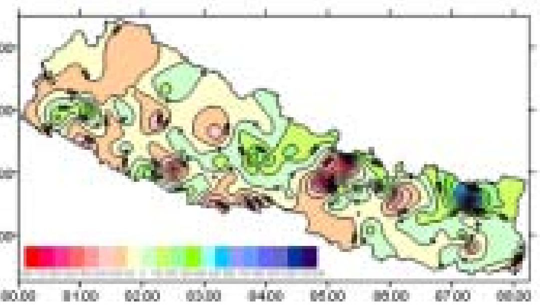


Figure 4. Chronological rainfall chart of study area

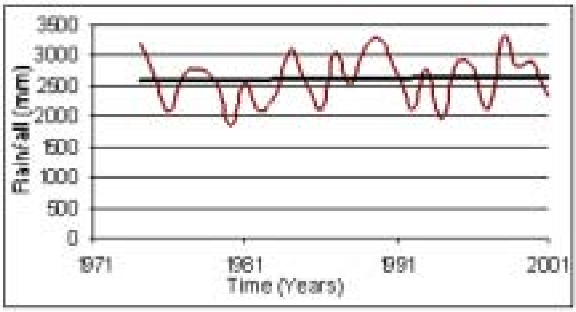
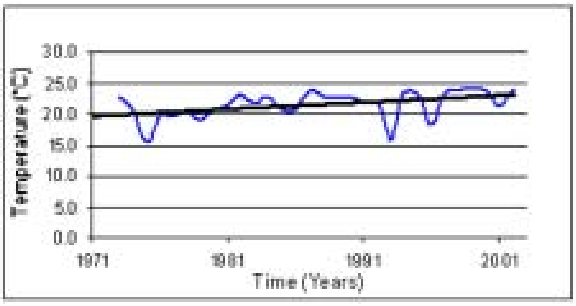


Figure 5. Chronological temperature chart of study area



The normal annual rainfall of the study area is 2,604.1 mm, with 10% precipitation in pre-monsoon, 82% in the monsoon, 6% in post-monsoon seasons, and 2% in winter. Most of the extreme rainfall occurred on the same month at all the stations. Monsoon variability is low in the monsoon season (June to September). Monsoon precipitation has a high trend relative to other season in the study area. The number of days of rainfall and distributions are equally important because Nepal's agricultural activities depend upon the monsoon rainfall. However, monthly rainfall data was not sufficient for a proper analysis of its relationship with agricultural production. Rainfall occurred only in the beginning and the end of the month with a prolonged dry spell occurring in between. This caused serious damage and losses in crop yield.

Drought analysis predicted that out of thirty years, agricultural drought would only occur during the following seven years: 1976, 1980, 1982, 1986, 1992, 1994, and 1997. However, the years 1974, 1984, 1989, and 1998 were abnormal rainfall years. This was consistent with community survey results. Almost half of the respondents (48%) said there was heavy rainfall and 46% said they experienced long drought. During the household survey, 22 respondents (42.3%) reported damage to their roofs; while 31 (39.6%) reported losing of crops due to hailstorm.

Temperature Analysis

The average temperature is 23.3°C, with 15.9°C in winter, and 27.2°C in summer. Isothermal maps of Nepal (Figure 6) show that the isothermal line of 23°C have been observed in the study area. The prediction of MOPE (2004) that a 0°C to 0.5°C rise in temperature per decade was observed in the study area (Figure 7). The winter temperature pattern in the study area shows that the diurnal variation is quite high (11°C) compared to other seasons (9°C).

Figure 6. Isothermal map of Nepal

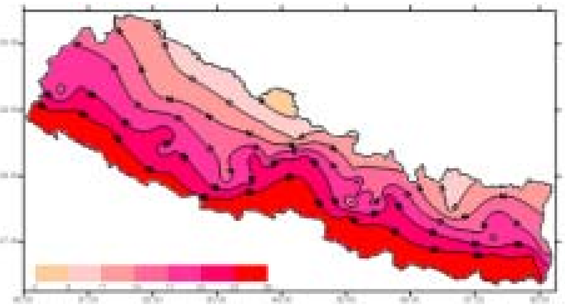
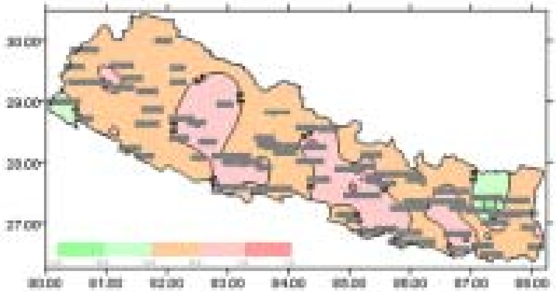


Fig 7. Isothermal map of annual temperature trends in Nepal



River System and Water Resources

The walkover survey found that the Sadu Holi (stream) is the only stable stream in the study area. Most of the streams were dry during the field visit. The Biduwa flow on the upstream of the confluence of Tirtire is around 1 liter/second discharge. There are two water supply schemes at upstream of Biduwa. The river course of Biduwa has shifted 400 m south at the confluence of Bukuwa and Biduwa in 1993. Likewise, water levels in the dug wells have been depleted.

Impacts

Nepal is a least developed country with a complex topographical and fragile structure. Small changes in climate cause large losses. The main impacts of climate change in the study area are as follows:

Agriculture. Agricultural productivity is highly dependent on rainfall and temperature. Changes in temperature, humidity, and radiation affect the incidence of insects, pests, diseases, and microorganisms. MOPE (2004) shows that a mere 1°C change alters the virulence of some strains of rusts infecting wheat and decreases productivity. Most of the people are dependent on a few crops, such as millet, maize, rice, and yam. Lack of rainfall at the proper period decreases production of all crops even if new fertilizers are used. Almost half (40.4%) of the respondents mentioned that different types of diseases like fungus were seen in mustard and other bean crops. The decrease in agricultural production has threatened the food security of the population in area, where many are poor. All 52 respondents said that agricultural production has been decreasing every year.

Different climate induced disasters such as flood and landslides have directly affected crops and agricultural land. The most severe problem is river cutting, change in river route that causes large-scale encroachment on agricultural land. Floods and landslides have changed fertile land into sandy places. Some 3.7 to 0.05 hectares (average of 0.47 hectares) of agricultural land have become sandy. Floods have washed out crops every year. In the last 20 years, each family lost an average of 877 kg of agricultural produce. Most of the people in the area depend on rain to water their plants but the lack of rainfall at the proper time has left the otherwise productive land without any crops. Agricultural production of majority (80.8%) of the respondents decreased due to soil erosion, with most (86.5%) reporting that erosion has made their land sandy.

Water Resources. Changes in temperature and precipitation alter water resources and the hydrological cycle. High intensity rainfall of short duration causes flash floods, landslides, and erosion—affecting water resources, particularly drinking water and irrigation. Half of the respondents (51.9%) said that landslides have damaged the intake tank, broke the drinking water pipe, and damaged the dug well; while 11.5% said that landslides have damaged the irrigation canal.

Majority (88.5%) of respondents said that the quantity of water is decreasing as some springs have dried out. Similarly, the water level in the dug well is decreasing every year. The long droughts are drying out some ponds. Majority (76.9%) of the respondents said that they have experienced water scarcity for years because of the long droughts. High infiltration capacity of the soils, deforestation, overgrazing of upland area, and changes in land used pattern have dried up many of the down streams.

Forestry and Biodiversity. Substantial elevation shifts change ecosystems in the mountains and uplands. At high elevations, weedy species displace tree species, although the rates of vegetation change are slow and constrained. However, such change was not observed in the study area. More than a third (36.5%) of the respondent said that landslides have directly affected the forest land and plants.

Socio-economy. Climatic changes have made people highly vulnerable. All of the respondents said that decrease in agricultural production has weakened their economic conditions and compelled many people to migrate elsewhere. Half (50%) of respondents shifted their houses and animal sheds to safer places to avoid climate induced disasters. Other reasons for out-migration are as follows: floods (34.6%), soil erosion (26.9%); landslides (19.2%); and river cutting (15.5%).

Community Adaptation Options

Communities have devised useful coping mechanisms to adapt to the impacts of climate change, enabling them to be resilient in the face of current and potential hazards.

Agriculture. The agricultural sector is the major provider of employment and will remain so in the near future. To minimize the impacts of landslides, 78.8% of the respondents started to plant vegetation. To minimize the impacts of floods, 84.6% of the respondents constructed embankments, 75% planted vegetation, 44.2% controlled grazing in the riverbank, and 13.5% collected stone and sand from the riverbank. To cope with the impacts of the drought, they planted crops that do not need much water. Most (94.2%) started to cultivate millet, yam, and buckwheat instead of rice. They also explored new varieties of rice that require less water and take a short period to harvest (Jaya and Dalle Aun). As production of traditional crops decreased by as much as 50%, majority (71.2%) of the respondents changed their cropping patterns. They refrained from planting cash crops such as mustard and white jute. More than half (57.7%) changed the crops that they planted. Different types of diseases such as fungus have likewise compelled some 40.4% of the respondents to change their cropping pattern. A tenth (9.6%) constructed an irrigation canal, while 11.5% converted slope land into flat plots.

Water Resources. Depletion of the groundwater has affected the springs and dug wells in many localities. To cope with this problem, 90.4% of the respondents have pumped the ground water and collected running water during rainy season for irrigation; one person has started collecting water from his kitchen. More than half (55.8%) of the respondents have started collecting rainwater from their roofs in large pots and tanks. Most (94.2%) collect water from far distances, with 53.8% storing the water in large pot or drums. A fifth (23.1%) use dug well and dig the ditches in the riverbank to collect water; 19.2% wash and bathe less and instead go to river; while 17.3% has initiated special conservation of forest and plantation near the watershed area. Most of the communities have started collecting water in the tank during night, opening taps only for certain periods at daytime, and people taking turns to get their share of water.

Forestry and Biodiversity. The survey was unable to find out any adaptation measures to reduce the losses in forest and plants because the community only started to conserve forest and promote aforestation.

Socio-economy. To cope with economic losses brought about by climate change, local communities have diversified their livelihoods practices. Many worked for longer periods, with 80.8% of respondents seeking seasonal employment outside their communities. Some worked as wage laborers. Half of the respondents (55.8%) started raising livestock, selling milk, ghee, and other animal products. Some sold their ornaments. Most of the poorer families (46.2%) limited their meals to porridge (Khole), with 32.7% eating only one meal a day.

People's Perception of Future Impacts

The Siwalik area is especially vulnerable to climate-induced natural disasters like landslides, floods, and river cutting that have adversely affected agricultural production, irrigation, and domestic water usage. Two-thirds (63.5%) of the respondent said that if disasters are to continue, the entire village will migrate. Almost half (40.4%) of the respondent believe that if river cutting is not controlled, all the agricultural land will be destroyed within a few years. A third (36.5%) think that water scarcity will turn the Siwalik area into a desert; while 28.8% fear that continuing decrease in agricultural production will threaten food security.

Conclusion

Primary and secondary data have confirmed the climatic increase in temperatures and precipitation, and the decrease in rainfall quantity. The major impacts consist of declining surface and groundwater resources; drought, water scarcity in the dry season; floods, soil erosion, and landslides in the monsoon season—with disasters occurring with greater intensity and frequency. These disasters have adversely affected agricultural productivity.

People have adapted to climate change by intensifying the conservation of drought resistant varieties, changing cropping practices to conserve water, promoting crop diversification, increasing the vegetation cover (i.e. planting kans, Saccarum sponteneum) along the flood plain area, and conserving forest area in the upland. These adaptive measures have reduced the vulnerability of mostly poor local communities.

Recommendations

While it is almost impossible to stop climate induced disasters, their impacts can be minimized. The recommendations below are based on community adaptation strategies:

- Implement participatory watershed conservation projects and aforestation programs.
- Install community level early flood warning systems to reduce the losses.
- Promote diversification of crops that consume less water.
- Promote water conservation mechanisms, such as rainwater harvesting, at household and community levels.
- Concerned non-government and governmental organizations should initiate more participatory action researches to inform climate response policy.

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Annex A
SPSS Results

Table 1: Classification of respondents by age and sex

Age class	Male	Female	Total
20-30	2 (3.8%)	0 (0%)	2 (3.8%)
31-40	12 (23.1%)	2 (3.8%)	14 (26.9%)
41-50	16 (30.8%)	0 (0%)	16 (30.8%)
51-60	9 (17.3%)	3 (5.8%)	12 (23.1%)
61-70	5 (9.6%)	0 (0%)	5 (9.6%)
71-80	3 (5.8%)	0 (0%)	3 (5.8%)
Total	47 (90.4%)	5 (9.6%)	52 (100%)

Table 2: Changes in temperature and rainfall

Rainfall decreased	Temperature increased		Total
	Yes	No	
Yes	50 (96.2%)	2 (3.8%)	52 (100%)
No	0 (0%)	0 (0%)	0 (0%)
Total	50 (96.2%)	2 (3.8%)	52 (100%)

Table 3: Community experiences of temperature and rainfall

Parameter	Yes	No	Total
Rainfall			
Heavy Rainfall	0 (0%)	52 (100%)	52
Low Rainfall	46 (88.5%)	6 (11.5%)	52
Heavy Rainfall at once	48 (92.3%)	4 (7.7%)	52
Long drought	46 (88.5%)	6 (11.5%)	52
Temperature			
Extreme cold	8 (15.4%)	44 (86.6%)	52
Extreme hot	26 (50%)	26 (50%)	52
Temp. increasing	46 (88.5%)	5 (9.6%)	51*

** One informant is missing*

Table 4: Natural disasters from 1983 to 2005

Year	Disasters				
	Landslides	Floods	Drought	Soil erosion	Hailstorms
1983	0	0	0	0	2
1988	14	11	0	12	1
1989	2	6	11	3	0
1990	4	6	0	6	0
1991	0	0	0	2	0
1992	0	2	2	0	0
1993	3	6	0	0	0
1994	3	3	7	0	0
1995	0	0	19	0	1
1996	0	0	0	6	0
1997	0	7	2	5	3
1998	2	0	0	0	0
1999	10	0	0	16	5
2000	0	0	0	16	5
2001	3	10	0	10	22
2002	12	4	1	0	10
2003	5	8	0	2	0
2004	5	0	0	6	1
2005	0	6	48	2	0

Table 5: Impacts of landslides and flood

Types of disaster		Landslide	Floods
Impacts	Loss of houses, animal shed, human and animals	8 (15.4%)	15 (28.8%)
	Effect on crops and agricultural land	32 (61.5%)	48 (92.3%)
	Effect on drinking water	27 (51.9%)	6 (11.5%)
	Effect on irrigation	6 (11.5%)	6 (11.5%)
	Effect on forest land	19 (36.5%)	*

** Flood does not affect forest land.*

Table 6: Impacts of drought

Disaster		Drought
Impacts	Reduce agricultural productivity	52 (100%)
	Water scarcity	40 ((76.9%)
	Diseases in man and animals	5 (9.6%)
	Loss of animals	2 (3.8%)

Table 7: Impacts of soil erosion

Disaster		Soil erosion
Impacts	Cutting and damage agricultural land	45 (86.5%)
	Reduce agricultural productivity	42 (80.8%)
	Irrigation problem	1 (1.9%)
	Damage of different infrastructure and out- migration	9 (17.3%)

Table 8: Impacts of hailstorms

Disaster		Hailstorms
Impacts	Damaged roof of houses	22 (42.3%)
	Damaged crops	31 (59.6%)
	Injured human beings	4 (7.6%)

Table 9: Average losses in livelihoods

Losses	Minimum	Maximum	Mean	Median
Agricultural land (Ropani)	1 (0.05 ha)	74 (3.7 ha)	9.58	5.50
Agricultural production (Muri)	2	90	14.62	7.6
Economy (NRs.)	2,000	2,50,000	39,420	20,000

** Live stocks of five families are affected.*

*** Two said effect on other things like temple, chautari, etc*

Table 10: Adaptation measures for landslides

Disaster		Landslides
Adaptation measures	Plantation	41(78.8%)
	Safe landing of running water during rainy period	4 (7.7%)
	Conserve forest and plants	34 (65.4%)
	Control grazing in public area	8 (15.4%)

Table 11: Adaptation measures for floods

Disaster		Floods
Adaptation measures	Construct embankment	44(84.6%)
	Plantation	39(75%)
	Control grazing in river bank	23 (44.2%)
	Collect sand & stone from river bank	7 (13.5%)

Table 12: Adaptation measures for drought

Disaster		Drought
Adaptation measures	Promote crops that do not need much water	49 (94.2%)
	Irrigate from kitchen water	1 (1.9%)
	Construct irrigation canal	2 (3.8%)
	Water is taken from well, by pumping from ground or from ditches	7 (13.5%)

Table 13. Adaptation measures for soil erosion

Disaster		Soil erosion
Adaptation measures	Plantation	20 (38.5%)
	Control grazing	34 (65.4%)
	Control ploughing	47 (90.4%)
	Construction of check dams	18 (34.6%)
	Safe landing of running water during rainy period	6 (11.5%)

Note: Nothing is done to reduce the impacts from hailstorm.

Table 14: People's perceptions of future impacts

Future impacts	Yes	No
Agricultural land will decrease	21 (40.4%)	31 (59.6%)
Land will become desert	19 (36.5%)	33 (63.5%)
Whole village will migrate	33 (63.5%)	19 (36.5%)
Food scarcity	15 (28.8%)	37 (71.2%)

Table 15: Relationship between change in agricultural production and production decrease

Change in agricultural production	Decrease in production		
	Yes	No	Total
Yes	52	0	52
No	0	0	0
Total	52	0	52

Table 16: Former major crops and changes in crops

Types of crops	Former crops		Change in crops	
	Yes	No	Yes	No
Millet	36 (69.2%)	16 (30.8%)	10 (19.2%)	42 (80.8%)
Maize	29 (55.8%)	23 (44.2%)	4 (7.7%)	48 (92.3%)
Rice	20 (38.5%)	32 (61.5%)	3 (5.8%)	49 (94.2%)
Yam	20 (38.5%)	32 (61.5%)	5 (9.6%)	47 (90.4%)
Mustard	27 (51.9%)	25 (48.1%)	24 (46.2%)	28 (53.8%)
Bean	6 (11.5%)	48 (88.5%)	2 (3.8%)	50 (96.2%)
Wheat	2 (3.8%)	50 (96.2%)	1 (2.9%)	51 (98.1%)
Buckwheat	2 (3.8%)	50 (96.2%)	2 (3.8%)	50 (96.2%)
White jute	14 (26.9%)	38 (73.1%)	14 (26.9%)	38 (73.1%)

**A total of 37 (71.2%) respondents changed crops.*

Table 17: Reasons for changing crops

Reasons	Number	Percent (%)
Decrease in production of former crops	30	47.7
Comes different diseases like fungus	21	40.4
Construct irrigation canal	5	9.6
Lack of water	3	5.8
Slope land is converted into flat plots	6	11.5

Table 18: Adaptation measures from heavy rainfall and drought

Adaptation measures	Number	Percent (%)
Catch the running water during rainy period	35	67.3
Plant crops that need less water	18	34.6

Table 19: Changes in water availability in the past and present

Past	Present		
	Yes	No	Total
Yes	47 (90.4%)	4 (7.7%)	51 (98.1%)
No	1 (1.9%)	0 (0%)	1 (1.9%)
Total	48 (92.3%)	4 (7.7%)	52 (100%)

Table 20: Adaptation measures to cope with scarcity of water for drinking & irrigation

Purpose	Adaptation measures	Number	Percent (%)
For Drinking Water	Rain water harvest	29	55.8
	Collect water from far distance	49	94.2
	Wash & bathe less and go to river	10	19.2
	Waiting for own turn to fill water	2	3.8
	Collect water in large drums and tank	28	53.8
	Water is taken from well and ditches	12	23.1
	Water collected in tank & taps are open for certain periods only	26	50
For Irrigation	Collecting the running water during rainy period	47	90.4
	Collecting the water from kitchen & irrigated	3	5.8
	By pumping the ground water	1	1.9
	Construct irrigation canal	5	9.4

Table 21: Relationship between change in watershed and type of change

Change in watershed	Decrease in water quantity		
	Yes	No	Total
Yes	46	3	49
No	0	3	3
Total	46	6	52

Table 22: Adaptation measures to cope with river cutting (change of river route)

Construction of embankment		Plantation		Control grazing	
Yes	No	Yes	No	Yes	No
46 (88.5%)	6 (11.5%)	43 (82.7%)	9 (17.3%)	23 (44.2%)	29 (55.8%)

Table 23: Disasters that cause migration

Landslides		Floods		Soil erosion		River cutting	
Yes	No	Yes	No	Yes	No	Yes	No
10 (19.2%)	42 (80.8%)	18 (34.6%)	34 (65.4%)	14 (26.9%)	38 (73.1%)	8 (15.4%)	44 (84.6%)

**These disasters weaken the economic condition of respondents.*

Table 24: Adaptation measures to cope with weakened economic conditions

Adaptation measures	Number	Percent (%)
Work more time than normal	32	61.5
Go outside for employment	42	80.8
Eat porridge (Khole)	24	46.2
Rear and sell livestock	29	55.8
Work as wage laborer	33	63.5
Take loans	14	26.9
Have a meal at once a day only	17	32.7

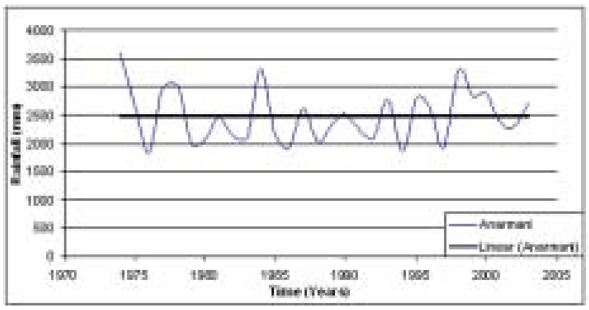
Table 25: Causes of unsuccessful of adaptation measures

Causes	Number	Percent (%)
Lack of water	16	30.8
Weak geography	25	48.1
Heavy rainfall at once	28	53.8
Uncontrolled grazing	1	1.9

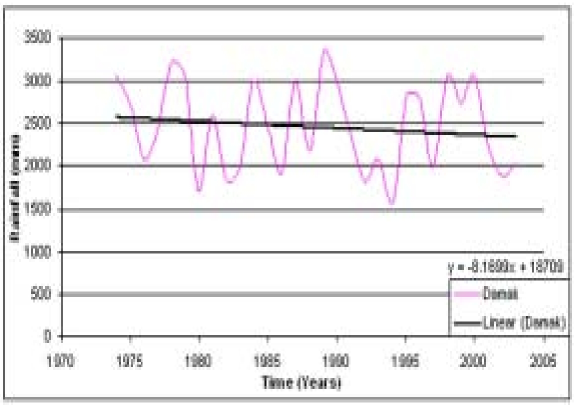
Table 26: Community expectations from government & different organizations to minimize such impacts

Expectations	Number	Percent (%)
Initiate measures to overcome scarcity of water for irrigation and drinking	30	57.7
Initiate measures to control soil erosion and river cutting	29	55.8
Construct bridge in Ratuwa river	5	9.6
Increase awareness about the impacts climate change	29	55.8
Develop this work as model for Siwalik	3	5.8

Annex B
Meteorological Analysis

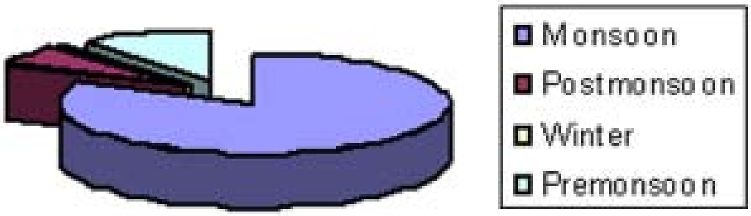


Chronological rainfall chart of Anarmani Birta rainfall station

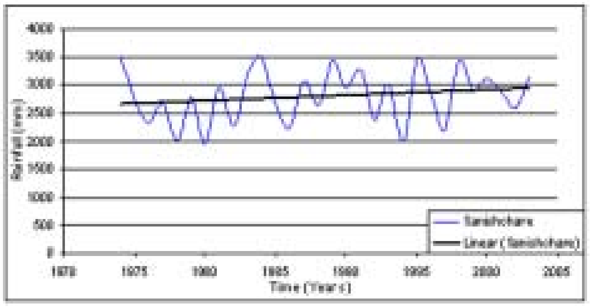


Chronological rainfall chart of Damak rainfall station

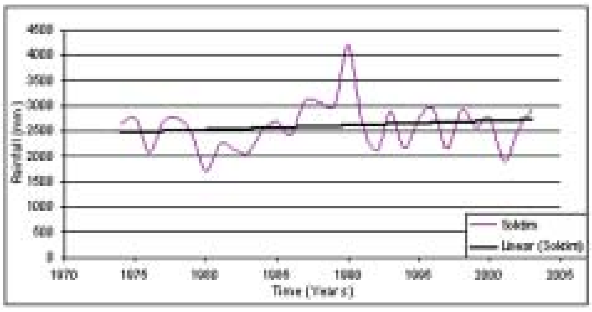
Annex B
Meteorological Analysis *(Continuation)*



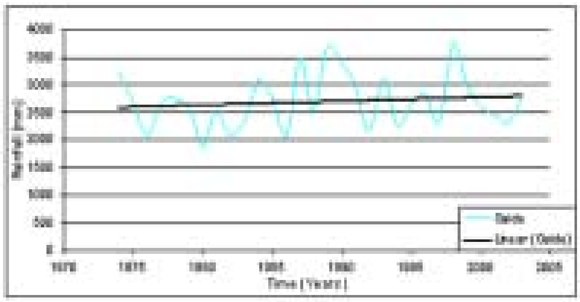
Seasonal variation of Rainfall



Chronological rainfall chart of Sanischare rainfall station



Chronological rainfall chart of Soktim rainfall station



Chronological rainfall chart of Gaide (Kankai) rainfall station

Iwas Sakuna (Prevent Disaster) -Kids' Training

The grant gave me the opportunity to write a very useful paper for communities by doing a risk assessment involving children. I learned a lot about children's needs and contributions for significant risk reduction. My organization's NGO partners are now doing child-oriented participatory risk assessment and planning.

- Mayfourth Luneta

Grant No. 2078

Child-Oriented Participatory Risk Assessment and Planning

Grantee

Mayfourth Delica Luneta

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Abstract

San Mateo is a fast urbanizing town close to Metro Manila. It covers Barangay[1] Banaba, which is located at the junction of the Marikina and Nangka Rivers. The North and South Libis are the most frequently flooded areas in Barangay Banaba, where most of the residents are informal dwellers. As children (0 to 17 years old) comprise more than half of the population, they are most affected whenever flooding occurs. The research aimed to produce risk assessment tools for children to know their needs, vulnerabilities, and capacities to ensure an appropriate basis of plans for children. Thus, the Child-Oriented Participatory Risk Assessment and Planning (COPRAP) was conducted in this barangay from September 2005 to June 2006.

From the development of the actual research plan to the implementation, the grantee worked alongside a core group of 14 community researchers from the barangay local government officers, Buklod Tao, and students of the Center for Positive Future.

Recognizing that children are actors in disaster risk reduction with unique perspectives, needs, and contributions distinct from adults, the COPRAP involved at least 140 children from the barangay's seven puroks[2] in hazard vulnerability capacity assessment. Discussions with children on disaster risks, community problems, and solutions were facilitated through drawings and clay work on safe and unsafe places, dangerous things, and role playing of responses before, during, and after a disaster; while discussions with adults focused on flooding, landside hazards, and socio-economic problems using hazard map and focus group discussions.

The risk assessment results and proposed preparedness and mitigation solutions were presented and discussed in a community assembly. The Research Team chose specific risk reduction measures that can benefit not only the children but the whole community.

The COPRAP process and results were shared with neighboring barangays on May 17, 2006 together with the validation of the sample toolkit. An English translation of the toolkit contains a short description of each of the activity for hazard vulnerability capacity assessment, objectives, materials, and procedures.

Hazard Addressed

Although many participatory risk assessment and risk reduction action planning methods and tools have been developed in the Philippines, this research is a first in involving children in risk assessment in an urban flooding setting. As staff of the Center for Disaster Preparedness (CDP), the grantee had been recently involved in the use of COPRAP in Southern Philippines to promote children's participation in disaster risk management as an integral part of local development planning and strengthening of local government structures. CDP conducted COPRAP in the seven barangays of the municipality of Pikit, Cotabato, Mindanao in Southern Philippines—site of armed conflict between Muslim separatists and the Philippines army. Its main partners were the barangay local government units.

The experiences and insights from this activity have provided an opportunity for the researcher to innovate the said approach for flooding hazards. This initiative paved the way for conceiving the COPRAP concept and implementing it in an urban flood prone area.

Majority of the country's populace are exposed to perennial flooding. The COPRAP is particularly

[1] The barangay or village is the smallest political unit in the Philippines. Barangay Banaba is part of the municipality of San Mateo in the Province of Rizal.
[2]The barangay is further subdivided into puroks or areas. Barangay Banaba is comprised of seven puroks.

valuable and beneficial to Filipino children because they are among the most vulnerable groups in the face of calamities. The International Committee of the Red Cross (ICRC) has reported that natural and human made calamities affect an average of 3.5 million Filipinos (about 4% of the population) a year. Considering that 39% of the total population is below 18 years, as many as 1.4 million children are affected annually by calamities.

As such, involvement of children in risk assessment is essential towards achieving holistic and sustainable development. The practice of COPRAP has become a fundamental tool in incorporating children's perspectives, contributions, and capacities before, during, and after a disaster. Indeed, this recent trend in the field of risk reduction is key to promoting disaster-resilient and safe communities.

The outputs of the COPRAP research consisted of the following: a documentation of the COPRAP process; development of a COPRAP toolkit from evaluation of tools used in hazard vulnerability capacity assessment and risk reduction action planning; development of a community risk reduction plan; and implementation of at least one doable child-focused risk reduction measure.

Methodology

The Child-Oriented Participatory Risk Assessment and Planning (COPRAP) was conducted in Barangay Banaba, San Mateo, Rizal, Philippines from September 2005 to June 2006. From the development of the actual research plan to the implementation, the grantee worked alongside a core group of 14 community researchers from the barangay local government officers, Buklod Tao (BT)—the local people's organization implementing community based disaster management, and students of the Center for Positive Future (CPF)—the local high school.

Orientation and Planning. Forty-two participants from the community, including Buklod Tao members, and representatives of the local government unit attended the research project orientation on August 24, 2005 at the BT seed bank. After the researcher presented the COPRAP research project objectives, activities, and expected outputs, the research partners gave their comments and suggested the idea of involving the students of CPF in the research. A Core Group/ Working Group composed of representatives of the seven puroks of the barangay, BT, the Barangay Council, and CPF was formed to discuss tasks, schedules, and facilitate the COPRAP implementation.

Child-Oriented Participatory Risk Assessment and Planning Training. With the Training Team of the Center for Disaster Preparedness (CDP), the grantee facilitated the COPRAP training for the Core Group members from November 13 to 15. Eighteen participants (6 from CPF, 2 from the Barangay Council, and 10 from BT) underwent training on the Basic Concepts on Community-Based Disaster Risk Management and COPRAP process, areas of inquiry, guide questions, and tools.

Actual COPRAP Fieldwork. The community partners agreed that COPRAP discussions also include female and male adults in the seven puroks to validate the data from the children and create a comprehensive community risk assessment—a broad picture of the risks, disaster management activities, and gaps in the barangay. The Core Group members divided themselves into four facilitating teams for the following groups: (1) male adults; (2) female adults; (3) teens aged 13-17 years;

Clay activity with children to depict their houses and what they need before, during, and after a disaster.

As the assessment continued from one purok to another, the Core Group adjusted the tools that they used. Later, they developed other tools to get data for the assessment. These were:

- "Make Me a Portrait"
- "Top Five Problems" for children and teens
- "Suggestions for oneself, parents, government, NGOs" for teens
- "What materials do they need before, during and after?"
- "What are things or animals that are considered dangerous?"

The fieldwork results were collated and analyzed in January and February.

"Make Me A Portrait" activity with teens of Purok 2, Barangay Banaba before a flooding event.

Community Validation Workshop. The results of the fieldwork were presented to the community for validation. Children and adult representatives from seven puroks discussed the community issues, problems, and proposed solutions. They also decided to refer the problems and issues unrelated to disaster risk to the Barangay Banaba Council for its regular planning.

Key Results

Scheduling activities with the research partners and the community proved to be a challenge. Nonetheless, with the support of all partners, the project was able to accomplish its research outputs as planned with minor adjustments.

The main output of the participatory research was the COPRAP Toolkit, which was presented to the neighboring communities, Barangays Ampid 1 and Barangay Nangka, on May 17, 2006. The barangay representatives were asked to practice and experience the child-oriented risk assessment tools. The experience of Barangay Banaba on COPRAP Research Project was also shared with them.

The Core Group and community partners all agreed that the participatory and child-oriented risk assessment was very useful in knowing the needs of the children and the community before, during, and after a disaster. It led to the implementation of risk reduction measures that were appropriate for children and the community. It also strengthened inter-generational communication and exchange of ideas in Barangay Banaba as they explored ways to ensure the safety and development of their community.

Incorporating the experiences of Barangay Banaba, the COPRAP Toolkit now contains easy to follow guidelines.
Based on COPRAP results, the research partners implemented disaster preparedness and risk reduction measures.

The Barangay Disaster Management Planning with the Barangay Officers and Buklod Tao focused mainly on creating an early warning system—which was the people's immediate concern—instead of developing a comprehensive disaster management plan covering pre-, during, and post-disaster responses.

The risk reduction measures that were identified and implemented were the following:

- Production of life vests for children. This not only promoted the safety of children, it also introduced livelihood opportunities for women in the barangay.
- Implementation of children's disaster preparedness training.
- Production of children's disaster preparedness identification and information cards.
- Placement of information tarpaulin boards in each of the seven puroks.
- Strengthening of early warning system, communication, and coordination between the local government, Buklod Tao, and the community.

COPRAP research results have stimulated interest among the neighboring communities, who have gotten in touch with Buklod Tao to help them undertake similar COPRAP activities. Barangay Banaba is thankful and proud of the opportunity to participate and contribute to knowledge building in disaster risk management.

Compared to the COPRAP implemented in Pikit, the process in Barangay Banaba was simpler and less formal, ensuring the participation of children and community residents throughout the whole process.

The publication of the training module from the COPRAP in Pikit has generated interest from the NGO community and the government. Discussion with PLAN International on how to integrate COPRAP in developing their disaster risk reduction and governance support programs is now in progress.

UNICEF has likewise expressed its interest to the Center for Disaster Preparedness. It wants CDP to prepare an orientation workshop for the National Disaster Coordinating Committee Technical Working Group and Office of Civil Defense regional personnel on COPRAP for all hazards.

Although time consuming, all partners were one in saying that the COPRAP process was effective and rewarding; and the outputs were more than commensurate to their inputs and contributions.

On hindsight, a digital camera should have been used instead of an instamatic camera for better photo documentation. The pictures of the most important activity, the COPRAP fieldwork, did not turn out very well. Pictures from the COPRAP fieldwork could have been used in the COPRAP toolkit.

Contribution to Disaster Risk Knowledge

Although children are most vulnerable in any disaster situation, it is often the adults who act and speak on their behalf. A first in the Philippines, this research used participatory tools with children, youth, and community residents in an urban flooding setting.

The COPRAP adapted tools for hazard vulnerability capacity assessment from the family of tools associated with Participatory Rural Appraisal (PRA) and Participatory Learning and Action (PLA). It also discovered and developed new tools to actively involve children in risk assessment and identification of appropriate risk reduction solutions. Many of the tools are from play activities of children and youth that do not require elaborate facilitation skills.

COPRAP's key tools for children and youth included the following: "Representation of Myself", "Safe and Dangerous Places for hazard mapping", "Make Me a Portrait", "Dangerous Things", "My Need Before, During and After the Storm and Flood", "Top Five Problems", "Solutions to Problems", and "Suggestions to Those in Authority" (Annex A). For adults, it used "Hazard and Resource Mapping", "Sharing Livelihood", "The Organization in Our Place", and "Disaster Timeline".

Children were provided life vests to promote a culture of safety

The production of life vests has promoted the safety of children and introduced livelihood opportunities for women. Listed at the back of the children's identification cards are the disaster preparedness tips on the public awareness. The same tips are on tarpaulins placed in strategic places in each of the seven puroks of Barangay Banaba.

Recommendations

- The Department of Interior and Local Government (DILG) should encourage the Barangay Disaster Coordinating Councils (BDCCs), Municipal Disaster Coordinating Councils (MDCCs), City Disaster Coordinating Councils (CDCCs), Provincial Disaster Coordinating Councils (PDCCs), and the Regional Disaster Coordinating Councils (RDCCs) to involve children in the whole process of disaster risk management from risk assessment, planning and implementation.
- Local Government Units should include the children in their local disaster risk assessments and in their planning.
- The Center for Disaster Preparedness (CDP) should mainstream COPRAP in all its programs and services.
- Other Non-Government Organizations (NGOs) should have training on COPRAP and conduct it with their partner communities.
- Child Oriented INGOs such as Save the Children UK, Plan International, and United Nations Children's Fund (UNICEF) should advocate risk assessment among children and fund COPRAP endeavors throughout the country like publication and reproduction of COPRAP tools.
- The ProVention Consortium should continue to disseminate similar researches on risk assessment to advance the cause of the children.
- The Asian Disaster Preparedness Center (ADPC) should help in building linkages and partnerships on promoting COPRAP and developing other risk assessment tools with different stakeholders.
- Partners in this research like Buklod Tao, Center for Positive Future, and Brgy. Banaba should continue promoting COPRAP and sharing their experiences to other communities.

Activities Done after the Project

- CDP advocated for COPRAP framework and tools. It is planning a forum and news features on children in disaster risk management.
- CDP mainstreamed the tool in CDP's training modules and materials in Community Based Disaster Risk Management.
- Buklod TAO shared the tools, results of the project to neighboring communities as well as uploaded the project result in their website.
- CDP used the tools in its other projects like the Promise Project in Dagupan (funded by USAID, implemented by Asian Disaster Preparedness Center through CDP with Local Government of Dagupan), and in Child Centered Disaster Risk Reduction Training in Southern Leyte for PLAN partners and children leaders.
- CDP sponsored the Forum/Exhibit on Children's Participation and Interactive Learning Activities in Disaster Risk Reduction on October 26, 2006.

Ways Forward After the Research Project and Suggestions

The Center for Disaster Preparedness will undertake the following:

- Upload the tools produced in its website.
- Replicate the COPRAP experience to other urban flood prone communities.
- Develop COPRAP for other hazards.
- Organize a Forum of Stakeholders Regarding Risk Assessment.
- Reproduce the COPRAP Toolkit.

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Annex A

COPRAP Tools used in the actual Participatory Risk Assessment in Barangay Banaba, San Mateo, Rizal

"Sama-samang Pagsusuri ng Kalagayan at Pagpaplano ng mga Bata at Komunidad" (Participatory Assessment of the Condition and Planned Preparedness of Children and the Community)

Objectives

- To assess the risks, strengths, and weaknesses of children and the community.
- To plan based on the results of the participatory assessment.

Pointers in Participatory Assessment

- Identify the information needed in assessing the condition of the place.
- Study the basic concepts of risks, weaknesses, and strengths of the community.
- Meet with the barangay that will undertake the assessment, facilitate, and act as the participants. (It is better to have representatives from women, men, youth and children.)
- Assign a facilitator and documenter.
- Select the appropriate assessment tools.
- Schedule the assessment and the target place.
- Gather the data and analyze them, identifying the strengths, weaknesses, risks, and elements affected by disaster, major problems, and the solution.
- Ratify the result in the General Assembly.
- Plan and identify which risk should be given solution first.
- Execute the plan together.

COPRAP'S KEY TOOLS FOR CHILDREN AND YOUTH:

Tool 1: Representation of Myself
This refers to the drawing of a thing, animal, or plant that represents or illustrates yourself. This is best done at the beginning of the activity to make the participants feel at ease. Children aged 7 to 17 years may use this strategy.

Objective: To make the facilitator and participants feel at east with each other, and to know and identify the strengths and weaknesses of the children participants.

Materials: Bond paper, crayon, pencil, or ball pen.

Procedure:

1. Ask the participants to draw the most fitting illustration of themselves. It may be a thing, animal, or plant.
2. Ask each participant to explain how his/her drawing reflects himself/ herself.
3. Thank the participants after the presentation.
4. Make sure that someone records the comments of each child.

Tool 2: Safe and Dangerous Place
This refers to the picture of the child's place regarded as safe and dangerous. This tool is recommended to children aged 7 to 12 years.

Objective: To check if the child has knowledge of safe and dangerous places, and how s/he perceives them.
Materials: Bond paper and crayon or clay.

Procedure:

1. Ask each child to use crayon to draw or use clay to mold his/her house and its surroundings.
2. Ask the children to put identifying marks on the safe and dangerous places.
3. Allow them to report their work after the activity.
4. Make sure that someone records the comments of each child.
5. Summarize all the reports, emphasizing their commonalities and differences.

Tool 3: Make Me a Portrait
This refers to the depiction of scenes by using the participants as parts of the picture. The facilitator will tell what they will illustrate like a hospital, zoo

or park, but the real intent of this activity is to see how they depict their condition and activity before, during, and after the flood. This tool has been used with children and teenagers aged 7 to 17 years.

Objective: To know how children participate before, during, and after the flood.

Materials: The participants themselves will serve as parts of the portrait.

Procedure:

1. Group the participants into five.
2. Ask them to create a portrait using their bodies and the things that are with them. Ask them to freeze into a tableau after 20 seconds.
3. Participants may be asked to depict a hospital, zoo or park, but it is more important to show their condition and activity before, during, and after the flood.
4. While they are in suspended animation, ask what they are trying to show, especially what they do before, during, and after the disaster. After all the group members have made an explanation, allow them to report what they did.
5. Make sure that someone records the comments of each child.

Tool 4: Dangerous Things
This refers to the use of clay or mud to mold dangerous things. This tool is more commonly used with participants aged 7 to 12 years.

Objective: To know the perspective of children towards dangerous things or animals.

Material: Clay of different colors.

Procedure:

1. Hand a piece of clay to each child.
2. Ask them to mold the things and animals they regard as dangerous.
3. Make sure that someone records the comments of each child.

Tool 5: My Need Before, During, and After the Storm and Flood
This refers to the use of clay to show the needs of children before, during, and after a disaster. This tool is more often used on participants aged 7 to 17 years.

Objective: To know the needs of children before, during, and after a disaster.

Material: Clay of different colors.

Procedure:

1. Mold the clay to resemble the things that the children need before, during, and after the flood.
2. Ask the participants to explain their molded clay.
3. Make sure that someone records the comments of each child.

Tool 6: Top Five Problems
This refers to the identification of the five primary problems of the children. This tool is commonly used on children aged 7 to 17 years. The problems may be classified into two: when there is flood and when there is none.

Objective: To know the five primary problems of the children.

Materials: Bond paper and pencil or ball pen

Procedure:

1. Ask the children to write what they consider their top five problems.
2. Allow them to report their answers.
3. Make sure that someone records the comments of each child.

Tool 7: Solutions to the Problems
This refers to the offering of solutions to the problems of the youth and children. This tool is used on participants aged 7 to 17 years.

Objective: To know the suggestions of youth and children in solving the problems that they face in the community.

Materials: Bond paper, and ball pen or pencil

Procedure:

1. Ask the participants suggest solutions to the problems of their community.
2. Allow them to report their answers.
3. Make sure that someone records the comments of each child.

Tool 8: Suggestions to Those in Authority
To teenagers aged 13 to 17 years, they may direct their suggested solutions to parents, Sangguniang Kabataan Leadership, Barangay Leadership, NGO, or fellow youth.

Objective: To know the suggestions of the teenagers to those in authority.

Materials: Bond paper, and ball pen or pencil.

Procedure:

1. Ask the participants to write down their suggestions to those in authority.
2. Allow them to report their work.
3. Make sure that someone records the comments of each child.

COPRAP'S KEY TOOLS FOR ADULTS:

Tool 1: Hazard and Resource Mapping
This refers to the drawing of the map of the community including the areas considered dangerous. Also included in the map are the areas containing the wealth of the community and the areas that are easily affected by disasters (categorized as high, medium, low risk areas). This tool is used with adults (18 years and above), males and females in separate groups.

Objective: To know the safe and dangerous areas in the barangay. To locate its wealth and know what will be affected by disaster.

Materials: Manila paper, permanent markers, crayons, and plastic cover.

Procedure:

1. Ask the participants to draw a map of their barangay and to mark where the wealth, resources, and basic services are located.
2. Place a plastic cover over the map and use markers to spot the "most dangerous," "slightly dangerous," and "safe" areas. Each type of dangerous place should have a distinct color agreed upon by the group.
3. Allow them to report their work.
4. Make sure that someone records the comments.

Tool 2: Sharing of Livelihood
This refers to the informal sharing about livelihood in the barangay, learning about alternative livelihoods during floods, and identifying livelihood problems. This also explores if there are child laborers. This is used with male and female adults grouped separately.

Objective: To know the livelihood in the barangay.

Materials: Paper and ball pen

Procedure:

1. Prepare the questions for the informal sharing of livelihood like:
   What is the primary source of income of the family? Of the Mother? Father? Children?
   What are the alternative livelihoods if there is flood?
   What are the problems and the solutions regarding livelihood?
2. Allow the participants to answer the questions.
3. Make sure that someone records the comments of each participant.

Tool 3: The Organizations in Our Place
This refers to the description of organizations in the barangay. This is to identify the parties who can potentially help advance or hinder the development of the barangay.

Objective: To know the organizations that can assist in advancing disaster preparedness efforts.

Materials: Flipchart paper, permanent markers, colored paper.

Procedure:

1. Ask the participants to list the organizations within the barangay and those outside which maintains connection to it.
2. Draw circles representing the organizations on flipchart paper. The size of the circle should be proportional to size of the organization. Draw a heart at the center, symbolizing the heart of the barangay. The location of the organizations in relation to the heart (i.e., near or far) should indicate the level of closeness of the organization to the heart of the barangay people.
3. Allow them to report their work after everyone has finished. Ask them to explain why some circles are near to the heart, and some are not.
4. Make sure that someone records the comments of each participant.

Tool 4: Disaster Timeline
This refers to the plotting of disasters experienced by the barangay from the present to the past. This activity is more appropriate with adults in the community, with males and females grouped together or separately. This also outlines the effect of the disaster and the actions they have taken to respond to it.

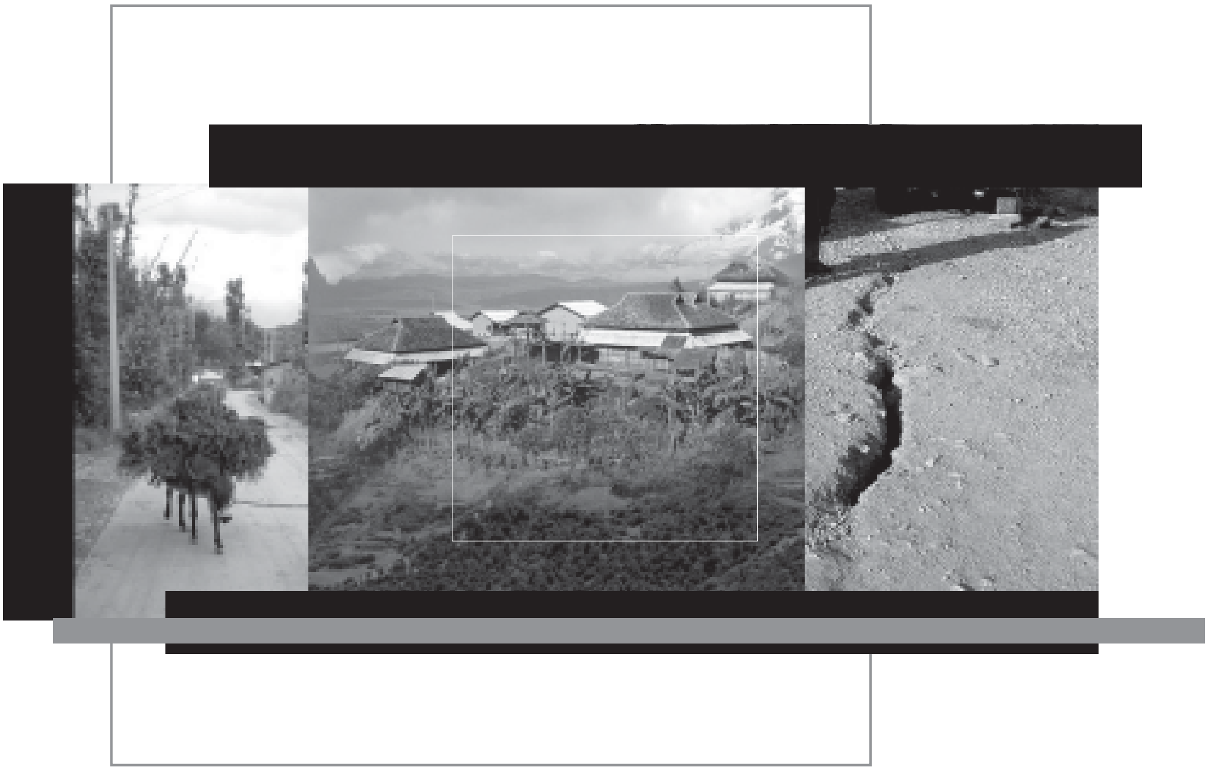
Objective: To know the disasters experienced by the barangay, their effects, and the actions taken by the people.

Materials: Manila paper, markers.

Procedure:

1. Ask the participants to draw and fill the chart below.
2. Allow them to report their work after everyone has finished.
3. Make sure that someone records the comments of each participant.

Year	Disaster	Effect	Action Taken		
			People	Barangay	NGO



In the process of implementing the research project, the Yunnan Provincial Department of Civil Affairs became very interested in our project, shared data with us, and provided invaluable guidance. The municipal government of Xishuangbanna also helped facilitate the implementation of our project and now uses it as a model.

-Dr. Hongzhou Lai

Grant No. 2048

Using Bamboo to Build Houses in Earthquake Prone Rural Areas in Yunnan Province, P. R. China

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Abstract

Yunnan Province faces grave risks in earthquake disasters. Developing and improving the earthquake resistance capacity of bamboo dwelling houses can greatly help local villagers, especially those with low incomes.

The field survey and research involved discussions with relevant experts and local governmental officials, identifying and studying the underlying earthquake risks, the basic properties and advantages of bamboo material, the current status of bamboo houses, the distribution of bamboo forest resources, and the ongoing risks in the process of recovery and reconstruction in Yunnan's earthquake-prone rural areas. The project selected Xishuangbanna Region as the pilot site where bamboo houses were found to have high earthquake resistance. The research results indicated that the construction of bamboo houses could also facilitate the development of the local economy and tourism. In addition, using bamboo as a wood substitute could help protect forest resources. Local governments and villagers were encouraged to build more bamboo dwelling houses and shelters in rural areas frequently affected by earthquakes.

Hazard Addressed

Yunnan Province frequently suffers from severe earthquakes that often result in grave losses to life and property. With its flexibility, durability, lightness, and abundance in warm climate, bamboo is a suitable material for building seismic-resistant structures constructions to protect local villagers from earthquake disasters.

With the development of the local economy, villagers have tended to discard their traditional bamboo houses for new concrete and brick houses. However, the new houses are not built to resist earthquakes because of limited funds or lack of awareness of the underlying risks.

Methodology

With the support of the National Disaster Reduction Center of China (NDRCC) and Yunnan Provincial Civil Affairs Department, the project carried out field survey research to find out about current earthquake risks, recovery and reconstruction processes in the earthquake-hit areas, bamboo forest resources, and the bamboo dwelling houses in Yunnan.

Key respondents included local governmental officials and the community leaders of the earthquake-prone pilot sites. Experts in the field of construction and seismic research gave valuable guidance and suggestions to the project. Some of their suggestions and proposals were shared to stakeholders to promote and facilitate the construction of bamboo dwelling houses and reduce the negative impact of earthquake disasters.

Earthquake-hit area in Yunnan on 10 August 2004 Courtesy of Yunnan Provincial Earthquake Bureau, P. R. China

Seismic-resistant bamboo houses designed by the Dai People in Yunnan Province, China. Courtesy of Yunnan Provincial Earthquake Bureau, P. R. China

Key Findings

- With its flexibility, durability, and lightness, bamboo is a suitable material for building seismic-resistant dwelling houses. There are enough bamboo forest resources available to build houses in Yunnan.
- The development of the local economy has resulted in the decrease in the construction of traditional bamboo houses as villages replace them with concrete brick houses in their desire to have better living conditions. However, these new houses are often not earthquake resistant.
- In the aftermath of an earthquake disaster, survivors, in the process of recovery and reconstruction, seldom think about making their newly built houses seismic resistant.
- Local governments have the responsibility of encouraging and guiding local villagers to build more seismic-resistant bamboo dwelling houses as part of the disaster preparedness process or post-disaster reconstruction phase.
- Bamboo houses embody the culture of ethnic minorities in Yunnan. The construction of bamboo houses can facilitate the development of tourism in the rural areas.
- As a wood substitute, the use of bamboo in the construction of houses in Yunnan can help protect the ecological environment.

Recommendations for Stakeholders

To the National Committee for Disaster Reduction of China:

- Provide supplementary support to decision-making processes of the central government on the recovery and reconstruction of earthquake-hit areas.
- Promote a culture of safety and resilience at the community level by building bamboo dwelling houses in Yunnan's earthquake-prone rural areas.

To local governments:

- Help identify and assess the underlying risks of earthquake in the rural areas of Yunnan.
- Strengthen disaster preparedness through building more bamboo shelters.
- Build more bamboo dwelling houses for low-income villages and contribute to the local economy and tourism.

Dissemination Strategy

With funding support from ProVention Consortium, the research monograph, "The Development of Bamboo Houses in the Earthquake Prone Rural Areas, Yunnan, China," has been published and sent to the National Committee for Disaster Reduction of China. The latter supports the central government in post-disaster recovery and reconstruction processes.

Through funding from the Ministry of Civil Affairs, the project will disseminate the monograph to local governmental officials in Yunnan's earthquake-prone rural areas to promote the construction of more bamboo houses.

Newly-built bamboo dwelling houses in the Dai People's Village, Yunnan Province, China. (Photo by the National Disaster Reduction Center of China)

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Community people do not know about the earthquake resistant element of buildings. We have been trying to inform them through lectures and fliers but they could not understand. The project gave me a chance to convert my dream into real work. Small grants can be utilized to reduce disaster risk.

-Binod Shrestha

Grant No. 2181

Sets of Standard Building Designs: A Supportive Step to Reduce Earthquake Risk

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Abstract

Earthquakes are an unavoidable part of Nepal's present and future. Unfortunately, current practices in non-engineered constructions are predominated by owners and craftsmen without technical qualifications who make decisions on structural elements. As such, many buildings in Nepal are highly vulnerable to disasters, posing enormous risks to human life and property. To minimize such hazards, all buildings should be structurally designed to be earthquake resistant. However, this situation is difficult to achieve because of the high costs involved and the lack of trained engineers.

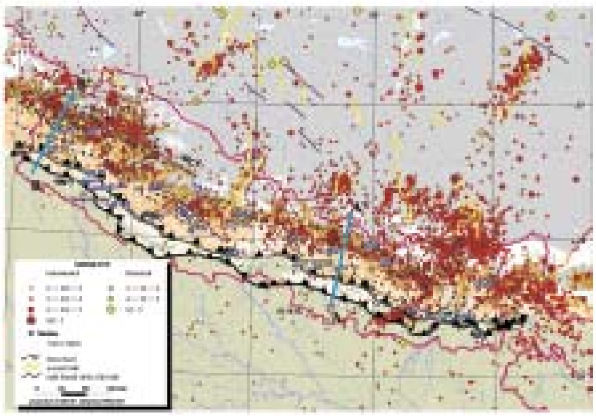
This research aims to address these problems by creating and propagating standard pre-engineered designs for buildings. The study collected information on current practices in construction, surveyed a sample of buildings, developed drawings of typical buildings, and identified good and bad practices in earthquake-resistance. Based on the information gathered, it prepared a set of standard designs of buildings that encompasses typical architectural drawings, structural designs, bill of quantities, and specifications that potential house owners could choose from, depending on their requirements.

The proposed building designs will be beneficial to the construction industry, house owners, and policy makers. Developing and promoting at least one of these building sets in each district is important. Funds need to be obtained for this purpose. The findings of the study will be shared with the relevant authorities and agencies to improve the quality and safety of buildings being constructed in Nepal.

Problem Addressed

All persons have the right to adequate housing. However, recent earthquake experiences, particularly in developing countries, demonstrate that this goal is far from being reached. The gap between developed and developing countries is widening—four out of every five deaths caused by earthquakes in the twentieth century occurred in developing countries. In the field of earthquake-disaster mitigation, acquiring the state-of-the-art knowledge is only the first step. The most important is to translate that knowledge into practice. Unfortunately, developing countries have not been very successful in translating knowledge on earthquake-resistant constructions into practice. To ensure aseismic structures, Earthquake Engineering knowledge needs to be spread across a broad spectrum of professional engineers within the country instead of confining it to a few organizations or individuals as a "super-specialization." Earthquake-resistant construction requires seismic considerations at all stages: from architectural planning to structural design to actual construction and quality control. Such an overall approach to aseismic construction will not develop until Earthquake Engineering is integrated with mainstream Civil Engineering and the professional engineers and architects are drawn into the process.

Figure 1: Seismicity Map



Source: National Seismological Centre, Nepal

Studies have shown that Nepal lies in the eleventh highest seismic risk zone in the world. Scientists are claiming that the energy needed for the occurrence of an earthquake with a greater than eight magnitude in the Richter scale is already stored in this region. This indicates that the next big earthquake will occur any time. Geography plays key role on building construction practices in Nepal. The high Himalayas, the middle hills, and the Tarai are the three physiographical regions with different physical and meteorological properties that should inform construction practices.

However, new buildings in Nepal are built by convention rather than a consideration of geographical characteristics of the environment and structural requirements. They are built based on socio-economic and political conditions, and availability of the construction materials. The overall process is very informal and often owners and craftsman with no technical qualification make decisions on structural elements. Even in urban areas—where obtaining a building permit is mandatory—incorporation of seismic safety in the construction process is not always done. This has resulted in the construction of highly vulnerable buildings in Nepal even if modern materials and technology are used. In an earthquake-prone environment, these structurally weak buildings and the people's low level of seismic awareness and disaster preparedness are posing grave risks to human life and property.

Methodology

The study undertook a review of previous reports and articles to visualize the building construction scenario. Discussions with stakeholders in the construction sector on current building trends and practices were carried out. The grantee made a field reconnaissance visit of Kathmandu valley and some fringe areas. From the information collected, the final survey format was developed.

The study developed a household survey form (Annex A) that incorporated all essential questions on major structural elements: building typology, building plan, number of stories, building dimension, size of column, and maximum length of beam.

The survey team consisted of three civil engineers. All of them underwent an orientation on earthquake risks, current construction practices, the key points to consider for earthquake-resistant constructions, and their tasks. They surveyed about 135 reinforced concrete non-engineered buildings, analyzed the geometrical dimensions of structural elements, looked into earthquake-resistant elements during design and construction, and identified deficiencies and positive practices.

There is a wide variety of building types in Nepal. The majority of buildings in the urban areas are reinforced concrete construction. Other types are made of brick in cement, brick in mud, stone in cement, stone in mud, and adobe. The reinforced concrete, brick in cement, and stone in cement cover more than 80% of non-engineered building construction in the periphery of the cities and market centers. There is a growing trend to construct more of these kinds of buildings compared to the load bearing structures. Load bearing structures are built significantly in urbanizing areas while low strength masonry structures are built massively in rural areas. Detailed work such as architecture drawings, structural design and drawings, bill of quantity, and specifications for a single building required voluminous work. Considering the time and budget available for the research work, it was decided that 10 buildings would be surveyed for each of the following categories: reinforced cement concrete (5), brick in cement (2), stone in cement (2), and stone in mud (1).

Survey Findings and Data Analysis

The survey revealed that very few buildings in Kathmandu valley incorporated earthquake resistant-elements during design and construction even if technicians designed most of the buildings (68%). Majority of the owners (67%) were highly involved in the construction process and almost all of them (84%) supervised the building construction. The survey also showed that 92% of the buildings have reinforced cement concrete with pillar size 9" x 9". Many (73%) also used beam lengths measuring less than 15". Survey findings are shown in table 1.

Selected Sample Buildings

Based on the survey findings and discussions with key respondents, the selected sample buildings were the reinforced cement concrete (RCC) frame and load bearing system. The latter was categorized in brick in cement, stone in cement, and mud-mortar. The architectural drawings for the sample buildings were developed from observations of prevalent building patterns in the urban area with preference to three storey building with maximum plinth area less than 1,000 square feet. The architecture drawings of all sample buildings were prepared before conducting intensive structural design work. Below are the details of structural analysis and building design of each system:

- RCC Frame System: The structural analysis and design was based on prevailing codes enforced in Nepal, the Nepal National Building Code, and the IS codes. With its characteristic ease in construction and availability, reinforced cement concrete (RCC) is the major structural material. According to Indian standard specification, the concrete grade used is M20. This material provides the minimum grade of structural concrete, easy to produce, and lends itself to easy production and quality control. Steel strength of 415n/mm2 is provided as longitudinal and shear reinforcement in beams, columns, foundations, and slabs.

- The loads distributed over the area are imposed on area element and those distributed over length are imposed on line element whenever

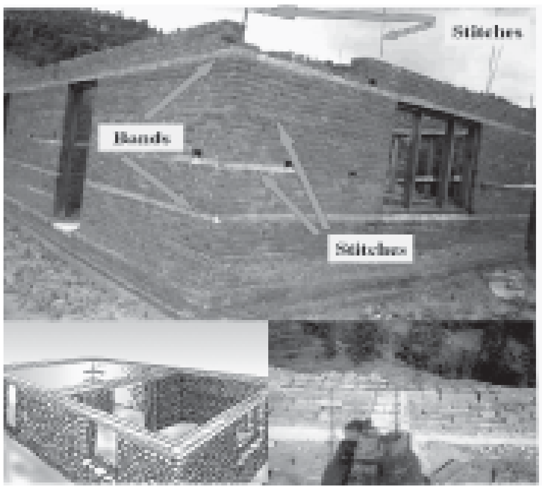
Table 1: Buildings Survey Results

Total No of House Survey 135

	Descriptions								
1	**Sampling area**	Core	68	Fringe	62	Outside Valley	5		
2	**Building Typology**	RCC	120	Load Bearing	10	Mud Mortar	5		
3	**No of Storey**	Max	5	Min	1				
4	**Plinth Area(Sq. Ft.)**	Max	1633	Min	227				
5	**Age of Buld(Year)**	Max	16	Min	0				
6	**Extention Plan**	Yes	41	No	94				
7	**Const Process**	Owner Built	90	Purchased	12	Contractor	33		
8	**Designer**	Self	31	Technical	92	Contractor	12		
9	**Supervisor**	Self	113	Technical	7	Contractor	15		
10	**Building Position**	Free Standing	75	Confined One Side	45	Two adj side	10	Two opp side	5
11	**Size of Pilllar**	9"x9"	116	9"x12"	12	12"x12"	2		
12	**Beam Leangth**	More than 15'	35	Less or equal to 15'	95				
13	**Cantilever with wall**	None	84	One side	31	Two adj side	6	Two opp side	9
14	**Length of Cantilever**	Max	5' 10"	Min	1' 6"				
15	**EQ consideration**	Design:				Construction:			
		Yes	5	No	130	Yes	3	No	132

possible. Where such facility is not feasible, equivalent conversion to different loading distribution is carried to load the model near the real case as much as possible. For lateral load, the necessary calculations used NBC 105: 1994 for seismic coefficient method. Different load combinations based on Nepal National Codes were developed and used for design purposes. The load combinations were based on NBC 105: 1994. For seismic loading, the mass equivalent to the load that composed of 100% of dead load and 25% of live load was taken into consideration. The earthquake lateral loads were used in the combination from the spectral load cases based on NBC 105:1994: Spectrum for Soil Type III. Spectral load is the product of structural seismic mass, modal response, and respective spectral ordinate. Modal analysis was carried out using FEM-based three-dimensional analyses.

- Load Bearing System: The designs of load bearing structures were developed using Nepal National Building Code and International Association for Earthquake Engineering (IAEE) Guidelines. The Nepal National Building Code (NBC) mandates that all small buildings be designed for strength by a professional adviser and provides the criteria for height, number of stories, and floor area. The NBC also provides guidelines for remote rural buildings. The key structural decision was based on IAEE guidelines.



After completing the structural design, quantity estimation, and specifications, standard design sets of buildings were developed.

Development of Standard Building Design Sets

- The study developed a complete set of 10 standard building designs that incorporate earthquake-resistant elements, a ready-made solution addressing underlying seismic hazards.

- Community people can choose from these sets according to their requirements and specifications. They would know the costs required to construct each of the 10 building designs.

Recommendations for Stakeholders

To benefit from the results of the study, municipal and village authorities are encouraged to promote the use of the building design sets that are appropriate to the geography of their respective areas.

Train key actors involved in building construction how to make houses earthquake-resistant using the results of the study and the building design sets.

Conduct an awareness campaign in the community to create demand for safe buildings and for the implementation of hazard mitigation measures.

Dissemination Strategy

The outcomes and lessons learned from this research was discussed with structural engineers, construction engineers, engineers of local and central government, and within the National Society for Earthquake Technology-Nepal (NSET). This study and its results will be further discussed among the practicing engineers and architects attending the regular training program of NSET and its partner organizations.

From the discussions and interactions, there was wide agreement that the study and the set of building designs will benefit those involved in the construction industry, house owners, and policy makers.

The findings of this study will be published in the form of handbook to be distributed to local authorities, mason groups, and disaster management committees at the local level. The book will present a comparative chart of key elements of buildings, recent construction practices in Nepal, damage caused by past earthquakes due to structural weaknesses of buildings, and ways to make buildings safe. In addition, many pictures will be included to make it more interesting to the readers.

Limitations and Constraints

During the survey, some house owners refused to cooperate because of several reasons. They feared that municipal authorities were checking their compliance with the plan in the building permit. They likewise feared that if the building were found to be vulnerable to earthquakes, their tenants would leave. Concerned about security, the house owners did not want to accommodate strangers asking for information about the building.

Data collection outside Kathmandu valley was constrained by travel and technical difficulties (e.g. no available photocopying machines). Preparation of the bill of quantities proved to be difficult because of the wide diversity in the structural and non-structural components of buildings (e.g., sanitary facilities and flooring).

The main challenge of the project is convincing private owners who do not see the immediate benefits of making their buildings earthquake-resistant and are unwilling to shoulder the additional costs involved.

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Annex A
ProVention Consortium
Applied Research Grants for Disaster Risk Reduction
Developing a set of Standard Building Design suitable for Nepal

BUILDING SURVEY FORM

SN: Date:

Municipality/Village:

House Address:

Name of House Owner:

Type of settlement: a. Core b. Fringe

Building Description:

1. Building Typology: 2. No of storey:

3. Plinth Area: 4. Age of Building:

5. Is there any future plan for vertical extension of building? i) Yes ii) No

6. Process of building construction: a. Owner built b. Purchased c. Constructed by contractor

7. Designer: a. Self b. Technical c. Contractor d. Mason

8. Supervisor: a. Self b. Technical c. Contractor d. Mason

9. Position of the building block:
   a. Free Standing
   b. Confined by other building in one side
   c. Confined by other buildings in two adjacent sides
   d. Confined by other buildings in two opposite sides
   e. Confined by other buildings in three sides

10. Type of foundation:
    a. Isolated b. combined c. Raft d. Pile e. Other if any

11. Building Dimension:
    a. Length: b. Breadth: d. Offset: c. Average floor height:

12. Size of Column:

13. Max length of beam:

14. Cantilever with wall:
    a. None b. One side c. Two opposite side d. Two adjacent/three sides

15. Length of Cantilever with wall Projection:

16. Location of staircase:
    a. Near the center of the building b. Near the corner of the building

17. Consideration of Earthquake:
    a. Design: i) Yes ii) No b. Construction/Detailing: i) Yes ii) No

Remarks or Comments (if any):
……………………………………………………………………………………………
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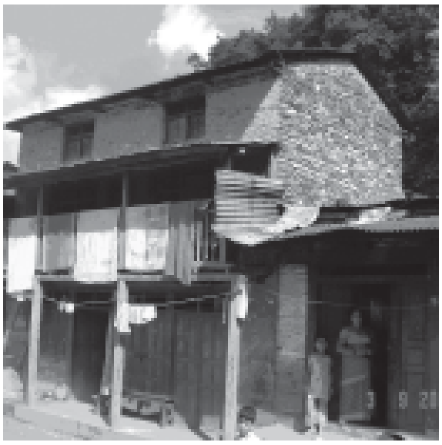
Annex B

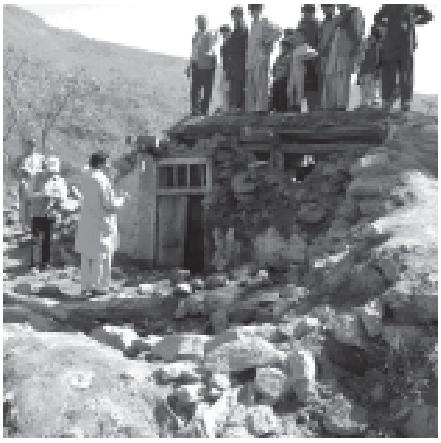
Comparison of Existing Nepalese Buildings and Collapsed Pakistani Buildings after an Earthquake with the Same Typologies and Same Construction Practices

Existing Buildings in Nepal	**Damaged buildings in Pakistan**

Reinforced cement concrete building system: Weak joints of elements

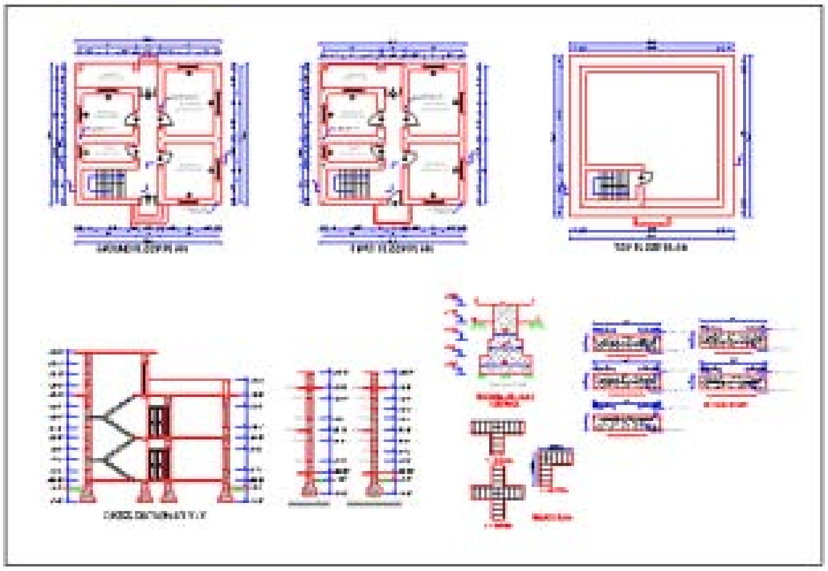
Building of load bearing system: No bands, vertical bars

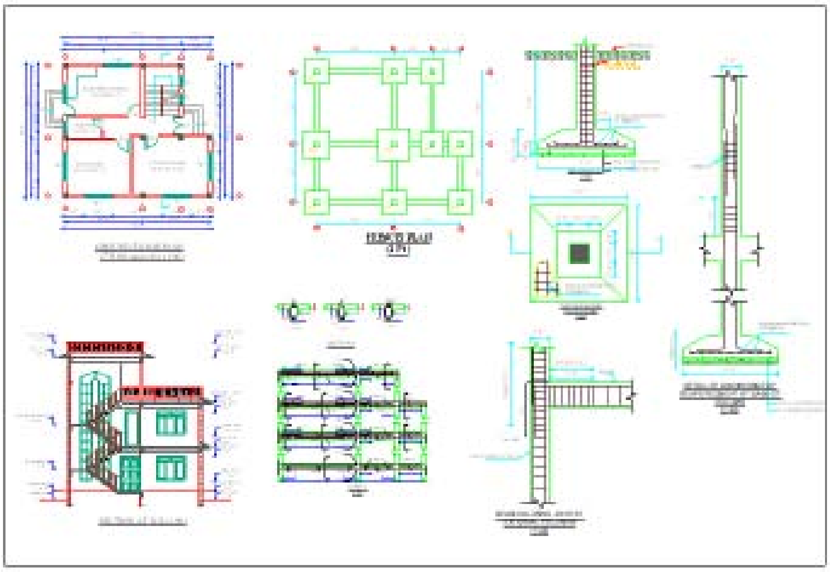


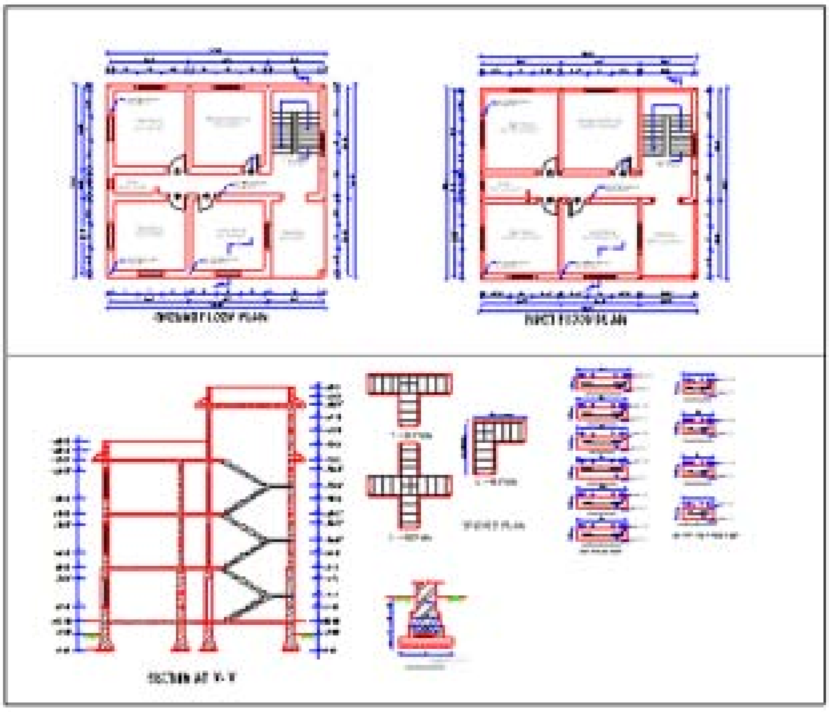


Load bearing system of stone in mud: No bands, vertical bars

Annex C


Ground Floor Plan, Section and Structural Features of One of the RC Buildings


Ground Floor Plan, Section and Structural Features of One of the Load Bearing System Buildings in Stone in Cement


Ground Floor Plan, Section and Structural Features of One of the Load Bearing System Buildings in Brick in Cement

I gained more knowledge and skills. I was also able to network and establish good relationships with experts from all over the world. Through this grant, I was able to carry out the required tasks in my work. The partnerships established helped produce concrete results.

-Hima Shrestha

Grant No. 2183

Vulnerability of Typical RC Frame Buildings in Nepal and Suitable Mitigation Measures

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Abstract

This paper presents an overview of the current problems of non-engineered frame buildings that are rapidly increasing in the urban areas of Nepal. Potentially vulnerable to earthquakes, these kinds of buildings pose a high risk to life and property.

Based on a survey of existing buildings, two prototypes were developed. Results of strength assessment and computer analysis of these structures indicated increased seismic risk of buildings of two stories and higher. These buildings lack both strength and ductility because of inferior masonry quality, lean frames, and lack of reinforcements.

As Nepal is located in a high seismic zone, a large earthquake is likely to occur in the near future. Thus, a seismic retrofit of these buildings is a pressing need. There are a number of available alternatives but some are expensive. Among the most practically feasible and economically viable methods are wall jacketing and introduction of shear walls. The estimated cost for such intervention is 15% to 40% of reconstruction. There is a plan to pilot this technique in one of the school buildings in Nepal.

Problem Addressed

Most buildings in the urban areas of Nepal have light reinforced concrete frames with masonry infill. With rapid urbanization and increases in the price of land, people have generally tended to add an additional storey to their existing building when they manage to save enough money without making a provision for additional floors prior to construction. As such, most residential buildings are between 2 to 6 stories, some even up to 9 to 10 stories. However, these structures are not constructed to withstand earthquakes. Many do not even meet the requirements of vertical load design. The structural details remain the same irrespective of the building's height. Because of higher height and larger occupancy, these buildings pose significant risks in urban areas in the likely event of an earthquake.

The collapse of similar buildings during past earthquakes in neighboring regions have had catastrophic results—tremendous loss of human lives and damage to property. However, none of the previous researches evaluated seismic risk and proposed practical solutions for the predominantly light frame buildings in Nepalese urban areas. The present study aims to evaluate more accurately the strength of these particular types of buildings by considering the combined effect of frame and brick masonry infill instead of the conventional practice of analyzing the bare frame structure.

The recently introduced Nepal Building Code addresses the earthquake resistance of this class of buildings for new constructions. However, it does not mention the seismic strengthening of existing buildings even if these structures comprise about 25% of the buildings in Nepalese urban areas. This study recognizes the critical need to improve the seismic resilience of these buildings by implementing appropriate counter measures to prevent or mitigate damage caused by earthquakes. This study hopes to contribute to the overall efforts to mitigate earthquake risks and promote sustainable development practice in Nepal and the region.

Methodology

The study undertook the following steps:

1. Rapid reconnaissance survey of buildings for an overview of the structures and identification of the sites that were surveyed in detail. The sites were selected in Kathmandu, Lalitpur and Bhaktapur—the three metropolitan cities of Kathmandu Valley.

2. Review of related literature.
3. Development of survey formats/structural assessment checklist for the specified building typology for the detailed survey.
4. Detailed survey of the selected building structures in Kathmandu Valley to correctly simulate the actual building type under consideration.
5. Collection of test specimen (i.e. prisms of concrete and brickwork) from the buildings under demolition in Kathmandu Valley and testing to simulate correctly their material property instead of assuming their typical material properties and values.
6. Structural analysis of the selected buildings using ETABS structural engineering software.
7. Identification of strengths and deficiencies of the selected buildings based on analysis and observed behavior in similar buildings during past earthquakes.
8. Development and finalization of intervention options for improving seismic resistance of the buildings.
9. Preparation of drawing and cost estimation for different intervention options.
10. Recommendations for different retrofitting measures with associated costs and levels of increment of seismic safety.

Key Findings

- Comprising about 25% of the existing building stock, the reinforced concrete non-engineered frame buildings in the urban areas of Nepal are unsafe against large impending earthquakes. This type of construction is rapidly growing and is the only current construction practice in the city. These buildings do not meet the basic earthquake resistant criteria as specified in Building Code: "Structures should be able to resist moderate earthquakes without significant damage" and "Structures should be able to resist major earthquakes without collapse."
- Laboratory experimental tests of masonry prisms from the existing buildings under demolition reflect very weak masonry material of compressive strength 1.426 N/mm^2.
- To maintain the seismic integrity of the different components of the building, all half brick walls need to be tied with the adjacent frames to prevent the outplane failure for buildings of one storey and above.
- Seismic risk for such buildings increases with height of two stories and above. The risks posed by these buildings' lack of strength and ductility can be significantly reduced by introducing seismic strengthening measures.
- It is advisable for buildings of 2 to 4 stories high to adopt wall jacketing as a strengthening measure to improve their resistance to large earthquakes. Wall jacketing, however, may not suffice for buildings above 4 stories. They should opt for other measures such as addition of reinforced concrete shear walls at appropriate locations. Integrity between the existing and newly introduced elements is very important because without this the strengthening measure would be useless. Although other expensive alternatives are available, wall jacketing and addition of reinforced concrete shear walls are the most practically feasible and economically viable. However, before carrying out any strengthening measure, detailed analysis of the building is required to conduct retrofitting design, detailing, and cost estimation.

- The estimated cost of strengthening is between 1,500 and 4,000 Nepalese Rupees (USD 20 to USD 60) per square meter of building area, which varies with height, against 11,000 Nepalese Rupees (USD 160) per square meter for new constructions. However, the cost of retrofitting for a particular building differs with building height, configuration, strength and rigidity distribution, redundancy, and feasibility of intervention with due regard to social and environmental aspects.

Recommendations for Stakeholders

House owners and inhabitants primarily face the risks of partial or total building collapse in the event of an earthquake. They should better understand the situation and realize the necessity of strengthening their existing weak building structures. To reduce large seismic risks in the region, retrofitting work has to be implemented on a massive scale. This task is not easy in developing countries, like Nepal, which does not consider it a priority. As a result, strengthening of structures is rarely done. However, without enhancing the resilience of existing buildings, communities would never be safe against earthquakes. Thus, there is a need to raise people's awareness. It is hoped by disseminating the findings of this study, all the concerned parties will better understand the issue and implement the recommendations in the near future.

As the primary stakeholder, the Nepalese government is new in the field of disaster risk reduction. Its Building Code is only relevant for new constructions. There is no official document that highlights the need to strengthen existing weak structures. Hence, the Building Code has to develop guidelines for existing structures and implement practical measures to safeguard these buildings. This can be done with support from other institutions that have in-depth knowledge on this field. In addition, academic institutions and professional organizations need to enhance their capacity in earthquake disaster mitigation.

The other stakeholders are local bodies, non-governmental, and private organizations working in the field of earthquake risk reduction. These organizations should make an integrated effort to promote seismic retrofitting in Nepal. While their effort in earthquake risk reduction awareness, preparedness, and disaster response is extensive, not a single organization has shown enough concern for the strengthening of structurally weak buildings. They should immediately focus on this matter before another devastating earthquake strikes to mitigate the impact. Responsible agencies should take action and introduce research-based disaster reduction practices in the country.

Similarly, many international development agencies working for poverty alleviation, gender balance, child and human rights, social equity, and many other issues can be encouraged to promote retrofitting schemes for the sustainable development of the nation.

Strengthening of buildings to withstand temblors will involve costs to building owners, the community, and to the nation. There should be better planning and budget allocation. Development agencies and policy makers should incorporate disaster risk management into investment decisions and plans.

The Applied Research Grants Programme should assist in promoting the use of research findings and help examine constraints in the dissemination of good practices. Assistance from other agencies to deal with the problem can also be sought. Involvement and collaboration with key stakeholders is crucial for effectiveness and success.

Dissemination Strategy

To put the research findings into practice, it is necessary to develop demand for seismic mitigation measures though the following:

Build awareness in the community through awareness trainings, workshops, and orientations to community people, policy makers, technicians, and engineers. This would promote information sharing and knowledge exchange within the target group. The National Society for Earthquake Technology-Nepal (NSET) has already organized meetings with in-house professionals, school representatives, and institutional members.

Prepare and publish guidelines and standardized manual on relevant topics that uses simple, non-technical language. A proposal to implement this strategy has already been submitted to ProVention and ADPC.

Build capacity of technicians and engineers through trainings and workshops conducted by experts with sound knowledge on relevant topics.

Action Plan

- Publish guidelines.
- Organize a workshop for dissemination of research findings.
- Implement seismic mitigation measures in at least one of the school buildings to show its benefits to the community
- Disseminate the findings in various training programmes and other activities organized by NSET.
- Present the research findings in regional and international workshops.

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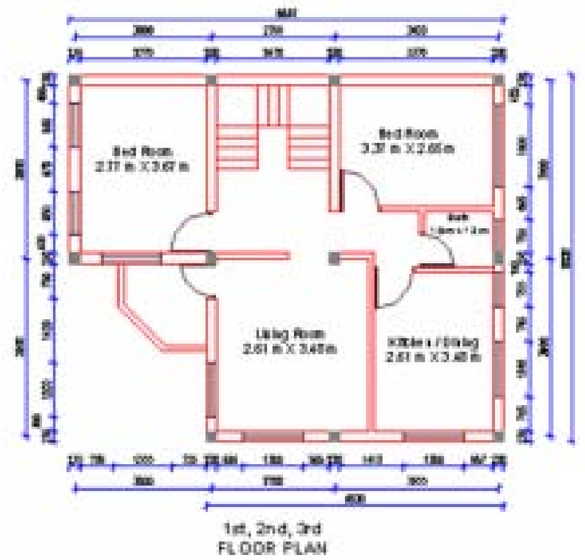
Annex A
Characteristic of the Typical Buildings Considered

Typical Features of Type 1 Building

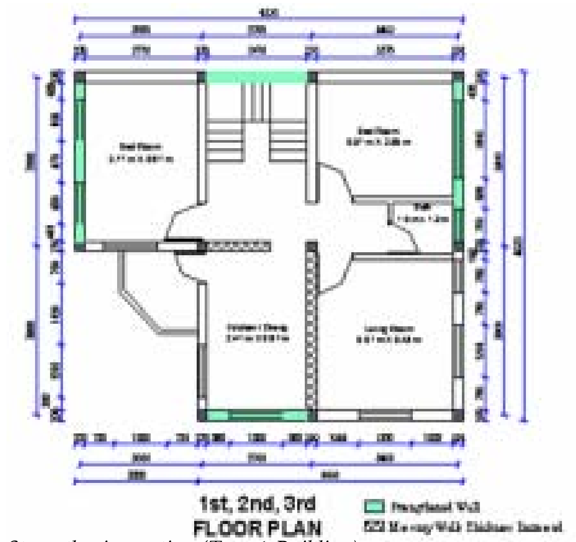
This is an independent building and not attached with any other building. All columns measure 230 mm X 230 mm in size and beams have 230 mm X 325 mm depth. Floor slabs are reinforced concrete 115 mm thick. Grade of concrete and steel for all structural elements are M15 and Fe 415, respectively. All the periphery walls and the walls adjacent to staircase are 230 mm thick and other internal partition walls are 115 mm (half brick) thick. The rear side of the building consists of a full brick wall while the remaining three sides have door and window openings. The floor area of the building is 61.0 m2. Maximum grid spacing is 3.9 m. This building resembles the most common building type in the urban areas of Nepal. The typical floor plan is shown on the adjacent column.

Typical Features of Type 2 Building

This is a row building and has a single bay. All columns measure 230 mm X 230 mm in size and all beams have a 230 mm X 325 mm depth. Floor slabs are 115 mm thick reinforced concrete. Grade of concrete and steel for all structural elements are M15 and Fe 415, respectively. All the periphery walls are 230 mm thick and other internal partition walls are 115 mm (half brick) thick. The building has a full brick wall (230 mm thick) without opening along the longitudinal direction on both sides while the remaining adjacent periphery walls have door and window openings. The floor area of the building is 30.0 m^2 and maximum grid spacing is 3.6 m. This building also resembles one of the most common building types in the urban areas of Nepal.



Typical floor plan (Type 1 Building)



Strengthening option (Type 1 Building)

Material Properties

For the estimation of the parameters such as compressive strength, tensile strength, shear strength, modulus of elasticity, poisson's ratio values of both brick masonry, and reinforced concrete cement of the building under consideration, a combination of analytical or empirical methods and experimental data were used.

The project also collected test specimens (i.e. prisms of concrete, brickwork, etc.) from buildings under demolition in Kathmandu Valley to supplement the assessment work.

Average values of compressive strength of the masonry and concrete obtained from laboratory experimental tests were 1.426 N/mm^2 and 14.76 N/mm^2, respectively. These values were used for determination of other design parameters for analysis and design purposes.

Modeling and Analysis of Selected Buildings

The buildings were analyzed as a combination of frame and brick masonry infill structures instead of the conventional practice of analyzing them as bare frame structures. Beams and columns were considered as reinforced concrete frame elements. Infill masonry walls were replaced by pin jointed diagonal compressive strut with an effective width of w.

Analysis and design of the building was performed using the prevalent design philosophy for building structures.

The Indian Seismic Code IS: 1893, 2002 was referred to for lateral load calculation. Base shear was estimated as per the Seismic Coefficient Method. The fundamental time period T of the building was calculated from the free vibration analysis of the building structure using ETABS structural analysis software.

Linear Static Process of analysis was carried out using ETABS structural analysis software program to obtain member forces and frame deformations. In the analysis, the floor slabs were assumed to act as rigid diaphragms. The masonry panels were modeled pin jointed diagonal strut. The number of degrees of freedom considered in the analysis was six (i.e., all three translation and all three rotational degrees of freedom). All the nodes at the plinth level were restrained in all six degrees of freedom.

Analytical Study

Two prototypes of typical building were considered for analysis. The model was prepared with column and beam elements as frame elements and brick masonry infill with pin jointed diagonal struts. For both building types, models were prepared and analyzed for 2 stories, 3 stories, and 4 stories separately—keeping the building plan and elevation the same in each storey—to have an in-depth knowledge of how stresses increase in load bearing structural elements and to assess the capacity of buildings with variable stories. The parameters investigated were the time period, inter-storey drift, base shear, and induced element stresses in struts, beams, and columns. Stresses induced were compared with their respective permissible values to identify which critical structural elements were more likely to fail.

The analysis was able to come up with the main causes of failure—whether shear, tension, or axial compression. Regarding induced stresses and the reinforcement provided in beams and columns, lap length required was calculated in each case. Lap length requirement was compared with the general practice in actual construction processes. Anchorage value required in beam column joints in each case was also tabulated (see tables below). The cases that exceeded the permissible value were strengthened either with wall jacketing or addition of reinforced concrete shear walls in selective walls on the periphery of the building model or by jacketing of columns. Results of the strengthened structure were further compared with the original existing structure and with their respective permissible values to verify the safety of the structure. Analysis for Type 1 and Type 2 Buildings is presented in the following tables:

Building 1(2 storey)

Strut axial stress(Table 1.1.1)

S.N.	Description	Axial stress(N/mm^2)
1	Existing building	0.9
2	With addition of walls	0.51
3	Wall jacketing in first floor	0.4

Column shear stress(Table1.2.1)

S.N.	Description	Shear stress(N/mm^2)
1	Existing building	0.21
2	With addition of walls	0.17
3	Wall jacketing in first floor	0.35

Beam anchorage(Table 1.3.1

S.N.	Description	Required anchorage(mm
1	Existing building	490
2	With addition of walls	410
3	Wall jacketing in first floor	400

Tension Column lap(Table 1.4.1)

S.N.	Description	Required lap length(mm)
1	Existing building	335
2	With addition of walls	300
3	Wall jacketing in first floor	200

Building 1(3 storey)

Strut axial stress(Table 1.1.2)

S.N.	Description	Axial stress(N/mm^2)
1	Existing building	1.4
2	Wall jacketing in first two floor	0.4

Column shear stress(Table 1.2.2)

S.N.	Description	Shear stress(N/mm^2)
1	Existing building	0.34
2	Wall jacketing in first two floor	0.4

Beam anchorage(Table 1.3.2)

S.N.	Description	Required anchorage(mm)
1	Existing building	600
2	Wall jacketing in first two floor	360

Column lap(Table 1.4.2)

S.N.	Description	Required lap length(mm)
1	Existing building	900
2	Wall jacketing in first two floor	250

Building 1(4 storey)

Strut axial stress(Table1.1.3)

S.N.	Description	Axial stress(N/mm^2)
1	Existing building	1.94
2	Partial shear wall	0.55
3	Full shear wall	0.39
4	Column jacketing	0.68
5	Wall jacketing	0.41

Column shear stress(Table 1.2.3)

S.N.	Description	Shear stress(N/mm^2)
1	Existing building	0.45
2	Partial shear wall	0.16
3	Full shear wall	0.15
4	Column jacketing	0.18
5	Wall jacketing	0.3

Beam anchorage(Table 1.3.3)

S.N.	Description	Required anchorage(mm)
1	Existing building	700
2	Partial shear wall	950
3	Full shear wall	350
4	Column jacketing	480
5	Wall jacketing	325

Column lap(Table 1.4.3)

S.N.	Description	Required lap length(mm)
1	Existing building	1300
2	Partial shear wall	350
3	Full shear wall	300
4	Column jacketing	
5	Wall jacketing	400

Intervention Options Suggested to Improve Seismic Performance

Out of the various available methods, the following alternatives are the most practically feasible and economically viable methods for the seismic retrofitting of buildings.

Type 1 Building

Alternative I: Jacketing of Selected Walls

One alternative for very light building frames would be to improve integrity and deformability by jacketing the building structure.

Reinforced concrete jacketing of all the selected four walls on the periphery as shown in the floor plan above could be a good option to improve strength and deformability, reducing the risk of the walls disintegrating and the total collapse of the building. Two steel meshes (welded wire fabric mesh) will be placed on the two sides of the wall and connected by steel anchors (each spaced at 600 mm). A 40 to 50 mm thick cement mortar or micro-concrete layer is applied on the two networks to give rise to two interconnected vertical plates.

Along with the jacketing of these walls, four more masonry (brick in cement) walls are added on the ground floor. On the second to fourth floor of the building, two walls are added to produce symmetric wall action and increase the strength of the building.

Alternative II: Addition of Reinforced Concrete Shear Walls

As the building lacks ductile detailing—a key factor of resisting earthquake force—deformation control is of primary concern. Deformation can be significantly reduced if few selected masonry walls are replaced by reinforced concrete shear walls designed to absorb the amount of lateral load that the existing structure is unable to withstand.

Removing selected brick masonry walls and replacing them with reinforced concrete shear walls that are tied with the existing frame structure could be the most promising method to reduce the damage from earthquake. This is a better option if newly built reinforced concrete shear walls can be integrated with the corresponding beams and column of the existing structure. Analytical results show that the addition of shear walls significantly increases strength and stiffness. Structural response in this case is better than the method of wall jacketing. This technique is recommended for the buildings of 4 stories and above.

Cost Estimate

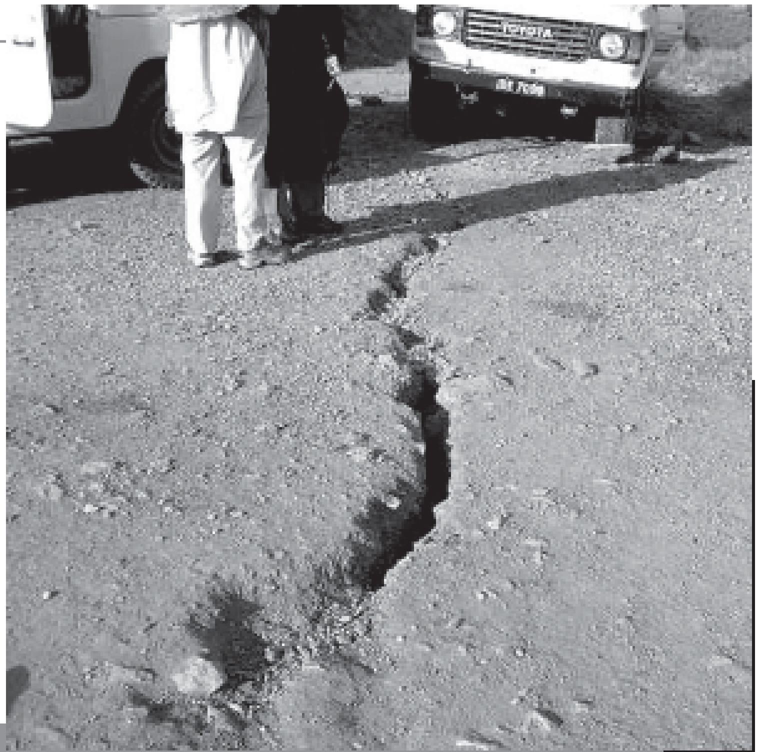
The estimated costs for the different intervention options for different building heights are listed below.

Type 1 Building

S.N.	Description of intervention method	No. of stories	Cost per square meter of floor area (Nepalese Rupees)
1	Jacketing of selected walls	2	1,300
2	Jacketing of selected walls	3	1,900
3	Jacketing of selected walls	4	2,500
4	Addition of RCC shear wall	4	3,000

Type 2 Building

S.N.	Description of intervention method	No. of stories	Cost per square meter of floor area (Nepalese Rupees)
1	Increase wall thickness along long span and wall jacketing on peripheral walls in the other direction	2	2,000
2	Increase wall thickness along long span and wall jacketing on inner walls in the other direction	3	2,900
3	Increase wall thickness along long span and addition of RCC shear wall in the other direction	4	3,600



The study made it very clear that there is an urgent need to make further geophysical investigations in Hoa Binh Hydropower Dam, which contributes significantly to the economic development of Vietnam.

- Hoang Quang Vinh

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Seismic Hazard Assessment in Hoa Binh Hydropower Dam

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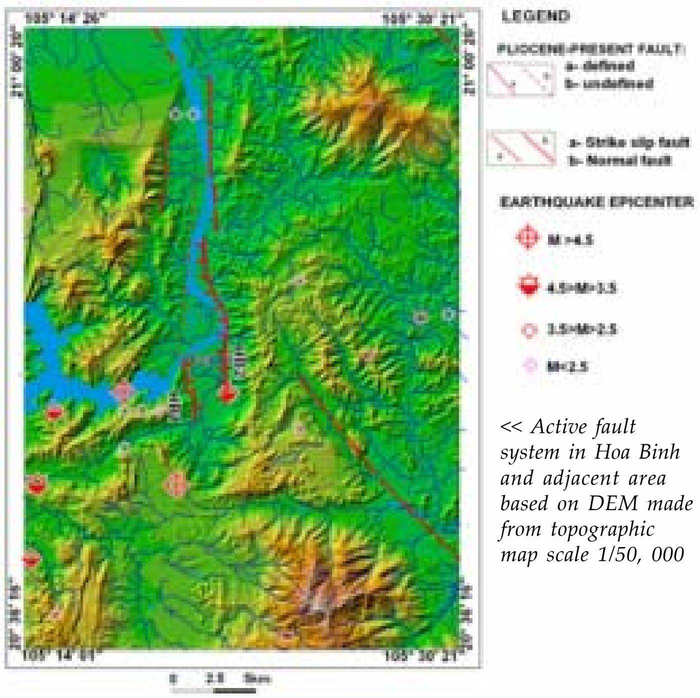
Abstract

Located in the northwest region of Vietnam, the Hoa Binh Hydropower Plant lies near active seismic faults in the Indochinese Peninsula. As such, it is important to evaluate its safety in the event of an earthquake.

Based on the results of remove sensing, geological, geomorphologic analysis, and fieldwork observations, fault systems that have the potential to generate earthquakes and cause damage to the dam and water reservoir in the Hoa Binh area were identified. The sub-meridian fault system consists of a segment on the central part of the east and west flanks of the Quaternary[1] Hoa Binh-Bat Bat graben. A segment dips on the east with the North-South trending measuring 4 km long and the dip angle measuring 75^{o} to 80^{o}. Two segments dip on the west. The N-S trending in Eastern Hoa Binh is 8.4 km long and the dip angle is 70^{o} to 75^{o}. The maximum credible earthquake (MCE) of Hoa Binh Segment 1 (HB1) and Hoa Binh Segment 2 (HB2) is 5.6 and 6.1, respectively; while the peak ground acceleration (PGA) is 0.30 g and 0.40 g, respectively.

Hazard Addressed

Measuring more than 120 meters high, Hoa Binh is the highest dam in Southeast Asia. Located less than 80 km from the Vietnamese capital of Hanoi, the Hoa Binh Hydroelectric Power Plant contributes significantly to the economic development of Vietnam. It was built on an area with complex geological structure that went through different periods of tectonic development under the strong impact of Cenozoic[2] deformation. The Hoa Binh reservoir is located next to two main active fault zones in North Vietnam: the Da river fault and Red River fault zone, which is the largest fault zone in Vietnam. The Red River fault zone splays into two major active fault branches. Right lateral strike-slip offsets of faults are recognized from Landsat and spot images, detailed topographical maps, and field observations of tributaries, stream channels, Quaternary alluvial fans, and river valleys. Along the SW fault of the Red River, right lateral offsets of stream channels range from 220 to 700 meters. Geomorphology and topographical offsets suggest that these strike-slip movements are combined with normal slip. In the Hoa Binh area, two active normal faults are located more than 1 km away from the dam on the east. These active faults were not considered when the dam was designed and constructed. During the 1970s when preparations were underway for the construction of Hoa Binh Hydropower Dam, Vietnamese and Russian workers conducted a series of geological and geophysical investigations. However, they did not pay attention to active faults and did not consider the effect of coulomb stress change near the fault.



<< Active fault system in Hoa Binh and adjacent area based on DEM made from topographic map scale 1/50, 000

[1]Quaternary is an Interval of geologic time, 1.8 million years ago to the present.
[2]Of, belonging to, or designating the latest era of geologic time, which includes the Tertiary Period and the Quaternary Period and is characterized by the formation of modern continents, glaciation, and the diversification of mammals, birds, and plants.

An earthquake would not only destroy the dam but also adversely affect Hanoi City and the more than 20 million inhabitants of the Red River Delta. To prevent such catastrophes and ensure the safety of the Hoa Binh Hydropower Dam, it is important to make a comprehensive seismic hazard assessment.

Methodology

To estimate seismic hazard sensitivity of the Hoa Binh Hydropower Reservoir, the study concentrated on the analysis of recent tectonic activities; made detailed measurements of geologic, geomorphologic, and tectonophysical parameters; and analyzed remote sensing data in the hydropower zone. The project investigated the characteristics of active faults in the fault segment; state of stress; seismicity in Hoa Binh area, made an assessment of maximum credible earthquake (MCE), maximum design earthquake (MDE), operating basic earthquake (OBE), and corresponding maximum peak ground acceleration (PGA); and modeled coulomb stress change.

The following tasks were completed:

1. Investigated the characteristics of active faults in fault segment, dipping, state of stress, and their recent activities.

2. Clarified the evidence of seismicity in Hoa Binh and surrounding areas—earthquake depth, recurrence, focal mechanism, and historical earthquakes.

3. Collected data of seismicity in Hoa Binh and surrounding areas—earthquake depth, recurrence, focal mechanism, and historical earthquakes (Appendix A).

4. Undertook 30 days of fieldwork in Hoa Binh and adjacent areas to observe geological structures, geomorphology, and characteristics of active faults in fault segment, state of stress, their recent activities, and geological structures.

5. Analyzed Landsat image topographical maps and other data to build active fault scheme of the North Viet Nam, geodynamic-seismotectonic scheme, and active fault scheme of the Hoa Binh area.

6. Assessed the maximum credible earthquake (MCE) and maximum peak ground acceleration (PGA) at Hoa Binh Hydropower Dam and PGA corresponding to maximum design earthquake (MDE) and operating basic earthquake (OBE).

Key Findings

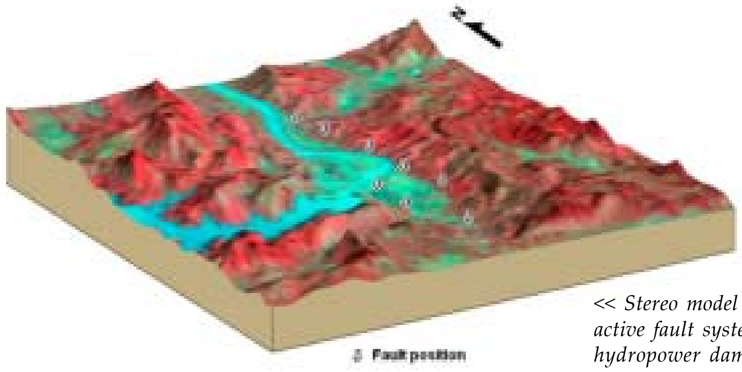
From Landsat and spot satellite images and digital elevation model (DEM), three North-South trending segments developing next to the Hoa Binh dam root that generate a nearly vertical-flank graben were identified. In some sites, the graben is 2.5 km wide filled with alluvial-proluvial deposits up to 70 m thick. The fault segment at the east flank is 8.4 km long and the one segment at the west flank is 4 km long. The distance between the latter and the dam is only 0.3 to 2.5 km. Diverging movement of the two fault segments can be observed clearly on spot satellite and Landsat images, DEM, and on the field. This movement is apparently characterized by triangular facets. Results obtained from tectonophysical methods were completely consistent with the representation above. If stress field is predominantly compressive in pre-Pliocene, stress field is predominated by normal extensity trend in Pliocene[1]-Quaternary periods.

In the modern tectonic framework, this is the youngest fault cutting and varying all older structures and former framework. On each flank of Hoa Binh-Bat Bat graben, the normal fault surfaces are nearly vertical, dipped to the graben center. Each fault coincides with some landforms and controls distribution of river terraces and alluvial flat.

The sub-meridian fault system is distributed along two flanks and controls structure of the Hoa Binh graben. The western fault branch running across the Ong Tuong hill area is more than 4 km long and its fault surface dips to the east. Along this segment, there are a number of normal active shear zones that could cause surface cracks in this area. The eastern fault branch consists of one segment measuring about 8.4 km long. Along this segment are triangular facets that are characteristic of normal faulting. In addition, the active shear zone system in Doc Cun area is also well defined. Along some segments at the western Hoa Binh depression—such as the Ong Tuong Hill area, mafic extrusive formations west of Hoa Binh Dam, or Doc Cun-Hoa Binh area—the active shear zones are normal slip form and its shear surfaces are concordant with the zone trend. Rolled materials are clay, debris of ferro-gel in fine-soft-porous state. Some sites have slickensides. Clearest in Ong Tuong hill area, the active shear zones cut across 20 to 50 meter-wide bedding plane system (bedding plane trending East to West, slope angle 75^o to 80^o) filled with black grey clay materials.

Faulting of the branches in the eastern Hoa Binh depression caused landslides and fissure cracks in 1996 at the Ong Tuong Hill area, severely damaging buildings and the water supply plant. In the Doc Cun area or in low hill range at the eastern Hoa Binh Dam, there are also similar normal shear zones whose scales are up to 60 to 80 cm.

[1]Of or belonging to the geologic time, rock series, or sedimentary deposits of the last epoch of the Tertiary Period, characterized by the appearance of distinctly modern animals.



<< Stereo model of Landsat image showing active fault system near Hoa Binh hydropower dam and adjacent area

Seismic Attenuation

There is a lack of specific law for the Vietnamese value of peak ground acceleration (PGA). These are Models 1, 2, 3, 4 of Campbell and formulas of Idriss, Xiang and Gao, Woodward-Clyde, and Ambraseys; and of Cornell McGuire, Estena, and Rosenblueth. The formula of Cornell, McGuire, Estena, and Rosenblueth has reference value only. Therefore, when taking the weight average to summarize the peak ground acceleration by different methods, the three methods above cannot be used. The Models 1, 2, 3, 4 of Campbell are based on global vibration data near the source so it has high reliability in assessing earthquakes within a radius of 50 km or less. The above formulas can use coefficient 2 for calculating weight average. The formula of Xiang and Gao can also use coefficient 2, because it is set up from earthquake data in Yunnan, China—which is close to the geological condition and structure of Vietnam. Result of the assessment of maximum credible earthquake (MCE) for active fault segment in the area is as follows: HB1 and HB2 is 5.6 and 6.1, and maximum PGA at Hoa Binh dam is 0.30g and 0.40 g, respectively.

Conclusion

Based on the satellite interpretation and geomorphologic observation, the N-S active fault systems that have the potential to generate earthquakes and cause significant damage to Hoa Binh Hydropower Dam have been found.

There is an urgent need to make further geophysical investigations and do trenching along fault segments to obtain more geological evidence. Stress modeling of coulomb stress change is necessary to forecast displacement and stress distribution in the deep and on the surface.

Action Plan

With funding support from the project, a field trip will be organised to investigate further active faults with geomorphological observation. Additional financial support from the Institute of Geological Sciences will be used to purchase topographic map and transfer to digital elevation model (DEM).

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Annex A
Hoa Binh Area Seismic Data from 1277 to 2003

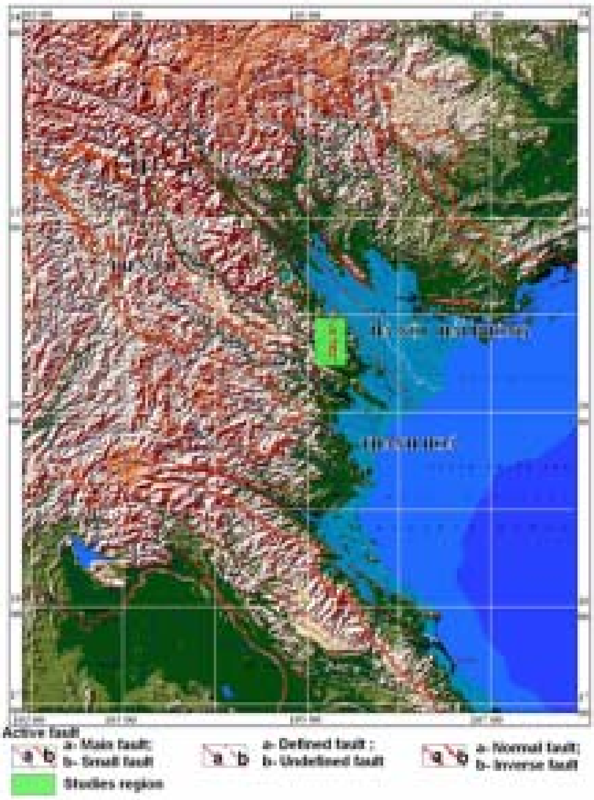
No	Year	Month	Day	Hour	Minute	Second	Longitude	Latitude	Depth	M	Type	Source
1	1277	5	1	1	1	0	21	105.85	15	4.8	M	Ls
2	1278	8	22	1	1	0	21	105.85	10	5.1	M	Ls
3	1285	9	24	1	1	0	21	105.85	10	5.1	M	Ls
28	1928	12	1	1	1	0	21.42	105.17	9	4.3	M	Nkm
32	1931	5	3	4	47	0	20.8	105.7	5	2	M	Nkm
41	1934	1	1	1	1	0	21.17	104.92	12	4.8	M	Nkm
45	1936	1	10	1	1	0	21.25	105.25	8	4.2	M	Nkm
52	1937	12	1	1	1	0	21.25	105.25	6	4	M	Nkm
54	1939	6	1	1	1	0	20.5	105.9	15	4.8	M	Nkm
58	1942	5	12	1	1	0	20.75	105.25	7	4.4	M	Nkm
66	1945	9	1	1	1	0	21.08	105.08	15	4.8	M	Nkm
65	1945	7	1	1	1	0	20.75	105.33	11	4.7	M	Nkm
73	1951	4	1	1	1	0	20.97	104.97	13	4.1	M	Nkm
75	1952	7	1	1	1	0	21	104.9	10	4.4	M	Nkm
88	1958	9	20	5	17	20	21.25	105.5	20	5.3	M	Nkm
95	1962	6	3	1	1	0	20.83	104.83	10	4.1	M	Nkm
97	1963	9	22	10	2	0	21	105.8	15	2.6	M	Nkm
102	1964	9	3	1	1	0	21.37	105	9	3.7	M	Nkm
101	1964	9	2	20	39	0	21.4	105.9	9	3.6	M	Nkm
115	1966	8	9	1	1	0	21.35	105.9	6	2.8	M	Nkm
115	1966	8	9	1	1	0	21.35	105.9	6	2.8	M	Nkm
119	1967	6	1	1	1	0	21	105.66	20	5	M	Ndx
119	1967	6	1	1	1	0	21	105.66	20	5	M	Ndx
129	1974	6	1	1	1	0	20.63	105.1	17	4.1	M	Ndx
129	1974	6	1	1	1	0	20.63	105.1	17	4.1	M	Ndx
142	1976	8	7	11	27	3.2	21.34	105.31	20	2.3	D	VIE
147	1976	9	20	14	46	26.8	20.84	105.47	5	2.5	D	VIE
142	1976	8	7	11	27	3.2	21.34	105.31	20	2.3	D	VIE
230	1980	12	17	17	46	46	20.93	104.82	5	3.2	D	VIE
254	1983	4	30	9	16	20.9	20.66	104.88	5	3	D	VIE
252	1983	3	7	6	54	58.6	20.55	104.95	15	3.1	D	VIE
388	1983	9	17	6	26	41.9	20.65	105.39	5	2.6	D	VIE
253	1983	3	21	7	19	35.2	20.82	105.44	5	2.7	D	VIE
406	1984	2	28	17	2	34.1	20.51	104.95	5	3	D	VIE
473	1988	3	14	16	35	33.6	20.63	104.97	18	3.6	D	VIE
487	1989	4	14	12	46	53.2	20.7	105.21	10	3.7	D	VIE
486	1989	4	14	12	37	44.8	20.71	105.23	20	3.8	D	VIE
493	1989	5	26	21	9	25.5	20.79	105.26	16	3.9	D	VIE
491	1989	5	22	23	5	23.2	20.8	105.3	15	4.9	D	HIG
490	1989	5	14	13	23	12.6	20.8	105.36	5	3.8	D	VIE
492	1989	5	22	18	28	45.4	20.78	105.4	8	2	D	VIE
501	1990	5	22	17	25	52.3	20.57	105.12	13	2.7	D	VIE
526	1991	7	10	12	47	12.6	20.97	104.79	13	3	D	VIE
533	1991	8	14	12	12	46.3	21.11	104.79	0	2.3	D	VIE
524	1991	6	12	18	54	48.3	20.73	105.18	20	2.2	D	VIE
545	1991	11	12	20	53	41.6	21.03	105.32	19	2.2	D	VIE
630	1995	11	28	17	3	46.4	20.73	105.08	4	2	D	VIE
598	1995	1	4	7	14	17.6	20.85	105.08	0	3.7	D	VIE
631	1995	11	28	20	25	39.2	20.77	105.09	9	2.4	D	VIE
618	1995	6	1	20	18	5.8	20.91	105.55	8	0.7	D	VIE

No	Year	Month	Day	Hour	Minute	Second	Longitude	Latitude	Depth	M	Type	Source
706	1997	11	17	22	2	3.9	21.08	104.79	19	3.2	D	VIE
670	1997	3	10	17	27	29.3	20.65	104.8	10	3.7	D	VIE
686	1997	6	7	14	7	35.2	21.09	104.82	9	3.9	D	VIE
695	1997	7	24	6	21	50.7	21.11	104.84	15	3.5	D	VIE
683	1997	5	7	21	8	12.89	21.24	104.87	12	2.1	D	K2
696	1997	7	24	13	21	52.33	21.25	104.87	10	1.8	D	K2
690	1997	7	11	10	17	16.9	21.4	105.52	21	2	D	VIE
705	1997	11	10	10	13	32.5	21.23	105.54	4	2.4	D	VIE
701	1997	10	6	3	34	14.82	20.68	105.61	18	1.6	D	K2
702	1997	10	24	7	19	3	20.98	105.65	5	2.9	D	VIE
722	1998	2	10	8	18	3.7	21.07	104.8	17	3.3	D	VIE
720	1998	2	6	16	22	48.3	21.15	104.88	19	2.7	D	VIE
728	1998	3	15	21	53	27.12	21.36	105.21	21	1.7	D	K2
711	1998	1	8	7	30	49.1	21.21	105.59	0	2.2	D	VIE
712	1998	1	10	12	42	19.99	20.5	105.86	9	0.9	D	K2
716	1998	1	29	5	29	39.1	21.09	104.81	19	2.5	D	VIE
752	1999	9	13	19	9	13	20.75	104.93	18	3.3	D	VIE
757	2000	1	2	5	12	11	21.11	105.38	6	2.2	D	VIE
813	2001	7	20	5	22	35	20.79	104.86	0	3	D	VIE
816	2001	8	23	4	5	51.9	21.23	105.08	16	1.8	D	VIE
859	2001	11	30	9	22	55.4	20.79	105.1	5	1.7	D	VIE
856	2001	11	25	6	53	20.2	20.8	105.11	5	1.6	D	VIE
854	2001	11	19	22	22	52.3	20.77	105.3	5	0.7	D	VIE
855	2001	11	20	6	4	1.5	20.79	105.3	5	0.9	D	VIE
858	2001	11	30	6	14	46.5	20.79	105.31	5	0.7	D	VIE
860	2001	12	20	7	51	54.5	20.79	105.32	5	1.2	D	VIE
819	2001	9	16	0	47	32	21.14	105.78	10	2.9	D	VIE
977	2002	9	6	16	6	59.3	20.66	105.17	19	2.5	D	VIE
952	2002	7	3	0	19	8.9	21.16	105.42	0	3.6	D	VIE
957	2002	7	9	19	47	58	20.73	105.53	0	1.9	D	VIE
959	2002	7	16	5	48	53.4	20.54	105.67	10	2.3	D	VIE
1086	2003	8	23	9	48	1.1	21.09	104.81	12	2.8	D	VIE
1075	2003	6	11	4	1	30.5	20.71	105.09	10	1.5	D	VIE
1060	2003	4	29	11	10	46.5	20.83	105.12	10	2.1	D	VIE
1062	2003	5	1	5	16	45.9	20.95	105.15	10	1.8	D	VIE
1087	2003	8	27	4	44	32.8	20.88	105.16	12	2	D	VIE
1079	2003	6	17	4	20	36.9	20.65	105.18	10	1.2	D	VIE
1084	2003	8	12	14	17	25.3	20.53	105.21	7	3.1	D	VIE
1081	2003	6	19	4	17	45.2	20.62	105.23	10	1.8	D	VIE
1056	2003	4	25	5	35	29.2	20.53	105.24	10	2	D	VIE
1076	2003	6	12	4	23	28	20.9	105.24	10	1.3	D	VIE
1080	2003	6	17	10	24	40.9	20.68	105.26	10	1	D	VIE
1077	2003	0.6	15	9	0	13.8	20.95	105.33	10	1	D	VIE
1054	2003	4	21	5	9	39.8	20.95	105.34	10	2.3	D	VIE
1082	2003	6	27	4	33	35.6	20.86	105.4	10	1.2	D	VIE
1059	2003	4	29	5	13	4.3	20.84	105.5	10	2.4	D	VIE
1072	2003	5	31	7	20	1.5	20.98	105.66	7	3.2	D	VIE

Annex B

Tectonic Setting

Some 50 million years ago, the process of collision between the Indian and Asian continents changed the basic tectonic framework of Asia. Systematic studies along the Red River Fault Zone (RRFZ) from Yunnan to Vietnam (Leloup et al., 1993 and 1995) proved that mostly gneiss structures along the Red River metamorphic zone were formed during the Cenozoic Period. The RRFZ played an important tectonic role in the formation and development of a series of Cenozoic structures at all scales in the northwest region and a part of northeast Vietnam. Many features of neotectonic deformation and topographical development of the northwest, in general, and Hoa Binh Hydropower Zone, in particular, have been clarified through analyses of deformational history of the RRFZ. Neotectonic activity in the northwest is expressed not only by the left lateral strike-slip displacement of the RRFZ, but it also happened along a series of fault zones in the same NW-SE direction. One can observe a series of structures of the northwest of Vietnam being formed in Cenozoi. Overthrusting phenomena were widely developed in the northwest as well as northeast of Vietnam, such as the Hoa Binh arc and Sapa marble.



Sketch of active faults in North Vietnam: I - Red River Fault Zone II-Dien Bien-Lai Chau Fault Zone

The Hoa Binh Dam zone is a regional boundary between RRFZ and Da River Zone. Uplifting of the N-S fault system is expressed clearly by high and average topographical elevation of more than 200 m in comparison with the southwest wing. This fault expresses clearly an active normal fault. The clearest manifestation is along the east segment. Triangular facets are expressed clearly with dipping toward the west. The height of triangular reaches 100 to 120 m. Typical hung valleys prove the fast uplift of NE wing that goes beyond erosion speed of gravel, sand, and soil. The Hoa Binh N-S system fault is not continuous but is divided into small segments. Extensive activities of the fault are manifested in this segment. The system fault is divided into two discontinuous segments called Hoa Binh 1 (HB1) and Hoa Binh 2 (HB2).

Hoa Binh and Adjacent Areas

From Landsat, spot satellite image and DEM, the study defined three N-S trending segments developing next to Hoa Binh dam root that generates a nearly vertical-flank graben. In some sites, the graben is 2.5 km wide, filled with alluvial-proluvial deposits up to 70 m thick. The fault segment at the east flank is 8.4 km long and the one segment is 4 km long at the west flank. Distance between the latter and the dam is only 0.3 to 2.5 km. Diverging movement of the two fault segments can be clearly observed on spot and Landsat images, DEM and in the field. This movement is apparently characterized by triangular facets. Results from tectonophysical methods are completely consistent with the representation above: If stress field is predominantly compressive in pre-Pliocene, stress field is predominated by normal extense trend in Pliocene-Quaternary.

Fault systems that have the potential to generate earthquakes and cause direct damage to the Hoa Binh dam have been identified. They are a sub-meridian fault system broadly developed in this area. They consist of segments focusing on in the central part of the east and the west flanks of the Quaternary Hoa Binh-Bat Bat graben, on the Kim Boi dome, and on the Tu Ly arc-uplifting massif. Except the faults controlling the Hoa Binh-Bat Bat that have a length of more than 10 km, other faults often are less than 10 km long.

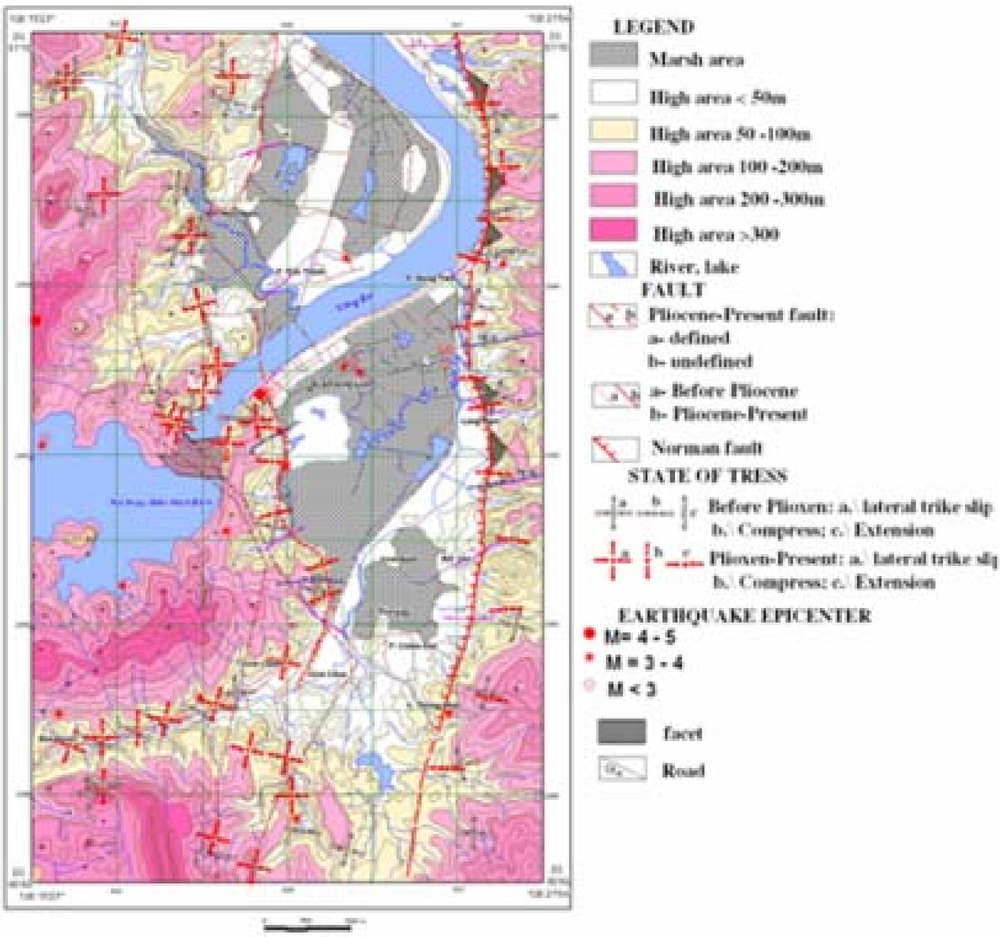
In modern tectonic framework, this is the youngest fault cutting and varying all older structures and former framework. On each flank of Hoa Binh- Bat Bat graben, the normal fault surfaces are nearly vertical, dipped to the graben center and each fault coincides with some landforms and controls distribution of river terraces and alluvial flat.

In general, all of the regions belonging to the southwestern part of the RRFZ and Quaternary graben and tectonic breccia zones develop next to the Red River fault with acute angle exhibit the right lateral movement regime of the RRFZ in the late Cenozoic Period.

The sub-meridian fault system is distributed along two flank and controls structure of the Hoa Binh graben. The western fault branch running across the Ong Tuong hill area is more than 4 km long. Its fault surface dips to the east. Along this segment, there are normal active shear zones that could cause surface cracks in this area. The eastern fault branch consists of one segment whose length is about 8.4 km. Triangular facets, characterized for normal faulting, have developed along this segment. In addition, the active shear zone system in Doc Cun area is also well defined. The fault controls the flow of river and stream system according to different base levels. They can be clearly seen on satellite images and actual topography through fault scrap, relief, and facets. Remarkably, along some segments at the eastern Hoa Binh depression, a series of triangular facets in Lang Ngoi, Lang Su have likewise been identified. These facets have a height of 70 to 120m and a wide footside of more than 500 m. The age of facets must be in the range of Pliocene-Quaternary that is formed from the earlier destruction of the Miocene[1] peneplain. Along some segments at the western Hoa Binh depression, such as in the Ong Tuong hill area, in mafic extrusive formation western of Hoa Binh Dam, or Doc Cun area-Hoa Binh, the active shear zones are normal slip form, with its shear surfaces concordant with the zone trend. Rolled materials are clay, debris of ferro-gel in fine-soft-porous state. In some sites, they can be recognized as slickensides. Clearest in Ong Tuong Hill area, the active shear zones cut across the 20 to 50 meter-wide bedding plane system (bedding plane trending E-W, slope angle 75^o to 80^o) filled with black grey clay materials.

Faulting of the branches in the eastern Hoa Binh depression caused landslides and fissure cracks in 1996 at the Ong Tuong Hill area, severely damaging buildings and the water supply plant. In addition, in Doc Cun area or in low hill range at the eastern Hoa Binh dam, there are also similar normal shear zones whose scales are sometimes up to 60 to 80m.

Radon and mercury investigation show that gas anomalies are relatively high, characteristic of the active sub-meridian fault system. The Hoa Binh graben cuts across Hoa Binh town stretching from Hoa Binh to Bat Bat. This structure could generate seismic risk for the two areas and the hydropower plant. This is a young structure that developed between the Fansipan zone and Ninh Binh zone.



Sketch map of Neotectonics-Acitve geodynamic in Hoa Binh Scale 1/25, 000

[1]Of or belonging to the geologic time, rock series, or sedimentary deposits of the fourth epoch of the Tertiary Period, characterized by the development of grasses and grazing mammals.

The sub-meridian trend from Hoa Binh to Bat Bat is 2.5 km wide and 40 km long. The Hoa Binh graben is filled up with formations of alluvial-colluvial pebble, gravel, sand, and a little of marsh facies at south of Hoa Binh. Thickness of this sedimentary layer varies according to each location, especially the 50 to 60 m in Hoa Binh.

Seismotectonic Assessment

Different methods were used to estimate maximum credible earthquake (MCE) based on fault length, fault area, and seismic movement. Coefficient 1 was used for fault length approach, coefficient 2 for rupture area approach, and coefficient 3 for earthquake moment approach.

To estimate peak ground acceleration (PGA), attenuation models 1, 2, 3, 4 of Campbell and formulas of Idriss, Xiang and Gao, Woodward-Clyde, Ambraseys; and Cornell, Mc Guire, Estena and Rosenblueth were used. The formula of Cornell, Mc Guire, and Estena and Rosenblueth has reference value only.

However, the three methods above could not be used to take weight average to summarize the peak ground acceleration. The five models of Campbell are based on global data of strong ground motion near the source. Thus, they have high reliability when assessing earthquakes within a radius 50 km or less. The above formulas can use coefficient 3 for calculating weight average. The formula of Xiang and Gao can also use coefficient 2, because it is set up from data of earthquake in Yunnan close to geological condition and structure of Vietnam.

The table below shows the MCE of fault segments and maximum PGA at Hoa Binh Dam:

No	Fault Segment	Length (km)	Depth (km)	Dip	Characteristic	Magnitude (MCE)	Maximum PGA(g)
1	HB1	4.0	6.0	75^{o}	Normal	5.6	0.30
3	HB2	8.4	6.0	70^{o}	Normal	6.1	0.40

The project got me to seriously think about disaster risk reduction (DRR) and allowed me to network with people working on DRR. The project was able to explain and demonstrate to the tsunami-affected communities why compliance to environmental laws is necessary.

- Achala Navaratne

Grant No. 2202

Strengthening Sri Lanka's Environmental Laws to Reduce Vulnerability of Coastal Populations in the Context of Post-Tsunami Reconstruction

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Background

The tsunami that hit Sri Lanka on December 26, 2004 was the country's worst devastation from a natural disaster in living memory. The human and property losses from the tsunami were extensive. More than 31,000 people were killed, approximately 6,300 went missing, and one million were affected—representing 5% of Sri Lanka's population. According to the survey of the Department of Census and Statistics (2005), the tsunami damaged an estimated 77,000 houses and completely destroyed some 36,000. The Joint Needs Assessment conducted by Asian Development Bank (ADB), Japan Bank for International Cooperation (JBIC), and the World Bank (2005) estimated the losses in the water and sanitation sector to be around US$ 42 million, and placed the amount needed for reconstruction at US$ 117 million. The assessment also estimated the financial needs for housing to be between US$437 to US$487 million and the total funding requirement for all sectors to be US$ 1,600 million.

The reconstruction effort following the tsunami presented a unique opportunity for the Government of Sri Lanka (GOSL) to improve the welfare of Sri Lanka's coastal population by taking measures to ensure a sustainable future. It presented the GOSL with the task of building safer communities with secure futures.

The project investigated the links between disasters, development, and the environment. With the goal of reducing the disaster vulnerability of coastal populations, the project educated local communities and agencies involved in post-tsunami reconstruction about environmental and legal mechanisms to reduce risks and strengthen sustainable coastal zone planning and management. In many instances, however, the objective of rebuilding better and safer communities has not been accomplished because of the lack of proper planning and the indifference of agencies and the affected populations.

Research Objectives

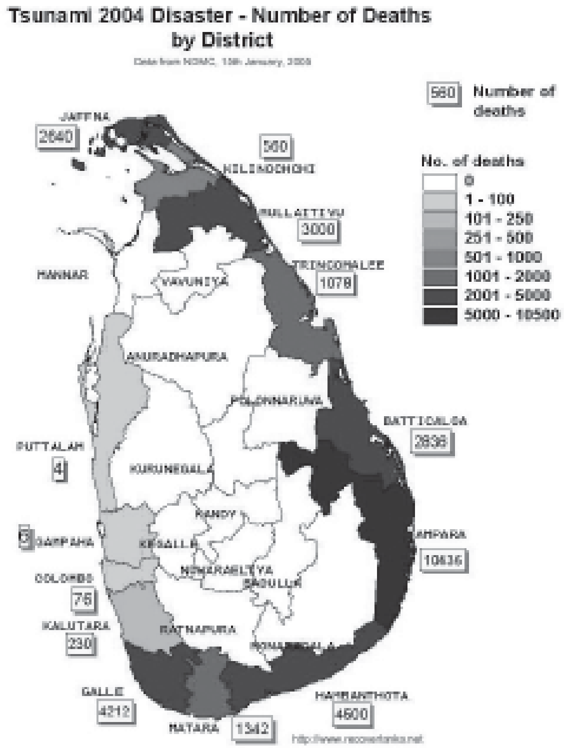
The project aimed to generate the following results:

- Relevant and accessible information on the environmental and legal aspects of risk reduction generated through a comprehensive review of Sri Lanka's legal framework on disaster management and risk reduction in coastal zone management and development.

- Community awareness of environmental and legal rights and responsibilities enhanced through the production and dissemination in the local language of awareness materials on environmental and legal rights and responsibilities in coastal zone management for communities.

- Decision-makers' and planners' access to information on environmental and legal support to disaster preparedness, prevention, and mitigation improved through the production and dissemination of briefing sheets and decision makers' guides for national and international governments, non-government organizations (NGOs), and private sector agencies engaged in post-tsunami reconstruction.

- Communication and participation among stakeholders on risk reduction strengthened through convening dialogues on environmental-legal aspects of coastal zone planning and development between different stakeholder agencies, sectors and communities involved in post-tsunami reconstruction at the national level and at selected coastal sites.



Picture 1; Discussions with the tsunami affected people in Palena, Weligama, Sri Lanka

Methodology

Legal Review. The review included the coverage of existing laws (especially those relating to land use planning, environmental management, and development activities in coastal areas) and recent laws introduced after the tsunami disaster, such as the Disaster Management Act No.13 of 2005.

Dissemination of Information Materials. Information materials produced after the legal review were translated to local languages and disseminated among government agencies, non-governmental organizations, and communities involved in post-tsunami reconstruction through existing networks, seminars, and awareness programs held at district level in collaboration with other agencies.

Site Visits, Meetings and Focus Group Discussions. Meetings and site visits were carried out to find areas of non-compliance and issues that could increase the probability of human-induced disasters in the reconstruction process. Examples of these are incidences of human-elephant conflict due to the relocation of communities near elephant reserves; and disease outbreaks due to the lack of water supply and sanitation. Meetings, forums, and discussions were held with government authorities, NGOs, and environmentalists on land use planning, provision of water and sanitation, and related issues to identify mechanisms to incorporate risk reduction measures and sustainability into the overall planning process.

Legal Action and Advocacy. Legal action, or the threat thereof, was instigated to prevent unplanned reconstruction activities from being implemented, particularly on land being allocated within or adjacent to national parks and forests.

As planned, the project carried out a legal review during its first few months and prepared legal briefs that were translated into the local languages—Sinhala and Tamil—for dissemination througout the country. The legal briefs were distributed to government agencies and other key stakeholders in the post-tsunami reconstruction process (i.e., donors, international, and local NGOs) through existing networks and channels. These briefs were also shared with local government officials during site visits, meetings, and seminars carried out in the areas to inform people of the present legal status and the need to enforce existing laws in building better, safer, and sustainable communities. A total of 3,000 documents were disseminated to increase awareness and improve law enforcement in the tsunami-affected coastal areas throughout the country. A number of site visits, meetings, and seminars were also conducted in collaboration with other government and NGOs to increase awareness at all levels.

Results

Research findings showed gaps in the environmental and legal provisions related to disaster risk reduction, introducing new problems in the rebuilding process. During the land identification and allocation process, the relevant authorities did not consult key stakeholders in land use planning and increased tension within government authorities. Land identification and selection was primarily based on availability instead of sound policies or the requirements of the people being relocated. This blatant disregard for the needs of the people was in direct violation of the National Involuntary Resettlement Policy (NIRP) approved by the Cabinet of Ministers on May 2001. Similarly, many policies and laws were violated in the process of land allocation, conducted mainly by the Urban Development Authority (UDA), the lead agency responsible for identifying land for resettlement. This initially resulted in lawsuits being filed against these decisions. Thus, government authorities had to ensure that due consideration was given to environmental factors at least in those instances.

The research materials, such as the decision makers' guide to legal aspects in reconstruction—prepared under the project—bridged some of these gaps. These materials were used in subsequent checklists prepared by government agencies for identifying suitable sites for tsunami housing reconstruction. After it was shown that neither proper assessments nor surveys were carried out at the outset, these checklists were utilized in the rapid environmental assessments carried out to reduce the environmental impact and disasters in the rebuilding process. However, in cases where sites were selected without proper assessment, people were exposed to many environmental hazards and human-induced environmental disasters. The hazards included threats from wildlife, drought, lack of clean water and sanitation facilities. When people were relocated adjacent to or within national parks and forests, conflict between the relocated communities and wildlife in the area arose, in the process destroying national treasures. These poorly planned relocation activities aggravate the human-elephant conflict that results in the death of approximately 50 people and 150 elephants every year (Griffin and Navaratne, 2005).

All the lands identified for reconstruction of houses were outside the buffer zone[1] declared by the government to reduce the risk of another tsunami strike. However, most of these identified lands were unsuitable for human habitation due to the high water table and marshy conditions (Picture 2). This resulted in wastewater back-flow into toilets, and low or no soakage of wastewater because of sanitation system failures. The study of Fraser Thomas (2006) for the National Water Supply and Drainage Board (NWS&DB) examined tsunami housing schemes with more than 250 housing units at a site. The study found out that more than 75% of these sites encountered problems with the high ground water table. This situation happens in large and small housing developments. If proper assessments were carried out in the land identification, these problems could have been avoided. Some completed tsunami housing schemes are inhabitable due to overflowing sewage (Navaratne, 2006).

Due to the lack of sound policies, the tsunami affected communities were displaced and relocated to areas prone to droughts and human-elephant conflict. As a result, many tsunami affected people in identified buffer zones or no-build zones refused to move from their original land. They claimed that being relocated inland (5 to 10 km) disrupted their main livelihood—fishing. In addition, it caused friction between the existing inhabitants and the new communities because of social divisions among them. The tsunami-affected people who refused new housing in inland areas defied the new no-build zones and built houses within disaster prone areas. They argued that tsunamis do not occur frequently; and even if another one would strike, there would be less damage because of better tsunami awareness and the tsunami early warning systems.

Picture 2: Water logged marshy land identified for tsunami housing in Kalutara, Sri Lanka

Discussion

Before the 2004 tsunami disaster, the government imposed a no-build zone in the coastal areas to protect the people from possible tsunami devastation. However, this became a controversial issue because the regulation was rarely enforced and many lobbied to have that provision removed. The new buffer zones were even criticized by the Committee on Natural Disasters in the Sri Lankan parliament. After much controversy, the government revised the guidelines set for construction in coastal areas following the tsunami disaster. On November 2005, it reversed the earlier controversial decision to enforce a 100-meter to 200-meter buffer zone (i.e., no build zone) and introduced a more flexible plan based on an old set of regulations in 1997. Although coastal restrictions have been in place, political interference, corruption, and government indifference have resulted in non-enforcement. Thus, it remains to be seen if the new regulations would be enforced this time around.

Picture 3. New houses built in the no-build zone in Denuwala, Weligama, Sri Lanka

[1]In early 2005, the buffer zone was initially set at 100 meters in the Western and Southern Provinces, and 200 meters in the Eastern and Northern Provinces. However, on November 2005, these were altered to regulations stipulated under the Coastal Zone.

The recent revision of coastal regulations has increased disaster risks, instilling in a sense in the coastal communities that there are no regulations set in place for rebuilding at present. In the meantime, reconstruction has commenced within the new, flexible buffer zones with scant regard to existing regulations.

Nonetheless, the project disseminated information on environmental and legal aspects related to the reconstruction process to all key stakeholders. Further, more research was carried out to identify issues related to non-compliance with such environmental aspects and laws. It also identified the gaps in the provision of adequate water and sanitation in relocation and reconstruction projects.

The project implemented awareness raising and capacity building programs for public health inspectors, engineers, and planners through training institutes, universities, and other agencies.

The research hopes to contribute to disaster risk reduction in the country through better understanding of the environmental and legal aspects related to identifying land suitable for relocation in the post-tsunami reconstruction process and for large environmentally sensitive projects.

Picture 4. Awareness program conducted at Public Health Inspector training institute

Conclusion

There is clear evidence that government agencies have relaxed rules on the no-build zones due to pressure from tsunami-affected people and politicians. The research primarily aimed to inform the decision makers of existing laws related to disaster risk reduction and environmental protection. Even with such information, authorities made decisions without focusing on reducing disaster risks, arguing that Sri Lanka now has an efficient and effective tsunami early warning system set up under the Disaster Management Centre (DMC). This system has performed successfully under actual conditions with its ability to inform and speedily evacuate people from tsunami disaster prone areas. However, this early warning system is effective only in the Western and Southern Provinces, and is only partly operational within the Eastern and Northern Province due the lack of government control in those areas.

Hence, the lack of law enforcement, political interference, and public apathy have served to increase disaster risks in the coastal zones and brought the level of vulnerability of communities to the time when the Asian tsunami struck Sri Lanka. The country still has a long way to go in enforcing environmental laws to ensure the safety of coastal communities.

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The research enabled me to have a comprehensive understanding of Thailand's emergency management. There is a need for a clear line of command and properly divided responsibilities among government agencies at the local, regional, and national levels so they can respond properly during emergencies.

-Tavida Kamolvej

Grant No. 2157

The Search for Collaborative Emergency Management in Thailand

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Abstract

With the low awareness of tsunami risk and lack of understanding of the large-scale emergency that devastated six coastal provinces, Thai national and provincial governments have experienced many difficulties working together to provide assistance to affected communities. The lack of experience in crisis management has led agencies to misinterpret severe risks, resulting in unorganized and inadequate responses. This study assessed the response to the 2004 tsunami disaster in southern Thailand and the Bangkok flood crisis management and accident emergency plan to identify the patterns of self-organization and adaptation in complex systems of emergency operation. Two emergency response systems were used as cases to show that the adaptive capacity of organizations would benefit participating agencies and affected communities. Lessons and experiences shared among agencies foster organizational flexibility to adapt to changes and deal with complexity.

Tsunami Emergency Response

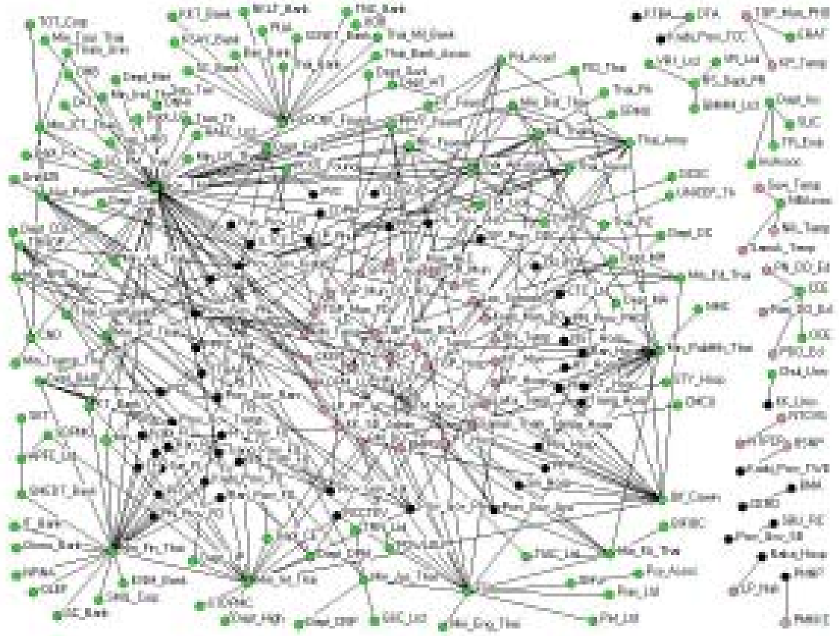
The Government of Thailand plays a critical role in mobilizing response operations, facilitating interactions, and connecting with international organizations through the response network. In accordance with the Thai Constitution, the Minister of Interior acts as commander in chief and the Ministry of Interior becomes the national command center during large-scale emergencies.

During the 2004 tsunami that affected coastal communities in southern Thailand, the frontline emergency response personnel came from the Department of Disaster Prevention and Mitigation (DDPM) Regional Center, Provincial Unit, and Headquarter in Bangkok, private rescue foundations, and Civil Defense Volunteer Units. The emergency response was slow due to several reasons: lack of information and inadequate experience in dealing with tsunami disasters, lack of coordination skills, absence of electricity, power, and effective communication systems. Many organizations and agencies in the area tried to undertake search and rescue operations without understanding how the other units worked. Redundancy and duplication of efforts delayed the delivery of assistance to victims, wasting vital human power and resources needed for the operation.

From the interaction matrix (Figure 1), circles represent organizations and lines represent interactions between organizations located in four different areas of the map. The area on the right hand side of the map shows a scatter plot of organizations that interact outside a main network. In the network, there are three layers of organizations: an outer layer of national organizations circling around the edge; a middle layer of provincial organizations; and a central area showing organizations from local jurisdictions. The response system appears to be loosely connected—with many organizations participating but not necessarily interacting efficiently with one another. This pattern reflects the poor connection and coordination among agencies at all levels. These organizations enter the system by themselves and choose to interact with fewer organizations to accomplish specific tasks. Such functional interactions are likely to be repeated because of the lack of coordination skills and communication difficulties. An unorganized emergency assistance system delays the delivery of assistance to people who need it most.

Co-training and skills transfer through interaction among emergency response agencies can facilitate knowledge and information sharing within the network of emergency personnel so they can react faster and more effectively. DDPM personnel receive training within their organization and are more frequently trained individually than any of the co-training programs provided by their agency or other organizations. However, organizations surveyed in this study reported the general lack of training and exchange in emergency response skills. This has led to inadequate understanding of work processes in other response organizations. It has also constrained the development of adaptive skills to deal, cope, and respond to problems and fluid situations.

Figure 1. Map of Domestic Organizational Interactions within the Thai Tsunami Response System from December 27, 2004 to January 17, 2005 (Source: Thai Rath Newspaper, December 27, 2004 to January 17, 2005).



NOTE: Green dots represent national organizations, black dots represent provincial organizations, and pink dots represent local organizations. The meanings of acronyms are in Annex A.

Information flow facilitates the dissemination of knowledge needed to understand tasks or future problems. During the tsunami emergency operation, the flow of information went into different directions—top-down, bottom-up, radial, lateral—indicating the possible existence of feedback from organizations that can evaluate performance and introduce new knowledge or solutions to previous problems. While the variety of directions of information flow assists in effective dissemination, the redundancy of information from various sources and directions can create confusion. Survey and interview data indicated that top or middle management staff primarily made the decisions.

The lack of timely, accurate information, and time constraints weakened the decision-making capacity of middle management personnel at the provincial level and delayed the delivery of needed assistance. Although information flow was decentralized, it was critical to provide information that corresponded to the needs of emergency operations and helped in the problem-solving process. Most of the emergency personnel interviewed thought that rules and regulations are important in providing guidelines and directions for action, especially in unfamiliar emergency situations. The flow of sufficient information and relevant knowledge requires an effective database management system alongside an efficient communication system to ensure the secure delivery of the information to operations personnel.

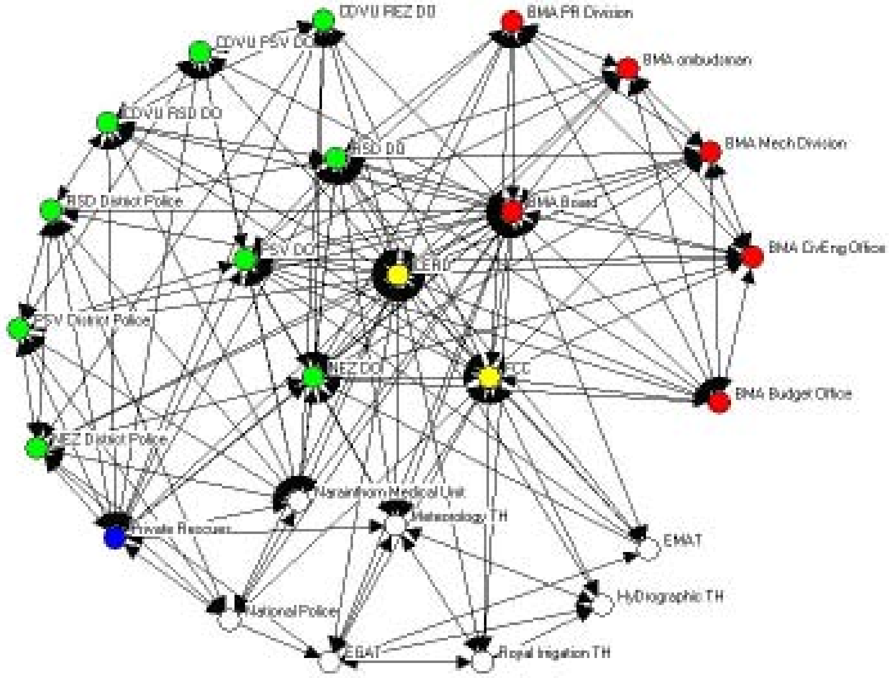
In the aftermath of the disaster, cell phone networks became congested and dysfunctional. However, emergency personnel were not equipped to operate Global Positioning System (GPS) and Geographical Information System (GIS) equipment and facilities. Under these circumstances, there were two alternatives: low radio frequency through local small networks, and high frequency radio through Ham or amateur network. During the tsunami emergency operations, local residents preferred to use megaphones through their community radio to communicate with their communities in the villages and beach areas. Local emergency front line personnel, on the other hand, preferred to use their amateur radio networks. Military and DDPM private radio networks are activated under emergency conditions. This study found alternative communication channels. Private organizations used their own radio networks for communication and mobilization. Also used were community radio networks that could function as an alternative communication system when power supply is down. Most importantly, locals usually trust their people to tell them news of emergencies. Other alternatives were the activation of special frequencies for radio networks and use of telephone networks of “emergency bridging” through satellite. High technology equipment is effective and efficient in large-scale emergency operations. However, low-cost technology is also useful for communication in local communities and can be used as back up system.

Bangkok Emergency Response

The Bangkok Metropolitan Authority (BMA) manages emergency operations in the capital city with the knowledge and skills acquired from the Fire Division and the District Field Officers. The analysis of interview results and of the existing response system revealed that the BMA emergency response network is well coordinated. Depending on the level of emergency and geographical coverage of the emergency, a similar response network operates in other areas.

This analysis provided a picture of how BMA emergency personnel interact among themselves and with other agencies across multiple jurisdictions and sectors. Survey results showed that BMA emergency personnel prefer to interact with local response agencies. The BMA network analysis confirmed this finding, showing that local district personnel function as frontline emergency personnel. Additional findings suggested that agencies such as the Flood Control Center (FCC) and Civil Emergency Relief Department (CERD) serve as information providers, coordinate and support major emergency response activities of the frontline emergency personnel operating in affected areas. This finding corresponded to the emergency response procedures specifying that BMA manage emergencies through local authorities with help and support from CERD and from FCC in flood crises. The BMA coordination chart (Figure 2) shows that CERD interacts frequently with local and national agencies; but less so with local agencies and district volunteers. This is understandable since CERD functions at the provincial level as a BMA central agency. District or local authorities are, in fact, the designated coordinators for local residents and volunteers. The FCC likewise works closely with local and provincial agencies to transfer information; but works less frequently with national agencies because they are under the BMA Sewerage and Drainage Department.

Figure 2. Organizational coordination matrix of the Bangkok Emergency Response and Management System
(Source: Civil Defense Action Plan of Bangkok Metropolitan Authority, 2005)



BMA (CENTRAL)	OTHER GOVERNMENTAL AGENCIES
BMA Board: BMA Administrative Board	Meteorology TH: Department of Meteorology
BMA PR Division: BMA Public Relation Division	EGAT: Electricity Generation Authority of Thailand
BMA CivEng Office: Office of Civil Engineering	EMAT: Electricity Metropolitan Authority of Thailand
BMA Mech Division: BMA Mechanical Control Division	NEZ District Police: New Economic Zone Police
FCC: Flood Control Center	PSV District Police: Preservation Zone Police
CERD: Civil Emergency relief Department	RSD District Police: Resident Zone Police
BMA (local/district)	Royal Irrigation TH
NEZ_DO: New economic Zone District Offices	Hydrographic TH: Hydrographic Department, Navy
PSV_DO: Preservation Zone District Offices	National Police
RSD_DO: Resident Zone District Offices	Private Rescue Unit
CDVU NEZ DO: New Economic Zone Civil Defense Volunteer Unit	Narainthorn Medical Unit
CDVU PSV DO: Preservation Zone Civil Defense Volunteer Unit	
CDVU RSD DO: Resident Zone Civil Defense Volunteer Unit	

Private organizations become involved because unexpected emergencies disrupt their activities. The district offices interact with the local level through various agencies; but also maintain well-connected networks of coordination that run through central and national emergency response agencies. The emergency response system under analysis has failed to provide adequate inter-organizational training. When information is shared adequately, emergency personnel operating at jurisdictional levels can quickly adapt to unforeseen problems as they arise. The lack of inter-organizational training largely caused the emergency response failures that occurred. This prevented emergency response agencies from working together to adapt to the disaster situation.

Although the BMA tends to have a decentralized pattern of information flow and its personnel are willing to give and receive critical information, it is important that the information being shared correspond to the needs of emergency personnel confronting the disaster. Sometimes emergency staff must take action without sufficient information. This is where rules and regulations play a crucial role in shaping the responsibilities and activities of emergency personnel. During an emergency, personnel who have less knowledge and experience cannot make informed and sound judgments or decisions. Interviewed emergency personnel said that when such a situation arises, they turn to laws, rules, and regulation as guidelines for action.

This study confirms that information sharing and efficient communication channels can expand the capacity of individuals and their organizations to adapt to complex situations and make sound decisions under pressure. Emergency response personnel need information that is reliable and actionable to maintain command of their operations. The events that occur during emergencies are complex and unpredictable. Emergency personnel must be able to react quickly to rapidly changing situations. Unfortunately, there are occasions when personnel are unable to communicate the needed information to enable them to adapt. While training programs can help prevent such situations, it is crucial that all emergency response personnel and organizations learn how to manage effectively the information flow within and among organizations.

Aside from communication patterns, it is also important to look into communication equipment. During a fire in Bangkok that resulted in the collapse of a building, emergency personnel contacted each other via cell phones rather than through the emergency radio network. Interview results showed that when an unexpected accident or consequence occurs, people would use tools that are most familiar—in this case, a cell phone. However, there were other practical reasons why emergency personnel did not use tools such as the emergency radio network. In chaotic situations, people tend to seek assistance from individuals or organizations that they believe will actually respond. Cell phones reassure people that when they call for assistance, information about their location and needs will be quickly passed along to the appropriate emergency response personnel.

Each of these technologies, however, comes with certain limitations that can reduce communication. For example, cell phones are convenient and handy. However, during large-scale emergencies, cellular networks often become congested and dysfunctional. The Civil Defense Volunteer Units report that low frequency radios such as walky-talkies are effective, but can create problems when their personnel operate outside the transmission range. Alternatively, each district office has special VHF radios that communicate throughout the BMA radio network without having to rely on repeaters. In the event of an emergency, this radio can shorten communication paths between decision-makers and front-line responders. However, this radio can only be used when authorized by the District Deputy. Given these limitations, emergency response personnel should not rely on any single form of technology or equipment for communication.

Towards an Adaptive Emergency Response System

Systems operating in the midst of chaos have the potential for creative and effective response to rapidly changing situations. Yet, the margin of choice is narrow. Systems that do not move toward creative new actions will slide into chaos as their old patterns of performance fracture under stress. This study makes recommendations on how the two emergency response systems of Thailand can move toward being an adaptive response system

Technical Infrastructure

The solution need not entail adopting expensive and sophisticated technology. There are three low cost alternatives: low frequency radio used by small local networks; high frequency radio used by Ham or amateur networks; and VHF radio networks used by public and private organizations. Both BMA and DDPM should develop a plan that will integrate these low cost and readily available methods of communication into a unified communication network that can facilitate the spread of information during emergencies. An effective information-sharing network needs effective database administration, organizational willingness to share knowledge and information, and efficient communication management to relay acquired information to emergency personnel in a timely manner. The movement toward training and mitigation is a sign that emergency response agencies are attempting to coordinate their infrastructure and their operations. Drills for tsunami evacuations should encourage the DDPM to activate and update their evacuation maps with provincial governments and municipalities. The DDPM information center should reorganize the information and knowledge needed for operations and share the information to emergency personnel. In addition, the national government must enforce building codes, prepare the technical infrastructure for emergency response, and make emergency facilities and equipment accessible so that both emergency response agencies and communities understand the risks and adequately prepare for them.

Cultural Openness

The cultural openness of emergency personnel is not driven by the enforcement of law or regulations. Rather, it is a necessity imposed by a public that experienced an ineffective emergency response operation in the midst of a disaster. Emergency personnel recognize that their lack of knowledge and skill to operate effective emergency responses can cost human lives during operations.

Through high awareness of risks, all parties can create the best opportunity for national and provincial governments to continue improving their emergency personnel and systems. In public management, culture and willingness to accept change are two of the most difficult factors to alter. Most of the time, policy makers have difficulties translating policy into practice because implementing personnel are often resistant to change. There is now greater public awareness of risks and hazards. Policy makers should seize this occasion to introduce co-training programs and encourage their operations personnel to develop self-learning behaviors. As this study has confirmed, the more knowledge response personnel have, the more effective their performance. Besides, international experts have offered assistance to enhance the government's capabilities to understand and manage disaster and emergency response. Learning from experts and local peers will help build adaptive capacity for emergency agencies to confront future disasters

Organizational Flexibility

Willingness to change and commitment to improvement can be useless if organizations do not allow flexibility in implementing the emergency response. BMA had a good start in designing two systems of single incident command and unified incident command. This will allow emergency response operations and personnel to move towards developing creative solutions if unexpected complications or consequences occur. The other pattern of transferring command to subordinates reflects the decentralized decision making process. This allows emergency personnel to make their own decisions about the situation at hand. These decision-making capabilities are critical because emergency personnel need accurate, timely, and updated information to make sound decisions. DDPM has to focus on the changes within BMA and consider whether these changes can be applied to their system. The DDPM academy should develop a curriculum for co-training programs that encourage all personnel to learn about their equipment, procedures, facilities, risk assessments, and action plans for responding to multi-hazards. The BMA should take this opportunity to integrate district officers and volunteers and teach them about the facilities and procedures of CERD and DDPM that are available within and around the area of Bangkok. The Regional DPM at the center, which is structured as supporting unit for provincial DPM, can help Bangkok emergency personnel to reallocate more resources and personnel to respond to a large-scale emergency. Knowing how to use alternate facilities, learning how the other emergency unit operates, and developing relationship through coordination help emergency personnel and organizations access the needed assistance.

Conclusion

The analysis and findings of this study demonstrate the important need to integrate inter-governmental coordination. This requires collaboration among emergency agencies through a systematic scalable agency management, and information sharing through communication management. To strengthen their individual and cooperative capabilities to manage crises and emergency response capabilities, emergency agencies need a moderate to high level of technical infrastructure, organizational flexibility, and cultural openness. Effective interagency emergency response, however, must also take into account the need for multi-jurisdictional cooperation among all actors, whether they are governmental or non-governmental. A self-adaptive system will be managed from the top by national agencies through the operational level of local level actors and communities

Figure 3. The Integration of Proposed Emergency Preparedness, Response, and Management Systems
(Source: Extracted from Pacific Disaster Center, Maui, Hawaii, USA, 2005)

To be effective, the individuals and organizations that operate within an emergency response system must have the ability to learn, cooperate, and adapt. The ability to cooperate though the sharing of information and knowledge builds and reinforces mutual understanding between the actors within the emergency response system. The ability to adapt strengthens the emergency response network as a whole so that governmental agencies and local communities can better confront the complex problems that arise during extreme events. In such an environment, emergency response personnel will develop tools and techniques that will assist them to make informed policy decisions that promote the safety of the public.

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Annex A
Interacting Organizations within the Thailand Emergency Response System - December 27, 2004 through January 17, 2005

Acronym	Organization	Acronym	Organization
AC_Bank	Agricultural and Coop Bank	PVC	Phuket Vocational College
BIFIOC	Body Identification and Forensic Investigation Operations Center, Th	PVS	Phuket Vocational School
CAT	Communication Authority of Thailand	Ran_Hosp	Ranong Hospital
CCE	Committee of Compulsory Education, Th	Ran_Prov_FO	Ranong Provincial Fiscal Office
Chul_Univ	Chulalongkorn University	Ran_Prov_LR	Ranong Provincial Labor Relation
CMCU	Central Medical Care Unit, Th	RCCTEV	Relief Command Center of Tsunami and Earthquake Victims, Phuket
CND	Committee of National Disaster, Th	RPAB	Ranong Provincial Administration Board
CVRF	Committee of Victims Relief Fund, Th	Sat_Prov_FO	Satoon Provincial Fiscal Office
Dep_NRG	Department of Natural Resource and Geology, Th	Siri_Bank	Siriraj Hospital, Bangkok
Dep_Tax	Department of Tax Collection, Th	SP_Prov_ODC	Sra Buri Provincial Office of Disease Control
Dept_CE	Department of Civil Engineering, Th	ST_Hosp	Surath Thani Hospital
Dept_COR	Department of Correction, Th	Trang_Hosp	Trang Hospital
Dept_CRP	Department of Civil Right Protection, Th	Trang_Prov_FO	Trang Provincial Fiscal Office
Dept_Cust	Department of Custom, Th	BM_DO	Bang Muang District Office
Dept_DC	Department of Disease Control, Th	BSNP	Bun Sea National Park
Dept_DPM	Department of Disaster Prevention and Mitigation, Th	IVC	International Volunteer Center
Dept_Fish	Department of Fishery, Th	KK_SD_Admin	KeukKuk Sub-District Administration
Dept_GAO	Department of General Account Office, Th	KP_Hosp	Krabi Provincial Hospital
Dept_Geol	Department of Geology, Reg. 4 Office, Th	Krabi_Mun_DO	Krabi Municipality District Office
Dept_High	Department of Highway Transportation, Th	Kratu_DO	Kratu District Office
Dept_Ins	Department of Insurance, Th	LDPM_LU	Local Disaster Prevention and Mitigation, Loma Unit
Dept_LG	Department of Local Governance, Th	Loc_Schools	Local Schools
Dept_MA	Department of Medical Administration, Th	LP_Nak	Local Police, Nakornsrithammaraj
Dept_Met	Department of Meteorology, Th	LP_PN	Local Police, Phang Nga

Acronym	Organization	Acronym	Organization
Dept_MH	Department of Mental Health, Th	LP_PP_Isl	Local Police, PP Island, Krabi
Dept_UP	Department of Urban Planning, Th	NT_Mun	New-Thai Municipality
Dept_WT	Department of Water Transportation, Th	NTCVG	Nara Thiwat Citizen Volunteers Group
ERAT	Electricity Regional Authority of Thailand	NTPCP	Nara Thiwat Provincial Community Police
EXIM_Bank	EXIM Bank	PDO_Ed	Phuket District Office of Education
FIO_Thai	Forensic Investigation Office, NPD, Th	PMKKC	Pra Mong Kut Klao Camp
FSI	Forensic Science Institute, Th	PN_DO_Ed	Phang Nga District Office of Education
Gov_Thai	Government of Thailand	PT_Hosp	Pha Thong Hospital
IT_Bank	Islam-Thai Bank	Ran_DO_Ed	Ranong District Office of Education
KT_Bank	Krung Thai Bank	SPPol_Acad	Sam Pran Police Academy
Mil_Thai	Military of Thailand	SSR_Mun	Suk Sum Ran Municipality
Min_Ag_Thai	Ministry of Agriculture, Th	TGP_Hosp	Ta Gua Pa Hospital
Min_Cul_Thai	Ministry of Culture, Th	TGP_Mun_DO	Ta Gua Pa Municipality District Office
Min_Def_Thai	Ministry of Defense, Th	TGP_Mun_DO_RO	Registar Office of Ta Gua Pa Municipality District Office
Min_Ed_Thai	Ministry of Education, Th	TGP_Mun_FD	Ta Gua Pa Municipality Fishery Department
Min_Eng_Thai	Ministry of Energy, Th	TGP_Mun_HEC	Ta Gua Pa Municipality Hygienical Environment Control
Min_FA_Thai	Ministry of Foreign Affairs, Th	TGP_Mun_PHO	Public Health Office of Ta Gua Pa Municipality District
Min_Fin_Thai	Ministry of Finance, Th	TM_Mun_Do	Tai Mueng Municaipality District Office
Min_ICT_Thai	Ministry of Information and Communication Technology, Th	TVC	Thai Volunteer Center
Min_Ind_Thai	Ministry of Industry, Th	DTA	Domestic Travel Association, Th
Min_Int_Thai	Ministry of Interior, Th	InsAssoc	Insurance Association, Th
Min_Jus_Thai	Ministry of Justice, Th	NBAssoc	National Budhism Association of Thailand
Min_LR_Thai	Ministry of Labor Relation, Th	NRNA	News Reporter and Newspaper Association, Th
Min_NRE_Thai	Ministry of Natural Resource and Environment, Th	OHB	Office of Head of Budhism

Acronym	Organization	Acronym	Organization
Min_PubHth_Thai	Ministry of Public Health, Th	PCSS_Found	Pra Cha Sunti Suk Foundation
Min_SDHS_Thai	Ministry of Social Development and Human Stability, Th	POWLOLP	Private Organization of We Love Our Land and People
Min_Tour_Thai	Ministry of Tourism and Sport, Th	PPYY_Found	Peun Peng (Pa) Yam Yak Foundation
Min_Transp_Thai	Ministry of Transportation, Th	PT_Found	Portek Tung Foundation
Nat_Pol	National Police Department, Th	PUA	Private University Association
NMC	Narainthorn Medical Center	RCPCNK_Found	Raj Cha Pra Cha Nu Kroh Foundation
OCE	Office of Compulsory Education, Th	RK_Found	Ruam Katanyu Foundation
OCSC	Office of Civil Service Committee, Th	TBNOP	To Be Number One Program
Off_Crown	Office of the Crown	Thai_Bank_Assoc	Thai Bank Association
OLEF	Office of Loan for Education Fund, Th	Thai_RC	Thai Red Cross
Omms_Bank	Ommsin Bank	UNICEF_Th	UNICEF Thailand
OMW	Office of Ministers' Wives	CDPM	Center of Disaster Prevention and Mitigation, Phuket
ONHI	Office of National Health Insurance, Th	CLRSDI	Coast Line and Sea Resource Development Institute of Phuket
Pol_Acad	Police Academy	KTBA	Krabi Travel Business Association
Psy_Assoc	Psychiatrist Association, Th	PCC	Phuket Commerce Council
RS_Dept_PR	Radio Station of Department of Public Relation	SBU_RC	Supan Buri Unit of Red Cross
SDPMC	Songkla Disaster Prevention and Mitigation Center	TTBAP	Tourism and Travel Business Association of Phuket
SMEDT_Bank	Small and Medium Enterprise Development of Thailand Bank	BM_Temp	Bang Muang Temple
SMIL_Corp	Small and Medium Industrial Leasing Corp.	BMPG	Bang Muang Protest Group
SO_PM_Thai	Secretary Office of the Prime Minister, Th	BN_Temp	Bang Niang Temple
SRMU	Sena Ruk Military Unit	CKKF	Chumporn Karn Kusol Foundation
STDPMC	Surath Thani Disaster Prevention and Mitigation Center	KP_Temp	Kongka Pimuk Temple
STY_Hosp	Sri Tun Ya Hospital, Bangkok	LaKa_Temp	Lak Kaen Temple
Thai_AirForce	Thai Air Force	Nik_Temp	Nikorn Temple

Acronym	Organization	Acronym	Organization
Thai_Army	Thai Army	Samuk_Temp	Samukkee Temple
Thai_CoastGuard	Thai Coast Guard	Samuk_Tham_Temp	Samukkee Tham Temple
Thai_Mil_Bank	Thai Military Bank	Suw_Temp	Suwankiri Temple
Thai_Navy	Thai Royal Navy	YY_Temp	Yan Yao Temple
Thai_PA	Thailand Port of Authority	APFC_Ltd	Aisa Plus Finance Co., Ltd.
Tham_Univ	Thammasat University	Ban_Bank	Bangkok Bank
Tour_Th	Tourism Authority of Thailand	GMMM_Ltd	GMM Media Ltd.
TR_Emb	Thai Royal Embassy, DC.	GSC_Ltd	Grand Sport Co., Ltd.
Unit425	Unit 425 of Border Protection Police	KKT_Bank	Kasi Korn Thai Bank
BMA	Bangkok Metropolitan Authority	KSAY_Bank	Krung Sri Ayutha Ya Bank
CERD	Civil Emergency Relief Department, CERD	NKLT_Bank	Na Korn Luang Thai Bank
CKUFCI	Chomporn Ket Udonsak Fishery College Institution	Pet_Ltd	Petroleum (Thailand) Ltd.,Plc.
Dept_For	Department of Forest, Th	Prax_Ltd	PraxAir (Thailand) Co., Ltd.
HY_Hosp	Had Yai Hospital	RAEC_Ltd	Rome Apollo Electronics Co.,Ltd.
ILTCC	Immigration Labor Temporary Control Center, Ranong	SC_Bank	Siam Commercial Bank
KK_Univ	Kon Kaen University	SCNKT_Bank	Standard Charter-Na Korn Thon Bank
Kra_Hosp	Krabi Hospital	SET	SET Thailand
Krabi_Prov_FO	Krabi Provincial Fiscal Office	SLIC	Southern Local Insurance Center
Krabi_Prov_TCC	Krabi Provincial Travel Coordination Center	Thai_Bank	Thai Bank
Krabi_Prov_TWD	Krabi Provincial Transportation Way Department	TIAC_Ltd	Thai International Airways Co., Ltd.
LP_Phu	Local Police, Phuket	TNC_Bank	Tha Na Chart Bank
NST_Hosp	Nakorn Sri Thammaraj Hospital	TOT_Corp	Telephone Organization of Thailand Corporation
Ph_Prov_FO	Phuket Provincial Fiscal Office	TPI_Ltd	TPI Cement Plc., Ltd.
Ph_Prov_PHO	Phuket Provincial Public Health Office	TRN_Ltd	Thai Rath Newspaper Co., Ltd.
Phu_Hosp	Phuket Hospital	UOB	UOB Group
PN_Hosp	Phang Nga Hospital	VR_Ltd	Vergin Radio Ltd.
PN_Prov_FO	Phang Nga Provincial Fiacal Office	VR1_Ltd	V R 1 Radio Ltd.

Acronym	Organization	Acronym	Organization
PN_Prov_PHO	Phang Nga Provincial Public Health Office	CTC_Ltd	Cement Thai Co., Ltd.
PNNP	Phang Nga National Park	Krabi_FI	Krabi Financial Institution
PPHO	Provincial Public Health Office, Phuket	Naka_Hosp	Nakarintara Hospital, Nakornsrithammaraj
Prov_Gov_Ayu	Ayuthaya Provincial Government	PFI	Phuket Financial Institution
Prov_Gov_Krabi	Krabi Provincial Government	PN_FI	Phang Nga Financial Institution
Prov_Gov_Ph	Phuket Provincial Government	PPRC_Ltd	PP Princess Resort Co., Ltd.
Prov_Gov_PN	Phang Nga Provincial Government	PRC	Private Rescue Center
Prov_Gov_Ran	Ranong Provincial Government	Ran_FI	Ranong Financial Institution
Prov_Gov_Sat	Satoon Provincial Government	Sat_FI	Satoon Financial Institution
Prov_Gov_SB	Supan Buri Provincial Government	TFI	Trang Financial Institution
Prov_Gov_Trang	Trang Provincial Government		

The success in implementing disaster preparedness programs is critically linked to the inclusion of a reliable monitoring tool for achievement of program objectives. This grant made it possible to develop a tool that measures community preparedness using 10 parameters...

-Biswanath Dash

Grant No. 021IND

Measuring Community Preparedness: A Monitoring Tool

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Abstract

This paper provides an overview of the Project "Indicators for Disaster Preparedness" completed on January 2004. The project aims to develop a monitoring tool for community disaster preparedness programs.

The success in implementing disaster preparedness programs is critically linked to the inclusion of a reliable monitoring tool for achievement of program objectives. This project developed a tool that measures community preparedness using ten parameters. Out of 85 indicators identified in the first phase, 35 were finally selected, both qualitative and quantitative, for six hazards—earthquake, cyclone, flood, drought, fire, and epidemics. The selection of indicators was done through Delphi analysis and a simple indexing method designed to combine these indicators. The tool and the indexing method were field tested in six vulnerable communities in three states of India: Gujarat, Andhra Pradesh, and Orissa.

The findings were as follows:

1. Preparedness in the context of developing countries need to be linked to some elements of recovery
2. Each community has some amount of inherent preparedness. As such, it is important to identify weak components (e.g., communities found reasonably prepared in infrastructure and services are poorly prepared in hazard awareness).
3. The monitoring tool was found reliable and effective in capturing preparedness through its constituent parameters.

Research Problem

At the beginning of 1990, both the Government and NGOs designed and implemented large preparedness programs. In 2002, the Government of India, in partnership with UNDP, launched a major initiative—Disaster Risk Management Program—in 17 states. Considering the scarcity of resources, one key issue was monitoring the effectiveness of these programs. How do we ensure that efforts actually benefit the recipient communities? How do we enable them to be prepared to face hazards? How can we identify deficiencies in preparedness that need immediate attention? Is there a framework or a mechanism that can guide us in assessing the community's preparedness objectively?

The dominant approaches to monitoring and evaluation based on expert opinion, case studies, and the like were found to be inadequate. To address this, the project aimed to develop a tool that can be used to monitor and assess a community's disaster preparedness to multi-hazards. The project had four objectives:

1. To suggest a conceptual framework that identifies key parameters in community preparedness.
2. To identify and select indicators that can be used to measures specific parameters of community preparedness.
3. To develop a methodology for indexing both qualitative and quantitative indicators together and build a reliable instrument that can satisfactorily assess community preparedness.
4. To share project findings with the communities where data have been collected and inform them about their state of preparedness.

Methodology

The project methodology consisted of five stages. In the first stage, a compre-hensive literature review was undertaken to formulate a conceptual framework that envisions community preparedness consisting of 10 parameters: physical safety, hazard awareness, organizational preparedness, infrastructure and services, recovery ability, social capital, physical environment, psychological preparedness, cultural capital, and household preparedness. To measure these parameters, 85 indicators were identified as possible indicators for six hazards: earthquake, cyclone, drought, flood, fire, and epidemics.

In the second stage, Delphi analysis was carried out with a panel of 20 experts who selected the most appropriate indicators. Based on an analysis of these experts' opinion, done in two phases, 35 indicators (i.e., applicable to all the six hazards) were selected and finalized.

In the third stage, an indexing method was developed. While combining various quantitative and qualitative indicators, this method made minimum use of statistical tools to make it user friendly. The indexing method used a two-pronged strategy. Based on a four-point scale of "very good," "good," "average," and "poor," all quantitative data were rated and assigned scores corresponding to "very good," "good," "average," and "poor," respectively. The qualitative indicators were rated using scales of 3, 2, 1, and 0 directly. The average score of each parameter was calculated and expressed in percentages. The average of 10 parameters provided the index of overall community preparedness.

In the fourth stage, the designed tool (i.e. the set of selected indicators together with the indexing technique) was used to assess preparedness in six most disaster-prone communities located in three different Indian states:

Case 1. Valdia Bitta (East), Anjar, Kutch, Gujarat
Case 2. Manginapudi, Machhlipatnam, Andhra Pradesh
Case 3. Mundapadr, Bolnagir, Orissa
Case 4. Gupti, Rajnagar, Jagatsinghpur, Orissa
Case 5. Rampar, Anjar, Kutch, Gujarat
Case 6. Kallana, Jajpur, Orissa (Control Group)

These communities differ considerably in terms of the hazards they face, economic conditions, past disaster experiences, and their cultural practices. Data collected from them communities were fed into the designed instrument for measuring preparedness.

In the fifth stage, findings from these field trials were disseminated among the target communities to get their opinion about the assessment results and to raise their awareness about probable hazards and their present state of preparedness. Pamphlets were posted in communities for this purpose.

Adjacent figures 2 to 11 show the variances in the ten parameters in the six communities where the monitoring tool was tested:

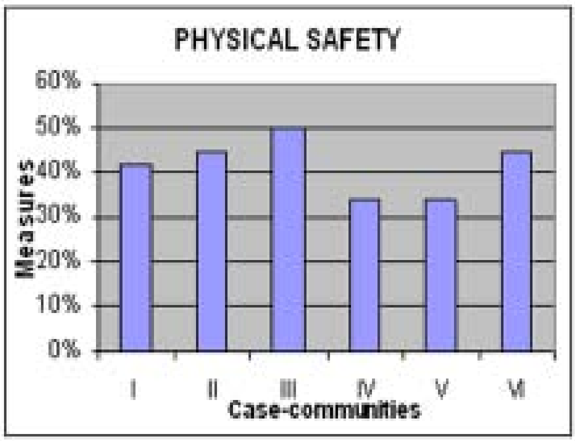


Figure 2

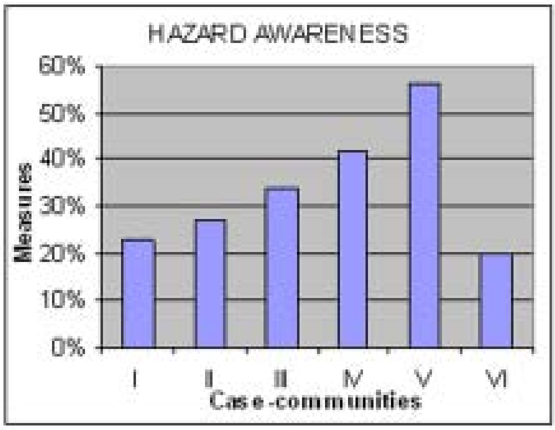


Figure 3

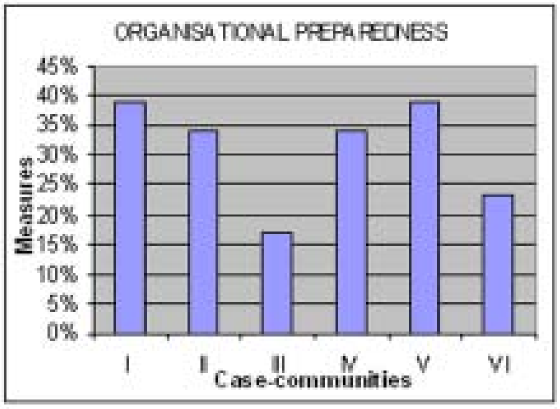


Figure 4

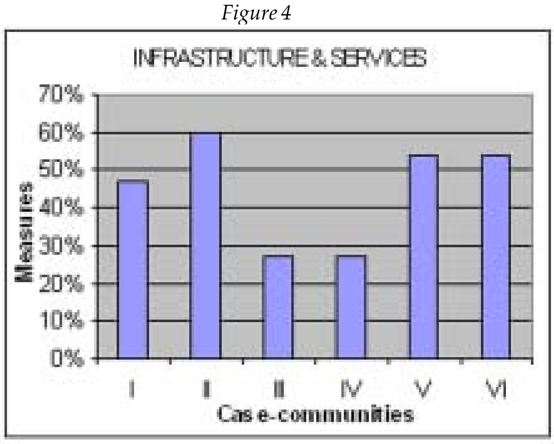


Figure 5

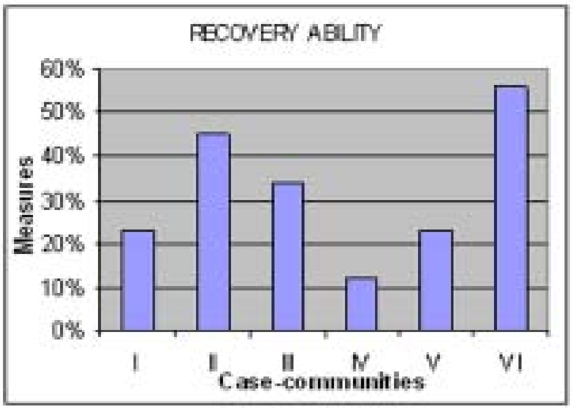


Figure 7

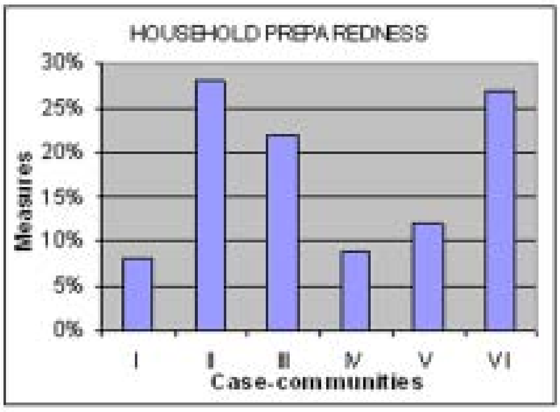


Figure 11

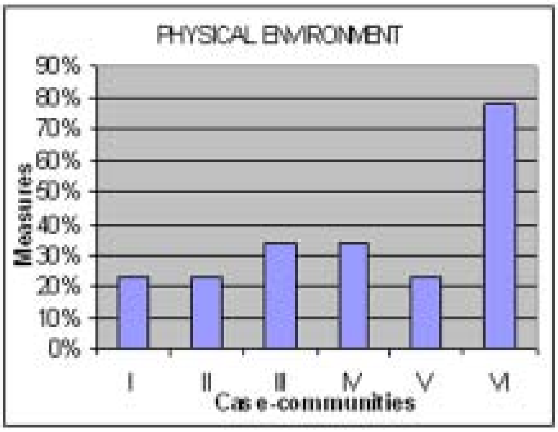


Figure 8

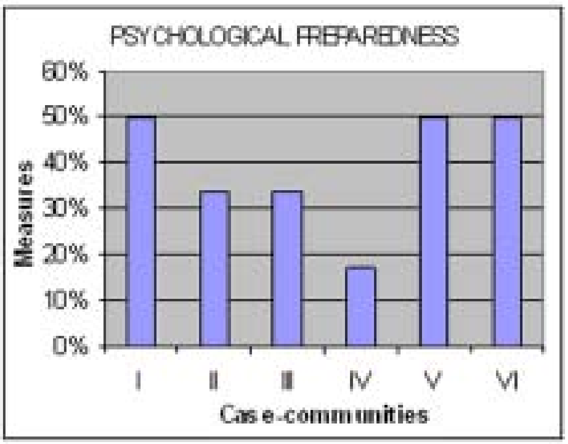


Figure 9

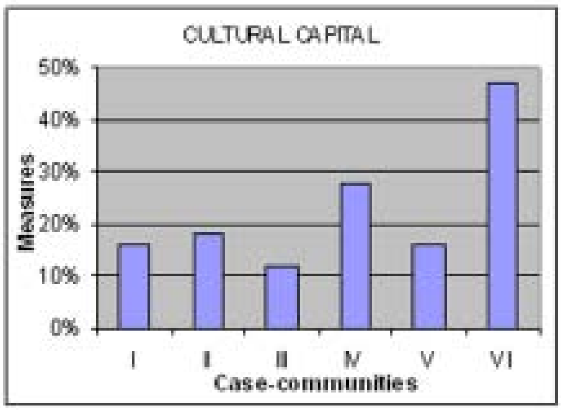
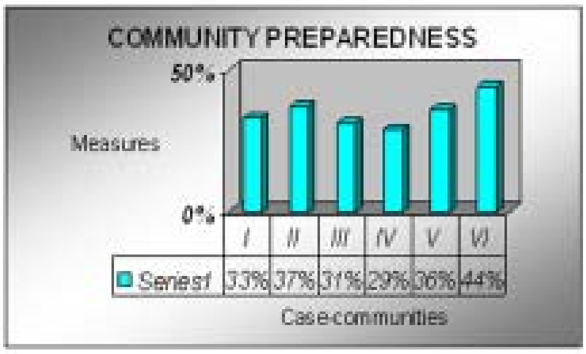


Figure 10

Key Findings

- The lowest overall index of community preparedness was 29% (Community Case No. 4: Gupti, Rajnagar, Jagatsinghpur, Orissa). This showed that all the target communities had a certain level of preparedness. Efforts should focus on supplementing the communities' existing level of preparedness and raise it to a point where occurrence of hazards would only cause minimum impact.



- The application of the tool in the different communities showed that communities that were highly prepared in one parameter (e.g., 60% for infrastructure and services) were poorly prepared in another parameter (e.g., 27% for hazard awareness). This could mean that spreading resources to target all the components of community preparedness may not be the best strategy for preparedness programs. Identification and prioritization of weak areas may be needed to enable communities be better prepared (see Annex A for more details).

- That only three of the ten parameters were dependent on hazards indicated that community preparedness was largely linked to developmental issues.

Project Outputs

- The international organization, Oxfam GB, attempted to apply the tool for its risk reduction program in Haiti but had to discontinue because of problems with a partner. However, Oxfam plans to use the tool in its projects in Guatemala and Nicaragua.

- The International Federation of Red Cross and Red Crescent Societies in New Delhi adapted the monitoring tool on a GIS platform to assess its community and organizational preparedness.

- The tool and methodology was applied in other communities as could be seen in the website of the Suburban Emergency Management Project (SEMP) in the US: http://www.semp.us/securitas/oct_nov04.html.

Update on Community Indicators for Preparedness Task Force

On October 22, 2004, the Community Indicators for Preparedness Task Force met at Naperville Police Headquarters where Chief David Dial charged the task force with developing a set of community security indicators using the Balanced Scorecard approach. He distributed as reference material a ProVention Consortium (World Bank) report titled "Indicators for Disaster Preparedness: Assessing Community Preparedness for Multi-Hazards" prepared by the Center for Studies in Science Policy School of Social Sciences at Jawaharlal Nehru University in New Delhi.

Source: SEMP website (http://www.semp.us/securitas/oct_nov04.html)

Recommendation to Stakeholders

- Preparedness measures need to look beyond the response phase and include some elements of recovery. Post-disaster issues such as access to compensation and insurance cover should also be addressed.

- Utilize the community preparedness monitoring tool for baseline assessment at the beginning of new preparedness programs and for measuring the progress of on-going preparedness programs. The tool could indicate if what remedial measures are needed or a change in strategy to achieve program objectives.

- Identify the strengths and weaknesses of communities according to the ten parameters of the tool and identify priority areas in the design of preparedness programs.

- Apply the tool on hazards other than the six disasters that the project focused on. Weigh the ten parameters to assess their relative importance and contribution to overall preparedness. Do further research to select key indicators for other hazards to make the tool more effective.

- A range of actors, such as donors and policy makers, should support the use of the tool in monitoring risk reduction programs.

Dissemination Strategy

- The project findings have been published as a working paper and presented at the World Bank Global Conference in 2004 as one of the best fifteen projects of ProVention Consortium Applied Research Grant Program Round 1. Available on the ProVention website, the working paper has reached a large audience.

- The findings have been published in a development journal, Down To Earth, in its March 2005 edition in New Delhi.

- The final project report has been distributed to many policy makers and donor agencies in India and outside.

- The final project report was shared to researchers from all over the world who requested for a copy.

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Annex A
Sample Case of Community Assessment Details

Case No. 2: Manginapudi, Machhlipatnam, Andhra Pradesh

The Manginapudi community (panchayat) is located in Machilipatnam Mandal of Krishna District, Andhra Pradesh. The panchayat is one village, spread over an area of 603 hectares, with a total population of 1,940 (i.e. 473 households). Located very close to the sea (3 km), the community is situated near the Manginapudi Beach, a popular tourist place. Good road transport is available but drinking water is a major problem and people are largely dependent on the tankers that get drinking water from Machilipatnam (7 km) on a daily basis. Community members have experienced cyclones, most notably the 1971 cyclone that killed more than 10,000 people in Krishna District. The ingress of saline water causes drought in the area and is considered a major hazard. A government owned desalination plant functioned once but had been closed for a year. There have also been cases of fire and epidemics in the

The household survey was conducted on 9% of total households (i.e., 40 respondents with an average age of 39 years and average household size of 4.3). Thirty eight (38) respondents (17 females, 10 of whom were under the age of 15 years; 21 males; approximately 2% of the total population) were surveyed on hazard awareness.

The hazards considered were cyclone, drought, fire, and epidemics.

1) Physical Safety:

Indicators	Q.Data	Rating	Av Score	Score	Parameter Score
1.1) Adequacy of the shelter	15%	Bad		0	
1.2) Public works program		Average		1	
1.3) Health care readiness			3	3	**0+1+3= 4**
1.3.1) Hospital distance	9 km	Good	2+3+3 =8		**out of 9 i.e.**
1.3.2) Kind of hospital	Ref.	V Good	out of 9 or		**45%**
1.3.3)Structural resistance of hospital building		V Good	89%		

2) Hazard Awareness:

Indicators	Q.Data	Ratings	Score	Parameter Score
2.1) Percentage of population exposed to awareness campaigns	6%	Bad	0	
2.2) Awareness about cyclone	75%	V Good	3	**0+3+0+1+0 =**
2.3) Awareness about drought	16%	Bad	0	**4 out of 15**
2.4) Awareness about epidemics	37%	Average	1	**or 27%**
2.5) School curriculum and adult literacy materials containing hazard information		Bad	0	

3) Organizational Preparedness:

Indicators	Q. Data	Ratings	Score	Parameter Score
3.1) Representation in the committee		Average	1	
3.2) Acceptance of community members	13%	Bad	0	
3.3) No. of volunteers per hundred population	1.7	Average	1	**1+0+1+2+2+0**
3.4) Average training days for volunteer	5days	Good	2	**= 6 out of 18**
3.5) Comprehensiveness of the plan		Good	2	**or 34%**
3.6) Awareness among people about plan	23%	Bad	0	

4) Infrastructure and services:

Indicators	Q.Data	Ratings	Score	Parameter Score
4.1) Approach road		Good	2	
4.2) Access to warning services[1]	95%	V Good	3	
4.3) Response time for Fire station	25min	Good	2	**2+3+2+0+2=**
4.4) Plan for ensuring drinking water supply	None	Bad	0	**9 out of 15**
4.5) Hospital preparedness		Good	2	**or 60%**

[1] Scale used in 4.2, 5.2, 5.3 and 6.3

5) Recovery Ability:

Indicators	Q.Data	Ratings	Score	Parameter Score
5.1) Per capita income per month	Rs. 510	Average	1	
5.2) Percentage of population who have access to formal credit services	58%	Good	2	**1+2+1 =4 out of 9 or 45%**
5.3) Percentage of population who have any kind of insurance coverage	28%	Average	1	

6) Social Capital:

Indicators	Q.Data	Ratings	Score	Parameter Score
6.1) No. of community based organizations	12	V Good	3	
6.2) Joint mitigation efforts in last 5 yrs.		Average	1	
6.3) Feeling of trust and cooperation existing among community members	30%	Average	1	**3+1+1 = 5 out of 9 or 56%**

7) Physical Environment:

Indicators	Q.Data	Ratings	Score	Parameter Score
7.1) Condition of sub-surface aquifers		Bad	0	
7.2) Farmers awareness about sustainable practices	37%	Average	1	
7.3) Condition of common resources		Average	1	**0+1+1 = 2 out of 9 or 23%**

8) Psychological Preparedness:

Indicators	Q.Data	Ratings	Parameter Score
8.1) Percentage of population who feel prepared	72%	Good	**2+0 = 2 out of 6 i.e. 34%**
8.2) Provision for post disaster psycho counseling		Bad	

9) Cultural Capital:

Indicators	Q. Data	Parameter Score
9.1) Percentage of population aware of traditional coping mechanisms and their usefulness	18%	**18%**

10) Household Preparedness:

Indicators	Q.Data	Ratings	Parameter Score
10.1) Percentage of households having family plan or have taken measures for hazards	28%	Average	**28%**

The scores for different parameters are as follows:

Parameter	Preparedness	Community Preparedness
2.1) Physical Safety	45%	Community Preparedness is computed by getting the average of the parameter scores i.e. **37%**
2.2) Hazard Awareness	27%	
2.3) Organizational Preparedness	34%	
2.4) Infrastructure and Services	60%	
2.5) Recovery Ability	45%	
2.6) Social Capital	56%	
2.7) Physical Environment	23%	
2.8) Psychological Preparedness	34%	
2.9) Cultural Capital	18%	
2.10) Household Preparedness	28%	

Flood risk maps are essential for assessing potential damage and successfully implementing a range of flood hazard mitigation measures, such as land use regulation and emergency measures. These maps would also inform the public of the risks. The grant enabled me to further disseminate the findings of my master's thesis to a wider audience.

-Ripendra Awal

Grant No. 073NPL

Floodplain Analysis and Risk Assessment of Lakhandei River

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Abstract

Flooding is one of the serious, common, and costly natural disasters that many countries are facing. One of the non-structural measures for risk reduction is the delineation of flood-prone areas. Flood risk mapping involves modeling the complex interaction of river flow hydraulics with topographical and land use features of the floodplains. From conventional flood hazard mapping technique based on field investigation to a knowledge-based system, the study integrated the hydraulic model with the Geographic Information System (GIS) and presented a systematic approach of this application with a case study of Lakhandei River in Nepal.

The study focused on the preparation of Triangulated Irregular Network (TIN) from available cross section data, contours and spot elevations, calculation of water surface profiles by steady and unsteady flow analysis, delineation of the flood areas, risk mapping, and creation of flood animation.

The approach adopted for the study consisted of dividing the risk into vulnerability associated with land use pattern and hazard associated with hydrological and hydraulic parameters. The results of these analyses were combined to see relationships such as discharge-flood area and flood depth-land use. A series of maps were prepared depicting different relationships, such as discharge-flood area and flood depth-land use. This provided a framework that would help administrators and planners to identify areas of risk and prioritize their mitigation and response efforts. This would also raise the public's awareness of flood risks and enable them to prepare mitigation activities. The research also prepared a general flood action plan. Using satellite images, the study further assessed changes in river course.

Problem Addressed

Nepal is a mountainous country. About 17% of its land bordering India is flat Terai Plain, which is most vulnerable to flooding every year. As the rivers emerge into the plain from steep and narrow mountain gorges, they spread out with an abrupt gradient decrease that has three major consequences: deposition of the bed load, changes in river course, and frequent floods (Jollinger, 1979). Each year, floods of varying magnitudes occur due to intense, localized storms during the monsoon months (June to September) in Nepal's numerous streams and rivers.

The Lakhandei River Basin is located in Sarlahi District of the Central Development Region of Nepal. Originating from the eastern Siwalik Hills, this river passes through the Terai plain, crosses the Nepal-India border at Bhadsar, and merges into the Bagmati River at Darbhanga in India. The basin area of the Lakhandei River is 300 sq km, consisting of 106 sq km of mountainous area and 194 sq km of plain area. The study area extends from the base of Siwalik Hills to the Indian border whose total length is about 30 km. The length of the meandering river is about 52 km. This area suffered from one of the biggest floods in 1997 that resulted in the loss of lives and damage to property (see Figure 1).

Figure 1. (A) Location of study area and river basin and (B) Losses of life and damage to property due to the 1997 flood (Source: JICA/DOI, 1999).

(A)

Loss of	Life	14	nos.
	Cattle	398	nos.
	Crops	8675	ton
	Land	234	hac
	Houses	236	nos.
Damage of	Crops	3052	ton
	Land	1263	hac
	Houses	691	nos.
	Public Facilities		
	Road	275	m
	Culvert	7	nos.
	School	6	nos.

(B)

Flood hazard mapping and risk assessment in Nepal is still very rudimentary. Most of the flood protection works are carried out at the local level without proper planning and without considering the problem at the river basin scale. Apart from piecemeal approaches on a limited scale, no pragmatic efforts at comprehensive flood risk assessment and hazard mapping have been done. In view of increasing flood disasters and the growing realization of the need to address the problem at a regional level, the government of Nepal has initiated a systematic study of its rivers. Thus, the Japan International Cooperation Agency (JICA), in collaboration with the Government of Nepal (GON) Department of Irrigation (DOI), undertook "The Study on Flood Mitigation Plan (FMP) for Selected Rivers in the Terai Plain in the Kingdom of Nepal" (JICA/DOI, 1998, 1999a, 1999b, & 1999c).

Originating from and covering a significant area in the Siwalik range, Lakhandei River is one of the most flood-prone rivers in Nepal. It was also one of the eight selected rivers for the FMP study. The FMP study made various analyses, including flood flow analysis using an unsteady flow simulation model and flood hazard maps based on field investigation and personal interviews. The simulated result showed that in many cross sections, the simulated water levels went far beyond the river cross-sections that could not represent the actual flood water levels. These maps, however, did not have a relationship with the intensity of flood and floodwater depth. Thus, the FMP study pointed out the need to prepare new flood hazard maps that refine those prepared for the study (JICA/DOI, 1999a).

The Department of Hydrology and Meteorology (DHM) prepared a flood risk mapping of Lakhandei River (July 1998) using the one-dimensional Ida method to determine flood levels along river cannels and river valley bottoms. However, with just seven river cross-sections surveyed in some 42.5 km of river, it used an insufficient number of cross sections and did not survey longitudinal sections.

To address this gap, this study prepared a flood vulnerability, hazard, and risk map by integrating the hydraulic model and GIS. It made the transition from conventional flood hazard mapping technique based on field investigation to a knowledge-based system. The application of a computer-based model could provide effective and efficient means of floodplain analysis and flood risk assessment. This could also provide a framework for decision makers that would enable them to assess and evaluate alternative strategies for flood management. Flood risk assessment and mapping of flood-prone areas according to magnitude and frequency of flooding provide vital information in flood management.

Below are the study's main objectives:

1. To analyze the floodplain by using the one-dimensional steady and unsteady flow model.
2. To make a flood risk map of the study area that depicts the relationship between vulnerability of land use and hazards related to hydraulic and hydrologic parameters.

Methodology

Data required for the study and results of previous studies were collected from different sources:

- **Documents from previous studies.** Different documents related to flooding in the study area, such as the study by the Water Induced Disaster Prevention Technical Center (DPTC, 1993), DHM

(1998), JICA/DOI (1999) and other studies related to flooding and hazard mapping in Nepal were collected.

- **Stream flow and precipitation data.** Stream gauge data of Lakhandei River at Pattharkot was collected from DHM. As the measured stage and flow (39 times) from 1996 to 2001 was not sufficient to produce a rating curve, different regional approaches were used to estimate flood of different return periods. The rainfall data of nearby station Manusmara, Malangawa, and Patharkot were likewise obtained from DHM.

- **Population data.** Population data of Village Development Committees (VDCs) affected by flood of Lakhandei River were obtained from the Central Bureau of Statistics (CBS).

- **Topographical map and survey data of previous studies.** Topographical maps (1998) of the Lakhandei River Basin with a scale of 1:25,000 (published by Government of Nepal, Survey Department) were collected. Longitudinal survey data and fifty two river cross-section survey data at the interval of about 1 km were also obtained from the FMP.

- **GIS/Remote Sensing (RS) data.** GIS based digital layers of the topographic sheets were obtained from the Survey Department. These layers included contours, spot height, drainage, land use, and land cover, settlements, and infrastructure. Topographical map with 1:10,000 scale prepared under the FMP Study was also available in analog format. The satellite image Landsat ETM+, captured on 24 October 2001 (Shilpakar, 2003), was used by pseudo-natural color combination (Red-B3, Green-B4, Blue-B2) for the study of the shifting course of Lakhendei River.

Model Development and Application. The flood vulnerability map, flood hazard map, and flood risk map were prepared based on the general approach described below:

The major data for the model development consisted of the topography and river channel and hydrologic data for the floods of different return periods. For the preparation of TIN digitized data (from the Survey Department, GON), digitized contour at interval 2.5 m and spot heights from 1:10,000 topographical map prepared for the FMP study (JICA/DOI, 1999) and cross sections at the interval of about 1 km from the river survey of 1998 were used.

Different empirical methods were used to estimate the probable maximum flood for different return period at various sites along the Lakhandei River. For unsteady flow analysis, the triangular hydrograph adapted in FMP study was used. The water surface profiles computations were made for the floods of 2, 5, 10, 20, 50 and 100 year return periods.

The risk assessment methodology in this study followed the approach developed by Gilard (1996), similar to the method adapted in the flood risk assessment of Babai River in Nepal (Shrestha, 2000, 2002). The flood risk was divided into hazard and vulnerability components. The vulnerability assessment was based on the presence or absence of a flood of particular intensity in a particular land use type. The spatial coexistence model was used for the hazard assessment, reclassifying the floodwater depth. The results of these two analyses were combined for the flood risk assessment.

In this study, Global Positioning System (GPS) was used to collect more information about the extent and depth of flood in a few locations of the study area during site visit. Most of the observed locations lie within the area flooded by two-year return period flood. The flood depth reported by local people, however, could not be linked with the flood of particular return period. The GPS was also used to identify the some points of river course shifting during site visit.

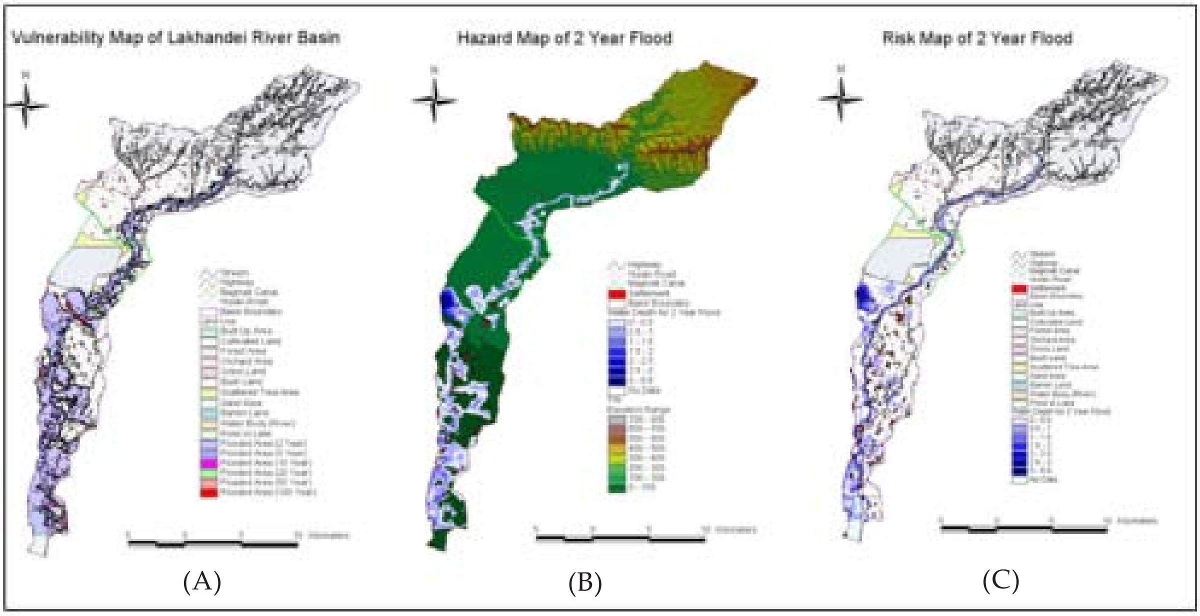
Key Findings

This study presented a systematic approach for the preparation of flood vulnerability, hazard, and risk map with the application of hydraulic model and GIS. The key findings are as follows:

Flood risk mapping based on hydraulic model and GIS. The flood map could be prepared for flow of different return periods by the steady flow model. It could also be mapped for particular flooding event by using the unsteady flow model. The automated floodplain mapping and analysis using these tools provided more efficient, effective, and standardized results, saving time and resources. The presentation of results in GIS provided a new perspective to the modeled data—facilitating a transition from a flood hazard model based on field investigation to a knowledge-based model that could be related to flood intensity.

Flood risk assessment. Providing a new perspective to the modeled data, the visualization and the quantification of the flood risks could help decision makers to better understand the problem. This study identified flood risks by combining land use vulnerability and the magnitude and extent of flood hazard. The graphical output created by this system for the different flooding scenarios could inform the decision making process regarding the desirable levels of protection. The flood vulnerability map and flood hazard map and flood risk map for two-year flood are shown in Figure 2.

Figure 2. (A) Flood Vulnerability Map, (B) Flood Hazard Map for Two-Year Flood and (C) Flood Risk Map for the Two-Year Flood



The assessment of vulnerability to flooding was made in relation to the land use pattern in the flood areas, which indicated that a large percentage (about 75%) of the vulnerable area consisted of cultivated land. Part of built up area was also affected by floods of different return period including other land use categories. Flooding had a considerable impact on the livelihood of the local people.

The study also made an assessment of flood hazards in relation to the return period of floods and their water depth. Most of the flooded areas had a water depth of less than two meters. The percentage of flooded areas under the floodwaters with a depth of more than two meters was not more than 5% for a different return period flood.

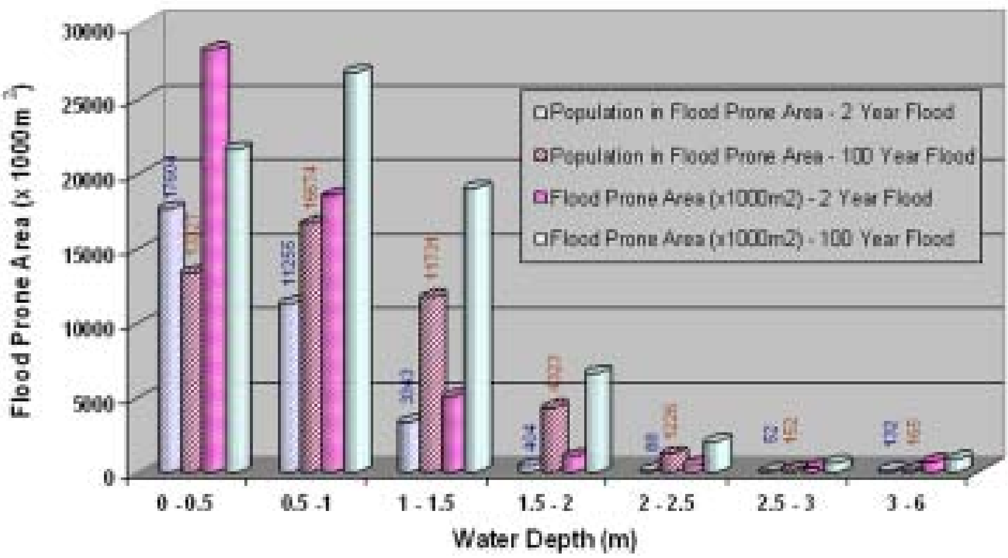
The flood risk assessment was made by combining the results of vulnerability and hazard assessments. There was only a small percentage of settlement areas with floodwater depth of more than one meter. However, there were many agricultural areas with floodwaters of more than one meter, indicating that flooding had a significant impact on agriculture.

Based on the average population density of different VDCs, the number of people that will be affected by 2-year and 100-year flood is estimated to be 32,875 and 47,594, respectively (Figure 3).

Animation of flooded area. Results of the unsteady flow model could be animated to help to present flood-related problems in a visual way for decision makers and the general public.

Shifting river course. The examination of the historical change in the river course indicated that the shifting of river course in the upper reaches was not severe but the river course actively shifted in the lower reaches.

Figure 3. Flood-prone areas and approximate population (based on population density of different villages (Population Census 2001, CBS) in flood-prone areas for 2-year and 100-year floods



Impact of global climate change. For sustainable flood plain management, the impact of global climate change should be considered. It is anticipated that the total number of average flood days a year and the number of consecutive flood days will increase, so the severity of flood will also increase in the future (Thapa, 2003).

Participation of community in flood management. Flood risk maps are essential for assessing potential damage and successfully implementing a range of flood hazard mitigation measures, such as land use regulation, emergency measures. These maps would also inform the public of the risks. Flood management needs the active involvement and participation of all. A general flood action plan was also prepared as an extension of this study.

Some of the practical applications of this study were derived from the use of an automated floodplain modeling process; some from the resulting floodplain maps. The potential applications of this study consist of the following: design of flood control structures and other structures, floodplain zoning, and real-time flood warning mapping. An example of a practical application is the creation of scenario maps that would indicate the need to issue a flood warning.

Recommendations to Stakeholders

- Adopt an appropriate land use plan in flood-prone areas (prohibitive, restrictive, and warning zone).
- Adopt sabo works, promote aforestation, watershed conservation efforts in the upper reaches, and implement both structural and non-structural flood control measures in the lower reaches of the river (integrated approach for the management of water related disasters in the whole river basin).
- Encourage the community to be involved in the flood action plan to mitigate the flood hazard and improve their awareness on the negative consequences of flooding.
- Establish evacuation centers at different settlements.

Dissemination Strategy

This study was part of the author's master's thesis. Its output was disseminated during the thesis presentation. A paper related to this study was also included in the proceedings of an international conference (Awal et al., 2005). Currently, the author is involved in a study on landslide dam failure and resulting flooding. Further dissemination of study will be done to governmental and nongovernmental organizations working in flood disasters.

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Annex A

Technical Description of Methodology

The flowchart of the floodplain analysis and risk assessment using HEC-RAS (1-D model), GIS, and HEC-GeoRAS is shown in Figure 1. The general procedure consisted of five basic steps: (1) preparation of TIN in ArcView GIS; (2) HEC-GeoRAS pre-processing to generate HEC-RAS import file; (3) running of HEC-RAS to calculate water surface profiles; (4) post-processing of HEC-RAS results; and (5) floodplain mapping and flood risk assessment. The flood risk assessment methodology followed the approach developed by Gilard (1996). A similar approach was adapted in the flood risk assessment of Babai River in Nepal (Shrestha, 2000, 2002). The flood risk was divided into hazard and vulnerability components. The vulnerability assessment used the binary model, based on the presence or absence of flood of particular intensity in a particular land use type. The spatial coexistence model was used for the hazard assessment and reclassification of floodwater depth. The results of these two analyses were combined for the flood risk assessment.

Model Development

The major data for model development consisted of the topography and river channel and hydrologic data for the floods of different return periods. For the preparation of TIN digitized data (from the Survey Department, GON), digitized contour at interval 2.5 m and spot heights from 1:10000 topographical map prepared for the FMP study (JICA/DOI, 1999) and cross sections at the interval of about 1 km from the river survey of 1998 were used.

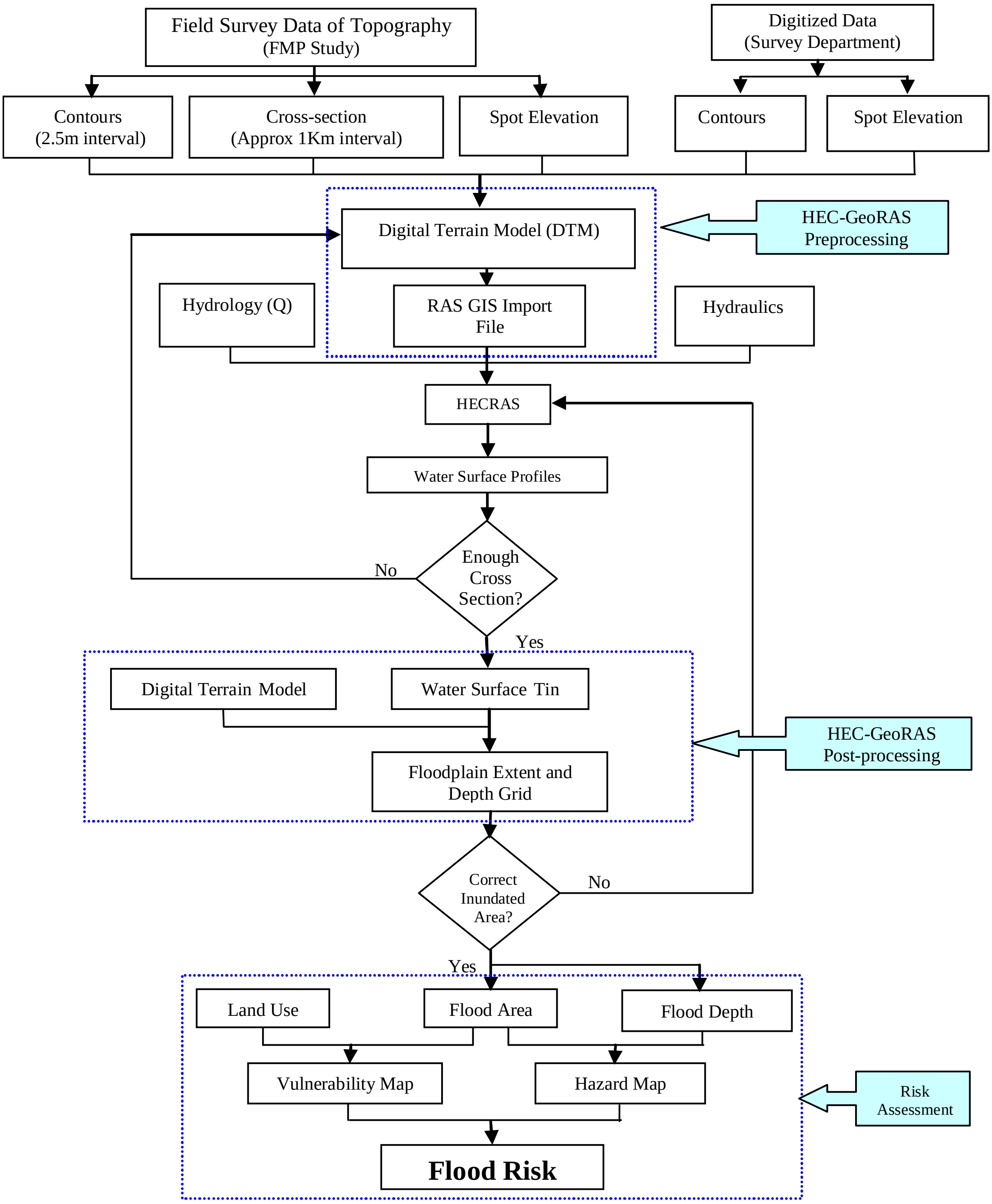
As the Lakhandei River is not gauged, the peak discharges were estimated by different empirical methods such as Creager's formula adopted in the FMP study, WECS/DHM, Modified Dicken's, B.D. Richard's, and Synder's method. Probable maximum flood for different return period at various sites along the Lakhandei River is shown in Table 1. For unsteady flow analysis, the triangular hydrograph adapted in FMP study was used. The water surface profiles computations were made for the floods of 2, 5, 10, 20, 50 and 100 year return periods. The flood vulnerability map, flood hazard map, and flood Risk map were prepared based on the methodology already described.

- Motivate and strengthen the coping capacity of local institutions through government and NGO support.
- Include housing design on building codes for strict implementation.
- Update hazard maps by incorporating additional survey data of all man-made structures with field verification.
- Identify evacuation centers and evacuation routes in the flood hazard map.
- Reestablish water level gauging station at Pattharkot to incorporate reliable flood discharge in the hydraulic model.
- Acquire RS data at flood peak time to help in model verification, to assess damage, and support post disaster mitigation measures.

Table: 1 Probable Maximum Flood for Different Return Period at various sites along the Lakhandei River

Distance from Indian Boarder (km)	Catchment Area (km^2)	Probable Discharge (m^3/s)					
		Q_2	Q_5	Q_{10}	Q_{20}	Q_{50}	Q_{100}
51.04	65	178.00	288.36	359.56	428.98	519.76	587.40
42.28	107	242.00	392.04	488.84	583.22	706.64	798.60
39.67	155	302.00	489.24	610.04	727.82	881.84	996.60
36.43	174	323.00	523.26	652.46	778.43	943.16	1065.90
30.74	208	357.00	578.34	721.14	860.37	1042.44	1178.10
11.82	289	428.00	693.36	864.56	1031.48	1249.76	1412.40
3.86	300	437.00	707.94	882.74	1053.17	1276.04	1442.10

Figure 1. One-Dimensional Floodplain Analysis Using HEC-RAS, GIS and HEC-GeoRAS

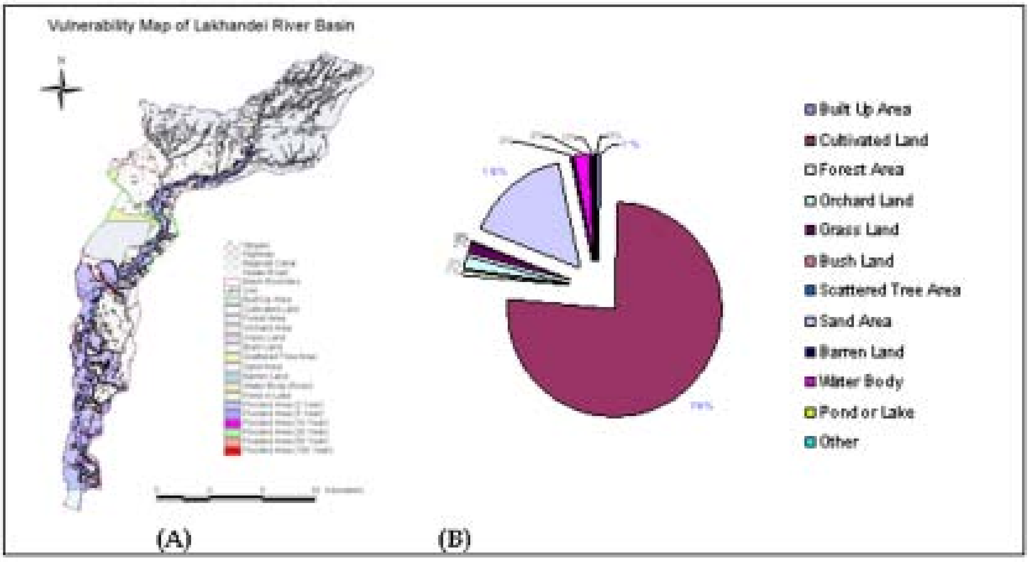


Flood Vulnerability Analysis

The vulnerability maps for the flood areas were prepared by intersecting the land use map of the floodplains with the flood area polygon for each of the flood event being modeled. This depicted the vulnerability aspect of the flood risk in the particular area in terms of the presence or absence of flooding of a particular return period as a binary model. The result of the model is shown in Figure 2(A) and the land use areas covered by the modeled flood are summarized in Figure 2(B).

The assessment of the flood areas indicated that large percentages (73% to 76%) of vulnerable areas were cultivated land. Flooding also affected some settlement areas, indicating that flooding had a considerable impact on the livelihood of the local people.

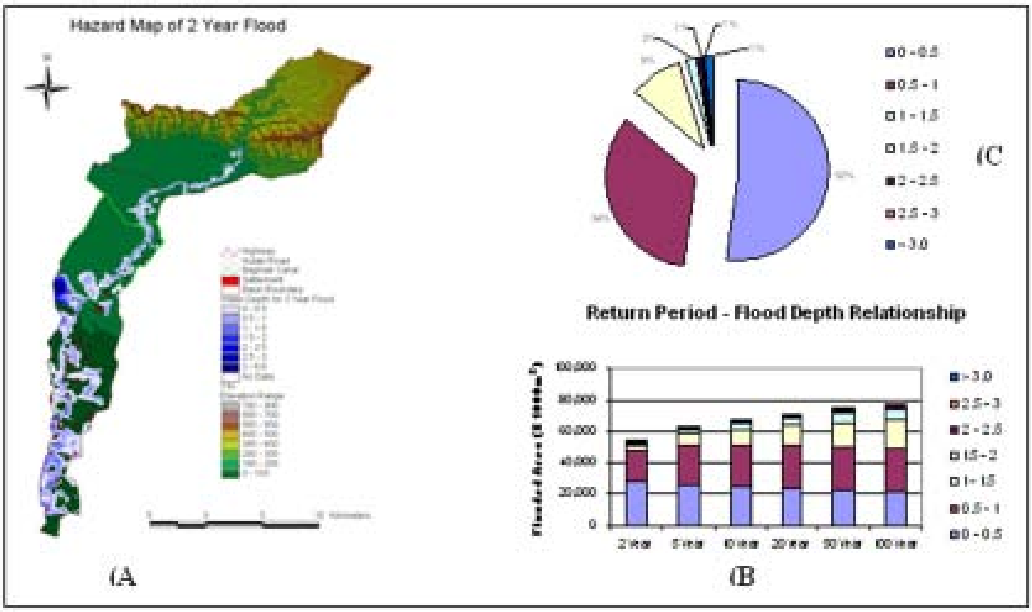
Figure 2. (A) Flood Vulnerability Map; (B) Flood Vulnerability Classification for Two-Year Flood



Flood Hazard Analysis

Water depth was a determining parameter for the quantification of the flood hazard and potential of damage. The weighted spatial coexistence model facilitated the analysis by ranking the hazard level in terms of water depth. In this study, the hazard level was determined by reclassifying the flood grids flood depths polygons bounding the water depth at the intervals of 0-0.5, 0.5-1.0, 1.0-1.5, 1.5 - 2.0, 2 - 2.5, 2.5 - 3.0 and >3.0. The areas bounded by the flood polygons were calculated to make an assessment of the flood hazard level. The results of this assessment are shown in Figure 3 (A), (B), and (C).

Figure 3. (A) Flood Hazard Map for Two-Year Flood; (B) Return Period-Flood Depth Relationship; and (C) Flood Hazard Analysis for 2 Year Flood.



The classification of flood depth areas indicated that 27% to 52% of the total flooded areas had water depths of less than 0.5 m. Most of the flooded areas had water depth of less than 2 meters. The flooded area with a water depth of more than 2.5 meters was quite small. Flooded areas under the water depth of 0.5 to 2 meters increase considerably with the increase in the intensity of flooding.

Flood Risk Analysis

The flood risk analysis included the combination of the results of the vulnerability and hazard assessments. This was defined by the relationship between the land use vulnerability classes and the flood depth hazard classes in a particular area. The flood risk maps were prepared by overlaying the flood depth grids with the land use map (Figure 4A). The land use and hazard classes were translated into color classes for the visualization of the level of flood hazards in the vulnerable areas. The flood depth polygons prepared during the hazard analysis are intersected with the land use vulnerability polygons. The resulting attribute tables are reclassified to develop the land use-flood depth relationship [Figure 4(B)]. This depicts potential flood areas in terms of both the land use vulnerability classes and water depth hazard classes.

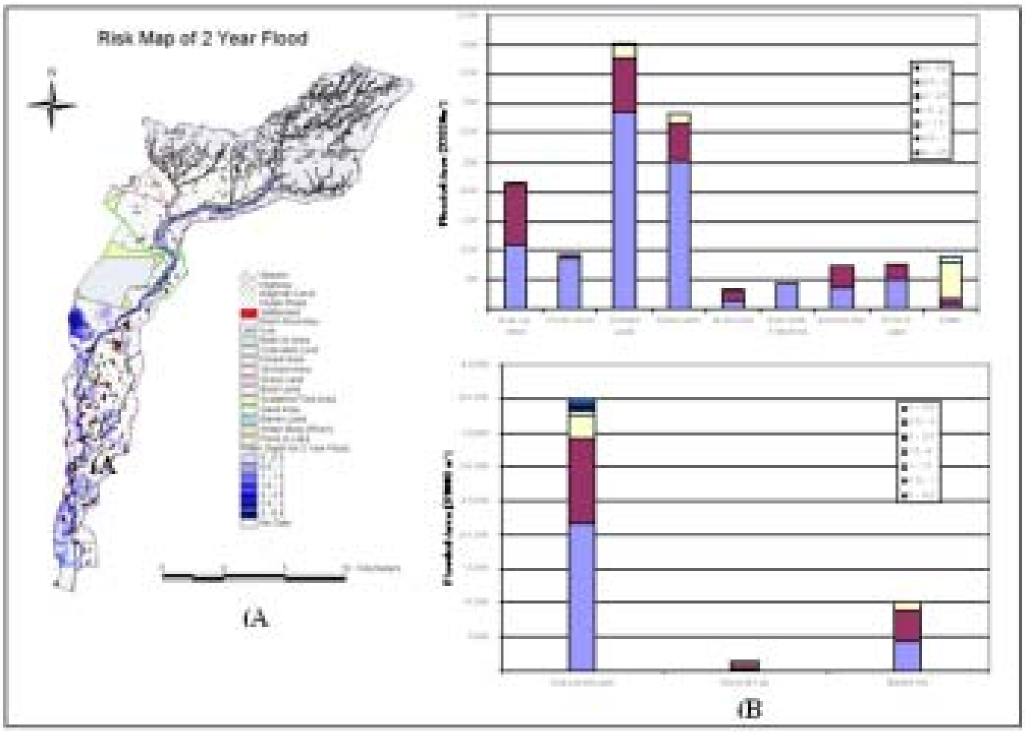
Only a small percentage of settlements were covered by floodwater with a depth of more than one meter. However, there were many areas of cultivated land that had floodwaters of more than one meter, indicating that flooding had a significant impact on cultivated land.

The spatial coverage of the different magnitude of flood risk was varied in different VDCs of the basin. The details of extent of spatial coverage for different return period were calculated. Based on the average population density of different VDCs, the number of people that will be affected by a two-year return period flood is estimated to be 32,875; while he number of people that will be affected by a 100-year return period flood is estimated to be 47,594.

Comparison of Steady and Unsteady Flow Modeling

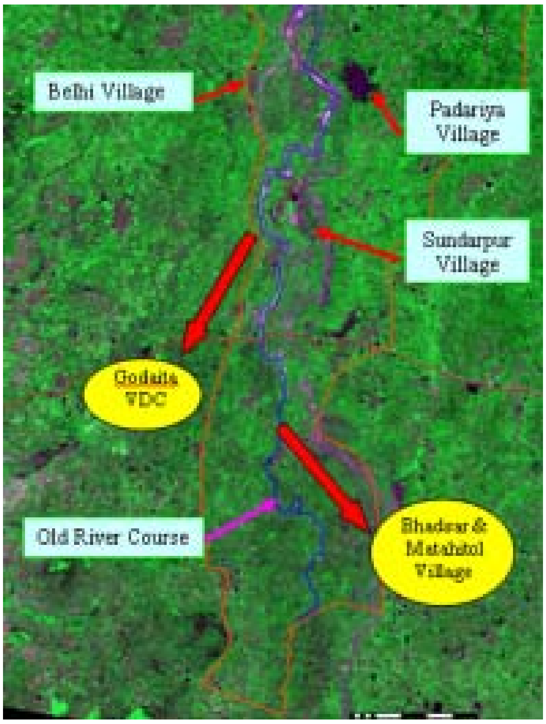
An additional analysis of the part of the study area was conducted using the HEC-RAS unsteady flow model to compare the result of steady and unsteady flow modeling. Based on the comparative study of steady and unsteady flow analysis, the water surface elevation computed by unsteady model was less than the steady flow analysis. In the steady analysis, the flooded area was about 2.84% more. When using a steady flow model, most modelers consider the peak runoff flows at the boundary conditions for a specified storm event, resulting in water stage height being significantly higher than one for the unsteady flow model. Thus, the steady flow analysis tends to overestimate flow. The unsteady flow model considers flood duration as a factor in flood analysis. Real property can be significantly affected by the difference in inundation time. The result of unsteady flow model could be animated to help present the flood-related problems in a visual way for decision makers and the general public.

Figure 4. (A) Flood Risk Map for 2 Year Flood; (B) Land Use-Flood Depth Relationship



River Course Shifting

Satellite image Landsat ETM+ was used for the study of river course shifting. The examination of the historical change in the river course indicated that the shifting of river course in upper reaches was not severe. The shifting seemed to remain within the meandering. However, river course actively shifted in the lower reaches.



Lakhandei River formed on the side of Belhi village merged with the Purano Lakhandei Nala. Due to increase in discharge in Purano Lakhandei Nala, the flooding of Madhopur village and Godaita village has increased in recent years. The new channel formed on the left bank at about 1.5 km downstream from the Phulparasi Bridge is carrying significant floodwater of Lakhandei River and flows toward Bhadsar and Matahitol villages. The frequent change in river course and formation of several river courses show that the use of the two-dimensional model is required for better floodplain analysis and mapping in the lower reaches.

Impact of Global Climate Change in Flood Hazard

Flood management including water resources management has been traditionally based on the assumption of stationary or unchanged climate and land-use conditions. A number of recent floods of exceptional severity and a long lasting drought have belied this assumption. Precipitation is the most significant aspect of climate change. Climate change impacts on the hydrologic resources of a country.

A case in point is the Bagmati River, which flows parallel to Lakhandei River in the Terai. The peak projected flows have occurred in a cyclic order, volume of runoff has increased, and monsoons have occurred early. Based on rainfall runoff simulation and analysis for the projected period of 2041 to 2059 (Thapa, 2003), the total number of average flood days a year and the number of consecutive flood days are expected to increase. If mitigation measures are not taken, the increase in flooding event will result in huge losses of lives and property.

General Flood Action Plan

Flood risk maps are essential for assessing potential damage and successfully implementing a range of flood hazard mitigation measures, such as land use regulation and emergency measures. These maps would also inform the public of the risks. Flood management needs the active involvement and participation of all. A general flood action plan was also prepared as an extension of this study. The action plan emphasized community participation and suggested the formation of a Community Flood Management Committee. The NGOs and voluntary organizations can act as interface between the committee, government, and other organizations. The functions of Community Flood Management Committee would consist of flood preparedness, flood response (i.e., relief, post-flood rehabilitation, and maintenance), and flood mitigation.

Focus group discussion held at the village school

I got a chance to enhance my knowledge about methodologies and establish good relationships with local NGOs. I found that community people readily accept knowledge from organizations working on environment issues.

-Krishna Prasad Sharma

Grant No. 2170

Landslide Risk Assessment in Thanamaula Village Development Committee in Parbat District

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Abstract

Quantifying hazard risk is one of the critical issues in disaster management. The geologic, physiographic, climatic, and geomorphic features of Nepalese mountains make them prone to landslides. However, very little has been done to quantify these risks in the country. The present study is an attempt towards landslide risk assessment using both Geographical Information Systems/Remote Sensing (GIS/RS) tools and community mapping procedures. Landslide risk is defined as the product of landslide hazard and vulnerability (i.e. elements at risk) divided by the response and recovery capacity of local people. The study used both socio-economic and spatial parameters influencing response and recovery capacity. Community mapping of landslide hazard proved to be very effective in hazard zonation. Across the lines of gender, ethnicity, caste, economic class, and occupation, there were significant variations in responses, recovery capacity, and landslide risk.

As recommended by the local community, the project also implemented an awareness program in collaboration with the Nepal Red Cross Parbat District Chapter and the Center for Social and Environmental Research (CENSER). With help from these two organizations, the project published and disseminated a brochure in the local language to raise awareness of local people on the risks posed by landslides.

Problem Addressed

Landslides occur frequently in Nepal. The unstable geology, step slope, rugged mountain topography, raging rivers, swiftly flowing streams, intense monsoon rains, and frequent earthquakes make the Nepalese mountains one of the most hazardous areas in the world (Paudel, 2004). The construction of roads, irrigation, canals, and dams without due consideration to natural hazards and encroachment of land for cultivation and settlement have helped trigger landslides. As the result, landslides kill more than 186 people and destroy property worth more than US$ 8 million every year (Khanal, 1996).

Sustainable development in a mountainous region refers in part to the implementation of schemes that considers the existing instability of the terrain to minimize geo-environmental hazards. After assessing the landslide hazard potential of an area, the next step is to design mitigation measures to reduce vulnerability. Concerned agencies can use this assessment to prioritize areas for the implementation of disaster preparedness plan and mitigation measures.

Poor people are most vulnerable to landslide hazard because they mostly live in weak housing structures located in marginal and disaster prone areas. Using a wide range of parameters, the project focused on understanding the response and recovery capacity of local people, especially the poor, and provided relevant information that would enable policy makers to implement appropriate poverty reductions programs that help reduce disaster risk.

Methodology

The project made use of the information below:

- Digital version of Landsat satellite images, MSS and TM, (1990, 1999, and 2002) and aerial photos (1996) from CENSER.
- Geological, land system, land utilization, land capability, and topographical base maps (1: 25,000 scale) from Survey Department/NG.
- Digital data of height and contour prepared by Survey Department/NG.
- 20 years precipitation data of 8 stations from the Department of Hydrology and Meteorology.

- Secondary information on casualties (life and property) in Nepal from disasters (1983 to 2004) from the Department of Water Induced Disaster Prevention (DWIDP).
- Socioeconomic and census data from Central Bureau of Statistics/NG.

The project took the following steps:

1. Rapid Rural Appraisal (RRA) and Global Positioning System (GPS) observation

The project carried out short preliminary field observation to obtain basic information from the Village Development Committee (VDC)[1] and through GPS reading of ground truth data and landmarks. It also established good relations with the VDC, NGOs, and local organizations working in disasters on the village and district levels.

2. GIS/RS lab work and basic map preparation

Pre-GIS/RS lab work consisted of identifying landslide scars, preparing base maps (scale 1:1,000), and marking suspicious units/pixels for further verification on the field.

3. Focus group discussion

Focus group discussions with each ward obtained information regarding landslide trends, past occurrences, losses of lives and property, preparedness plan, relief and post management program implemented in past, their effectiveness, and decision- making processes in local disaster management.

4. Structured and semi-structured interviews

The semi-structured qualitative interviews obtained data regarding landslide occurrence and impact, causes of landslides, local mitigation measures used by respondents, local criteria used to assess the landslide hazard, decision-making, and disaster management.

The household survey conducted in the identified risk zones from GIS/RS analysis and community mapping procedures (i.e., in Ward no. 1, 2, 3, 7 and 9) obtained socio- economic information regarding the response and recovery capacity of local people.

5. Field observation and measurement

Fieldwork consisted of recording and measuring GPS readings of landslide scars and their characteristics: type, materials, depth, lithological, geomorphological, and geological features.

6. Participatory community mapping of landslide hazard

Community participants marked the basic maps that the project provided to them with different levels of landslide hazards. Through intense discussions, they also made a time series analysis of landslide occurrence using time series satellite images and aerial photos.

7. GIS/RS analysis and landslide hazard mapping (bivariate statistical method)

Landslide hazard map was prepared using bivariate statistical method. The response and recovery capacity of local people was calculated based on the results of household survey and spatial information derived from GIS analysis.

The vulnerability map was prepared considering the risk elements. The landslide risk of the Thanamaula VDC was calculated by combining the hazard map with the vulnerability map and response and recovery capacity.

Key Findings

The project found four major landslide scars sites in Thanamaula VDC of Parbat District, namely, Khalte, Dhap, Archale and Chitre. Composed of mud, soil, and rock, all the landslides were destructive. The Archale landslide was dry. The largest landslides in terms of coverage, length, depth, and socio-economic impact occurred in Khalte since 1933. All these landslides have frequently occurred in the last 30 years. The recurrence of common landslides has ranged from 1 to 3 years; while the recurrence of major landslides has ranged from 10 to 25 years, causing huge losses to life and property. Occurrence of hazardous landslides highly correlated (r = 0.83) with the monsoon rainfall.

In the study area, major landslides destroyed an estimated 23.92 hectares of cropland and directly affected about 116 families. With a recurrence interval of 15 to 25 years, these landslides cause significant losses. The indirect effects of landslides to local people—out-migration of relatives, destruction of previous irrigation canals, and difficulty of constructing new irrigation canals—are actually greater than direct losses.

Table 1. Impact of landslides in Thanamaula

Sites of landslides	No. of affected families		No. of displaced HH	Land lost (hectare)
	Direct	Indirect		
Khalte	75		18	15.3
Dhap	13	30	1	8.1
Archale	4	8		0.3
Chitre	1	16		0.3

[1] The Village Development Committee is the smallest adminis trative unit or local governing body in Nepal. It is divided into nine wards. One ward represents one village.

In the past, NGOs and INGOs introduced some measures to reduce the risk of landslides. For instance, JICA constructed a check dam and gabions in different landslide sites. However, the gabions were not effective in controlling landslides and debris flow and there was no regular monitoring and maintenance of previously constructed check dams, the local people said. JICA and GTZ also initiated plantation projects. But with the lack of well-established mechanisms to protect the newly planted trees, most of them died.

Landslide hazard maps prepared using the GIS/RS bivariate statistical technique and community mapping processes (Figures 1a and 1b) were highly correlated (r = 0.64). However, local people centered only on areas where there were recent landslides. During the mapping exercises, local people considered the nature and form of previous slides, cracked landform, and the nature of runoff drainage of hill slope. They also regarded heavy rainfall as the primary cause of landslides. They did not look into debris flow in forests, grazing areas, and barren land.

Figure 1a. Landslide hazard map based on GIS/RS analysis

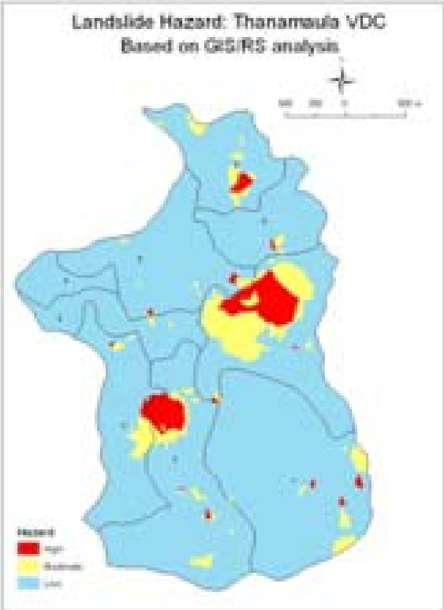
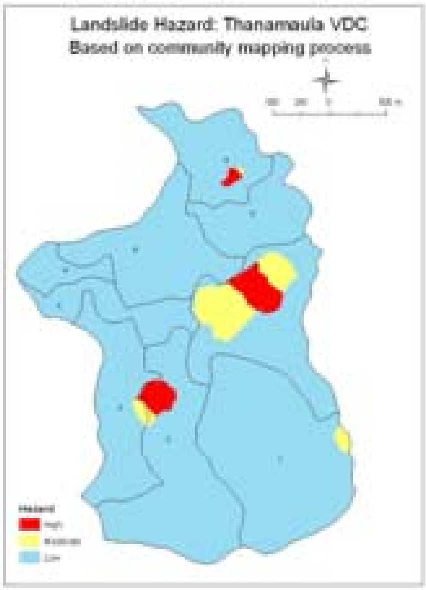


Figure 1b. Landslide hazard map based on community mapping



Out of 34 sample households, 27 households were exposed to landslide hazards. Lower caste people and Gurung ethnic households were most vulnerable to landslide hazard. About 25 private houses, 20 livestock sheds, 24 hectares of land and livestock (with an estimated value of more than US$ 8,000) were exposed to landslide risk (Table 2). The estimated value of other assets such as fruit and fodder trees and crops is about US$ 1,700.

Subsistence agriculture characterizes the economy of Thanamaula VDC. About 21% of the sample households have been suffering from food deficiency for more than 9 months. Only 29% of the sample households are able to produce sufficient food grain for the whole year. Ten households rent land for share cropping arrangement; while 6 households rent out their land. Almost all of them keep different types of livestock. The number of livestock kept indicates the economic well-being of households. In addition to agro-pastoral production, 11 households have regular income from pension (e.g., army) or from government service. Recently, many households have been receiving remittances from relatives working abroad. Seven households have neither income from permanent sources like pension nor foreign remittances. Three households in Ward No. 9 do not even own any livestock. Two households in Ward No. 7 were landless.

Almost all the houses are built of mud and stone. Most have thatched roofs; a few have tin roofs. The marginally poor, landless, food-deficient agro-pastoral households have very low capacity to cope with hazards.

Table 2. Property affected in landslides

Ward no.	Private House	Livestock Shed	Land area (in hectares)				Value (in US $)
			Khet	Bari	Grazing land	Private forest	
7	18	15	3.66	3.36	1.60	1.07	5,543
2/3	3	3	3.92	1.78	1.40	0.36	2,176
9	4	2	2.04	0.00	0.00	0.00	318
1			2.60	0.97	1.02	0.00	-
Total	**25**	**20**	**12.216**	**6.108**	**4.0211**	**1.4252**	**8,036**

Sample: 34 HH

All the wards have similar spatial parameters influencing response and recovery capacity—access to the nearest road, health service, banks, and other services However, Wards No. 9 and 7 have better access than the others (i.e., half an hour less walking distance to all services). The calculated cumulative response and recovery capacity to landslide risk of 9 marginalized households was very low. Seven households had better response and recover capacity.

Ward No. 7 was generally most vulnerable to landslide hazards and disasters. However, particular households in Wards No. 2/3 (2 HH) and 9 (3 HH) were highly at risk. Hence, in disaster management, there should be strategic measures to strengthen the response and recovery capacity of marginalized people to prevent or mitigate disasters.

Local people's perception of landslide risk was highly influenced by a set of community characteristics such as economic insecurity, length of exposure to hazards, return period of disaster, and their previous experiences of dealing with disasters. They showed their willingness to contribute their labor in the implementation of any landslide mitigation measure.

Recommendations

The major stakeholders are the local people of disaster prone areas, social workers, local political leaders, DDC, VDC, GOs, and NGOs concerned with disaster management like Nepal Red Cross Society, DWIDP, and CENSER. Below are the study's recommendations:

- Implement community mapping procedures in risk and hazard assessment because they are effective methods in data collection and hazard zonation, especially in rural and remote settings where it is difficult or impossible to use GIS/RS tools because of financial and technical limitations. The local community possesses indigenous knowledge of their area's geological structure, drainage system, soil properties, and other parameters. Community mapping procedures are appropriate for quantifying hazard risks and prioritization of mitigation measures.

- Since all households have almost the same socio-economic and spatial parameters, examine micro levels and categorize areas according different levels of disaster risk.

- Disaster risk mitigation measures should incorporate poverty alleviation and empowerment of groups marginalized along the lines of gender, wealth, class, caste, ethnicity, and occupation to increase their claim-making capacity and to reduce their vulnerability to hazards.

- Develop and implement a user-friendly Disaster Management Information System at the local levels to systematically collect, store, and manage disaster-related information.

- Establish mechanisms to monitor measures introduced by different governmental and non-governmental organizations to prevent the failure of disaster risk reduction or disaster mitigation activities.

- Discuss research findings and project results to the local community and obtain their feedback to help disseminate information to relevant stakeholders.

- Incorporate local indigenous knowledge in designing disaster mitigation measures and involve the community in the planning and implementation of strategies and activities.

- Create mechanisms to disseminate the results of research findings at the national and regional levels for practical application of risk reduction activities.

Dissemination Strategy and Action Plan

The project conducted two workshops with key stakeholders and the local community in Parbat District headquarter and the project site to disseminate the findings. The production and distribution of a brochure containing information on how to minimize risks posed by landslides, as suggested by the participants, was one of the important results of these workshops.

A brochure in Nepali language was published and disseminated with the help of CENSER and Nepal Red Cross Society Parbat Chapter. There are plans to prepare and distribute the same brochure in English and in the local dialects (Gurung).

There is likewise a plan to post handwritten posters containing information on different risk zones and the steps to take before, during, and after a landslide disaster in public places. These posters will complement the signboards that disseminate project findings.

The implementation of planned disaster risk management programs are currently constrained by financial difficulties.

Workshop held at Kusma

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Annex A
Parameters Used for Response and Recovery Capacity

Parameters	Indicator	Parameters	Indicator
Demographic		***Facilities***	
% people aged below 4 and 65 years	(-)	Health service	Index value
Education		Telephone facility	Index value
% literate	(+)	***Housing***	
Average number of schooling year	(+)	% pakki on the basis of wall type	(+)
Income		% pakki in terms of roof types	(+)
% people engaged in non-farm activities	(+)	% one story house	(-)
% household with food sufficient only for less than six months	(-)	***Accessibility***	
Annual household income (Rs)	(+)	Road facilities	Index value
% income outside from agriculture (crop, horticulture and livestock)	(+)	Distance to services	Index value
% loss in annual income	(-)	Distance from district headquarters	Index value
Assets		***Facilities***	
% khet land within hazard zone	(-)	Health service	Index value
% pakho land within susceptible zone	(-)	Telephone facility	Index value
% cereal crops within hazard zone	(-)		
% other crops within hazard zone	(-)		
% vegetable within hazard zone	(-)		

List of Grantees, Mentors, and Titles of Research Papers Applied Research Grants for Disaster Risk Reduction Round I (2003-2004)

SOUTH ASIA

ID #	Research Title	Grantees	Mentors
Bangladesh			
006BGD	***Reducing Vulnerability to Floods in Southwest Border Districts of Bangladesh***	**Ms. Marina Parvin Juthi** Coastal Development Partnership (CDP) Bangladesh	**Mr. Ashraf-ul-Alam Tutu**
027BGD	***Technological and Chemical Hazards and the Risk of Bulk Transportation of Dangerous Goods Along the Chittagong Port and Adjacent Area: A Qualitative Analysis of the Combination of Risk Factors***	**Mr. Syed Ashraf ul Islam** Disaster Management Bureau Bangladesh	**M. Safiur Rahman**
Bhutan			
040BTN	***Demonstration to the Bhutan Building Industry: Improving Safety from Seismic Attack and Cost Saving by Avoiding Un-Reinforced Brick Infill in RCC Frames***	**Mr. Jigme Dorji** Thimpu City Corporation Thimpu, Bhutan	**Mr. Spencer Nicholls**
India			
007IND	***Rehabilitation Including Basic Health Care for 35,000 Reang Displaced Population at Kanchanpur, North Tripura District, India***	**Mrs. Rashmi Tewari** Sikkim Manipal University of Health, Medical & Technological Sciences, Extension Center, New Delhi, India	**Prof. Dr. P.R. Trivedi**
020IND	***Urban Multiple Disaster Scenario and Decision Making System for Vulnerable Area of Madhya Pradesh, India***	**Mr. Amit Kumar** Disaster Management Insitute, Bhopal, India	**Prof. Amit Bose**
021IND	***Indicators for Disaster Preparedness***	**Mr. Biswanath Dash** Jawaharlal Nehru University, New Delhi, India	**Prof. Vinod K. Sharma**
022IND	***Environmental Monitoring of Pesticide Residues and Heavy Metals in and Around Kanpur, Uttar Pradesh, India***	**Dr. Nalini Sankararamakrishnan (Team Leader) & Dr. Rashmi Sanghi** Facility for Ecological and Analytical Testing Laboratory (FEAT) Indian Institute of Technology Kanpur, Uttar Pradesh, India	**Prof. Dr. R.N. Mukherjee**
024IND	***Action Advocacy to Ensure Right to Livelihood Risk Reduction and Beyond***	**Mr. Prabhir Vishnu** Disaster Mitigation Institute Ahmedabad, India	**Mr. Mihir R. Bhatt**
029IND	***Organizational Learning for Community Based Disaster Risk***	**Ms. Shivani Khanna** Disaster Mitigation Institute	**Mr. Mihir R. Bhatt**

035IND	*Disaster Management Information System*	**Mr. Aurobindo Ogra (Team Leader) & Mr. Deepak Kaul** Uttaranchal State Operations City Managers' Association of Uttaranchal, India	**Mr. Vivek Ogra**
044IND	*Testing Communication Strategies for Industrial Disaster Risk Reduction*	**Mr. Avanish Kumar** Centre for Environment Education Nehru Foundation for Development Gujarat, India	**Ms. Meena Raghunathan**
045IND	*Earthquake Hazard Assessment and Information Dissemination in Mumbai, India*	**Mr. Kishor Subhash Jaiswal** Dept. of Civil Engineering Indian Institute of Technology Mumbai, India	**Dr. Ravi Sinha**
047IND	*Institutionalizing Innovative Local Practices and Partnerships for Risk Reduction in Earthquake-Prone Settlements of the Poor: A Case Study in Porbandar District, Gujarat, India*	**Mr. Shagun Mehrotra** Urban Environmental Management Field of Study School of Environment Resources & Development (SERD) Asian Institute of Technology, Thailand	**Dr. Ranjith Perera**
050IND	*Developing and Disseminating a Model of Community Based Disaster Mitigating Developmental Planning*	**Ms. Rawat Pushplata** Center for Development Initiatives, Uttaranchal India	**Dr. Dinesh Sati**
053IND	*Community Based Advanced Risk Sharing Programme (CBARSP)*	**Mr. Jojo Sunil Kumar** CONSIDER Andhra Pradesh India	**Dr. Bipin Kr. Jojo**
066IND	*Planning for Risk Reduction Through Sustainable Siting of Embankments in the Sundarbans*	**Ms. Aparna Das** Forum of Scientists, Engineers & Technologists Kolkata, India	**Dr. Shekhar Chandra Dutta**
074IND	*Improving the Methodology for Assessing Natural Hazard Impacts*	**Ms. Upasna Sharma** SJM School of Mangement, Indian Institute of Technology, Bombay, Powai, Mumbai, India	**Prof. Anand Patwardhan**
076IND	*Post Disaster Risk Identification: A Case of Rehabilitation Processes of Rural Kutchh, Gujarat State, India*	**Ms. Pratima Singh** School of Planning, CEPT Ahmedabad, India	**Dr. Gregory Bankoff**
079IND	*A Critical Study into the Government Policies on Disaster Management and in Particular*	**Mr. P.V. Krishnan (Team Leader) & Mrs. Amita S.Kaushik**	**Mr. D.K. Mishra**
089IND	*Hazard Resistant Health Delivery System*	**Ms. Sonalini Khetrapal** Cornell University USA	**Dr. Bipin Kumar Verma**

NEPAL			
004NPL	*Community Disaster Management with GIS in Nepal*	**Mr. Komal R. Aryal** University of Northumbria at Newcastle, UK	**Dr. Andrew Collins & Dr. Robert Mac. Farlane**
063NPL	*Mapping and Assessing Risk and Vulnerability of Water Induced Disaster in the Tinau Watershed, Western Nepal*	**Mr. Keshav Prasad Paudel** Central Department of Geography, Tribhuvan University Kathmandu, Nepal	**Assoc. Prof. Dr. Narendra Raj Khanal**
073NPL	*Floodplain Analysis and Risk Assessment: A Case Study of Lakhandei River, Nepal*	**Mr. Ripendra Awal** Water Rsources Engineering Program, Pulchowk Campus, Tribhuvan Unviersity Nepal	**Dr. Narendra Man Shakya**
075NPL	*GIS and Remote Sensing for Flood Disaster Identification: A Case Study of the Koshi River Basin In Nepal*	**Ms. Archana Pradhan** Office of the Dept Head Central Department of Geology Tribhuvan University, Kirtipur, Kathmandu, Nepal	**Dr. Prakash Chandra Adhikari**
PAKISTAN			
023PAK	*Effectiveness of Policies for the Reduction of Flood Hazard in Pakistan: A Case Study of Lai Nullah, Rawalpindi City*	**Ms. Sarwat Naz (Team Leader) & Mr. Mohammad Ishfaq** Department of Environmental Sciences University of Peshawar, Pakistan	**Prof. Dr. S. Shafiqur Rehman & Mr. Falak Nawaz (Co-Advisor)**
049PAK	*Ghariat Potential Landslide: Demonstrating Hazard Risk Assessment Tools and Techniques in Mountain Environments*	**Mr. Syed Jalal ud din Shah** Focus Humanitarian Assistance Pakistan	**Mr. Hadi Husani**

EAST ASIA

ID #	RESEARCH TITLE	GRANTEES	MENTORS
CHINA			
015CHN	*Vulnerability of a Community's Structures, People, and Property Based on Flood Risk Assessment*	**Ms. He Xiaoyan** Water disaster Mitigation Center, Beijing PR China	**Dr. Cheng Xiaotao**
060CHN	*Near Source Strong Ground Motion Estimation*	**Mr. Yi Tinghua** Earthquake Engineering Research Institute Dalian University of Technology, Dalian, PR China	**Dr. Wang Guoxin**
061CHN	*Social Forestry-Based Disaster Preparedness and Management in Rural Community of Menkong Catchment, Yunnan Province, Southwest China*	**Mr. Shen Lixin** Kunming Development Institute for Traditions & Environment Yunnan, PR China	**Dr. Hu Gang**

030CHN	*The Disaster Awareness and Risk Management of Flooded Yangtze River: A Case Study of the 1998 Dyke Burst in Jiujiang*	**Ms. Wang Honglei (Team Leader) & Mr. Zeng Huaide** Soochow University PR China	**Prof. Guo Qiang**

SOUTH EAST ASIA

ID #	RESEARCH TITLE	GRANTEES	MENTORS
INDONESIA			
070IDN	*Multidimensional SNMR Modelling for Groundwater Exploration*	**Mr. W. Warsa** Department of Appiled Geophysics, Institute of Applied Geosciences, Technical University of Berlin, Germany	**Dr. Ugur Yaramanci & Dr. Martin Muller**
PHILIPPINES			
041PHL	*Coastal Erosion Vulnerability Mapping Along the Southern Coast of La Union, Philippines*	**Ms. Rose Berdin** National Institute of Geological Science University of the Philippines Diliman, Philippines	**Dr. Fernando P. Siringan**
VIETNAM			
039VNM	*Fire-Safety Assessment for Tall Buildings in Large Cities of Vietnam*	**Mr. Hoang Nam** School of Civil Engineering Asian Institute of Technology, Thailand	**Dr. Pham Huy Giao**
091VNM	*Seismic Microzonation in Ancient Quarter of Ha Noi Based on Microtremor Observations*	**Mr. Nhu Nguyen Hong Cuong** School of Civil Engineering Asian Institute of Technology, Thailand	**Dr. Pham Huy Giao**

List of Grantees, Mentors, and Titles of Research Papers Applied Research Grants for Disaster Risk Reduction Round II (2005-2006)

SOUTH ASIA

ID #	RESEARCH TITLE	GRANTEES	MENTORS
INDIA			
2017IND	*Integrating Disaster Mitigation in Urban Planning Practices in India*	**Ms. Sweta Byahut (Team Leader) & *Mr. Darshan Vinod Parikh** Environmental Planning Collaborative (EPC) Ahmedabad, India	**Mr. B.R. Balachandran**
2051IND	*Institutional and Community Capacity Bilding in Disaster Management in Kashmir*	***Mr. Arjimand Hussain Wani** ActionAid International (India), Kashmir Region Srinagar, Kashmir	**Mr. Sudipta Kumar Badapandra**
2059IND	*Delineation of High Risk Zones in Tamil Nadu Coast, India*	**Ms. Laveena Rathore** Suganthi Devadason Marine Research Institute Tamil Nadu, India	**Dr. J. K. Patterson Edward**
2093IND	*Participatory Development of Home Owners Disaster-Resistant Building*	**Mr. Mihir Joshi** SEEDS India, New Delhi India	**Dr. Marla Petal**
2137IND	*Risk Reduction through Community Driven Disaster Management Plan in Earthquake Affected Kachchh Region of Gujarat*	**Mr. Tapan Patel** Centre for Integrated Development Ahmedabad, India	**Mr. Binoy Acharya**
NEPAL			
2085NEP	*Using Local Knowledge to Understand and Mitigate Community Risks from Climate Change in Nepal*	***Mr. Suresh Marahatta** Research Center for Hydrology and Meteorology (RECHAM) Kathmandu, Nepal	**Mr. Ram Chandra Khanal**
2136NEP	*Community Based Risk Reduction in Rural Nepal: A Case Study of Ratu River Watershed*	**Mr. Deepak Paudel** Natural Disaster Management Forum Nepal, Kathmandu, Nepal	**Dr. Sharad P. Adhikary**
2170NEP	*Landslide Risk Assessment in Thana Maula VDC, Parbat*	***Mr. Krishna Prasad Sharma** Center for Social and Environmental Research (CENSER) Kathmandu, Nepal	**Dr. Shiva Ram Neupane**
2181NEP	*Developing a Set of Standard Building Designs Suitable for Nepal*	***Mr. Binod Shrestha** National Society for Earthquake Technology-Nepal (NSET) Kathmandu, Nepal	**Mr. Amod Mani Dixit**

[*] *These grantees participated in the Bangkok Workshop on December 6-8, 2006.*

2183NEP	***Development of Seismic Retrofitting Scheme for Typical Nepali Non-Engineered Mesonry Infill Reinforced Concrete Framed Buildings***	***Mr. Hima Shrestha** National Society for Earthquake Technology-Nepal (NSET) Kathmandu, Nepal	**Mr. Jitendra Kumar Bothara**
2184NEP	***Effectiveness of Risk Reduction Mechanisms for Forest Fires in Nepal: A Comparative Study Between Buffer Zone and Non-Buffer Zone Community Forests***	***Mr. Bhoj Raj Khanal** Research Development, Mekong Institute, Khon Kaen University Khon Kaen, Thailand	**Dr. Bernadette Resurrecion**
2239PAK	***Community Risk Index (CRI) Toolkit for Conducting Community-wide Vulnerability Assessment and Computing Composite Hazard Risk Index in Pakistan***	**Mr. Mujeeb Alam** Focus Humanitarian Assistance Pakistan, Islamabad, Pakistan	**Mr. Ghulam Amin Beg**
SRI LANKA			
2193LKA	***Development of a Web-based Meta-Database of Tsunami Related Activities Implemented in Sri Lanka Along with a Public Awareness Seminar Series on Natural Disasters***	**Ms. Sanjeewani Somarathna** Faculty of Agriculture University of Peradeniya Peradeniya, Sri Lanka	**Dr. N.D.K. Dayawansa**
2202LKA	***Strengthening Environmental Laws to Reduce Risk and Vulnerability Among Sri Lanka's Coastal Populations in the Context of Post-Tsunami Reconstruction***	***Ms. Achala Navaratne** Environmental Foundation Ltd. Colombo, Sri Lanka	**Ms. Lucy Emerton**

EAST ASIA

ID #	RESEARCH TITLE	GRANTEES	MENTORS
CHINA			
2048CHN	***The Study of Reinforcing Houses Using Bamboo in the Rural Areas Prone to Earthquakes, Yunnan Province, China***	**Dr. Hongzhou Lai** National Disaster Reduction Center of China Beijing, PR China	**Dr. Wang Zhenyao**
2062CHN	***Water Scarcity and Changing Agriculture Production System in Guizhou Province***	**Ms. Jing Liu** Institute of Agricultural Economics (IAE) Beijing, PR China	**Dr. Claudia Ringler and Prof. Keming Qian**
MONGOLIA			
2053MNG	***Flood Risk Analysis of Capital City Ulaanbaatar, Mongolia***	**Ms. Otgonchimeg Choidogjav** National Emergency Management Agency, Ulaanbaatar, Mongolia	**Mr. Purevkhuu Luvsan**

* *These grantees participated in the Bangkok Workshop on December 6-8, 2006.*

SOUTH EAST ASIA

ID #	RESEARCH TITLE	GRANTEES	MENTORS
INDONESIA			
2154IDN	*Modelling of Coastal Protection from Tsunami Using Vegetation (Mangrove)*	**Mr. Aditya Riadi Gusman** Institut Teknologi Bandung Bandung, Indonesia	**Dr. Hamzah Latief**
PHILIPPINES			
2078PHL	*Child Oriented Participatory Risk Assessment and Planning*	***Ms. Mayfourth Luneta** Center for Disaster Preparedness Foundation, Inc. (CDP) University of the Philippines, Diliman, Quezon City Philippines	**Ms. Lorna P. Victoria**
THAILAND			
2157THA	*Interagency Coordination in Emergency Response Operations*	***Ms. Tavida Kamolvej** Department of Public Adminstration and Policy School of Political Science Thammasat University Bangkok, Thailand	**Dr. Louise K. Comfort**
VIETNAM			
2058VNM	*Seismic Hazard Assessment in Hao Binh Hydropower Dam*	**Mr. Hoang Quang Vinh** Institute of Geological Sciences Vietnam Academy of Sciences & Technology Ha Noi, Vietam	**Dr. Phan Trong Trinh**

* *These grantees participated in the Bangkok Workshop on December 6-8, 2006.*

Applied Research Grants Program for Disaster Risk Reduction- Rounds I and II (2003-2006) Management Team

In the first round (2003-2004), the program was managed by the World Bank's Hazard Management Unit (HMU) inv collaboration with the University of Wisconsin-Disaster Management Center (UW-DMC), the Asian Disaster Preparedness Center (ADPC) and Cranfield Disaster Management Center (CDMC).

After the first successful round, a second round was launched (June 2005-December 2006), which was managed by the ProVention Secretariat based at the International Federation of Red Cross and Red Crescent Societies (IFRC) in a continuing and more decentralized collaboration with University of Wisconsin-Disaster Management Center (UW-DMC), the Asian Disaster Preparedness Center (ADPC) and the Disaster Mitigation for Sustainable Livelihoods Programme- University of Cape Town (DiMP).

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