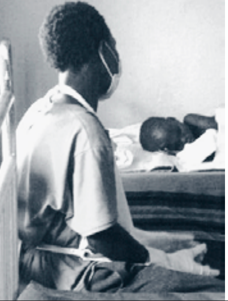

PROVENTION CONSORTIUM

APPLIED RESEARCH GRANTS FOR DISASTER RISK REDUCTION

Global Symposium for Hazard Risk Reduction

Lessons Learned from the Applied Research Grants for Disaster Risk Reduction Program

26–28 July 2004

Washington, DC

WORKING PAPERS

The World Bank

To explore innovative ways to address human vulnerability to hazards(natural and human-made), the ProVention Consortium invited a special disaster management audience—the world's youth. The Consortium launched a program of Applied Grants for Disaster Risk Reduction in 2002. Sixty-five grants were awarded and fifteen projects have now been selected for presentation at this Global Symposium. This outreach program was managed by the World Bank's Hazard Management Unit (HMU) in collaboration with the Asian Disaster Preparedness Center (ADPC), Cranfield Disaster Management Centre (CDMC) and the University of Wisconsin–Disaster Management Center (UW-DMC).

This collection of working papers presents current research on disaster management issues and practice.

For additional regional information, please contact:

Asian Disaster Preparedness Center (ADPC)
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Website — http://www.adpc.net/

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COVER PHOTOS
Aliou Mamadou Dia, Chipo Muvezwa, Gabriela Muñoz Rodriguez, Rose Berdin

COVER DESIGN
Susan Kummer, Artifax

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Preface

On behalf of the ProVention Consortium, the World Bank's Hazard Management Unit (HMU) organized a competitive forum to support innovative disaster risk management projects and the promotion of competent young professionals (under 35 years of age) dedicated to reducing disaster risk in developing countries. The ProVention Consortium is a global coalition of governments, internationall organizations, academic institutions, the private sector, and civil society organizations aimed at reducing disaster impacts in developing countries. The Applied Research Grants for Disaster Risk Reduction program has been administered by the HMU in cooperation with three collaborating centers.

The program’s objective is to support innovative risk management projects dedicated to reducing disaster risk and developed by disaster professionals in developing countries. Young researchers from around the world were invited to propose creative projects to reduce disaster impacts, and the most promising ideas were awarded small grants for implementation. The applications were screened by an independent panel of disaster management specialists, who nominated for award those proposals that best fulfilled the grant criteria in three categories: (1) hazard and risk identification; (2) risk reduction; and, (3) risk sharing / transfer. Sixty-five individuals and/or teams won grants of up to US$5,000.

The ProVention Consortium launched the program in December 2002 and awarded the grants in June 2003. The young researchers completed their projects in January 2004. For more information about the grants program, please visit the website at: http://www.proventionconsortium.org/projects/ appliedres.htm.

Awards were granted to students and young professionals from the following 27 countries: Argentina, Armenia, Bangladesh, Barbados, Bhutan, Bulgaria, China, Colombia, Costa Rica, Georgia, India, Indonesia, Kenya, Mexico, Nepal, Nigeria, Pakistan, Philippines, Senegal, South Africa, Sudan, Tajikistan, Turkey, Uzbekistan, Venezuela, Vietnam, and Zimbabwe.

After a series of independent and peer reviews, fifteen projects were selected as representative of the most innovative and sustainable activities; summaries and lessons learned from these projects comprise this document. Team leaders from these projects present their findings at the "Global Symposium for Hazard Risk Reduction," July 26-28, 2004 at World Bank headquarters in Washington, DC.

The fifteen selected project leaders have prepared Working Papers reporting the results of their research activities. Those projects have been arranged as scheduled for presentation at the Symposium. Following those papers, there is a complete list of all sixty-five projects with contact information for those involved in each. We encourage you to contact the project teams if you are interested in more details about the results and lessons learned.

At the end of this publication, there is brief information about each of the collaborating centers: the Asian Disaster Preparedness Center (ADPC), Cranfield Disaster Management Centre (CDMC) and the University of Wisconsin-Disaster Management Center (UW-DMC).

ADPC was responsible for coordination and support for the grantees in two regions, East Asia Pacific and South Asia.

CDMC was responsible for coordination and support for the grantees in one region, Sub-Saharan Africa.

UW–DMC was responsible for coordination and support for the grantees in two regions, Europe & Central Asia and Latin America & Caribbean; they also had global administrative responsibilities for the grant application process, the independent review panel for grant awards, maintenance of the program's website for project sharing by grantees, the independent review panel for selection of representative projects, the regional webconferences for project peer review, project publications and the Symposium.

Acknowledgements

The Working Papers in this publication were prepared as part of the Applied Research Grants for Disaster Risk Reduction program, which was organized by the World Bank's Hazard Management Unit under the umbrella of the ProVention Consortium. These papers are the basis for the "Global Symposium for Hazard Risk Reduction," a meeting held July 26-28, 2004 at World Bank headquarters in Washington, DC.

The ProVention Consortium would like to thank all who submitted research proposals and those sixty-five who were awarded grants, along with their team members and advisors. Next, we thank those who served as independent reviewers for the proposals and for selection of the most representative projects for presentation at the Symposium: William Anderson, Claude DeVille, Jim Good, Bruno Haghebaert, Ailsa Holloway, Terry Jeggle, Alcira Kreimer, David Peppiatt, Sheila Reed, Juan Pablo Sarmiento, John Telford, Paul Thompson, and Jaime Valdés.

We would also like to thank program leaders and staff at the Asian Disaster Preparedness Center, Cranfield Disaster Management Centre and the University of Wisconsin–Disaster Management Center.

We are also grateful to the following individuals for their assistance and timely support: Margaret Arnold, Michelle Addison, David Alexander, Maxx Dilley, Lynn Gross, Ian Davis, Susan Kummer, Manisha Malla Shrestha, Lorraine Ortner-Blake, Alcira Kreimer, Linda Martin-Chitturi, Maryvonne Plessis-Fraissard, Maria Eugenia Quintero, Loy Rego, Tim Randall, Maya Schaerer, Don Schramm, M. Vitor Serra, Eva von Oelreich, and Zoe Trohanis.

The ProVention Consortium would especially like to thank the United Kingdom's Department for International Development (DFID) and the Government of the Kingdom of Norway's Royal Ministry of Foreign Affairs for their generous support.

Colombia

Expert system for post-earthquake building damage evaluation and massive risk occupancy decision-making

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SYMPOSIUM NOTES

Lessons learned or important elements that will have impacts on disaster risk reduction – Colombia and worldwide

The experience in all countries has demonstrated that whenever a moderate or strong earthquake occurs, that causes widespread damage in an urban center, serious problems emerge for the processes of risk evaluation of the affected buildings. These problems have serious legal, economic and security implications. A similar situation was repeated in the case of the building damage evaluation after the earthquake of January 1999 in coffee growing area of Colombia.

These problems have appeared, partly, due to the lack of experience of the inspectors and the unavoidable need to have involving in the process non-expert people to make difficult decisions of much responsibility about the security of the buildings. Therefore, it is common, that errors are being made, like demolishing or evacuating constructions that probably were not in so serious conditions, or underestimating damage, placing in danger the life of the occupants.

Due to this situation, within the Program of Damage Evaluation, that was implemented by the Asociación Colombiana de Ingeniería Sísmica (AIS) and the Oficina Municipal de Prevención y Atención de Desastres (OMPAD) of Manizales, Colombia, it was agreed to develop a computational tool, based on Artificial Intelligence (AI) to avoid the error-making before mentioned, and with the purpose of complement the conventional methods of damage evaluation –inspection forms, guidelines and evaluation procedures– that were elaborated for risk estimation in case of an earthquake in the city.

This Expert System will help to avoid the loss of life, identify the unsafe buildings and prevent its occupation. Also, it will contribute to identify the safe places that can be used like shelters for people who have lost their homes or that have had to be evacuated. The system is a support for the decision-making by the non-expert inspectors. Then, it will facilitate the massive and right evaluation of damage, risk, habitability and reparability of buildings after an earthquake.

This system is also being implementing officially by the city of Bogotá and it is hoped that will be adopted by othre cities of Colombia with the technical support of AIS. Also, it could be used in other countries, once it become adapted in agreement with their construction classes, contributing to a fast and reliable decision making; problem of risk and disaster that must be faced and that has deep social and economic implications for the society when an important earthquake strikes.

Summary on the implementation of the project and its results

Using techniques of Computational Intelligence (CI) an Expert System was developed, based on expert criteria, in order to employ properly subjective and incomplete information about the damage of affected buildings after an earthquake, and to carry out linguistic or qualitative qualifications about their level of risk, habitability and reparability in a reliable way. This system was designed using fuzzy sets and fuzzy logic and it was calibrated by means of an artificial neural network (ANN); modern technologies of AI suitable for the handling of vague and qualitative information.

In order to carry out the proposed tool it was necessary to participate in some activities in the framework of the Program of Damage Evaluation that was made in Colombia by AIS and the OMPAD. These activities have been fundamental for the suitable understanding of the problem and to develop a useful product, witch was not had initially into consideration within the mentioned program. These activities to develop the Expert system were:

- To participate in the review of the main existing methodologies of building damage evaluation.
- To participate in the development of the guidelines and inspection forms for buildings affected by earthquakes in Manizales city.
- To formulate the conceptual and mathematical model of neuro-fuzzy expert system based on Computational Intelligence.
- Development, calibration and test of the expert system using information from evaluations made during the January 1999 Quindio earthquake.

A summarized description of each activity is presented in the following paragraphs.

Review of the main existing methodologies of building damage evaluation

The main elements for a methodology of building damage evaluation are: classification of building damage, definition of the possibilities to use the constructions that suffered damage, organization for collection of data, and the analysis and information processing. This was considered very useful to study the different methods and to compare the most recent formats and criteria of evaluation of the different methodologies with the purpose of identifying the main conceptual differences among. This activity was made partially in Barcelona within the academic activities of the author and during visits made to Bogotá, D.C. It meant the careful revision of the methodologies before mentioned, with the purpose of obtaining fundamental inputs for the development of the Expert System object of this project.

For the review of the existing methodologies a group of specialists of AIS was comprised. The author of this project was part of the group and contributed with her work related to the topic made during her graduate studies. It was carried out a bibliographical compilation on the existing methodologies of different countries. The main methodologies evaluated were from Macedonia (old Yugoslavia), USA, Japan, Mexico, Italy, Greece, Turkey, and Colombia. This review was made with the purpose of analyzing comparatively the different methodologies considering aspects such as: their objectives and scope, criteria for description and location of constructions, criteria for damage evaluation and classification, type of recommendations and emergency measures proposed, among others.

The conclusion, after a rigorous review of all methodologies, has been that the more complete approaches are: the ATC-20 from USA, the methodology developed by the Mexican Society of Seismic Engineering, the method promoted by the Ministry of the Construction of Japan and by the National Seismic Service of Italy. Also it is important to acknowledge the previous techniques developed in Colombia.

In general, the methodologies are relatively recent, in almost all countries the forms and guidelines have been updated due to the improvement of knowledge after each earthquake. The damage evaluation procedures normally are applied by different stages, which have been classified in fast, detailed and engineering evaluations, being the first two of special interest for the object of this work.

The fast evaluation of habitability of constructions is applied usually in the short term to define the possible occupation and use of the building. After the evaluation, if the buildings are safe, they can be used. In addition, some recommendations are issued with the purpose to reduce risk for their inhabitants. The detailed evaluations that describe the level of structural damage and its classification should be developed due to several reasons, but in general they are made with the objective to verify the safety level of the constructions on which there are some doubts due to a very fast evaluation or due to the lack of experience of the inspectors.

To participate in the development of the guidelines and inspection forms for buildings affected by earthquakes in Manizales city

From the review of the work made in Colombia to date and other places of the world, it was possible to conclude that the existence of a detailed fast evaluation with aims of emergency response has been in order to verify doubtful evaluations or to make a look by a person with more criterion and experience to make decisions. Therefore, it was concluded that it is more efficient to apply a single evaluation form and that the inspectors teams should be comprised, at least, by two people to have a greater trustworthiness in the concepts. Also, it was possible to conclude that is better to avoid making a double evaluation and that in case of need the second professional concept would be easier if it could be made in the same form in the second visit; hoping that these cases are exceptional and not the rule. However, it was ratified that with the aid of an Expert System based on AI, made to support the decisions of less experienced inspectors, it is possible to solve this problem.

Considering the Program of Damage Evaluation that AIS and OMPAD make in Colombia, with the purpose of preparing the institutions of the city and the private sector to carry out the estimation of risk in the buildings affected in case of earthquake, the design of the inspection guidelines of constructions after an earthquake was made. Also, the damage inspection forms and the warning formats of habitability were developed. This work was carried out in a participative way with the potential users in the city and with the coordination of a team of specialists of AIS in which the author of his project was involved.

The design of the field guidelines was taking into account that the persons who will apply them will be professionals related to construction sector, like civil engineers, architects or technicians, advanced students of the same professional areas and, in general, people that will even arrive from other cities in case of an extreme event. The guidelines, the inspection forms and the warnings formats of habitability are the output of the research process made with the purpose of consolidating a basic methodology useful not only for the city of Manizales but also for other cities and the national level. The objective of the inspection guidelines is to have a methodology for building damage and safety evaluation that might be applied after an earthquake. This methodology allows defining the habitability of constructions quickly and facilitates the later actions of rehabilitation and reconstruction.

The scope of the guidelines was limited by agreement of all participants. The classification of the building damage and the habitability are based on the results of the building global inspection, the damage in the structural and non-structural elements and the ground conditions of surroundings. Therefore, the guidelines do not include the procedures to evaluate the definitive rehabilitation of the construction. For this, each owner should contract a structural engineer, who makes detailed and complete inspection or carries out tests on the quality of the materials, the state of reinforcement, etc. On the other hand, it was not developed procedures to quantify the detailed economic and social impact generated by the earthquake, but with the guidelines is possible to obtain a gross estimation of the magnitude of the disaster, useful for rehabilitation and reconstruction planning.

Formulation of the conceptual and mathematical model of neuro-fuzzy expert system based on Computational Intelligence

In agreement with the previous remarks, the conventional damage evaluation consists on identification and registry of damage occurred in the affected buildings, with the purpose of determining in a fast way if they are at risk. In other words, if they are safe or they must be evacuated to protect the life of his occupants. This process demands experience, criterion and training; therefore, it is a need that all people involved in the process must be experts in the evaluation process. Unfortunately, the professionals who usually fulfill this requirement are very few. On the other hand, the evaluation is an urgent and massive task that should be made by several professionals and the current methodologies are not very objective if non-expert people are involved because they have the tendency to aggravate or to underestimate the real level of damage. Therefore, in the case of the Program of Damage Evaluation for Manizales, promoted by AIS and OMPAD, it was concluded about the need to complement the current methodology of damage evaluation with an innovating tool that help to solve the deficiencies before mentioned.

The evaluation of the damage and the level of risk that presents a construction after an earthquake are a complex activity that demands much criterion and knowledge and can have serious implications for security of life. The information that takes part in the evaluation is highly subjective and depends on the conception and the inspector perception in each case. Mistakes can be made, such as the demolition of buildings that probably were not in so serious conditions, or buildings can be evacuated unnecessarily. Also, it is possible that non-expert inspectors ignore failures in the construction that jeopardize their stability, putting in danger the life of his occupants. For that reason it is so important to guarantee that the more experienced people and with the better knowledge on structural behavior and pathology make the evaluations.

The levels of damage in one building are defined in most of the evaluation methodologies by means of linguistics qualifications such as slight, minor, moderate, average, severe or heavy. These concepts can have a remarkable variation in their meaning according to the knowledge and experience of each person. Therefore, a defined frontier between these valuations does not exist clearly. What for a person could be moderate for another can be severe, as well as it can be in the middle of both concepts for another one. For this reason it is necessary to unify the sense of these concepts and to make the evaluation more quantitative as possible, determining percentage of affected elements, size and type of cracks, etc.

In agreement with the research made by the author, using fuzzy sets it is possible to represent qualitative or subjective information in a numerical way, such as it is required in damage evaluation after an earthquake. Fuzzy sets do not have defined limits perfectly; that is to say, the transition between the membership and the non-membership of an element to a set is gradual. On the other hand, the ANNs have been used to face nonlinear complex problems, simulating the operation of the nervous system of the humans. These algorithms are demonstrating to be very useful for several applications, like pattern and image recognition, signal processing, optimization and the automatic control.

Taking into account this features a computational tool was designed that helps to avoid the mistakes usually made by non-expert people before mentioned and considering they use subjective and incomplete information. In addition, this tool allows carrying out the massive and suitable evaluation of damage, habitability and reparability of buildings affected by earthquakes, being based on linguistics or qualitative qualifications, using artificial neural networks and fuzzy logic.

Development, calibration and test of the expert system using the information of the evaluations made during the January 1999 Quindío earthquake.

The source code of the expert system was developed in Visual BASIC with registry modules made in Access. The computer program "Earthquake Damage Evaluation" of buildings (EDE) for Manizales runs on Windows 95, 98, 2000 or XP. The computer program is the direct product of this project.

The neural network in which the system is based was calibrated by means of a Kohonen-type learning algorithm. The learning process was made using damage evaluations achieved after the 1999 Quindio earthquake in Colombia. The training of the network did not consider structural systems such as wood and steel frames because the absence of these structural systems in the area affected by the earthquake. Only few composite (frame and wall) reinforced concrete buildings were used because there are a few of them in the area.

In order to carry out correctly this training an exhaustive review of the evaluation forms used for the Ministry of Development for the census of affected buildings in the area was made. This information was analyzed with the purpose of identifying the cases (building class, levels of damage, diagnosis) and the inspectors who made the evaluations. Thus, AIS made a detailed review of the registries to develop the database for the calibration and training of the neural network. It meant also the work of experts and the administrative and logistical support of people related to AIS to collect and adjust the information.

Once the system was calibrated using the database it was necessary to make several tests with hypothetical cases. They allowed to the experts verify the performance of the system. Also, it was made a process of qualification and verification with local experts in Manizales city, with the purpose of exploring feasible cases and to guide the right use of the system by people who will have the responsibility to carry out the evaluations in case of an earthquake in the future, with the coordination of OMPAD.

The Expert System EDE was delivered to the city, like a complementary tool for damage evaluation, for individual and complex cases, within the Program of Damage Evaluation made by AIS and OMPAD in Manizales. At present, EDE is also implementing in the city of Bogotá, the capitol city of the country, and it now part of the Program for Post-earthquake Building Damage Evaluation that AIS develops with the Dirección de Prevención y Atención de Emergencias (DPAE) from Bogotá.

The author thanks to the ProVentium Consortium by the grant. This aid has been an important support to include the doctoral research activities of the author –developed in the Technical University of Catalonia– in the Program of Damage Evaluation that is made in Colombia for the city of Manizales and Bogotá. Also the author is very grateful with the professors Alex H. Barbat and Omar D. Cardona by their academic direction and with AIS due to the opportunity to be part of its program and to include the model proposed for practical application. Particularly, the author acknowledges the guidance of Omar D. Cardona as president of AIS and Ana Campos as technical coordinator of the program for Manizales and of the second stage of the program in Bogotá, in execution at present.

Brief description of the model

Computational model

The presented model uses a fuzzy logic approach, required by the subjective and incomplete character of the information. Post-earthquake damage evaluations use qualitative and linguistic expressions that are appropriately handled by the fuzzy sets theory. In addition, an artificial neural network (ANN) is used to calibrate the system using the judgement of specialists. Artificial neural networks were inspired by the modelling of neural networks of natural neurons in a human brain. In this case a network with fuzzy signals is used. This enables the use of computational intelligence for the damage evaluation by non-experts.

The artificial neural network (ANN) structure of this model consists of three layers. The neurons in the input layer are grouped in four types, namely structural elements (SE), non-structural elements (NE), ground conditions (GC), and pre-existent conditions (PC). Each one contributes with information to the neurons in the intermediate layer; they only affect the intermediate neuron in the group to which they belong. The input neurons number or variables in the model is not constant; this number depends on the structural system and on the importance of the groups of variables for the evaluation. The number of neurons of the input layer used for the structural elements group changes according to the class of building. Table 1 shows the structural elements or variables considered according to the structural system.

A qualification is assigned depending on the observed damage using five possible damage levels that are represented by means of fuzzy sets. For structural and non-structural elements, the following linguistics damage qualifications are used: none (N), light (L), moderate (M), heavy (H) and severe (S). Figure 1 illustrates the membership functions for these qualifications.

Table 1. Structural elements according to structural system

Structural system	Structural elements
RC frames or (with) shear walls	Columns/walls, beams, joints and floors
Steel or wood frames	Columns, beams, connections and floors
Unreinforced Reinforced Confined masonry	Bearing walls and floors
Bahareque or tapial walls	Bearing walls and floors

Figures 2 and 3 show some damage levels in different structural and non-structural elements. The membership functions of fuzzy sets achieve their maximum membership point for the values of the damage indices whose selection will be explained forward.

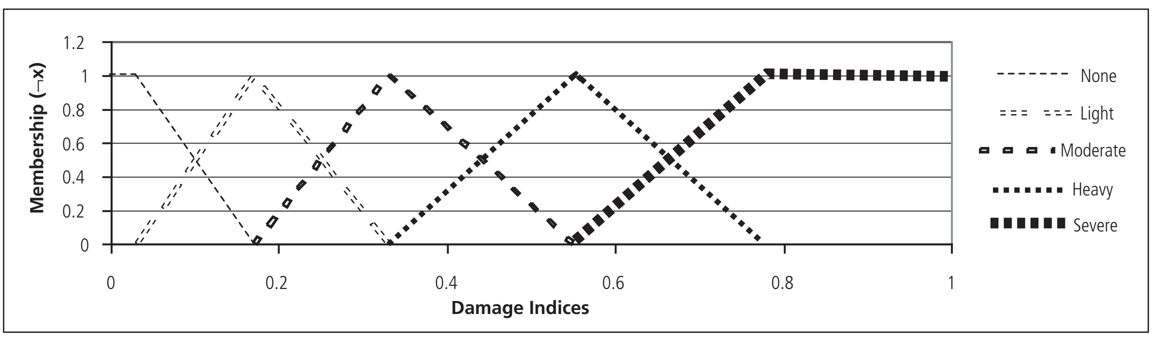


Figure 1. Membership functions for linguistic qualifications

Figure 2. Damage in structural elements. a) Severe damage in a reinforced concrete joint b) Moderate damage in a reinforced concrete beam c) Heavy damage in a masonry wall d) Heavy damage in a bahareque wall

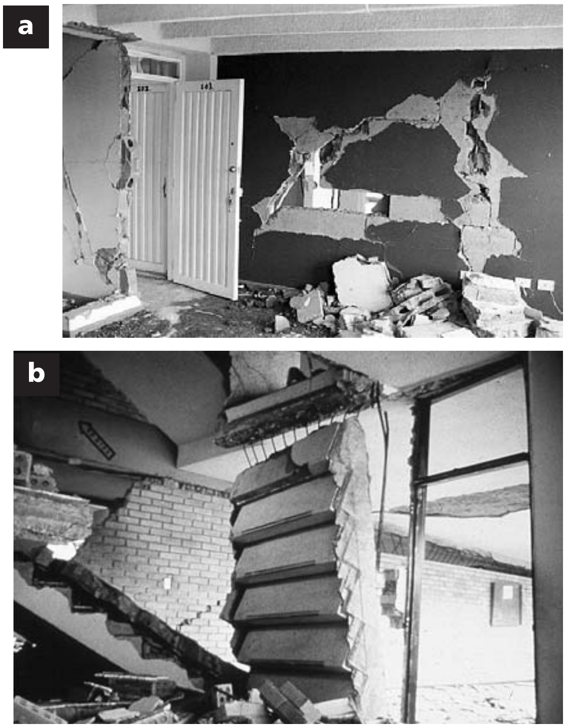


Figure 3.
Damage in non-structural elements
a) Severe damage in partitions
b) Severe damage in stairs

Damage in the non-structural elements does not affect the stability of the buildings, but may put at risk the security of the occupants. Table 2 presents the classification of the non-structural elements: elements whose evaluation is compulsory and elements whose evaluation is optional.

Table 2. Non-structural elements

Compulsatory evaluation elements	Partition
	Elements of façade
	Stairs
Optional evaluation elements	Ceiling and lights
	Installations
	Roof
	Elevated tanks

The ground and pre-existent conditions variables are valued through the qualification of their state at the evaluation moment. The linguistic qualifications used are: very good (VG), good (G), medium (M), bad (B) and very bad (VB). Ground conditions consist of variables that can affect the stability of the building, such as landslides and soil liquefaction; examples of these situations can be observed in Figure 4. Pre-existent conditions are related to the quality of the construction materials, plane and vertical shape irregularities of the building, and the structural configuration, illustrated in the Figure 5; these conditions may increase the seismic vulnerability of a building.

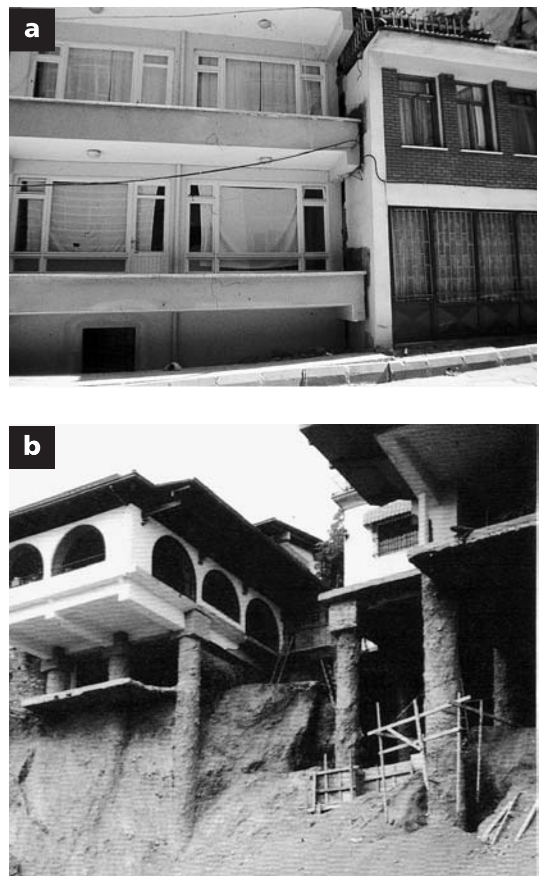


Figure 4 Ground conditions
a) Soil settlement due to liquefaction
b) Landslides and ground failure

This model is a user-friendly computer program called Earthquake Damage Evaluation of Buildings, EDE. It offers aids for the inspectors, such as detailed descriptions and damage photographs. Recently, another computer program has been developed (ATC 2003). Unlike, this other program does not support the decision-making and basically its objective is to facilitate the data collection of the existing inspection form of ATC-20 (ATC 1989).

Description of the ANN

Input layer of the artificial neural network. The fuzzy sets for each element or variable i (for instance columns, walls or beams) in the input layer are obtained from the inspector's linguistic qualifications of damage Dj at each level j and its extension wj. The damage extension, or percentage of each damage level in each element, varies from 0 to 100 and it is normalized

$$w_j = \frac{D_j}{\sum_N D_j}, \sum_N w_j = 1 \qquad (1)$$

The accumulated qualification of damage Di for each variable is obtained as the union of the scaled fuzzy sets, taking into account the damage membership functions $mDj(Dj)$, and its extensions or weights assigned by the inspector

$$D_i = (D_N \cup D_L \cup D_M \cup D_H \cup D_S) \qquad (2)$$

$$\mu_{D_i}(D) = \max\left(w_{N,i} \times \mu_{D_N}(D_{N,i}),\ldots, w_{S,i} \times \mu_{D_S}(D_{S,i})\right) \qquad (3)$$

The union in the theory of the fuzzy sets is represented by the maximum membership or dependency. By means of defuzzification, using the centroid of area method (COA), a qualification index Ci is obtained for each variable of each group of neurons

$$C_i = \left[max\left(w_{N,i} \times \mu_{D_N}(D_{N,i})\ldots, w_{S,i} \times \mu_{D_S}(D_{S,i})\right)\right]_{centroid} \qquad (4)$$

Figure 5
Pre-existent conditions:
a) Bad construction quality
b) Vertical shape irregularity: soft floor
c) Plane shape irregularity
d) Bad structural configuration: lack of frame continuity

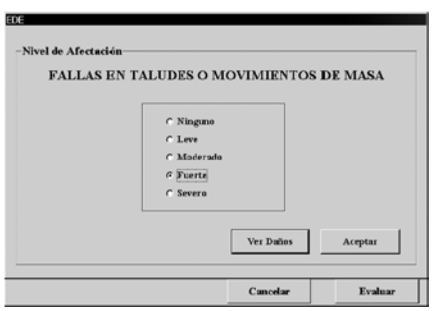
Each variable has predefined the basic membership functions for the fuzzy sets corresponding to the five possible levels of damage. The linguistic qualifications change in each case. Figures 6 and 7 show some examples of the data input of the computer program.

a

b

Figure 6. Input of the damage qualifications a) Damage extension at each damage level for a structural element b) For a non-structural element

a



b

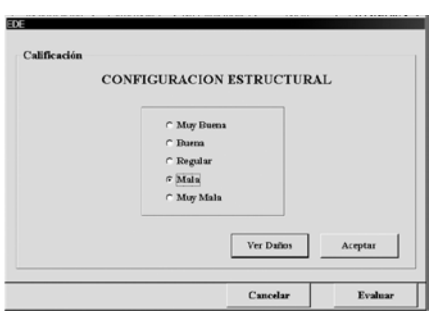


Figure 7. Input of the qualifications for ground conditions and pre-existent conditions a) Landslides and ground failure b) Structural configuration

Intermediate or hidden layer of ANN. This layer has four neurons corresponding to each group of variables: structural elements, non-structural elements, ground conditions and pre-existent conditions. Figure 8 shows a general scheme of the evaluation process. In this neural network model, the inputs of the four neurons are the qualifications Ci obtained for each variable of the each group of neurons and its weight Wi or degree of importance on the corresponding intermediate neurone. These weights were defined with the participation of experts in earthquake damage evaluation. Using these qualifications and weights for each variable i, a global index could be obtained, for each group k, from the defuzzification of the union or maximum membership of the scaled fuzzy sets. The membership functions $mCki(Cki)$ and their weights Wki show the notation for the group of structural elements.

$$I_{SE} = \left[\max\left(W_{SE1} \times \mu_{C_{SE1}}\left(C_{SE1}\right),\ldots, W_{SEi} \times \mu_{C_{SEi}}\left(C_{SEi}\right)\right)\right]_{centroid} \quad (5)$$

$$\mu_{CSE}(C) = \max\left(W_{SE1} \times \mu_{C_{SE1}}\left(C_{SE1}\right),\ldots, W_{SEi} \times \mu_{C_{SEi}}\left(C_{SEi}\right)\right) \quad (6)$$

The groups of variables related to ground and pre-existing conditions are optional, thus they can be or can be not considered within the evaluation. If this happens, the habitability and reparability of building is assessed only with the structural and non-structural information.

Output layer of ANN. In this layer, the global indices obtained for structural elements, non-structural elements, ground and pre-existent conditions correspond to one final linguistic qualification in each case. The damage level (qualitative) is obtained according to the "proximity" of the value obtained to a global damage function of reference. The training process of the neural network is achieved in this layer. The indices that identify each qualitative level (center of cluster) are changed in agreement with the indices calculated in each evaluation and with a learning rate. Once the final qualifications are made, it is possible to determine the global building damage, the habitability and reparability of the building using a set of fuzzy rule bases.

Training process of the ANN

The neuronal network is calibrated in the output layer when the damage functions are defined in relation to the damage matrix indices. In order to start the calibration, a departure point is defined,

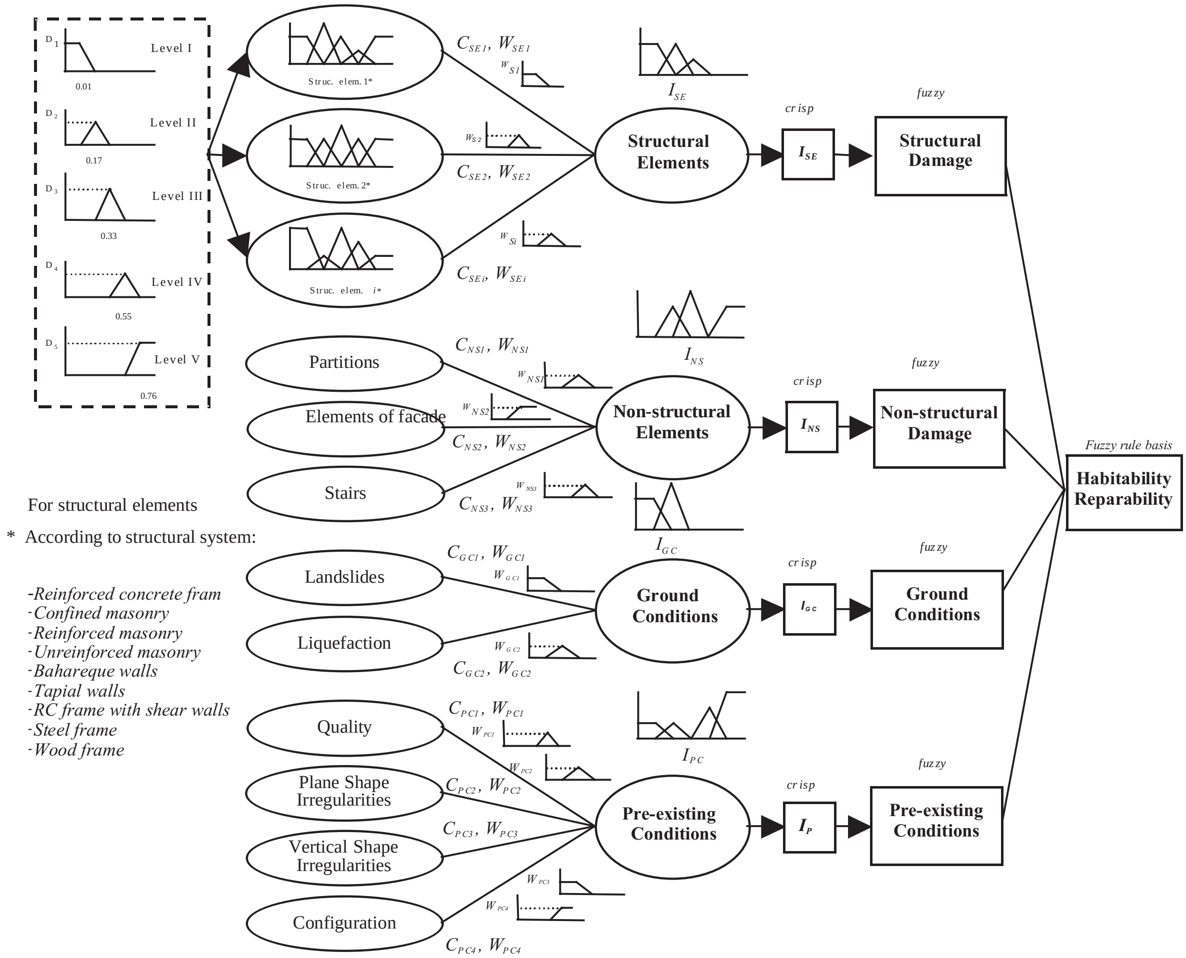


Figure 8. Structure of the proposed artificial neural network

that means the initial indices of each level of damage. The indices proposed by the ATC (1985), Park, Ang and Wen (1984), the fragility curves used by HAZUS (FEMA 1999), and the indices used by Sanchez-Silva and García (2001) have been considered. The values of these indices correspond to the center of the area for every membership function related to each damage level. Table 3 shows the indices proposed in this work.

Damage Level	Park, Ang and Wen	Sanchez-Silva	Proposed
Very light	< 0.10	0.07	0.10
Light	0.10 – 0.25	0.175	0.20
Moderate	0.25 – 0.40	0.325	0.35
Severe	0.40 – 0.80	0.6	0.60
Destruction	>0.80	0.8	0.90

Table 3. Comparative table for damage indices

Some authors consider that collapse occurs for a value equal to 0.8 and others propose a collapse threshold of 0.77. Therefore, a value of 0.76 has been selected to describe the destruction level index or collapse. In the selection of the damage index, the author decided to be conservative, since the indices corresponding to severe and moderate damage have been highly discussed, and doubts exist on whether they should be smaller.

The calibration is performed for each damage level and only the indices corresponding to the groups of variables considered in each case are calibrated. The network learning is made using a Kohonen network

$$I_{kj}(t+1) = I_{kj}(t) + \alpha(t)\left[I_{kj}(t) - I_{kj}\right] \tag{7}$$

where Ikj is the value of the index of the variables group k recalculated considering a learning rate a, a function with exponential decay, and the difference between the resulting index of the present evaluation and the previous indices in each damage level j. The learning rate is defined by

$$\alpha(t) = 0.1 \times exp(-0.1 \times t) \tag{8}$$

where t is the number of times that has been used the index that is calibrated. The damage evaluations made after the Quindío earthquake in Colombia (1999) were used for training.

Fuzzy rule bases for decision-making

The building habitability and reparability are assessed based on previous results of damage level of the structural and non-structural elements, the state of the ground and pre-existent conditions. The global level of a building damage is estimated with the structural and non-structural damage results. This has five possible qualifications: none, light, moderate, heavy and severe damage. The global building state is determined taking into account the rule bases on ground conditions, and by this way the habitability of the building. The linguistic qualification for the building habitability has four possibilities: usable, restricted use, dangerous and prohibited. They mean habitable immediately, usable after reparation, usable after structural reinforcement, and not usable at all. The building reparability depends besides on other fuzzy rule bases: the pre-existent conditions. The building reparability has four possibilities: not any or minor treatment, reparation, reinforcement, and possible demolition.

References

ATC, (1985). Earthquake damage evaluation data for California, ATC-13, Applied Technology Council, Redwood City, California.

ATC, (1989). Procedures for postearthquake safety evaluation of buildings, ATC-20, Applied Technology Council, Redwood City, California.

ATC, (2003). Users manual: Mobile postearthquake building safety evaluation data acquisition system (Version 1.0), ATC-20i, Applied Technology Council, Redwood City, California.

FEMA, (1999). Earthquake Loss Estimation Methodology HAZUS, Technical Manual, Vol. I, II and III, First edition 1997, National Institute of Buildings Sciences of Federal Emergency Management Agency, Washington.

Sanchez-Silva, M. and L. García, (2001). Earthquake Damage Assessment Based on Fuzzy Logic and Neural Networks, EERI Earthquake Spectra, Vol. 17, N. 1, February, pp. 89-11 2. Oakland, California.

Y.J. Park, A. Ang and Y. Wen, (1984). Seismic Damage Analysis and Damage-Limiting Design of R.C. Buildings, Structural Research Series, Report No 516, University of Illinois at Urban-Champaign.

How does your project address the links between poverty and disaster risk reduction in developing countries?

The disasters generate poverty and the poverty generates disasters. The constructions of the low-income socioeconomic layers are the most vulnerable and therefore they are more affected when earthquakes happen. In this sense the benefits of this project are more for the people that, as result of a suitable damage evaluation, are protected in their lives, avoiding they occupy buildings at risk, or protecting their patrimony, avoiding the unnecessary demolition of their houses when in fact they do not threaten ruin. In any case, this project contributes with an innovating tool, from the technical point of view, that will be useful for all socioeconomic layers of a community affected by an earthquake, both in developing as in developed countries.

How will your project be sustainable beyond these first six months?

The tool developed into this project is now a component of technical support within the Program of Building Damage Evaluation that Asociación Colombiana de Ingeniería Sísmica (AIS) is coordinating in the cities of Manizales and Bogotá (the latter in process of implementation, phase II). The AIS-400 Committee, related to Vulnerability of

Buildings and Damage Evaluation will promote the program in other cities of the country in the next years. Also, together with the Advisory National Commission of Seismic and Volcanic Risk and the National Commission for Earthquake Resistant Building Code, AIS will promote a unified national methodology. This methodology of national level will include the Expert System, EDE developed in this project like a key tool for the preparedness, training and response of the engineers in support to the National System for Disaster Prevention and Risk Mitigation of Colombia, in case of an earthquake anywhere within the country.

How will your project have ownership among a broad community and institutional base?

Initially the project was developed as part of the Program of Damage Evaluation developed for Manizales city and now for Bogotá, under the direction of the organizations in charge of the prevention and attention of disasters (or disaster risk management) in each city, with the technical support of AIS. Although the project was developed with an academic scope, from the beginning it was proposed within the frame of the institutional action and within an existing program of preparedness for the damage evaluation in case of an earthquake in a city interested in the subject (Manizales). Due to the outcomes and advances, a second city (the capital) was interested in the Expert System, object of this project, for its adoption as official tool to support the building evaluations in case of an earthquake. At present a phase of training is implemented and involves hundreds of engineers, several universities and numerous public organizations. In the two cities a remarkable advance has been obtained that, like a replica, surely other cities and the national level will follow.

What are the components of learning in your project?

The project corresponds to a highly technical outcome where advanced Computational Intelligence (CI) techniques have been explored, like the fuzzy logic and artificial neural networks. This tool was developed to face a real problem of seismic security of remarkable complexity, such as the decision-making on habitability and reparability of buildings affected by earthquakes it is. The developed tool using these techniques improves the effectiveness of the damage evaluation and risk of the constructions, avoiding that non-expert people evaluate in a wrong way the level of security of buildings. Decision-making about the possibilities of building occupation and reparation, by this way, is more reliable and quick, favoring the efficient management to attend the community in case of a seismic disaster.

Armenia

The main principles of earthquake early warning system creation around critical facilities in seismic active zone

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Before the Spitak (Armenia) 1998 destructive earthquake the territory of Armenia was constructed with buildings and structures designed for a ground acceleration of 0.1-0.2g corresponding to seismic effect with an intensity of 7-8 by scale MSK-64, according to the seismic zonation map of that time.

However, the Spitak earthquake with a magnitude M=7.0 and with intensity influence of 10 in the epicentral zone causing more than 25 thousand deaths and the destruction of most buildings and constructions in all Northern regions of Armenia, has shown that the level of seismic resistance of buildings and structures in Armenia is considerably lower than the level of seismic hazard. Taking this fact into account the new seismic zonation map of the territory of Armenia was developed in the National Survey for Seismic Protection (NSSP) RA in 1995. This map was designed by a detailed analysis of the statistic of the region's seismisity including prehistorical, historical and instrumental periods. According to this map the level of seismic hazard has been found to be I=9 with expected horizontal ground acceleration of up to 0.4g in Yerevan (the capital of Armenia).

Nearly the entire territory of Armenia is located in zones of high seismic risk. In addition, the presence of Nuclear power plant, large chemical facilities and dams creates the threat of occurring technogenic sources and flood in case of strong earthquake. However, without doubt undoubted the most dangerous zone is the territory around the Armenian nuclear power plant (ANPP).

The Armenian NPP is located in the southwest of Armenia, 28 km from the Yerevan city, capital of Armenia with 1.3 million population, 4 km from the Metsamor village and 16 km north of the Araks River.

The Armenian NPP was originally designed in 1969 to withstand seismic loads of 7 bal. After 1977 Vrancea (Romania) earthquake the seismic resistance of structures of ANPP was increased to 8 bal, and some constructions up to 9 bal. The Armenian NPP has two units of 408 mwat (gross capacity) each. Both are WWR 440-270 Soviet type reactors, which is a version of the WWER 440-230 model. The units 1 and 2 came into commercial operation in December 1976 and January 1980, respectively.

During the Armenian NPP operation time the earthquake hazard at ANNP site was revised several times:

- original site intensity, (0.1g)
- following 1977 Vrancea (Romania) earthquake re-evaluated site intensity (0.2g)
- following 1988 Spiak (Armenia) earthquake, re-evaluated seismic hazard, using the determinist approach.

Peak ground accelerations (pga) obtained for two different fractile values (50% and 84%) of those pga are 0.21g and 0.35g respectively.

The last earthquake hazard assessment at the ANPP site was performed on the basis of seismotectonic model which was scaled by Armenian NPP in 1994 [Karakhanian at al, 1994]. According to that model the nearest two faults to the NPP site are well exposed Araks active fault and Nearyerevan buried deep fault, which activity at least in holozone not revealed. Another remarkable peculiarity is the presence of dissipating seismisity zone with M=5.5 in the radius of 10 km from ANPP and the source of the strongest near-located earthquake.

The new attenuation model of ground motion for Armenia and adjacent area

Attenuation relationships play a vital role in earthquake hazard analysis and seismic design of structures. In recent years, a large number of investigations were carried out in this field and many regional relationships between earthquake, magnitude, source-station distance, local site conditions and ground motion parameters such as peak acceleration and spectral acceleration have been derived.

Based on the acceleration time histories recorded between June 1990 and September 1998 with the permanent and temporary digital strong motion network in the Caucasus and adjacent area an empirical PHA attenuation model for Caucasus area was developed [6]. This attenuation model is the first model in Caucasus region developed on the basis of accelerograms registered in Caucasus region.

The equation for larger values of peak horizontal acceleration is:

$$\log pha = 0.72 + 0.44 * M - \log R - 0.00231 * R + 0.28 * P$$

$$R = \left(D^2 + 4.5^2\right)^{1/2}$$

were pha is the peak horizontal acceleration in (cm/sec2), M is the surface-wave magnitude and D is the hypocentral distance in [km], p is 0 for 50 percentile values and 1 for 84 percentile.

The empirical attenuation relationship is considered to be valid for hypocentral distance between 4 km and 230 km and surface-wave magnitude between 4 and 7.

The predicted peak ground motion acceleration values are in good agreement with corresponding models from Western-North America. Due to the complex structure of the Caucasus the scatter and absorption of ground motion is somewhat higher than in European areas.

Using this new attenuation model the expected peak ground acceleration was estimated for ANPP site.

The performed calculations showed that expected peak ground acceleration at the ANPP site can reach 0.329g, which corresponds to accepted now PGA for ANPP site -0.35g.

Earthquake Early Warning System

It is internationally accepted that the Soviet designed nuclear power plants require seismic upgrading to various degrees (Fraas et al., 1997). The International Atomic Energy Agency (IAEA) has been carrying out assessments of seismic upgrading of the Soviet designed nuclear power plants over the past decade (Gulpinar et al., 1997). In the case where seismic upgrading by strengthening of the buildings and equipments is an expensive procedure and not feasible due to economical, political and timing reasons, an active reactor protection system based on an earthquake early warning system like alternative approaches have to be taken into consideration.

The idea of alarm system is the following: to detect the earthquake motion as early as possible near the source in order to prepare against the earthquake before seismic motion reaches the site, using difference of transmission velocities, electric communication (300.000 km/sec) and seismic waves (~3.5 km/sec). Such systems can provide pre-warning time of up to a few dozens seconds before the arrival of the destructive ground motion.

The main concept of Early Warning System was firstly introduced by J. D. Cooper, M. D. Ou in San Francisco Daily Evening Bulletin on 3rd November 1868. The report explained the concept as follows:

Since the Japanese magnet indicator has proved a failure, we are now obliged to look for some means of prognosticating this fearful convulsion, and I wish to suggest the following mode by which we may make electricity the means, perhaps, of saving thousands of lives in case of occurrence of more severe shocks than we have yet experienced. It is well known that these shocks are produced by a wave–motion of the surface of the earth, the waves radiating from a center just as they do in water when a stone is thrown in. If this center happens to be far enough from this city, we may be easily notified of the coming wave in time for all to escape from dangerous buildings before it reaches us. The rate of velocity, as observed and recorded in Dr. J. B. Trask's work in Earthquake in California from 1800 to 1864, is 61.5 (six and one fifth) miles per minute, or a little less per hour (40 miles) than the tidal wave is reported to have traveled across the ocean to this port from the Sandwich Islands or Japan.

A very simple mechanical contrivance can be arranged at various points from 10 to 100 miles from San Francisco, by which a wave of the earth high enough to do damage, will start an electric current over the wires now radiating from this city, and almost instantaneously ring an alarm bell, which should be hung in a high tower near the center of the city. This bell should be very large or peculiar sound, and known to everybody as the earthquake bell. Of course, nothing but the distant undulation of the surface of the earth should ring it. This machinery would be self-acting, and not dependent on the telegraph operators, who might not always retain presence of mind enough to telegraph at the moment, or might sound the alarm too often. As some shocks appear to come from the west, a cable might be laid to the Farallone Islands, 25 miles distant, and warning thus given of any danger from that direction (Fig. 1).

Of course there might be shocks the central force of which was too near this city to be thus protected but that is not likely to occur once in a hundred times.

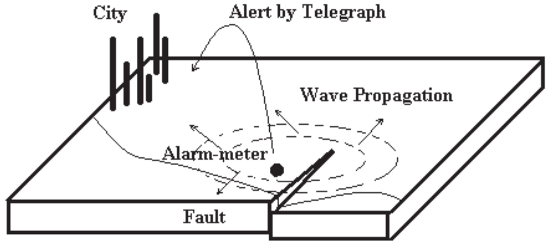

Figure 1. Concept of the Front Alarm by Dr. J. D. Cooper.

At that time, no system could realize this idea. After a century, based on this concept the several Earthquake Early Warning System were constructed in the World.

They are:

Urgent earthquake detection and alarm system (UrEDAS) in Japan.

The special feature of this system is the rapid alarm upon detecting the earthquake using information from P-wave data. By monitoring the earthquake motion of a single observation point in real time, an UrEDAS detects initial P-wave motion, estimates epicenter azimuth and magnitude, calculates epicentral distance within about three seconds after detecting P-wave. System for different railways has been in operation since 1983 (Nakamura, 1996)

Seismic Alert System (SAS) for Mexico City.

The seismic detector system has 12 digital strong motion field stations along 300km of the Mexican coast at 25 km spacing. This system consists of three units: seismic detection, telecommunications, and radio warning. The warning time in Mexico City varies between 58 and 74 seconds [2].

Seismic early warning system for Ignalina nuclear power plant.

This Seismic early warning system was installed recently in Ignalina Nuclear power Plant (INPP) in Lithuania [7]. Six seismic stations were installed in a ring centered at the plant at a distance of approximately 30 km, and the seventh station was placed in the plant. The stations are uniformly distributed as shown in Fig. 2. Each consists of three independent substations, which are approximately 500 m apart. The ground motion at each station is measured and recorded continuously by three accelerometers and seismometers. The data is transmitted via telemetry to the control center at INPP.

The time for emergency stop for RBMK reactors at Ignalina is only 2.5 seconds. The pre-warning time, provided by the seismic alarm system for the Ignalina NPP is 4 seconds. Therefore, the nuclear reaction can be stopped before the earthquake arrives.

Concept of ANPP Earthquake Early Warning System

Concept of ANPP Earthquake Early Warning System was developed on the basis of Yerevan EEWS project, considered in [1]. According to this project, the system can be based on 15 radiotelemetric control points located by circular arrangements around Yerevan city at a distance of approximately 30 km. According to this project, the warning time for Yerevan city is about 3–6.5 seconds. It is suggested that the nets of accelerographs not only be used for EWS, but also for current monitoring of weak earthquake.

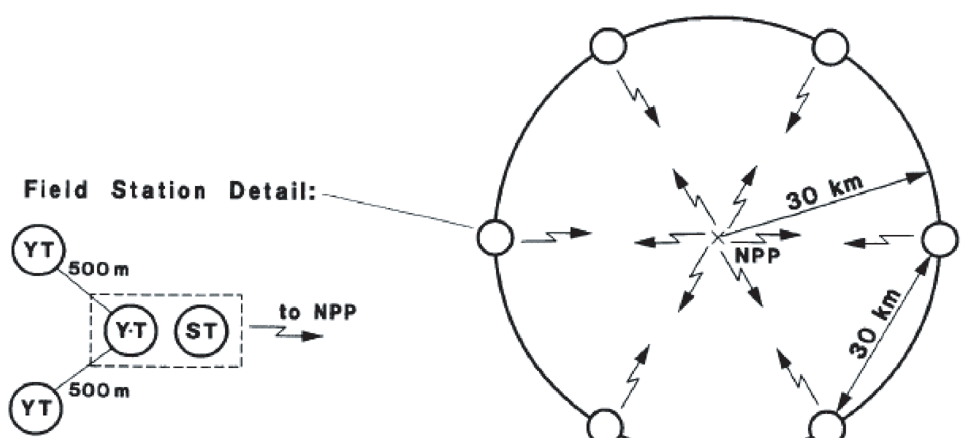

Figure 2. Layout of earthquake early warning system of Ignalina Nuclear Power Plant (INPP) (YT: accelerometer, ST: seismometer)

WORKING PAPERS
Earthquakes

This concept can be used for other industrial facilities, such as chemical plants, life-line systems etc.

The earthquake detection is based on S-waves. In order to provide the maximum pre-warning time the seismic field stations will be installed approximately in circular arrangements around ANPP. The distance from ANPP to the field stations should be optimal. It cannot be too short, because in this case the time of the alarm will not be enough to initiate protective actions. And it also should not be too long for the following reasons: a lot of seismogeneous zones will be out of range; second, due to large perimeters of the location of the field stations in all directions.

Taking into account the location of seismogeneous zones around ANPP, as well as above mentioned arguments, it is useful to set optimal distance to 25-35 km. From this point of view, the ten field stations are required. Due to the availability of several monitoring sites around ANPP, eight of them will be located at existing NSSP telemetric stations. Another two stations will have to be new installation points (Fig. 3).

The existing monitoring system applies relay stations at several locations. These will also be used for EEWS. At the two new installation points, necessity of relay stations should be investigated. One accelerometer per station will be required. The principle of the alarm should be based on positive reaction of at least two neighboring stations in a given temporal window - in order to exclude the possibility of a false alarm in cases of equipment failures.

In a setup with ten stations, the distance between the field stations is approximately 15-20 km. The probability is extremely low that ground shaking from sources other than seismic events, e.g. from railway traffic, construction works or other man-made events, affect two stations at the same time at a distance 15-20 km.

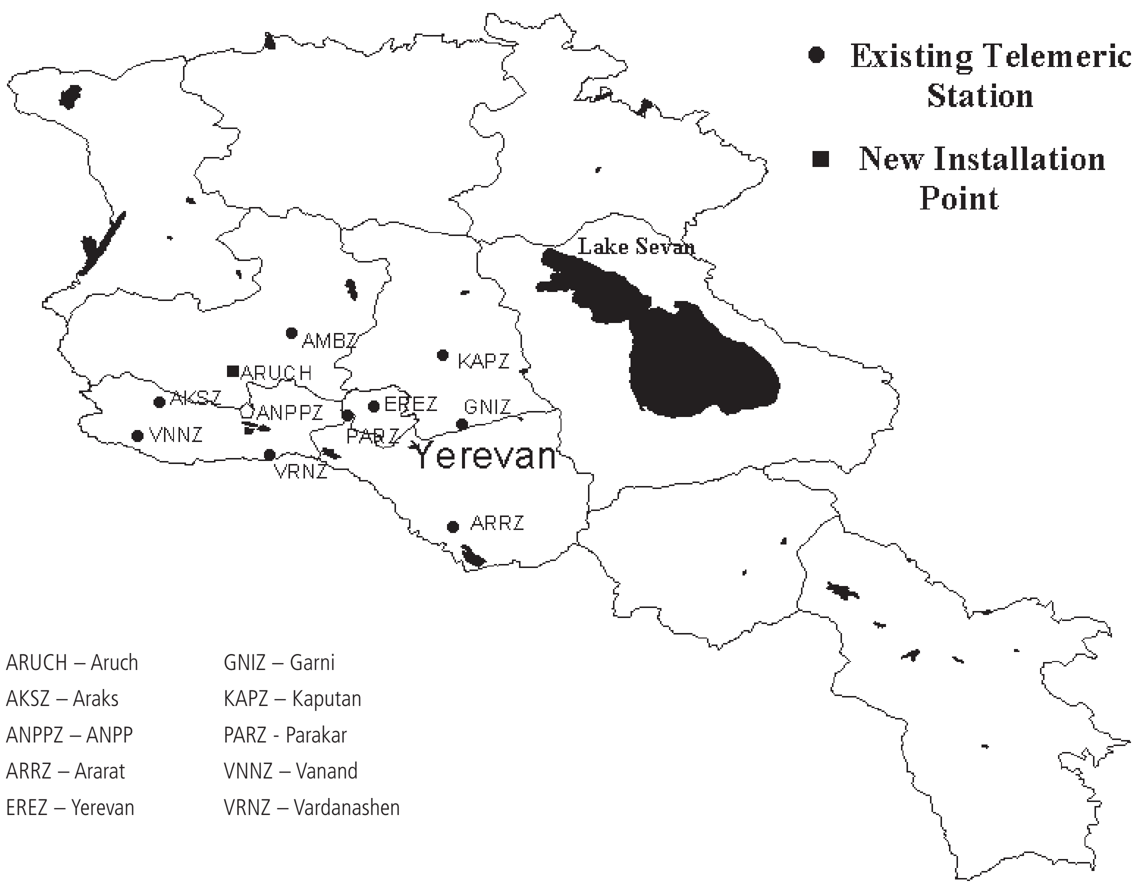

Figure 3. Map of existing telemetric stations around ANNP and new installation points

Each field station will include an accelerometers and a digitizer (Fig. 4).

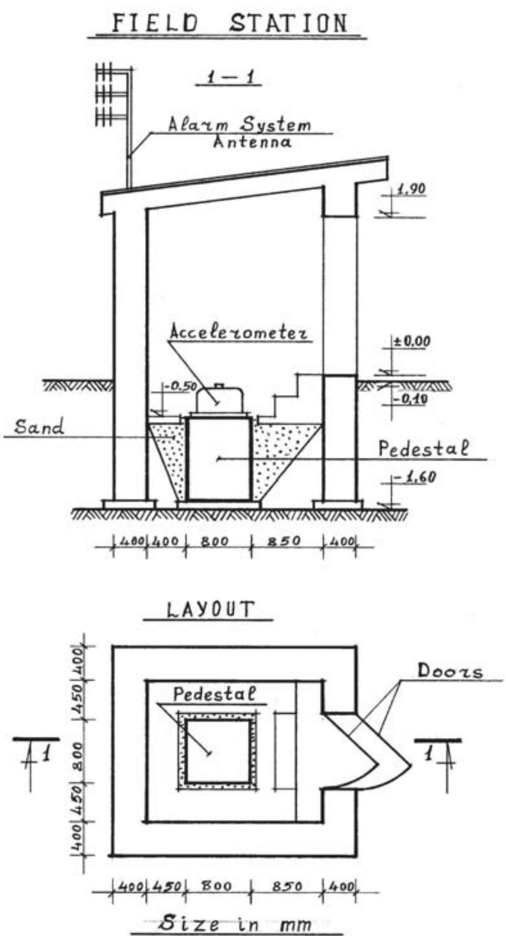

Figure 4. Simple scheme of investigation station

The digital signal will lead to the differentiation software processor. The special software will differentiate each event on seismic event and non-seismic event. One factor in this context is the frequency. Above 10Hz, a non seismic event is indicated, at lower frequencies it may be an earth-quake. For seismic events the frequency peak must be between 2 to 10 Hz. The Fast Fourier Transformation (FFT) provides valuable information about frequency content of a seismic event. If the FFT shows a dominant frequency within the predetermined bandwidth, a switch is set to FFT: Yes.

Seismic events with frequencies beyond 10Hz are possible. However, these are minor events, which do not cause any problems for the nuclear power plant.

The second factor is Cumulative Absolute Velocity (CAV). The CAV algorithm is applied to the seismic data, which is filtered between 2 to 10Hz. If, within 1 second, the data exceeds a predefined level, the acceleration value is multiplied by 1 second (resulting in a velocity) and added to the CAV sum. If CAV exceeds a predetermined value, a switch is set to CAV: Yes.

For this purpose, the Seismic Alarm System Software, SEISDIFF, which was conceptually developed by EWE-GeoSys, should be useful. The time required by SEISDIFF to detect a relevant Seismic event is 1second following the arrival of the S-wave at the field station. Since the event is checked from different points of view, the reliability of the alarm is improved and false alarms are eliminated. This increases the reliability of the Seismic Alarm System.

As to threshold, acceleration values above which the installed accelerographs at control points must respond should be estimated taking into account that at ANPP site acceleration should be more than 0.1g. By the studying the seismic waves attenuation with the distance, as well as ground condition at field points we estimated the threshold value of instruments on control points. It is equal to 0.15g.

Finally, about the mean time of the alarm. The simple estimation including the configuration of EEWS and considering velocity of seismic shear waves of about 3.5 km/sec show that the earthquake will be detected 7-10 seconds before the arrival at the plant site. Differentiation of each event to seismic event and non-seismic event requires 2 seconds, also 1-2 seconds will be lost on receiving the alarm signals from the two neighboring field stations. Therefore the pre-warning time should be 3-7 seconds.

Application to WWER-type reactors

The WWER Soviet built nuclear reactor is pressurized water reactor. The emergency shutdown of the WWER nuclear reactor is characterized by an increased insertion time of the control rods up to 12 seconds. The pre-warning time provided by AEEWS may not be sufficient for the control rods to reach their lower position in the reactor core. But it will be sufficient to issue control rods insertion signal and to release them from the positioning mechanism. The control rods may not have reached the lower position in the reactor core before the destructive earthquake arrives at the site, but the dropping down of the rods is at least in progress.

Conclusion

The concept of Earthquake Early Warning System for ANPP is developed. In this system, the earthquake detection is based on S-waves. The seismic field stations will be installed approximately in circular arrangements around ANPP. The pre-warning time provided by AEEWS is about 3-7seconds, that may not be sufficient for the WWER type nuclear reactor control rods to reach their lower position in the reactor core, but it will be sufficient to issue control rods insertion signal and to release them from the positioning mechanism, and dropping down of the rods will be at least in progress. The principle of the alarm should be based on positive reaction of at least two neighboring stations in a given temporal window- in order to exclude the possibility of a false alarm in case of instrument failures. More than one algorithm for differentiation between seismic and non–seismic events will be used. This concept also can be used for other industrial facilities, such as chemical plants, life-line systems and others.

References

Balasanian S., Nazaretian s. et al (1997) The New Seismic Zonation Map for the Territory of Armenia. Natural Hazard 15, Kluwer Academic Publishers, Netherlands, pp 231-249

Balassanian S., Martirossyan A., Arsumanyan V., (1998) Project of Creation of an Earthquake early warning system for Armenia. International IDNDR conference on early warning system for the Reduction on natural Disasters (1998; Potsdam, Germany) Early warning system for natural Disaster reduction (2003) (edited by J. Zchau, A. Kuppers)

Espinosa – Aranda G.M. et al (1996), Results of the Mexico city early warning system, Proc. 11-th world conference on Earthquake Engineering, Acapulto, Mexico

Fraas K. et al. (1997), Seismic re-evaluation and upgrading of Bohunice NPP, Proc. SMIRT 14 Post conference seminar no. 16, Vienna

Gurpinar A., Zola M. (1997), Overview and general comparison for Paks NPP, Proc. SMIRT 14 Post conference seminar no. 16, Vienna

Nakamura Y. (1996), Real-time information systems for hazard mitigation, Proc. 11-th world conference on Earthquake engineering, Acapulco, Mexico.

Smit P., Arsumanyan V., Gavakhishvili Z., Arefiev S., Mayer Rosa D., Balassanian S., Chelidze T. (2000). The digital Accelerograph Network in the Caucasus. Kluwer Academic Publishers. Earthquake Hazard and Seismic Risk Reduction (edited by S. Balassanian, A. Cisternas, M. Melkoumian).

Wieland M. et al (1997), Seismic alarm system for Ignalina Nuclear Power Plant Proc. SMIRT 14 Post conference seminar no. 16, Vienna, August 1997.

Willy H. K. Lee, Juan Manuel Espinosa-Aranda Earthquake Early Warning Systems: Current Status and Perspectives Early warning system for natural Disaster reduction (2003) (edited by J. Zchau, A. Kuppers)

Turkey

Seismic conservation of historical and cultural treasures of a world city: sizing the need and formulating an action plan for the museums of Istanbul, Turkey

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NOTE: Authors Nevra Erturk and Bilgen Sungay formed the project implementation team. The team is advised by mentor, Marla Petal, Coordinator, Bogazici University, Kandilli Observatory and Earthquake Research Institute, Disaster Preparedness Education Program. The project team is grateful for the valuable contribution of Republic of Turkey, Ministry of Culture and Tourism; Republic of Turkey, Istanbul Provincial Directorate of Culture and Tourism; Dr. Jerry Podany, Conservator, John Paul Getty Museum; Prof. Tomur Atagok, Chairperson, Yildiz Technical University, Faculty of Art and Design, Museum Studies Graduate Program; Prof. Dr. Gulay Barbarosoglu, Director, Bogazici University, Kandilli Observatory and Earthquake Research Institute; Prof. Dr. Mustafa Erdik, Chairman, and Assoc. Prof. Eser Durukal, Earthquake Engineering Department, Bogazici University, Kandilli Observatory and Earthquake Research Institute; Mr. Suha Ulgen, Interactive Media and Geographic Information Systems Inc.; Ms. Suheyla Sezan from Disaster Preparedness Education Program, Bogazici University, Kandilli Observatory and Earthquake Research Institute; Mr. Kevin Marshall, Preparator, J. Paul Getty Museum; Mr. Omur Tufan, Museum Professional, Topkapi Palace Museum; directors and museum staff of all Istanbul Museums and ProVention Consortium Disaster Risk Reduction Program.

The exposure of the Marmara and Aegean regions of Turkey to a major and devastating earthquake in the near future is a scientific fact. An earthquake will put the rich and irreplaceable cultural heritage of world civilizations which are exhibited and stored in Istanbul Museums, at great peril. The tourism sector in the Marmara Region is largely dependent on the integral part of the world cultural heritage and cultural tourism. Protecting the tourism sector of the economy involves disaster preparedness education, and business resumption planning. Most importantly it involves seismic mitigation of the collections themselves. Disaster preparedness is needed for the protection of museum visitors, staff and the museum collections.

OBJECTIVES

This project aimed to make the knowledge about disaster preparedness focusing on non-structural mitigation more widely available in order to save lives and prevent injuries of museum staff and visitors; to preserve our cultural heritage for future generations; to protect business continuity in the tourism sector and to assist this sector in prioritizing and developing practical non-structural seismic mitigation action plans.

MILESTONES

The project accomplished the following:

1. Compiled examples of hazards and best practices
2. Prepared educational electronic slide presentation explaining non-structural hazards and mitigation methods for museum collections both on display and in storage. Two hundred and fourteen slides covered the following topics:
    - What Happens During An Earthquake?
    - What Is Non-Structural Mitigation?
    - Principles for Non-Structural Mitigation
    - How Are Objects Damaged?
    - Reducing Risk in Exhibits
    - Reducing Risk in Storage
    - Reducing Risk in Public Facilities, Offices and Libraries in Museums
    - Where Can We Start?
    - What Is Being Done in Istanbul Museums? (Green et al., 2003; Marshall; Podany, 2001a; Podany, 2001b; Podany, 2001c)

Topkapi Palace Museum, Photograph: T Mimarlik Dekorasyon. Taahhüt San. Ve Tic. Ltd.

Sadberk Hanim Museum, Photograph: B.U., K.O.E.R.I., Disaster Preparedness Education Program

3. Held a seminar for museum directors and staff with sixty-one participants from 31 museums and organizations. The slideshow was shared by the project team (see note previous page) at the seminar.
4. Developed Non-structural Hazard Survey Forms
    - Museum Information Form to collect information about management and budget, museum building, museum collection, disaster experience and preparedness of each museum.
    - Rapid Room Survey Form to quantify non-structural mitigation needs.
    - Rapid Room Survey Summary Form
    - Object Risk Identification Form to tackle problem-solving and decision making for each object. (Marshall; Podany, 2001a; Podany, 2001b; Podany, 2001c).
5. Museum visits: Exhibit areas in fourteen museums were visited and surveyed, and storage areas in six museums were surveyed among 50 museums in Istanbul to test survey forms and to quickly identify and quantify risks and develop potential approach. These museums were selected according to the following criteria:

- The institutions they work under: Museums' management; budget, staff and technical possibilities differ according to the institutions they work under.
- Collection content: Museums that have different type of collection content, have different needs in the field of non-structural mitigation.
- Museum type: A variety of types of museums such as palace museums, monumental museums, house-museums have different exhibition and storage conditions.
- Number of visitors: The most visited museums within their directorate will be those whose contribution to the local economy seems significant (Atagok, 1999).

6. Data analyzed and report prepared: A full report was prepared for the Ministry of Tourism and Culture, and disaster mitigation advocates. Recommendations include rapid implementation of easy non-structural mitigation measures and a series of short and long-term steps to develop more expertise and research-based solutions in this area.

PROJECT RESULTS

Identifying non-structural risk in museums

Risks

Non-structural risks were evaluated from the perspective of the potential risks to visitors, staff, and the collections themselves. The most common risks at the museums are as follows:

Risk of broken glass
- Window and door glass
- Showcase glass
- Mirror glass
- Balustrade and elevator glass.

Risk of free-standing objects and riggings on the floor

Free-standing objects and riggings on the floor, which are taller than they are wide (or deep), are at risk of overturning. Shorter or wider objects may slide. Large objects that have been fastened only from their bottom or objects fastened on a free-standing unsecured base or rigging (esp. bust fastened on pedestal) are also at risk of overturning These are:

- Showcases
- Free-standing objects on the floor or standing on unsecured base
- Humidity controllers and air conditions
- Fire extinguishers
- Footed storyboards
- Furniture (for instance; bookcases, buffets or tables at palace museums etc.)
- Computers for visitors' usage
- Barriers
- Folding screens

Risks within showcases

In addition to fastening the showcases themselves, the objects within the showcases need to be stabilized and secondary dangers also need to be mitigated. These risks are:

- Objects falling by overturning, sliding, slipping out from their places or hitting of hanging and swinging objects,
- Objects hitting into each other because of crowding
- Pedestals, mannequins or mounts used to exhibit/fasten that are not fixed to the showcase base may fall or slide,
- Glass or panels in the showcase's ceiling under the lighting fixture may break,
- Fluorescent light bulbs may fall,
- Glass shelves within the showcase may break.

Risks of hanging objects

Objects hanging on walls or from a case or ceiling can swing and hit other objects or slip out of their places and fall. This risk takes three forms:

- Unsecured objects hung on the wall (eg. with only one nail)
- Objects hung from ceiling with open hooks,
- Objects which are secure, but can hit other objects if they swing.

Risks from the ceiling of the building

Piece or objects, which can fall from the ceiling of the building by breaking off, can damage uncovered objects below. These are as follows:

- Plaster relief pieces on ceiling breaking and falling off (esp.; plaster relieves at palace museums),
- Pipes falling from above or pipes cracking and releasing water,

- Lighting fixtures falling, sliding or hitting objects,
- Suspended ceiling pieces falling and hitting object,
- Roof window breakage. (Marshall; Podany, 2001a; Podany, 2001b; Podany, 2001c).

Forms

The project team developed three survey forms that are aimed to help museum staff in quantifying non-structural risks in the museums.

Method

The method used in the forms and during the on-site surveys at the museums begins with categorizing the measures into 3 categories; easy, medium and hard to apply. These categories also correspond roughly to cost of application. The reason for this is our belief in the general principle that anything that can be done easily and inexpensively should be tackled as a high priority as there are few barriers to safety, beyond a decision to act.

Easy methods are considered to be low-cost and can be easily-applied. These methods include:

- Using museum wax, monofilament and steel wire to fasten objects to horizontal or vertical surfaces, to reduce risk of tipping and falling
- Using metal hooks on objects that are hung on walls, or from ceilings to reduce risk of falling
- Placing sand bags inside the objects in order to reduce the risk of toppling
- Placing rubberized shelf mats under small objects to reduce risk of sliding
- Using mechanical latches to prevent cupboard doors from opening
- Placing restraints on open shelving to reduce risk of objects falling.

Medium methods are considered to be ones that cost somewhat more, are more time consuming and require more labor power. Some methods may also be in this category because they require special permission to accomplish. These include:

- Fastening objects to surfaces using specially-produced mounts
- Using padding between objects
- Preserving objects in storage in boxes or containers
- Covering glass surfaces with security film
- Bolting or screwing objects to surfaces in order to reduce risk of toppling

Difficult methods are considered to be those that are expensive, require special production or may be very hard to find an appropriate solution due to the difficulty in fastening to a wall of a historical building or the aesthetic concerns, etc. These methods include:

- Designing & producing or buying a new shelving system
- Producing a base isolation for the particular object
- Producing special solutions for objects that have special conditions

The project team spent time with museum professionals to verify the logic of this categorization system. While there is general consensus, the decisions made during a rapid assessment are necessarily subjective. The project team found that it was possible to spend time discussing the dilemmas posed by any one object, and many considerations beyond time and money might also influence decisions about a particular method, or application of a method. Some of these are: aesthetics, adjacent objects, available skills and materials, medium and long-term plans for the exhibit, the frequency of exhibit change, the durability of method, and so forth might all.

During the research on non-structural risk identification in museums, the project team's purpose was to conduct a rapid survey. Rather than to make final decisions about mitigation methods, the objective was to gain an overview of needs. It is recommended therefore, that each museum undertake this process using it's own staff both for rapid survey and prioritization as well as for making individual decisions about the stabilization method to be used with any particular object or group of objects.

How to use the forms

<u>Step 1 – Form 1A:</u>
<u>RAPID ROOM SURVEY FORM</u>

The aim in using Form 1A is to quickly and easily separate the objects that need to be mitigated into easy, medium or difficult methods. The reason for this is to focus on the easy methods that can be realized quickly and help taking action.

By looking at the room as a whole, and considering the range of objects, materials and display methods, a pre-classification and sifting can be done by referencing the Rapid Room Survey form. Making this pre-classification does not require looking at the objects separately. Instead, museum specialists can easily decide the category of the mitigation method for groups of objects in general, and then quickly count the objects in each group.

One could generally determine the size of the object or material for the mitigation method by using the columns "small, medium and large" on same form if desired. The logic of this is that larger objects require more material to create a fastner, and that this separation would further help in estimating the cost of mitigation.

Step 2 – Form 1B:
RAPID ROOM SURVEY SUMMARY FORM

After surveying and collecting information using Form 1A in every room, Form 1B can be used to summarize this data, consider the results museum-wide and determine the approximate cost for the mitigation methods. This is a tool for museum administrators to use in planning and budgeting.

Step 3 – Form 1C:
OBJECT RISK IDENTIFICATION FORM

This form can be used after Form 1A and/or Form 1B, to help in making decisions about how to secure objects that can not be secured by an easy method. When medium or difficult methods are required it becomes important to examine each object individually. Form 1C can be used in two different ways:

- Only the upper part including the sections named "Photograph" and "Notes on the mitigation method suggested" can be used. It is important to write the inventory number, the name and the place of the object in order to be able to identify particular objects among many forms filled. If a museum specialist is able to decide what kind of method is needed to secure the object and what the priority level is at first glance, then it would be enough to fill the upper part only. However, the photograph of the object with its surrounding and a sketch/notes on what kind of method is thought to be appropriate for that object, would help a team in considering the options and deciding on details. It would also aid mount-makers in reviewing and planning the work to be done.
- Using the whole form: If museum specialists or teams have trouble in assessing the risk to the object, or how to approach mitigation, the scoring system at the lower part of the form can be helpful both in deciding the priority level of the object and in specifying its vulnerabilities. The questions investigate subjects like physical condition of the object, the possibility of toppling, and secondary threats. In the scoring part at the end, the checkmarks in each column are counted, and the priority level set based on the highest score. When two scores are very close to each other, the higher risk level should be accepted.

In the end, these decisions will be subjective. It may change according to the people working on the subject, and may vary from situation to situation.There may be places where an easy method can turn into "hard to apply" because of a variety of challenges. The scoring is offered only to help professionals become conscious of the variables and considerations, and as consistent as possible in decision making.

It is not easy to create a standard under these circumstances. Comments on the use of the forms vary from museum to museum. Museums that are big in size and have many objects mention that the forms may be useful, while on the other hand, smaller museums mention that it may not be necessary to use such forms as decision-making and action may more easily be controlled.

FORM 1A - NON-STRUCTURAL MITIGATION IN MUSEUMS
RAPID ROOM SURVEY FORM

Name / Number of the Exhibition Gallery - Storage:

			Difficulty of Mitigation Methods								
			Easy Methods			Medium Methods			Difficult Methods		
Type of Object / Other*	# Objects	No Risk	Small	Med.	Big	Small	Med.	Big	Small	Med.	Big
TOTAL											

* **Other:** (fire extinguisher, humidity controller, lighting, suspended ceiling, pipes and ducts, window glass, furniture, signs and storyboards, showcases and cabinets and etc.) may also cause a threat during an earthquake.

Classification of Fastening Methods at the Exhibition Galleries:
Easy: Museum wax, sand bag, monofilament, steel wire, rubberized shelf mat, metal hook
Medium: Plexi and metal mounts, security film to the window, anchoring
Difficult: Base isolation

Classification of Fastening Methods at the Storage Areas:
Easy: Mechanical latches, restraint in open shelves, rubberized shelf mat, metal hooks
Medium: Padding between objects, boxing, anchoring
Difficult: Base isolation, fastening big objects, new shelving system

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FORM 1B - NON-STRUCTURAL MITIGATION IN MUSEUMS
RAPID ROOM SURVEY / SUMMARY FORM

Name of the Museum:

Room Name	Application Process of the Mitigation Method								
	Easy			Medium			Difficult		
	Small	Medium	Big	Small	Medium	Big	Small	Medium	Big
TOTAL									
APPROXIMATE COST OF METHOD									
APPROXIMATE COST (TOTAL)									

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FORM 1C - NON-STRUCTURAL MITIGATION IN MUSEUMS
OBJECT RISK IDENTIFICATION FORM

INVENTORY NO: ______________________ **OBJECT / TECHNICAL RIGGING NAME:** ______________

OBJECT / TECHNICAL RIGGING LOCATION / NO AT THE MUSEUM : ______________________

EXHIBITION / STORAGE METHOD: ______________________

SUGGESTED FASTENING METHOD (More than one method can be used):

☐ Specially produced mount	☐ Anchoring	☐ Security Film	☐ Base isolation
☐ Padding	☐ Boxing	☐ New shelving system	☐ Other

PRIORITY IN FASTENING:	☐ Low	☐ Medium	☐ High

PHOTOGRAPH	**NOTES ON THE SUGGESTED FASTENING METHOD**

	LOW PRIORITY	MEDIUM PRIORITY	HIGH PRIORITY
Material Property	☐ elastic and soft	☐ ______	☐ hard and fragile
Object / Tech. Rigging Condition	☐ strong, in good condition	☐ some parts are weak	☐ touchy and fragile
Number of pieces	☐ monolith	☐ several pieces, tight connection	☐ loose connections
Eccentric Element (projection,arm)	☐ none	☐ a little but small	☐ some and big
Proportion Height / Base	☐ base is larger than its height	☐ its height is equal to base	☐ its height is greater than its base
Weight Dispersion	☐ lower than 1/3 of height	☐ evenly distributed	☐ higher than 1/3 of height
Form of the Base	☐ flat and/or symetric	☐ a little unequality	☐ unequal or not flat
Stability (during shaking)	☐ stable and solid	☐ slight movement or rocking	☐ easily moved or rocked
Threat to Object/People Around	☐ none	☐ to objects around only	☐ to people and objects
Location / Accessibility	☐ easy to access	☐ a little difficulty in access	☐ difficult to access
Relocation	☐ easy, quick	☐ with some difficulty	☐ very difficult
Secondary Threats*	☐ none	☐ a little	☐ several or many
Importance Degree	☐ study pieces	☐ for display	☐ unique
Components that the object is on - in**	☐ low risk	☐ medium risk	☐ high risk
GRADING (number of signed boxes)	**LOW PRIORITY**	**MEDIUM PRIORITY**	**HIGH PRIORITY**
CONCLUSION			

*Secondary Threats : all of the objects that can fall down on it or collide it, glass that can be broken etc.

** These components can be pedestal, shelving systems, case, cupboards or other structures. The risks that they can have are, risk of toppling, to damage or to be damaged.

NOTE: Always choose the higher risk level when you come across two grades that are very close to each other.

N.B. THIS DOCUMENT WAS ADAPTED FROM AN UNIDENTIFIED SOURCE

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REDUCING NON-STRUCTURAL RISK IN MUSEUMS

Challenges facing non-structural mitigation work at museums

Some challenges are faced when undertaking non-structural mitigation work for the protection of people and objects. They differ from museum to museum according to their administrative status, physical conditions, earthquake consciousness of the museum staff and their collection content.

Some of the museum buildings in Istanbul are historical, therefore special permission is needed to fasten objects to the walls, ceilings and floor where these are assumed to alter or damage the structure. The temperature and humidity control are also difficult in historical buildings and extra space cannot be added. However, extra space is mostly needed as the collections are very large in most of the museums and the number is constantly increasing. The increase in the number of objects also cause changes at the exhibition and storage that also increases the cost of taking measures and the time period for taking measures. On the contrary, it is also difficult to obtain approval for decreasing the number of exhibited objects to prevent overcrowding in showcases. Decreasing the number also requires extra space in storage areas which as it is discussed, is not a possible solution for many museums under the existing circumstances.

Some of Istanbul Museums also face some bureaucratic difficulties. For instance, when the management changes, the agenda may also change modifying the priorities of the work to be done in the museum. Additionally, it may require time to obtain approvals for taking specific measures from the administrators of the institutions they are under.

In most of the Istanbul Museums, the limited budget is making actions like obtaining materials or assuring staff to focus on non-structural mitigation work difficult. The existing staff are overburdened and have insufficient time for any additional responsibility in most of the museums. Therefore, there is a need for additional staff who will focus working on the non-structural mitigation work. They also should be conscious and qualified professionals. However, these criteria limits to find qualified staff as the subject is yet new. It should be mentioned that there is a lack of volunteer system in most of the Istanbul Museums, which could help with duties of the existing staff.

There are also some aesthetic worries in taking measures. Some of the museum professionals believe that the measures taken change the value of the object as it is an addition to it. Additionally, museum staff is suspicious whether the methods would damage the objects and thus there is a need to research and design on the field which will take time. The measures will be subjective as they may be designed in several different ways according to the people working on it.

From the functional point of view, there are concerns like; necessity of taking measures in storage areas leaving the objects visible so that they are easily reachable when the researchers need access or making custom mounts not specific only to one object so that when there is a change in exhibition, it could fit to hold another one. On the other hand, mitigation measure work may make changes of exhibits and periodic care more time-consuming and it may pose additional risks to objects while mounting and unmounting. Museum staff would like to be sure about the specifications and limits of certain methods as there is a lack of research data or engineering knowledge.

There are also psychological and social worries about the subject. There are question marks like; whether the people’s morale will be brought down, if earthquakes are always of concern or whether the museums will get the support they need from the community to undertake these measures. At some of the Istanbul Museums, we should emphasize that the necessity in strengthening the museum building structurally receives as a competing priority.

It is very important to form the earthquake consciousness among different groups in the society to be able to handle non-structural mitigation work and all of the challenges to be faced along the way.

Suggestions

For the existing situation, although there is mostly a problem with limited budget, it is possible to start with cheap and practical non-structural mitigation methods immediately. This action would further help to focus on the more complex methods afterwards. It is observed that there is relatively less difficulty in mitigating storage than exhibits, mostly because the mitigation measures do not need to include aesthetic considerations. Therefore, some exhibits might be protected by decreasing the existing number of same type of objects on display, and boxing these safely in storage, thus remembering that it is important to organize storage areas in a way that the objects can be seen and identified easily which will provide easy access to the objects during research or display changes. It is also important to organize storage areas to be able to have easy and quick access in emergency situations. Additionally, specially-designed storage facilities protecting objects from fire and water as well as earthquake are extremely important.

There is a need to employ assistants to the curator, conservationist, restorationist, carpenter, etc. to focus working on non-structural mitigation against earthquake.

Mitigation efforts should be taken against earthquake not only in the exhibition galleries and storage areas, but also in offices, museum shops, exits, corridors, halls and other public service spaces. Measures should be checked periodically and should be continuous and routine. Additionally, special effort should be given during exhibition changes and cleaning. The quality of both application and material used are very important for both efficiency and effectiveness. Knowing which methods are appropriate for which objects is also important for the efficiency of the application.

For future applications, it is very important to design new museums bearing earthquake risks of both structural and non-structural components in mind thus avoiding the cost of doing this as an afterthought. Museums need new and wide storage areas both to store the existing objects in better conditions and to use for salvage operations after a disaster.

The protection of objects against earthquake needs to become a routine consideration at the beginning of acquisition, exhibition, and storage becoming as common as protection from fire and theft. When the expense of non-structural mitigation work become a line-item in the budget, it will speed up and encourage the necessary works to be done.

Standard Museum Emergency Plans should be adapted for each museum. Emergency planning is needed to develop safe and efficient procedures for evacuation of people and objects. Museum staff and tour guides should be trained in basic disaster awareness, structural and non-structural awareness, and community emergency response and the plan should be practiced in all museums.

It is important to publish the research and work realized in this field in order to be able to put the subject on the agenda of scientific field and of public opinion. This will also increase the potential for identifying and receiving financial support for this undertaking.

CONCLUSION

The need

In conclusion the project team's experience doing this research has led a number of points that may be important in accomplishing non-structural mitigation both in Istanbul's museums and in other places.

It seems important to develop some interdisciplinary teams that can undertake the extensive initial efforts of non-structural mitigation not for each museum in isolation, but across museums, in a consultative capacity. There is a clear need for professionals who will specialize in the subject of non-structural mitigation planning, problem-solving, training and implementation, and will accumulate and share the very specific knowledge needed for the future. Such groups working with each museum should, of course, include at least one lead member of the staff with the interest and authority to coordinate museum staff participation. Small teams within the museum, working with guidance and support from outside teams dedicated to this task may be an effective way to approach this comprehensive task. There are a number of distinct tasks that might be addressed by different multi-disciplinary teams:

- Structural safety investigation of museum buildings: The need for triaging buildings which may be structurally sound, may require modest or extensive retrofitting, or may in fact not be an advisable place to locate treasures.
- Non-structural mitigation assessment and planning: Risk identification, prioritization, budgeting, and action-planning.
- Scientific research on methods and materials for non-structural mitigation: This research should include both materials testing for safety and preservation of objects and shake-table testing and engineering calculations to determine: applicability and size/weight and configuration limitations of existing and new materials and techniques (in collaboration with exhibition designers).
- Implementation of non-structural mitigation measures: This includes work in exhibits and storage, mount-making, boxing, packing and other activities.

- Education: Update and deliver educational materials and programs, especially in relation to research on the subject worldwide.
- Public relations, advocacy and promotion: Identification of sponsors and champions who will take on this mission until it becomes part of the ongoing work of all museums in seismic risk areas, and ongoing research.

Regular and repeated training programs for people in various roles should include:

- Education to raise public awareness of the vulnerability of cultural heritage to natural disasters.
- Education within tourism sector in order to raise interest and support from industry leaders and workers,
- Education of museum directors and staff, both decision-makers and project implementers to secure their understanding and commitment,
- Education of students, who study in related departments of universities (museologists, earthquake engineers, interior designers, architects, archeologists),
- Education of trade school students, skilled craftspeople and restorationists who will work on mount-making, packing for storage, and other applications. These individuals should be carefully selected for their meticulous care, maturity, and their awareness of the gravity of this responsibility.

The project team recommends the following short-term projects:

- Preliminary research can be given to students from related departments of universities as homework, projects or theses.
- The technical specifications and limits of existing methods should be experimentally researched with shake-table testing. New methods should also be investigated in this manner.
- Sources for purchasing non-structural mitigation materials in local markets should be researched and chemical content of these materials should be tested as necessary at the Directorate of the Central Laboratory for Restoration and Conservation.
- A multi-disciplinary group of people from various fields (museum studies, earthquake engineering, architecture, chemical engineering, etc.) and volunteers who want to become specialists in this subject is to be identified to support and to participate in local and international training programs.
- Basic non-structural mitigation training available from Bogazici University Continuing Education Department and Kandilli Observatory and Earthquake Research Institute can be made available to all professional museum staff (administrators, curators, restorationists, preparators, conservationists, designers, etc.)
- A mobile training and mount-making unit can be established to tour museums and provide on-site consultation and training on simple mitigation techniques and acrylic mount-making.
- One or two museums can be selected as demonstration sites to implement and showcase comprehensive non-structural mitigation, emergency planning, and staff training.
- A variety of national and international governmental, non-governmental and private resources must be called upon to support this important work.

The project team recommends the following long-term approach to assure ongoing leadership and attention to these tasks:

An institute, which will concentrate inter-disciplinary interest and expertise and workspace for research-development, education, consulting, technical support, specialized and temporary storage, and salvage operations after disaster can be created for long-term systematic implementation and extension of these lessons throughout Turkey and the region.

Achievements and the sustainability of the project

The need for a broad-base of ownership has been addressed by the development of several important new collaborative efforts.

- Several Istanbul Museums have already taken or began to take impressive measures on non-structural mitigation against earthquake and are continuing to be the leaders and the advocates for the action. These museums have provided project team with information and are continuing to encourage other museums by sharing information and provide collaborative impetus in applying non-structural mitigation measures, emergency planning and education.
- Bogazici University, Kandilli Observatory and Earthquake Research Institute and Yildiz Technical University, Faculty of Art and Design, Museum

Studies Program directors have met and stated their commitment to working together on future projects. We are going through the process of developing official agreements with other universities to create wider collaboration.

- Two training programs in non-structural mitigation for museum collections have been integrated into lessons on Maintenance & Conservation and Collection Management at Yildiz Technical University, Faculty of Art and Design, Museum Studies Graduate Program.
- A slide presentation about non-structural damage mitigation in museums has been prepared in both English and Turkish, and will be shared over internet via web-site of Bogazici University, Kandilli Observatory and Earthquake Research Institute(KOERI), Disaster Preparedness Education Program (AHEP); www.ahep.org.

"Seismic Conservation of Historical and Cultural Treasures of a World City: Sizing the Need and Formulating an Action Plan for the Museums of Istanbul, Turkey" is a pilot project implemented in the field of cultural heritage protection in connection with museology and earthquake preparedness. This project's results are believed to provide a basis for the forthcoming projects and have important influence for museums in Turkey and all developing countries throughout the world.

References

Atagok, Tomur (Comp.), Yeniden Muzeciligi Dusunmek. Istanbul: Yildiz Teknik Universitesi Yayinlari, 1999.

Erturk, Nevra; Sungay, Bilgen and Marla Petal, Seismic Conservation of Historical and Cultural Treasures of a Wold City: Sizing the need and Formulating an Action Plan for the Museums of Istanbul, Turkey, Final Report to World Bank ProVention Consortium, January 2004.

Green, Rebekah; Caliskan, Omer; Sungay, Bilgen and Zara Paci, Non-Structural Mitigation Handbook. Istanbul: Bo¤aziçi University, Kandilli Observatory and Earthquake Research Institute, 2003. available at: www.ahep.org

Green, Rebekah; Caliskan, Omer; Sungay, Bilgen and Zara Paci, YOTA Yapisal Olmayan Tehlikelerin Azaltilmasi El Kitabi. Istanbul: Beyaz Gemi Yayinlari, 2003.

Green, Rebekah, Caliskan, Omer, Sungay, Bilgen and Zara Paci, YOTA Yapisal Olmayan Tehlikelerin Azaltilmasi Powerpoint Sunumu. Istanbul: Bogazici Universitesi, Kandilli Rasathanesi ve Deprem Arastirma Enstitusu Afete Hazirlik Egitim Projesi, 2003.

Marshall, Kevin L., Slide presentation entitled Packing for Storage in Seismically Active Regions. J. Paul Getty Museum.

Podany, Jerry, Muze Koleksiyonlari Icin Afet Hazirliklari. Istanbul: Bogazici Universitesi, Kandilli Rasathanesi ve Deprem Arastirma Enstitusu, Istanbul Afete Hazirlik Egitim Projesi, 2001a.

Podany, Jerry, Muze Koleksiyonlari Icin Sismik Guvenlik Calismasi. Istanbul: Bogazici Universitesi, Kandilli Rasathanesi ve Deprem Arastirma Enstitusu, Istanbul Afete Hazirlik Egitim Projesi, 2001b.

Podany, Jerry, Slide presentation entitled Disaster Preparedness for Museum Collections. J. Paul Getty Museum, 2001c.

T.C. Kultur Bakanligi, Turkiye Müzeleri. Ankara: T.C. Kultur Bakanligi Anitlar ve Muzeler Genel Mudurlugu, 2002.

Tufan, Omur, Slide presentation entitled Japon Muzeleri'nde Depreme Karsi Alinan Tedbirler, Topkapi Palace Museum, October 2001.

Senegal

Earth observation and GIS-based flood monitoring in the Senegal River Estuary and Valley

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SYMPOSIUM NOTES

The Senegal River basin

The Senegal River basin is located in West Africa and occupies an area of roughly 300 000 km^2. The entire basin, including the upstream catchments is drained by the 1700 km long Senegal River and its tributaries. The area of the river basin accounts for about 1.6% of the African continent and lies within the territory of four different countries: Guinea, Mali, Mauritania and Senegal (Figure 1).

Hundreds of thousands of people live along the Senegal river which rises in the Fouta Djallon mountains of Guinea and flows north towards the edge of the Sahara desert before swinging west to empty into the Atlantic Ocean. Its water is used irrigate large areas of rice, sugar cane, maize and tomatoes as well as grazing land for livestock. The basin is divided into three distinct regions: the upper basin which lies in the mountains of Mali and Guinea, the middle valley which forms the 500 km long borderline between Senegal and Mauritania, and the delta in the lower valley where the Senegal River discharge into the Atlantic Ocean.

The flow rate of the river is determined mainly by the rainfall in the upper basin. The high-water season lasts from July to October; the low-water season, with a steady decrease in volume, begins in November and lasts until May or June. The high-water season peaks at the end of August or beginning of September and quickly ends during October.

Another important feature of the Senegal River prior to the construction of its two dams was the inter-annual irregularity in its flow volume. For a long time this inter-annual flood irregularity posed a major problem for the valley, as it decreased the potential for guaranteed agricultural production in this narrow geographic area. The arable land area that could effectively be farmed after the flood could vary between 15,000 ha and 150,000 ha, depending on the magnitude and duration of the flood. Exceptionally high water levels caused widespread devastation in 1890, 1906, 1950, 1994, 1999 and 2003.

The particularly low water level during the dry season resulted in a deep intrusion of the ocean's salted waters into the riverbed. During the 1970s a saltwater wedge penetrated more than 200 km upstream of Saint-Louis. To address the problems associated with the significant inter-annual variability in rainfall and water flow of the Senegal River, three of the four main bordering countries (Mali, Mauritania, and Senegal) entered into a treaty to form the Senegal River Authority, the Organisation pour la Mise en Valeur du Fleuve Sénégal (OMVS), and related organizational structures in 1972.

The tasks of the OMVS were to attain the goal of food self-sufficiency for the Senegal River Basin inhabitants; reduce the economic vulnerability of the organization's member states to climatic fluctuations as well as to external factors; accelerate the economic development of member states; conserve ecosystem balance in the sub-region, particularly in the basin; and secure and improve the incomes of basin inhabitants. To accomplish these goals the OMVS was charged with constructing and managing a regional infrastructure consisting of two major dams. The first to be completed (in 1986) was the Diama dam, located 27 km upstream from the city of

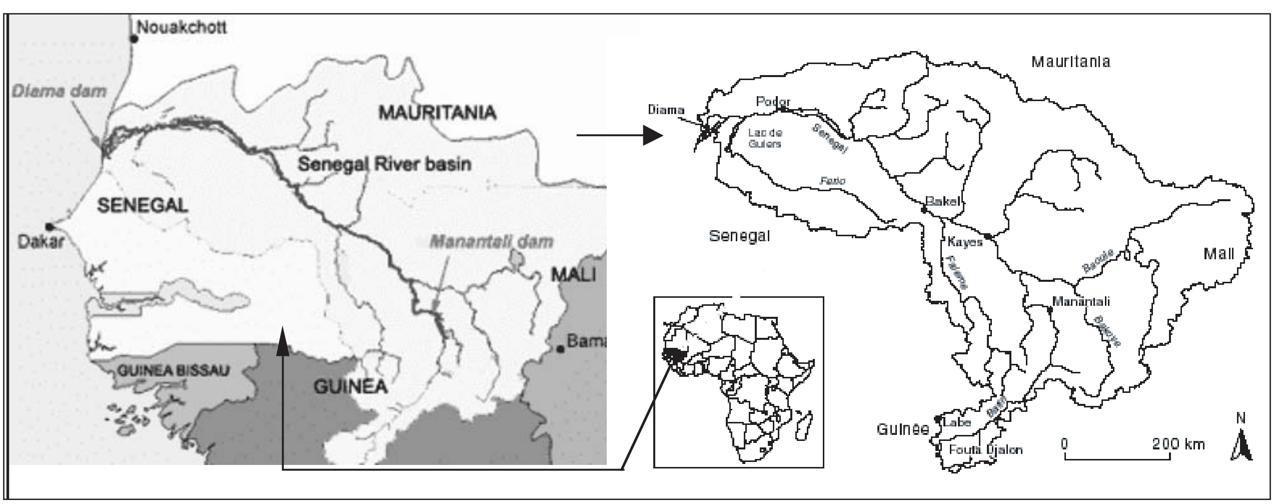


Figure 1: The Senegal River basin

St Louis (Senegal). It was built to stop the dry-season intrusion of sea water along the river bed which, during the drought years, would penetrate over 100 km inland. The second is the storage dam at Manantali in Mali (completed in 1990) on the Bafing, the main tributary of the river, which supplies approximately 50% of the annual flow. The reservoir is theoretically capable of stocking 11 billion m3 of the strongly seasonal rainfall on the Fouta Djalon Mountains in Guinea. The water can then be gradually released over a longer period than the natural flood. The two dams should provide enough water to achieve the following development objectives: irrigate 375 000 hectares of former floodplain, especially for rice production; produce hydropower (800 Gwh per year); make the river navigable all year round between Saint Louis at the river mouth and Ambibédi in Mali.

Water level and discharge measurements in the estuary

Discharge information from Diama dam is available from July 1986 to now. As shown below, releases from the barrage occur each year from approximately July through to December. At other times of the year there is no flow through the barrage.

Over the measurement period the data shows variations in both mean sea level and tidal range. Subsequent analysis of the data is presented, which displays tidal range both at St Louis (from the measured data) and the ocean (from tidal predictions) and mean water level at St Louis. The water level measurements from Diama Barrage are also shown. Note that as these measurements are only daily recordings, tidal range cannot be extracted.

When water levels exceed 1.2 m above MSL flooding occurs in Saint-Louis. According to the measurements at Saint-Louis, this has occurred nine times since 1964. Since the barrage was constructed in 1985, this has only occurred three times. The discharges from the barrage from 1985 onwards are also shown below. Note that the peak discharge greater than 3000 m^3/s recorded in 1987 is considered to be incorrect, and should be approximately 1500 m^3/s (Gilif, 2002).

OBJECTIVES OF THIS PROJECT

In 1999, the western part of Africa experienced higher precipitation rates, resulting in higher river discharge in the Senegal River and its tributaries and thus larger inundations in the river valley and delta than seen during the last 30 years. Several villages and irrigation infrastructures were destroyed. People had to abandon their houses and rice field crops were lost. Further downstream, Saint-Louis, the former capital of Senegal, experienced large damages due to inundation of areas built up during the dryer years in the 80s. Floods risk reduction is related to poverty in the sense that floods consequences

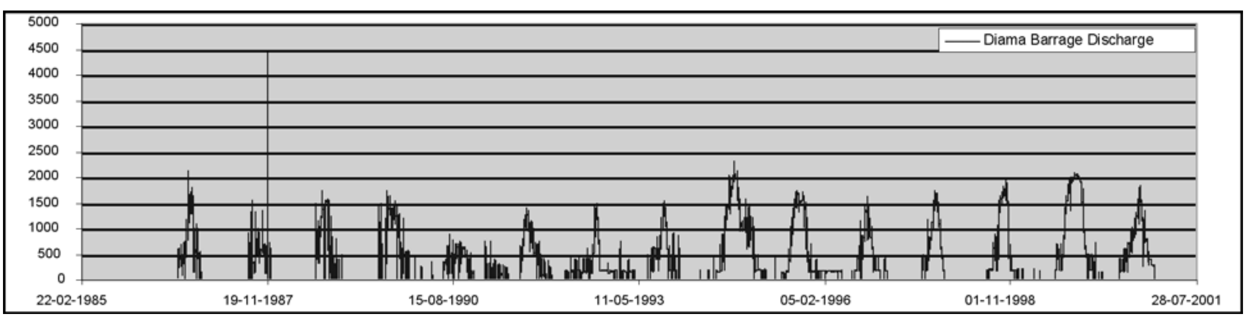


Figure 2: Time Series of Discharge, Diama Barrage (1986-2003)

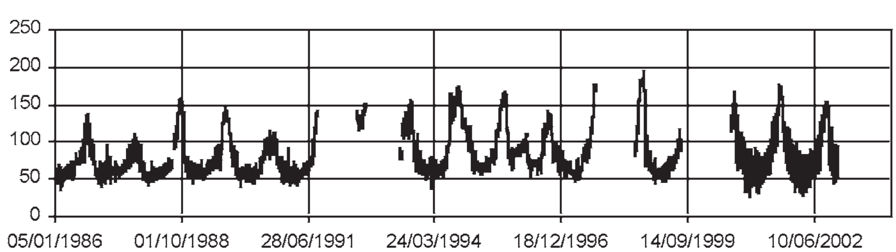


Figure 3: Water level at Saint-Louis 1986-2002

(removal of population, housing problem, health problem, lost crops, etc.) reinforce poverty; thus reducing flood risk will inevitably cut down the rate of poverty.

Therefore, local and regional decision-makers need management tools and materials for flood monitoring. The ultimate objective of this project is to develop new tools base on satellite images for flood monitoring and forecast in the Senegal River valley and estuary that can be used on regional, national and local level by relevant authorities to improve water management and to reduce impacts of extreme events like floods.

Accurate mapping of the areal extent and duration of the yearly flood of the Senegal River is desirable in order to monitor hazards on people, irrigated agriculture, buildings and infrastructure and also to assess the potential for the traditional flood recession agriculture. Furthermore it has been highlighted the necessity to have precise Land Cover Maps as a means to assess flood damage but also as a way of modelling the hydrological functioning to better characterise the watershed in the Senegal River valley and estuary.

METHODOLOGY

Data and image acquisition

Data acquisition was an important stage of this project. Several missions were carried out in the estuary and the lower valley because flood monitoring in the Senegal River valley and estuary require a large number of data sets. The most critical data include atmospheric weather data, soil physical data, current and historical land-use data for a general description of land cover and land-use management around the town of Saint-Louis.

Date	Mode	Season	Observations
13-10-1998	XS 4	Rainy	high floods
23-10-1999	XS 4	Rainy	high floods
31-10-2001	XS 4	Rainy	low floods
16-01-2002	Panchromatic	Dry	no floods

Table 1 : Satellite data

The SPOT 4 (1999, 2001, 2002) and SPOT 5 (2002) images were acquired near the University of Dakar in collaboration with University of Marne la Vallée (France). The SPOT Xi image of October 13, 1998 is recovered to the GILIF[1] project developed in 2002 on the Senegal river by the DGPRE[2], (UNEP) but belongs to former UTIS[3] center. The available satellite data are listed in Table 1.

This kind of approach based on satellite images has previously been used by Sandholt and al., (2000) in the lower valley around the city of Podor. This pilot study focused on different Landsat images in combination with data from other sensors like AVHRR and radar data from ERS.

Pre-processing

Geometric correction

The SPOT data were preprocessed for data extraction and geometric correction. The images we use in this study were not directly georefenced and at the beginning they have deformations and must be stood up to be put to the better orientation in conformity with the geographic reality, in a plan of projection. All images have been geometrically rectified to UTM Zone 28 North. Because of the differences in spatial scale and thus areal coverage for the images, different areal coverages are available in each case, so direct comparisons are only possible in regions with overlap.

The Ground Control Points (GCP) we have chosen at the beginning with the Japanese International Cooperation Agency (JICA) maps (1/50 000), had not known conclusive results because the RMS often was being enough raised. The precision of those measures was not satisfied. The choice was being particularly focussed on remarkable points, as intersections of roads, trees, angles of fields, etc.

In order to correct these ground control points and to have a better precision in the choice of GCPs, we carried out a mission to complete the points with the GPS. This solution has permitted to obtain a precision of 5 m. These points thus made it possible to rectify the images with a high degree of accuracy.

Data fusion

In this case of images fusion, we have searched to combine judiciously the spatial information of high resolution panchromatic image of January 16, 2001

[1] Gestion Intégrée du Littoral et du Bassin Fluvial

[2] Direction de la Gestion et de la Planification des Ressources en Eau

[3] Unité de Traitement de l'Imagerie Satellitaire

(10 m of resolution), with themultispectral SPOT images of October 23, 1999 and of October 31, 2002 (20 m of resolution). This permits to obtain an image richer simultaneously in spatial and spectral information (Figure 4). The fusion is most certainly an important manipulation to realize in the case of such a study, but we realise that the panchromatic image brings noise on the Spot XS image and this information is very difficult to analyse in the classification process.

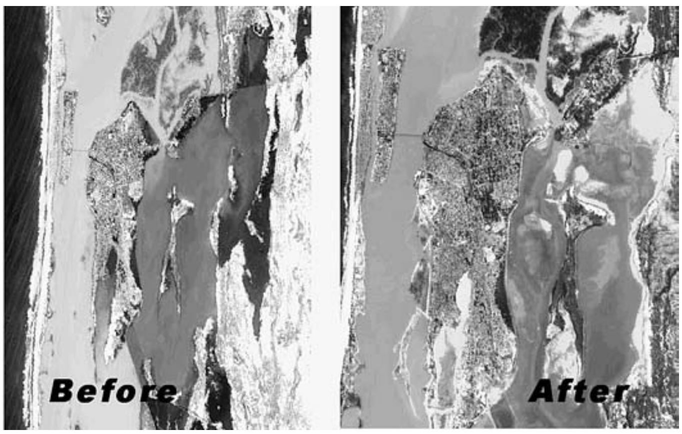


Figure 4: Fusion process between SPOT image (23/10/1999 and 16/01/2001)

The Classification process

The first unsupervised classification process is a method of reiterated classification and this process does not lean on any exterior data. The pixels are regrouped according to the method of minimum distance. The K-Means unsupervised classification method has given satisfied results. It is based on the calculation of classes to obtain a result distributed regularly in the data space, then iteratively regroups the pixels according to the class the more near using the method of minimum distance. From the great classes obtained in a coarse way, we refined the classification with the method of supervised classification (Figure 5).

A standard supervised maximum likelihood classification was carried out using the ENVI image processing system. A total of five spectrally different classes are identified corresponding to spectral variability in the image. Differences on water reflectance are caused by turbidity and water depth and presence of varying amounts of green vegetation. Training and test areas were defined using field observations and delimitation carried out from a visual interpretation of SPOT images.

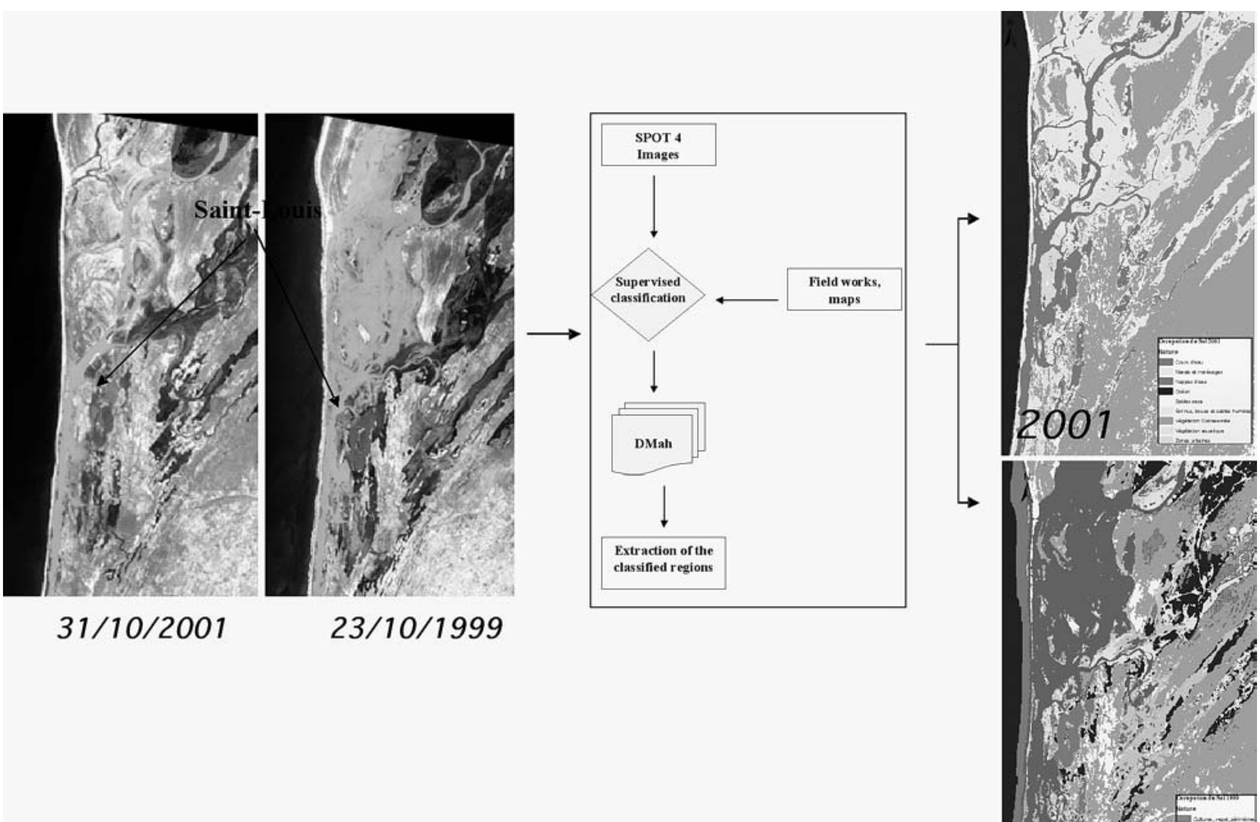


Figure 5: The classification process

MAPPING FLOOD EXTENSION AROUND THE CITY OF ST LOUIS

The relevance of the study has been accentuated by extensive flooding in 1999, when the greatest river flow in 30 years was reported. Because of exceptionally high rainfall in Fouta-Djalon in the rainy season of 1999, peak flow at Bakel reached 4440 m^3/s (IRD—Institut de Recherche pour le Développement, 2001). The result was the destruction of many villages and irrigation infrastructure. Substantial parts of low lying Saint-Louis by the Atlantic Ocean was struck by flooding. Man-made factors contributed to the seriousness of the event. Dikes constructed along the river channel to protect populations hindered or delayed up-stream flooding of the wide river valley, exacerbating problems downstream (Figure 6).

Figure 6: A view of flooded area in Saint-Louis in October 1999

Cartography of flooded area in October 1999

The cartography of flooded surfaces permitted to isolate the different regions reached by the flood in October 1999. It is a multi-temporal approach which consists in comparing the level of water surfaces between the flooded period and the normal period. The characteristics of the 2 multispectral SPOT images used are presented in the table below.

We took as reference the 2001 image, because it has the same seasonal and temporal characteristics that the 1999s image, except only that it was acquired in a normal period with out floods. Figure 7 shows satellite imagery of the lower estuary around the city of Saint-Louis during the flood period in October 1999 (left) and during the normal period in 2001 (right).

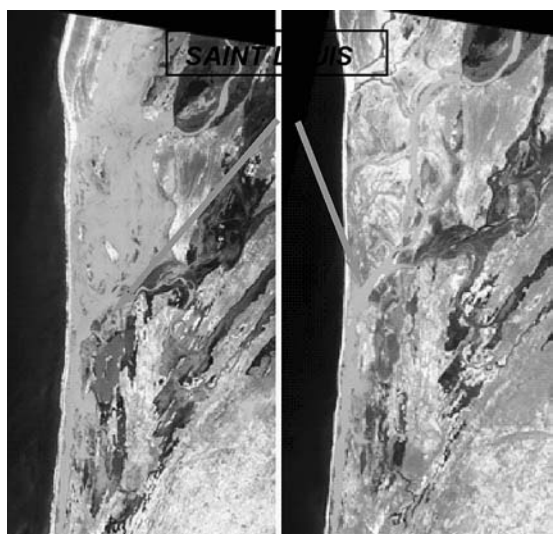


Figure 7a: Satellite Imagery of Senegal River Lower Estuary, Flood conditions in October 1999 (left) and no flood conditions in October 2001 (right)

Date	Mode	Season	Observations
23 10 1999	XS 4	Rainy	High flood
31 10 2001	XS 4	Rainy	not flood

Table 2. Characteristics of multispectral SPOT images

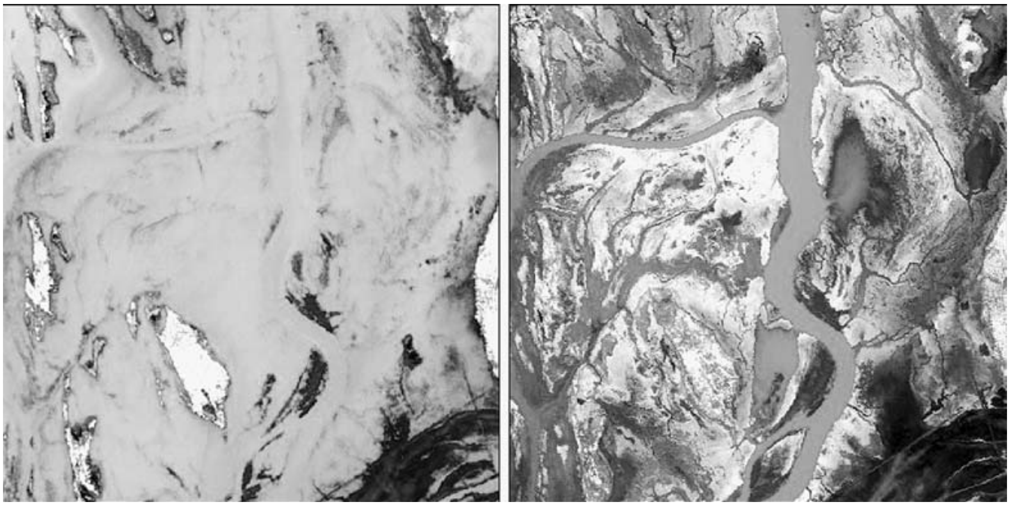


Figure 7b: Extract of spot 4 xs of 23/10/199 (left) and Spot 4 xs of 31/10/2001 (right).

One observes on these two extracts, the importance of the surfaces covered by the floods in October 1999. The principal bed of the river is largely overflowed and all the regions in the north of the town of Saint-Louis were considerably flooded (Figure. 8).

The floods devastated very important surfaces. With a comparison of these two satellite images (1999 and 2001), it appear that the different flooded surfaces have some difference. Slightly flooded surfaces account for 64.86% of flooded surfaces. Strongly flooded surfaces account for 21.52% of flooded surfaces and the other is the flooded and muddy surfaces (Table 3 and Figure 9).

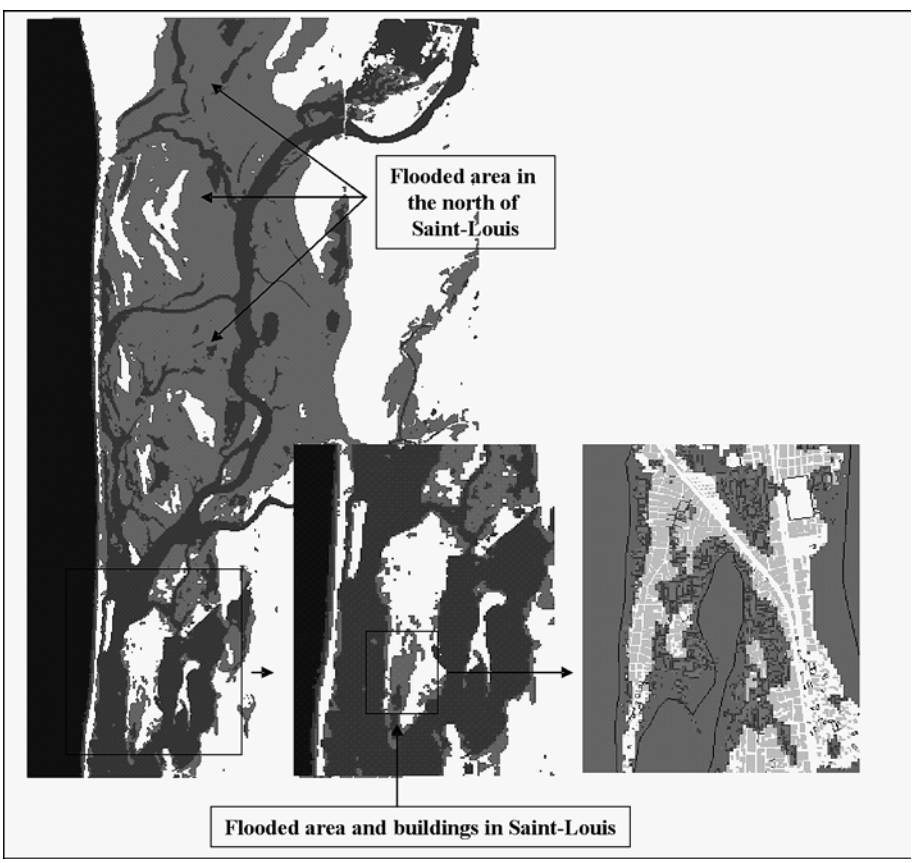
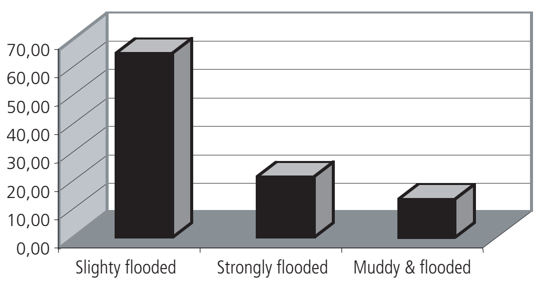


Figure 8: Flooded area in the region of Saint-Louis in October 1999

Types of objects	Number of objects	Min	Mean	Max	Summon	Standard deviation
Flooded surfaces (low)	1332	400	150759.16	28595200	200811200	1432383.37
Flooded surfaces (high)	2836	400	23493.37	3207600	66627200	136738.7
Flooded and muddy surfaces	2665	400	15821.84	1881600	42165200	67334.53

Table 3: Statistics of the surfaces flooded in October 1999, the surfaces are expressed in meters

Figure 9 : Flooded surfaces in 1999 (%)



These 3 layers of vectors were extracted automatically and exported with the Shape format to be integrated in the GIS (Figure 10a and 10b).

Figure 10a. Extract of the vector layers relating to the surfaces flooded in 199 in light blue, surfaces slightly flooded; in dark blue, strongly flooded surfaces; in red, flooded and muddy surfaces.

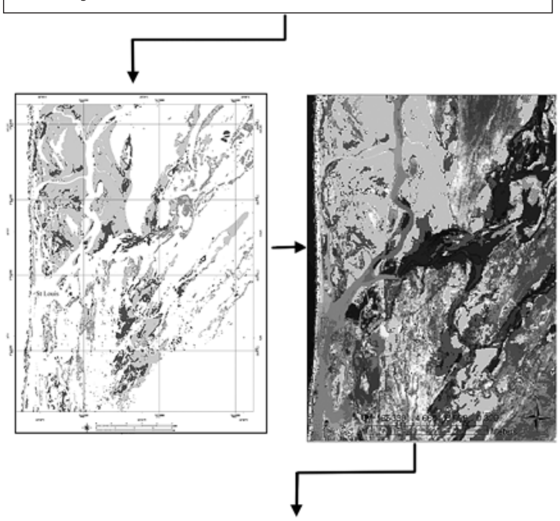


Figure 10b. Flooded surfaces in 1999 superimosed on image of fusion of Spot 4xs of 31/10/2001 and panchromatic of 16/01/2002. Scale 1/100 000

Water surfaces represent an important part of the total area considered. The total surface of water is 20.48% of the total surface of the area considered. Turbid water accounts for 16.93% of the total surface water.

Comparison of flood extension between 1998 and 1999

In October 1998 and 1999, important floods occurred in the area of Saint-Louis. Their respective extents were compared with satellite images by a multi-temporal approach. It arises that the floods were of 1999 were more important in term of surfaces flooded compared to those of 1998 (Table 4).

Year	No. of objects	Min	Mean	Max	Somme	Stand. Dev.
1998	510	400	41915.29	5104800	21376800	317499.44
1999	1062	400	86145.01	13822800	91486000	618155.77

Table 4: Statistics of the two SPOT images (1998–1999)

The 1999 floods have affected non flooded surfaces in 1998. The extent of flooded surfaces in 1999 represents 70,109 km^2 more ever than that of 1998.

THE DIGITAL ELEVATION MODEL

The relief of the area of St Louis is very low. The first peaks of altitude 10 to 15 m are located at several kilometers of the river. In the interior of the city the topography does not exceed 3m. The maps were delineated using topographic base maps with contour intervals of 10 feet, except in the city, where the contour intervals were five feet. The status of the topographic maps and the lack of high-resolution elevation data pose great difficulties. Availability and use of a DEM would expedite planning and development of land use for precision agriculture, drainage systems, land subdivision, utilities, commercial and industrial districts, etc., and improve the quality of soils mapping.

The solution chosen to establish a DTM was to exploit the altimetric data provided in the form of point sides and level lines by JICA5 and SEGECOT maps. The precision of these altimetric data is unfortunately not easily measurable. Indeed, we don't know the reliability of the original data, neither the methods employed to obtain these data, and even less the geoids.

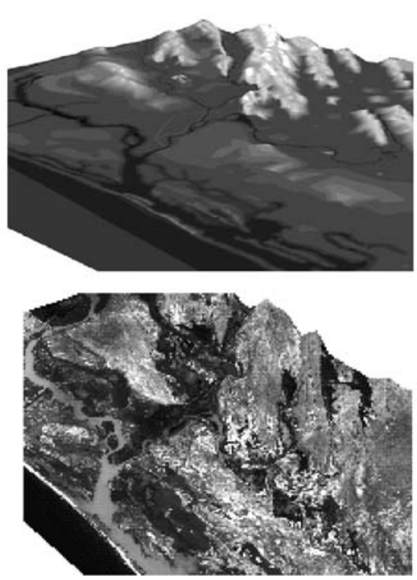


Figure 12a. DTM of the estuary area

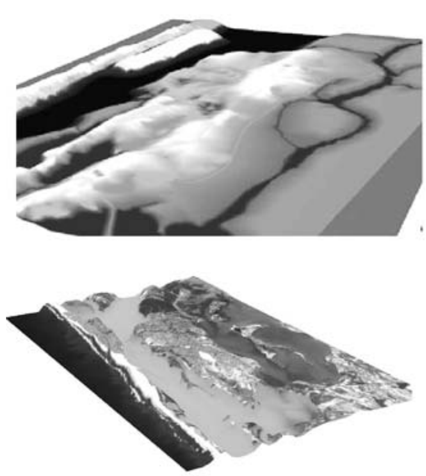


Figure 12b. DTM of the town of Saint-Louis

The traditional method of satellite data combination (Spot 4) and the gathering of important information made it possible to produce a Geographical Information System to monitor floods in the lower estuary of the Senegal River valley. Remote Sensing, DTM and GIS seem to be powerful tools for combining important information for a better comprehension of the floods and the characterization of surface qualities on the estuary.

We developed a Geographic Information System including approximately many layers of local and/or regional spatial data. We backdated relevant parameters such that the GIS is both uniformly formatted and historically accurate. With this GIS in place, we are able to assess the flood extension.

By a multi-temporal approach, we established the qualitative and quantitative impact of floods on the various geographical objects, a detailed cartography of the occupation of the ground, the surfaces flooded in 1998 and 1999. The study undertaken to St Louis made possible to consider surfaces flooded in 1999 and to understand the width of these floods compared to those of 1998. The constitution of a tool of decision-making aid makes possible to have information relating to the limits reached by the flood, the surface of flooded surfaces and to detect the more exposed zones (the most reached) in order to establish a hierarchical map according to the percentage of exposure to the risk of the geographical objects touched by the floods (populations), road infrastructures and tracks, medical and social infrastructures, perimeters of cultures (agriculture), etc.

LESSONS LEARNED

African countries know unceasingly and almost each year dramatic natural disasters. It is the case in particular of Algeria (with repetitive earthquakes), Mozambique, Zimbabwe, and Senegal (which was struck by floods). Many of these disasters especially affected poor populations and had serious effects on the already fragile and unstable local economies. Their consequences are all the more serious as these affected populations do not have the means of being protected from such catastrophes and the States could not set up true policies or strategies of prevention or reduction of the natural disasters. The few rare strategies are often inappropriate and dedicated to the failure.

Disaster risk reduction and management approach is relatively new in concept as well as in practice. Although a few countries have adopted risk management concepts and principles in disaster management, most countries, especially developing countries, remain unfamiliar with this approach. The prevailing practices, particularly in Africa, are more inclined towards managing response to disasters (which requires preparedness) than towards managing risks and the underlying conditions that lead to disasters (which requires, among others, risk assessment, vulnerability reduction, and capacity enhancement).

In the Senegal River valley and estuary for example, poor and socially disadvantaged groups are usually the most vulnerable and affected by floods. These disasters, in turn, are a source of transient hardship and distress and a factor contributing to persistent poverty. Indeed, at the household level, poverty is the single most important factor determining vulnerability. In Senegal, the prevalence of poverty is very high. In 1994, the first Household Budget/Consumption Survey (ESAM-I)[4] made it possible to estimate the proportion of households below the poverty threshold (fixed at 2,400 calories per adult equivalent and per day) at 57.9 percent. On the basis of extrapolations made from the CWIQ[5] (2001) data, the percentage of households below the poverty threshold is about 53.9 percent, i.e. a slight drop compared with 1994, as a result certainly of the increase in per capita income over the period 1995-2001. However, these figures are well below the findings of the EPPS[6] (2001) according to which 65 percent of the households interviewed (same sample as the CWIQ) consider themselves poor and 23 percent even rate themselves as very poor. Moreover, 64 percent of the households declare that poverty has worsened over the past five years, a perception that is contrary to what is stated above. This apparent contradiction undoubtedly results from different criteria for assessing poverty.

Poverty in Senegal is located for a large part in the rural areas and more especially in the rural zones of the Center, South and Northeast. This concentration of poverty in rural areas is also confirmed by the EPPS (2001): in point of fact, in rural areas the incidence of poverty varies between 72 percent and 88 percent while in urban zones it ranges between 44 percent and 59 percent. In both cases, the incidence of poverty remains high. This situation is especially worsened by the floods which strike the rural populations. For example, the floods that swept through Senegal between 9-11 January 2002 led to the loss of 28 lives, with over 100,000 other affected. A damage assessment revealed that an estimated 105,471 head of livestock had perished and 13,993 homes here demolished. As much as 581 ha of crops were washed away. Approximately 1,537 tons of rice was also destroyed.

The 1994, 1999 and 2003 floods in the basin were also unusual, for both their depth and duration. Unlike the normal floods, which cover large parts of the valley for several days or weeks during August to September, the floods in 1999 lasted until mid-October in many areas, killing people and destroying roads, houses, crops, and other assets. Flood impacts have been severe in the zone because of the high levels of vulnerability and low levels of resilience of the population, the lack of adequate physical protection infrastructure and changing flooding patterns due to environmental change and the impact of the dam's structures.

Thus, to attenuate the impact of the natural disasters on the poor populations, it is important to undertake in-depth studies on the relation between disaster and poverty. Our project tries to tackle this question in the Senegal River basin by using space technology to map the floods extension and thus to identify area and populations which are touched or which are in danger. The establishment of this project provided a beginning of coordinated approach to a flood mitigation strategy for the Senegal estuary and lower valley. Since 1999, the local scientist community and local authorities try to made good progress in addressing the existing flood threats in the area.

The Government of Senegal, for instance, identifies floods in the Senegal River as one of the factors eroding the income of the poor populations via crisis-related expenditure and reductions in income earning capabilities. Furthermore, it recognizes that poverty alleviation cannot be achieved simply by increasing income, but instead requires a range of other measures, including the strengthening of local capacity to protect the poor against these floods.

In this case, recent catastrophic floods (2001 and 2003) all over the basin have raised new questions as to traditional approaches in dealing with such extreme events. The increasing occupation of floodplains around the city of Saint Louis in the

[4] Household Budget/Consumption Survey

[5] Core Welfare Indicators Questionnaire

[6] Household Survey on Perception of Poverty in Senegal

estuary, competing and conflicting developmental demands in the lower valley have exacerbated the impacts of floods on society and the environment. Furthermore, the concerns of human vulnerability and an environment that can be further mismanaged or abused, have focused attention to the need for more integrated, anticipatory, and far-reaching water policies and strategies. Understanding and responding to floods requires a comprehensive view of intervening environmental, social and economic factors. This calls for joint approaches by all relevant national agencies, as well as for the development of integrated support strategies by international agencies with expertise on the subject, as UNEP (United Nations Environment Programme) or UN/ISDR (International Strategy for Disaster Reduction).

The Senegalese Government should continue to give priority attention to its strategy for Disaster Reduction as a common platform for responding to the challenges presented by the increased incidence and scale of floods in the lower valley.

The analysis and lessons learned from prior experiences of floods help to define profiles of risk attached to people, activities and places that share attributes, in the face of particular potential sources of damage. Understanding risk relates to the ability to define what could happen in the future, given a range of possible alternatives. Assessing risks, based on vulnerability and hazard analysis, is a required step for the adoption of adequate and successful disaster reduction policies and measure in the Senegal River estuary.

The project allows us to carry out several fields works and to collect many information and data related to the floods and to carry out a GIS. The investigations gave an idea on the overall organisation of the study zone in particular on the occupation of the easily flooded area around the town of Saint-Louis and some villages and small towns in the lower valley. The investigations allowed by stepping of testimonies to define the limit of the extension of the past floods and to index the level of the various historical risings. In this study the issue of flood hazard mapping has been addressed from the perspective of different mapping scale in a GIS environment. The flood hazard map is particularly handy for the planners and administrators for formulating remedial strategy. It also makes the process of resource allocation simple resulting in a smooth and effective implementation of the adopted flood management strategy. The aim of this regional study is to broadly identify the high hazard area in the area around the city of Saint-Louis and in the lower estuary of the Senegal River valley. Our project eventually leads to identification of the higher hazard zone.

This project meet a double aim: on the one hand to better include/understand the dynamic of the floods in the estuary, on the other hand to produce documents for early alarm in direction to the authorities and to place at their disposal tools of decision making. Its purpose was to provide a preliminary approach that can be used as a demonstration of the capabilities, applications and advantages of satellite images, and as a guide for future investigations. Remote Sensing technology has its special superiority and potentiality for flood monitoring and assessment, so it has been applied for this purpose in this project, especially for the disaster resulting from floods. A lot of scientific and practical achievements have been obtained in the study area. The information on inundated area and the variation of river channel was successfully obtained. In 1998 and 1999, by using the SPOT satellites images, the floods occur in the lower estuary of the Senegal River were investigated separately. After that, a lot of local experts recognized the importance of remote sensing image data for disaster risk reduction especially for the town of Saint-Louis in the lower valley and suggested to set-up the real time transmission system of airborne remote sensing for disaster monitoring with data providers.

This is a pilot study, and has not been subject to the rigorous calibration and validation exercise normally expected in a more advanced risk reduction assessment. This means that the results and findings should be considered as preliminary. Our project has thus the merit to apply such a step and to have satisfactory results. The GIS developed constitutes a tool of decision making aid for governmental and local authorities.

Bibliography

Codata (2002): Scientific Data for decision making toward sustainable development Senegal River Basin: Case Study. Workshop, March 11-15, 2002, Dakar, Senegal.

Diop Isabelle Niang, Dansokho Mamadou, LY Ibrahima., Niang Seydou (2002): Senegal national report. Phase 1: Integrated problem Analysis. GEF MSP Sub-Saharan Africa Project (GF/6010-0016): "Development and Protection of the Coastal and Marine Environment in Sub-Saharan Africa"

Gilif (2002: Gestion intégrée du littoral et du bassin fluvial du Sénégal, Rapport final, 2002

IRD, (2001): Programme d'Optimisation des Reservoires. Rapport préliminaire.

Sandholt and al., (2000): Remote Sensing Techniques for Flood Monitoring in the Senegal River Valley.

Republic of Senegal (2002): Poverty reduction strategy paper.

Vengroff Richard, (2000): Decentralization, Democratization and Development in Senegal, Department of Political Science, University of Connecticut, Storrs, CT 06269-1024. Paper prepared for delivery at the Yale Colloquium on Decentralization and Development, January 21, 2000.

Philippines

Coastal erosion vulnerability mapping along the southern coast of La Union, Philippines

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INTRODUCTION

The coastal zone of the Philippines covers approximately 11,000 km^2, which accounts for less than 4% of the country's total land area but is home to almost 50 million people or 63% of the country's total population. As population and investments in infrastructures steadily grow along with rapid urbanization and expansion, coastal communities become more and more at risk or vulnerable to coastal hazards such as tsunamis, storm surges and erosion: the latter being the most widespread and persistent in the past several decades.

Coastal erosion is common in the Philippines despite the present-day elevated sediment yield of rivers. Erosion could be due to natural factors, for instance, river mouth switching in the bayhead of Lingayen Gulf (Mateo and Siringan, submitted), mass wasting as a result of rapid sedimentation at the mouth of the Bucao River in Zambales (Siringan and Ringor, 1996), and return to normal sediment yield of rivers years after a volcanic eruption in Pamatawan Delta, Zambales (Siringan and Ringor, 1996). However, there are just as many coastal segments where erosion is attributed directly to human activities. Erosion along the shores of Pampanga and Cavite in Manila Bay is attributed to dam construction and offshore sand mining, respectively (Siringan and Ringor, 1997; Doruelo, 2000). Thus, for proper mitigation, if amenable, the cause or causes of erosion should be established. Including the abovementioned work, only few studies, however, address this problem (e.g., Siringan et al., 1999; Siringan and Jaraula, 2002).

This study sought to develop a coastal vulnerability index for southern La Union. Coastal segments were classified according to the degree of vulnerability to erosion based on established shoreline trends, known coastal characteristics and available socio-economic information. Long-term or decadal trends of shoreline changes were derived from time-series analysis of maps and anecdotal accounts. Probable causes of shoreline changes and the common response of the government and affected communities are also presented. The results of this study hopefully will be used to guide the government and stakeholders to come up with development plans and disaster management strategies, and to refine or formulate policies that would consider the consequences of coastal erosion.

STUDY AREA

Situated in northwestern Luzon is the 60-km north-south trending coastal stretch of southern La Union, from San Fernando in the north to Sto. Tomas in the south (Fig. 1). Except in San Fernando, wherein some coastal segments are made up of rocky headlands and some are fringed by coral reefs, the entire coastline of the study area is characterized by sandy beaches along gentle coastal plains. Two large river systems drain into the area, Bauang and Aringay Rivers, which have watershed areas of 516 km^2 and 397 km^2, respectively (Siringan and Mateo, 1999). Wind data indicate predominant winds coming from the northwest. At wind speed ranging from 2 to 6 m/s during normal conditions, waves with significant height of less than 1 m are generated; at 10 to 20 m/s, wave heights reach over 3 m (Woodward Clyde, 1999). Wind-driven circulation model by Delas Alas (1981) indicate the predominance of southerly currents in the area. Sediments coming from Bauang and Aringay Rivers, coupled with the predominant southerly longshore currents, formed the Sto. Tomas spit, an elongated sand body that extends from the delta flanks of Aringay southwards to approximately 12.5 km The study area covers the towns of San Fernando, Bauang, Caba, Aringay, Agoo and Sto. Tomas (Fig. 1), of which 48 coastal barangays (barangay is the smallest political unit in the Philippines) are included.

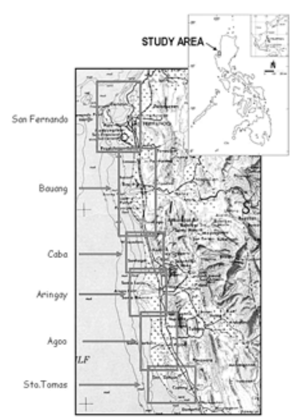

Figure 1. The study area consists of six coastal municipalities in southern La Union. Boxes show the coastline extent of each municipality.

METHODS AND DATABASE

Several steps were undertaken before the coastal vulnerability index (CVI) was developed. Physical and socio-economic data were acquired from primary and secondary sources. The physical data included establishing trends of shoreline and bathymetric (or water depth) changes. Shoreline trend analysis was complemented by interviews of long-time coastal residents. Collectively, these data were used to construct the coastal vulnerability index for southern La Union.

Shoreline trend analysis

Long-term changes in shoreline position were determined by overlaying digitized shoreline from old maps and from a recent GPS survey (Table 1). The present shoreline was mapped by taking GPS readings, with average accuracy of ±8m, every approximately 30 to 40 m while walking the coast. To properly position the GPS readings on the map, GPS fix of ground control points, such as major road intersections and bridges, were also obtained. The different shorelines were corrected for differences in projection and were superimposed on vertical aerial photographs taken in 1990, again using prominent features such as roads and intersections as control points. Although the aerial photographs were not corrected for distortion, possible distortion was minimized by cropping the edges and making use of the central part of each frame before stitching them together using a graphics software.

The maximum amount of shoreline translation was measured perpendicular to the shoreline orientation along a particular segment. In the succeeding sections, shoreline position based on the 1944 and 1956 maps is denoted as 1940s because the information used in the maps was based on aerial photography from the 40s. Similarly, the 1970s shoreline is derived from the 1977 topographic map; although the data could have been acquired earlier as the source of information was not indicated in the map.

Ground-truthing of these changes was performed during the course of the GPS survey by taking note of coastal features associated with erosion and accretion. Photographs were also taken for documentation.

Bathymetric change

Although the year of the survey was not indicated, the 1977 map represents water depth information sometime within 1940s to 1970s because it contains information not reported in the early 1900s survey. The water depth data from the 1977 map were georeferenced and digitized to extract the old bathymetry.

Except off the coast of Caba, which was surveyed in August and January, 2002 (Siringan and Jaraula, 2002), bathymetric survey for the rest of the study area was conducted in April and September, 2003 using Garmin GPS sounder with an accuracy of ±15 m for position and ±10 cm for water depth. Along a zigzag route perpendicular to the coast, at an average cruising speed of 10 km/h, water depth and

Year	Type of Data	Area of coverage	Reference
1901	Map	San Fernando	In Meimban, 1997. La Union: The Making of a Province (1850-1921).
1944	1:50,000 topographic map	San Fernando to Bauang	USC&GS Map sheet 3160 I (based on 1944 aerial photography)
1956	1:50,000 topographic map	Bauang to Sto. Tomas	Corps of Engineer, US Army map sheets 3068 I and 3069 II (based on 1946, 1947 and 1959 aerial photography)
1977	1:50,000 topographic map	San Fernando to Sto. Tomas	NAMRIA map sheets 7075 I and 7076 II (source of data not indicated)
1991	1:40,000 vertical aerial photographs	San Fernando to Sto. Tomas	NAMRIA
2003	GPS survey	San Fernando to Sto. Tomas	This study

Table 1. Database used in determining long-term trends of shoreline changes.

position were acquired every two seconds. Both old and new raw data were then gridded using a 50 x 50 m square grid. Changes in bathymetry were calculated by subtracting the gridded output. A blanking file was generated from the plotted new data such that only the changes within the area covered by the recent survey are considered. Correction for tides and waves was not applied.

Social survey

Interviews of longtime residents with good recall of events were conducted to validate, augment and complement field data and to understand how the locals perceive the cause of erosion and how they respond to it. The survey questionnaire, with emphasis on shoreline and land use changes, was modified from the instrument used by Siringan and Rodolfo (2002) and was first tested in Wenceslao, Caba (Siringan and Jaraula, 2002). In each municipality, barangays showing significant long-term shoreline changes as assessed from spatial data were selected: six from San Fernando City, four from Sto. Tomas, three each from Caba and Agoo, and two each for Bauang and Aringay. From the 20 barangays chosen, 63 respondents aged 30 to 84 years old, mostly between 55 to 60 years old, were interviewed. Almost all of the respondents are fishermen and barangay officials.

Coastal Vulnerability Index

The Coastal Vulnerability Index (CVI) for the study area was developed following mainly the method of McLaughlin et al. (2002). Variables contributing significantly to the study area's vulnerability to erosion were chosen and grouped into three sub-indices: coastal characteristics (wave buffers, substrate, shoreface slope and shoreline evolution), natural (wave exposure) and anthropogenic forcings (mining history), and socio-economic characteristics (population, land use, roads and bridges, cultural and historical landmarks, and conservation status). Each variable is then ranked on a scale of 1 to 5, with 5 being the most vulnerable and 1 the least, according to their perceived level of vulnerability. After the scores per sub-index are added, the final CVI score was calculated by getting the sum of the partial weight of each sub index: 40% for coastal characteristics, 20% forcing and 40% socio-economic. Calculation for CVI was limited to barangay level, which is the highest resolution of the available socio-economic data. Four categories were used in classifying the vulnerability of the coastal barangays: low, medium, high and extremely high. A color code is then assigned to each category to derive a coastal vulnerability map. Below is a brief description of the variables used and how they were ranked.

Coastal characteristics

Coral reefs, sand dunes and mangroves are natural coastal features, which serve as buffers against the erosive energy of waves. Thus, the presence of these features lessens a coastal segment's vulnerability to erosion. Areas where any of these natural buffers is present are given a score of 1 and where not one of these features is present, a score of 5.

In the study area, the substrates encountered are bare rock or cliff, mud and sand. Among the three, bare rock or cliffs are the least vulnerable to erosion because they are more indurated and therefore, more difficult to entrain. Sandy beaches, on the other hand, would be the most vulnerable to erosion; although larger in grain size and heavier as opposed to mud, sand is less cohesive and therefore, relatively easier to erode. A score of 1 is given to areas with bare rock or rocky beach, mud flats 3 and sandy beaches 5.

Shoreface slope on a regional scale affects the waves that reach the coastline. Areas with steeper slope allow waves to break closer to the coast and thus, enhancing erosion. Along coastal segments with gentler slope, waves approaching the shore break at a greater distance from the shore therefore, dissipating much of the wave energy before hitting the shoreline. Shoreface slope for each coastal barangay was calculated from the new bathymetric data. Slopes values were divided into five equal ranges: the lowest range was given a rank of 1 whereas the highest range a rank 5.

Ranking for the shoreline evolution variable is derived from the established long-term trend of shoreline changes in the study area (see Results and Discussion): rapidly translating, rapidly retreating, slowly retreating, highly variable and relatively "stable". This classification considers the time factor – how the coast behaved in the past several decades – which may also give us an idea of how it might respond to processes and events in the future. Furthermore, it takes into account the geomorphological setting (e.g., delta, spit) and relative proximity to major sediment sources, which may or may not be an advantage (see Results and Discussion). Barangays along rapidly translating coastal segments, although not necessarily eroding, are given the highest score because of the high potential for erosion. Consistently rapidly eroding shorelines are ranked 4, and the retreating, but at a slower pace, shorelines ranked 3. Less vulnerable, with score of 2, are highly variable coastal segments, wherein no consistent trend of change occurs. Least vulnerable to erosion are the relatively "stable" coasts; in the past several decades, the shoreline along these coastal segments appears to have remained constant.

Natural and anthropogenic forcings

Only two variables are included in this sub-index: wave exposure and coastal mining history. In evaluating a coastal segment's relative exposure to waves, the predominant wind direction, which is northwest, was used as proxy. The most vulnerable segment, therefore, would be one facing northwest whereas a south-facing segment the least vulnerable.

Magnetite sand mining by Filmag in the 60s to 70s along almost the entire La Union coast negatively impacted the coast. This activity physically removed huge volumes of sand from the beach, loosened materials thereby making it easily transported by waves and removed a natural beach armor, the heavy magnetite sand. The negative effect of coastal mining trailed long after the operations stopped; therefore, we assigned a score of 1 for coastal segments not mined and 5 for those mined by Filmag.

Socio-economic characteristics

Information about the socio-economic variables are based largely on reports obtained from each locality namely, the comprehensive land use plan of San Fernando City, Aringay, Caba, Agoo and Sto. Tomas; municipal development report of Bauang and coastal development framework of La Union. These are supplemented by secondary data obtained from each municipal/city hall.

Instead of classifying the coast according to settlement type, population density, or the number of persons per hectare, was used. Population densities in coastal barangays range between 2 and 362 persons per hectare. Only Caba and Aringay registered lower figures than the average population density of 4 persons per heactare in the entire La Union. On the other hand, three barangays (Ilocanos Norte, Ilocanos Sur and Baluarte) have densities greater than 100 persons per hectare; hence, a rank of 5 was assigned to areas with at least 100 persons per hectare and a rank of 1 to areas with less than 10 persons per hectare. The difference between the upper and lower limits was equally distributed over the remaining ranks.

The ranking was simpler for the other categories. In land use, residential area has been omitted since it is already incorporated in the population ranking. The

Sub-index 1. Coastal characteristics.

VARIABLE	1	2	3	4	5
Natural buffers (coral reefs, dunes, mangroves)	present			none	
Substrate	Bare rock, cliff	Mudflat	Sandy beach/ Sand flat		
Shoreface slope	<0.8°	0.8-1.4°	1.4-2.1°	2.1-2.7°	2.7-3.4°
Shoreline evolution	Relatively "stable"	Highly variable	Slowly retreating	Rapidly retreating	Rapidly translating

Sub-index 2. Natural and anthropogenic forcings.

VARIABLE	1	2	3	4	5
Wave exposure relative to NW winds	S-facing	SW-facing	N-facing	W-facing	NW-facing
Mining history	none				present

Sub-index 3. Socio-economic characteristics.

VARIABLE	1	2	3	4	5
Population	<10 per ha.	10-40 per ha.	40-70 per ha.	70-100 per ha.	>100 per ha.
Land use	Natural habitat/ Open spaces	Institutional/Parks/ Health Facilities	Aquaculture/ Agriculture	Commercial/Resorts	Industrial (plants and ports)
Roads and bridges	None		Provincial/Municipal/ Barangay	National	
Cultural/Historical landmarks	None				present
Conservation status	None				present

rest of the categories were ranked according to their relative economic significance in the area. Highest ranked are industrial areas, followed by commercial, agricultural, institutional and natural habitats. This ranking does not belittle the socio-economic importance of natural habitats; the presence of such habitats could make the shoreline more stable and therefore, less vulnerable to erosion.

Roads and bridges were categorized into barangay, municipal/city, provincial or national. Because of the difficulty to distinguish one from the other, barangay, municipal and provincial roads were lumped into a single category and given a rank of 3. National roads were assigned a rank of 5 due to its scale and higher construction costs, which translates to greater budgetary requirements for repairs, if and when needed.

The last two variables – landmarks and conservation status – are dichotomous and limited to presence or absence. Historical and cultural landmarks include lighthouses, bell towers, monuments, old churches and buildings and even railways. A major conduit to the north from early 1900s until the 1970s, the provincial government plan to restore the railways. In terms of the last category, many coastal areas in La Union are part of the Network of Protected Agricultural Areas (PLUC-TWG, 1996), which primarily limits further industrialization of important agricultural lands. Existing natural habitats such as Carlatan Lagoon are also under conservation status.

RESULTS AND DISCUSSION

Trends and causes of shoreline changes along the coast of southern La Union

Long-term changes

Time-series analysis of maps and images coupled with social survey results (Fig. 2) show that erosion from the 1940s to present is prevalent along the 60-km long coast of southern La Union. This is corroborated by changes in bathymetry, which indicate an overall deepening in the nearshore areas. Spatially, the coastal stretch can be divided into five types based on the magnitude and trend of shoreline change: rapidly translating, relatively "stable", rapidly retreating, slowly retreating, and highly variable coasts.

Coastal segments along the southern flanks of the Bauang and Aringay River deltas experienced large shoreline translations during the past six decades (Fig. 2). In Parian Oeste and Payocpoc Norte/Oeste in Bauang, the shoreline advanced by 650 m from 1940s to 1970s, 800m from 1970s to 1991 and 600m from 1991 to present. Shifting of river mouth and the elongation of the spit accompanied this series of net land gain from the northern end of the mouth towards the south. In contrast, the adjacent coastal stretch of Payocpoc Sur, Pilar and Santiago retreated by 550 m from 1970s to the present. Residents from Pilar, however, noted as much as 1700 m of land loss since 1940s. The land area of

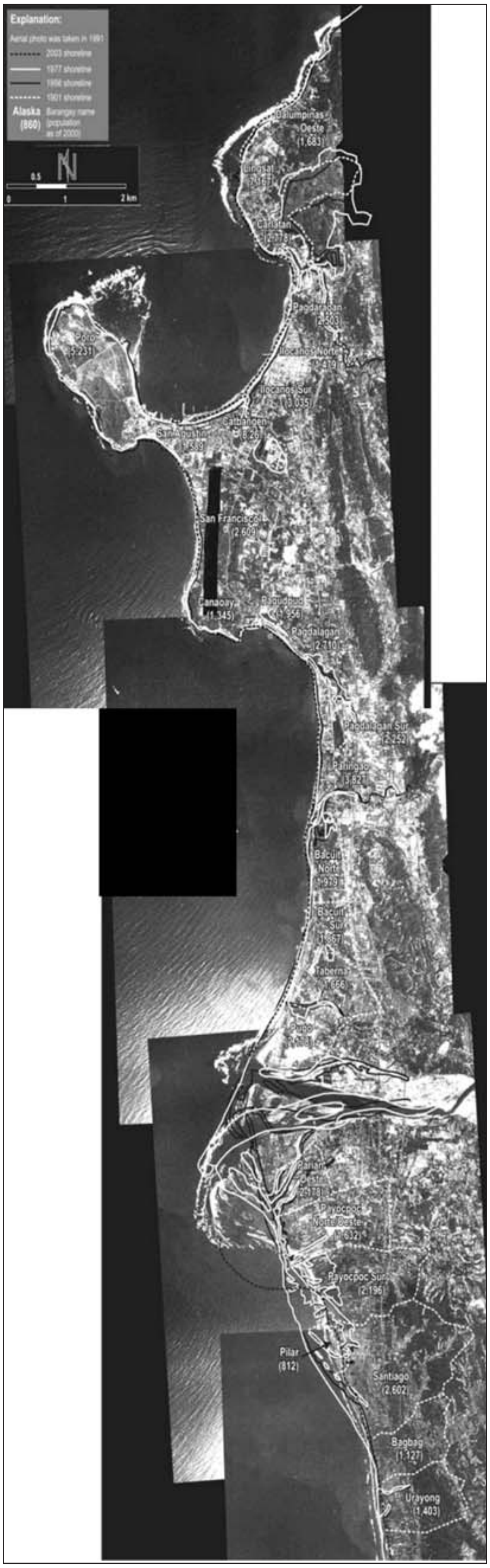

Figure 2. Changes in shoreline position over decadal time scales. Also shown are the barangay limits and corresponding population data for year 2000.

this barangay was reduced to 3 ha from the original 11.5 ha. The coastal segment immediately south of the Aringay river mouth, in Alaska, gained 400 m of land from 1940s to 1970s, but lost 500 m when the shoreline retreated since then. Locals from this barangay observed 480 to 1300 m of sea encroachment since the 1960s. Farther south, in Dulao, Sta. Rita Central and Sta. Rita West, the shoreline consistently prograded and is at present 800 m of its 1940s position. Respondents from Dulao reported a consistent trend, whereas Sta. Rita West folks had the opposite observation. These large and rapid changes have been occurring even prior to the 1940s as these regions are labeled as such in the 1940s maps.

A marked contrast occurs north of the deltas; along Pagdalagan Sur through Pugo and Santiago Sur through Samara, the shoreline appears to have undergone minimal changes (Fig. 2). Based on the maps, slight accretion occurred along these coastal segments. This is, however, inconsistent with the 200 to 500 m land loss observed by Baccuit Sur residents.

Shoreline retreat has been predominant since the 1940s along Bagbag through San Carlos in Caba, and Sta. Rita Sur through San Isidro in Agoo (Fig. 2). Maps indicate 150-250 m of net erosion, but the locals give larger estimates of land loss: 500 to 1000 m in Wenceslao and San Carlos, 1000 to 2000 m in Baluarte, and 300 to 535 m in San Manuel. At present, a series of groins and bulkheads line the coast of Agoo. Construction of these structures started in the 1980s. Similarly, the entire coast of San Fernando has been retreating, but at a slower pace (Fig. 2). Maps dating back to 1900s, indicate shoreline fluctuations throughout the San Fernando coast in the order of a few tens of meters. This trend is consistent with the anecdotal accounts: a maximum land loss of 70 m since the 1960s.

The western coast of Sto. Tomas is on a southeast-accreting spit. This thin strip of land includes Baybay, Cabaroan and Narvacan, the westernmost shoreline of which can be characterized as highly variable (Fig. 2). Based on the maps, no consistent shoreline trend exists and variation occurs along 1 to 3 km-long segments of the coast; however, residents from Narvacan narrated that 300 to 1000 m of retreat occurred since the 1960s. The most conspicuous change occurred in the southernmost terminus of the spit, which extended by as much as 1000 m in about 50 years.

The apparent inconsistencies between the magnitudes of erosion derived from the time-series analysis of maps and the social survey may be explained by the different perspectives provided by these datasets. Shoreline positions from maps, because they were derived from aerial photographs, provide a snapshot of the area during a specific time only – that is, when the aerial photo was taken. On the other hand, the observations of the locals span a longer period of time. However, errors may arise in the respondents' estimate of distances, which vary from person to person. This can be tested by checking how a particular change at a particular time was consistently quoted by the respondents in a barangay. Nonetheless, the general trends derived from the maps and from anecdotal accounts are consistent.

Changes in bathymetry during the past decades confirm the abovementioned results. Along coastal segments where significant erosion took place, deepening occurred in the immediate vicinity. This is exhibited off Payocpoc Sur through Wenceslao, Samara, Alaska, and Sta. Rita Sur through San Manuel Norte, where as much as 4 m of deepening occurred. Likewise, San Fernando Bay generally deepened, except for its central part which underwent shallowing. Maximum deepening of about 8 m took place in the narrow passage of the mouth of San Fernando Bay. Conversely, shoaling occurred where progradation is considerable. This is seen adjacent to the mouth of Bauang and Aringay River. In Bauang, the offshore area fronting Parian Oeste and Payocpoc Norte/Oeste became shallower by 3 to 9 m. The same amount of shoaling took place in front of the Aringay River mouth, whereas offshore Dulao through Sta. Rita West, water depth shallowed by 5 m. Shoaling of approximately 4 m in the offshore area shows two along-coast elongate pattern originating in front of the Bauang River mouth and extending south, 3 km off the coast of Santiago Sur. A similar pattern is observed south of Aringay River. The area of shallowing close to the coast, however, extends only in front of Sta. Rita West whereas the more distal area of shoaling reaches about 1 km offshore Baybay. These spatial variations in bathymetric change indicate sites where sediments are being removed and where they are being deposited. The trends observed in the study area show that in general, sediments that are eroded from the coast are delivered offshore. Furthermore, materials coming from the rivers are mostly deposited to the south, which is consistent with the predominant southward longshore drift in the area.

Response to coastal changes

Individually or as a community, the people of La Union responded to the prevalent erosion either by temporarily evacuating, relocating, building ripraps or sandbags, or if funds are available, by constructing seawalls (Fig. 3). Short-term erosion that occurs during storms or typhoons prompts affected communities to temporarily evacuate to a safer place; nevertheless, when conditions return to normal and partial or full beach recovery occurs, residents go back and restore whatever's left of their properties. In a lot of cases, however, beach recovery does not happen and people are forced to relocate, usually just several meters inland. Relocating has become frequent for many, especially for those living in persistently eroding coastal segments. In the case of Pilar in Bauang, residents have transferred five times already since 1975. To protect properties and infrastructures from erosion, private individuals and some communities resorted to building structures like ripraps, sandbags and seawalls. The ripraps and sandbags, according to the locals, were not effective in preventing erosion and maintaining them became costly in the long run. Those who have more resources, such as along Carlatan in San Fernando, construct more robust structures.

Figure 3. Cheaper alternatives to the more expensive coastal protection structures: sandbags in Wenceslao (top) and ripraps in Alaska (bottom). In the long run, however, maintaining these structures also becomes costly.

On the Government's part, huge funds have been allocated to construct coastal engineering structures to counter erosion. In 1980, a 1.5 km-long seawall was built in Sta. Rita to protect the Agoo-Damortis National Park. The entire structure was completed in 1988; however, its southern end had to be repaired periodically due to weak foundation. The 1990 earthquake further damaged the base of the seawall, which prompted the construction of its second layer. This, and the original construction of the Sta. Rita seawall over a period of 14 years, from 1980 to 1994, cost approximately PhP250 M. Since 1984, a series of groins and bulkheads have been put up to protect the Agoo-Sto. Tomas coast. Initially built to protect the pavement just south of Agoo Playa compound, groin construction was further extended to San Julian Norte, Agoo in the north and to Sto. Tomas in the south. At present, more than 60 groins, costing around PhP57 M, dot the Agoo to Sto. Tomas coastline. More groins are being proposed for construction to arrest the erosion of areas downdrift of these structures.

On the contrary, new coastal lands formed by progradation are promptly occupied and even titled, though by law it should be public land (Commonwealth Act 141, Chapter IX). In Sta. Rita Central, Aringay, shoreline prograded by approximately 350 m from 1940s to 1970s. This newly-accreted land is now inhabited and the Agoo-Damortis National Park, which includes a basketball court, church, resort, cemented access road and the seawall, is built on it (Fig. 4). In the past 30 years, another 450 m of land was added to this coastal stretch and is also being slowly occupied (Fig. 4). This prompt occupation of newly-formed land leads to a lot of problems later on: in Caba, for example, progradation in the late 1930s until 1960s lured people to settle in, but were later forced to relocate several times because of the subsequent erosion that took place (Siringan and Jaraula, 2002). This led to loss of properties. Thus, the local government should be prompt in declaring accreted land as public property to avoid a similar scenario.

Causes

Changes in shoreline position along the southern coast of La Union during the 60-year period can be attributed to natural and anthropogenic factors. Natural causes of erosion include local forcings such as waves, earthquakes and shifting position of river mouth. Constant wave action on the coast brings about erosion by removing materials from the beach and by wearing away hard materials that it cannot carry. Hence, coastal segments where wave energy is high are more prone to erosion than those in more protected settings. The general north-south orientation of La Union's shoreline renders it open to waves originating from South China Sea. Wind data from observations in Poro Point, San Fernando indicate predominant winds coming from the northwest. Typically, waves with significant height of less than a meter are generated at wind speed ranging from 2 to 6 m/s during normal conditions but, at wind speed of 10 to 20 m/s, can reach as high as 3 m (Woodward Clyde, 1999). Furthermore, waves during storms, in the form of storm surges, can be even higher; documented storm surge height in Ilocos Sur, north of the study area, ranges from 3 to10 m (PAGASA, 2002).

Figure 4. In 1980, a 1.5-km long seawall was constructed to protect communities and the Agoo-Damortis National Seashore Park in Sta. Rita (left). At present, however, approximately 450 m of land accreted in front of the structure (below) due to the natural southward drift of sediments coming from Aringay River, 5 km north of the area.

In July 16, 1990, a 7.8-magnitude earthquake rocked central Luzon. This devastating earthquake caused several areas in La Union, specifically along the coasts of Aringay, Agoo and Sto. Tomas to subside instantaneously due to liquefaction: 1 to 2 m in Alaska (anecdotal account), 0.5 m in San Nicolas West, 1 to 2 m in Cabaroan, 1 to 3 m in Narvacan (Geomatrix, 1995), among others. Widespread inundation accompanied the lowering of coastal lands; the most severely-affected area is Alaska, wherein residents recounted about 1 km of sea encroachment (Fig. 5). After the earthquake, the locals in Sto. Tomas observed slight shoreline progradation; but because the land is now lower, it became more prone to erosion. Torres et al. (1994) attributes liquefaction in La Union and in the neighboring provinces to the nature of the underlying material: relatively unconsolidated and water-saturated sands. Aringay sits on a delta, which is built by rapid and continuous deposition of materials from Aringay River. Agoo and Sto. Tomas, are atop very young sandy deposits formed by accumulation of sediments transported by the longshore current.

In contrast to the large shoreline retreat that occurred in Alaska, the coastal stretch to the south, in Dulao and Sta. Rita, experienced rapid land accretion after the earthquake (Fig. 4). These areas are at the receiving end of the eroded materials from Alaska and the sudden influx of sediments from the rivers due to earthquake-induced mass wasting in the upstream. Rapid progradation south of the Bauang River is ascribed to the southward migration of the river mouth coupled with the south-directed longshore currents. However, because these lands are relatively new, they are also likely to experience liquefaction in the future. Furthermore, because these segments are very close to the river, future shifts in river course may lead to rapid erosion. The northern flanks of the deltas, although seemingly "stable" at present, may also be at risk of rapid erosion as shifting of the rivers northwards is also probable. A more northerly position of the river mouths in the distant past, no longer covered by the period with maps, is indicated by scars of previous stream positions, which can be seen in aerial photographs.

On the global scale, widespread erosion can be ascribed to the effects of global warming: decreased precipitation, increased storminess and sea-level rise. El Nino Southern Oscillation (ENSO) record for the past several decades indicates a shift from a La Nina-dominated to El Nino-dominated climate in the 1970s. With El Nino occurring more frequently, the amount of precipitation decreases, hence, river discharge to the coast also goes down. Peak annual discharge data from 1946 to present of the two major rivers in the study area indicate a decline (Streamflow data 1980-2000, 2001), which may be related to the observed shift in climate regime.

Storms and typhoons in the Philippines are very frequent and cause the greatest damage to properties and the most number of lives lost among all the other natural disasters (ADRC, 2002). Residents of La Union attribute about 5 to10 m of erosion to typhoon passage. In the past several decades, the locals observed that the beach is able to recover almost after every typhoon; however, the series of strong typhoons that hit the area in the 1990s hindered the shoreline from returning to its pre-storm position. Typhoons such as Trining (International Code Ruth; October 24, 1991), Mameng (Cybil; September 27, 1995) and Feria (Utor; July 3, 2001) caused significant destruction to the coastal communities of La Union. Should storm frequency continue to increase due to climate change, erosion would accelerate because the affected coastal segments are not able to recover to pre-storm conditions.

Figure 5. Present shoreline of Barangay Alaska is littered with tree stumps indicating that trees used to thrive along the coast. During the July 1990 earthquake, a large area of Alaska subsided by 1 to 2 m as a result of liquefaction. According to the locals, prior to the earthquake, the shoreline was approximately 1 km farther offshore.

Tide-gauge records in the Philippines registered a rise in sea level in the past decades (Siringan et al., 2000). Over the next century, global sea-level rise is projected by the International Panel on Climate Change (IPCC) to range from 15 to 90 cm, with 48 cm as its best estimate (Wigley and Raper, 1992). The values may seem minimal, but the effect of rising sea level on gentle coastal plains, such as in the study area, would be significant as it would allow the sea to encroach farther landwards. Therefore, as sea level continues to rise, erosion will continue to threaten coastal communities.

On top of these natural causes, certain anthropogenic activities exacerbate coastal erosion. The most extensive, and probably the most detrimental, of these activities is the mining of magnetite sand by Filmag Inc. For 10 years, from 1964 to 1974, Filmag extracted approximately 2M cubic meters of magnetite along almost the entire La Union coast, which stretches for about 100 km The total volume of sand extracted would translate to an average deepening of 2 m and shoreline retreat of 10 m per meter of coastal segment. This is a conservative estimate because not the entire La Union coast was mined; hence, certain sections most likely have deepened and retreated more than the estimated values. Furthermore, extracting materials from the coast entails loosening of the substrate, thereby rendering the sediments more susceptible to transport by waves and currents. More importantly, the heavy magnetite sand serves as beach armor; thus, removing them is analogous to destroying the beach's natural protection.

Another human activity that contributes to erosion is the destruction of natural resources, such as coral reefs, sand dunes and native coastal vegetation (e.g., mangroves, aroma trees and the like), which act as natural wave buffers. In San Fernando, for example, coral reefs that extend out to the northeast of Poro and fringe Dalumpinas, Lingsat and Carlatan protect the coastal areas along San Fernando Bay by attenuating waves coming from South China Sea. At present, however, large areas of these reefs have been damaged already due to illegal fishing practices (e.g., dynamite fishing). Thus, erosion along these coastal segments can be due partly to increased impact of waves, which in turn is due to reef destruction. Furthermore, coral reefs contribute considerable amounts of sediments to the beach. The most prolific sand producers are the foraminifers, minute one-celled organisms that secrete $CaCO_3$ tests, which thrive in reef flats with healthy sea grass communities. Destruction of the reef flat or coral reef would deprive the beach of a major sediment source. This is critical for San Fernando, because the major rivers are far and are located downdrift of the bay.

Sand dunes also offer a natural means of protecting the coast. They take the brunt of the waves and also serve as sand reservoir. Sand dunes in Dalumpinas Oeste, according to anecdotal accounts, have been leveled to provide a mining company access to the beach sometime in the 60s to 70s. With the use of loaders, sand was also quarried for construction purposes. At present, the height of the remaining dunes in the area is only a third of its previous level. Further dune degradation is occurring to accommodate more houses and resorts in the area.

To protect properties from erosion, ripraps and makeshift seawalls in Carlatan were built using the exposed rock platform along the coast as primary material. According to a resident, attempts were also made to level this platform, which extends several tens of meters offshore, by blasting the protruding rocks so that Carlatan can have a sandy beach instead of a rocky shore. What the community is unaware of is that the rocky platform also acts as a wave buffer, similar to coral reefs; instead of waves breaking on the coast, incoming waves expend their energy offshore when they encounter the platform, hence reducing erosion.

Erosion is also aggravated by artificial structures that interfere with sediment distribution. A groin promotes beach accretion on the updrift segment of the coast but deprives sediments to the downdrift end, thus, enhancing erosion along that side. The series of groins in Aringay and Agoo (Fig. 6), therefore, is detrimental to the Sto. Tomas coast because they decrease the amount of sediments that normally reaches Sto. Tomas. Geomorphological evidence indicate that Sto. Tomas, a spit, was formed by the accumulation of sediments transported through the south-directed longshore drift. Piers can also serve as groins if the structure's design does not allow sediments to pass through. An example of this is the

Figure 6. Series of groins dotting the Agoo-Sto. Tomas coastline.

Bauang Power Plant Company pier in Pilar, which may enhance erosion to the south by trapping sediments on the north side of the structure. The presence of this structure is critical especially since the coastal stretch south of it has been undergoing severe erosion. Armoring the shoreline with seawalls and revetments, although effective in protecting properties and fixing the shoreline, cause beach narrowing and loss in retreating coasts as demonstrated in Oahu, Hawaii (Fletcher et al., 1997). These structures reduce sediment delivery to the beach by preventing the natural process of "upland" erosion, thus refocusing wave energy on the beach in front of the structure. Furthermore, decreased sediment amount in the updrift beaches means decreased supply to the downdrift segments, hence, amplifying erosion. This appears to be the case along several coastal segments in San Fernando wherein beaches in front of armored structures are either very narrow or completely lost. A similar scenario was observed in front of a series of resorts south of San Fernando through north of the Bauang River (Fig. 7), which indicates that these lighter structures may also induce an effect similar to seawalls and revetments.

Figure 7. Resorts and restaurants line the southern coast of San Fernando and extends to north of Bauang. These structures provide very narrow shoreline setback for beach adjustment, thereby causing an effect similar to impermeable structures like seawalls and revetments. These photographs were taken in San Vicente; the top photo is the view looking north; bottom is looking south.

The net accretion in front of the Sta. Rita seawall, which at present sits behind 450 m of newly-accreted land, is a different case. This is because it is situated along the southern flank of Aringay delta where sediment supply is abundant and transport direction is towards the south. Furthermore, based on the maps (Fig. 1), the seawall and the Agoo-Damortis National Seashore Park are on top of newly-accreted land. Land gain, therefore, is not due to the structure.

Activities in the watershed may also contribute to coastal erosion. Initially, deforestation and urbanization would lead to rapid soil erosion in the uplands, which would translate to large sediment input to the coast and thus, allow progradation. However, as surfaces are covered by grass and cemented pavements, upland erosion decreases and sediment input to the coast declines. This then translates to shoreline erosion. To date, there are no data on the watershed history of the study area; however a decrease in the river's sediment yield due to changes in vegetation cover as documented by Kummer et al. (1994) in other parts of the Philippines could have also occurred in the watersheds of rivers draining into southern La Union.

Vulnerability mapping

Figure 8 shows the vulnerability map derived from computing the coastal vulnerability index (CVI) of each barangay. Coastal segments are marked according to their degree of vulnerability to erosion: extremely high, high, moderate and low. Also presented in the figure are the vulnerability profiles of each barangay represented as pie charts. This method was suggested by previous studies (Gornitz, 1993 in McLaughlin et al., 2002) to distinguish the relative strengths of each sub-index in a particular site. By viewing the index and the profile side by side, one can then have a better understanding of the factors that make an area vulnerable to erosion.

Barangays situated within the immediate vicinity of the mouths of Bauang and Aringay rivers ranked most vulnerable with respect to coastal characteristics. These coastal segments are classified as rapidly translating and thus, are easily affected by shifting of river mouths and sediment delivery from the watershed. The adjacent barangays in Agoo, Sta. Rita Central and Sta. Rita West, where a 1.5-km long seawall was built, also ranked highly vulnerable. Lowest scores were obtained for Poro, San Francisco, Canaoay and San Vicente, all situated in the Lingayen Gulf-facing southern communities of San Fernando City.

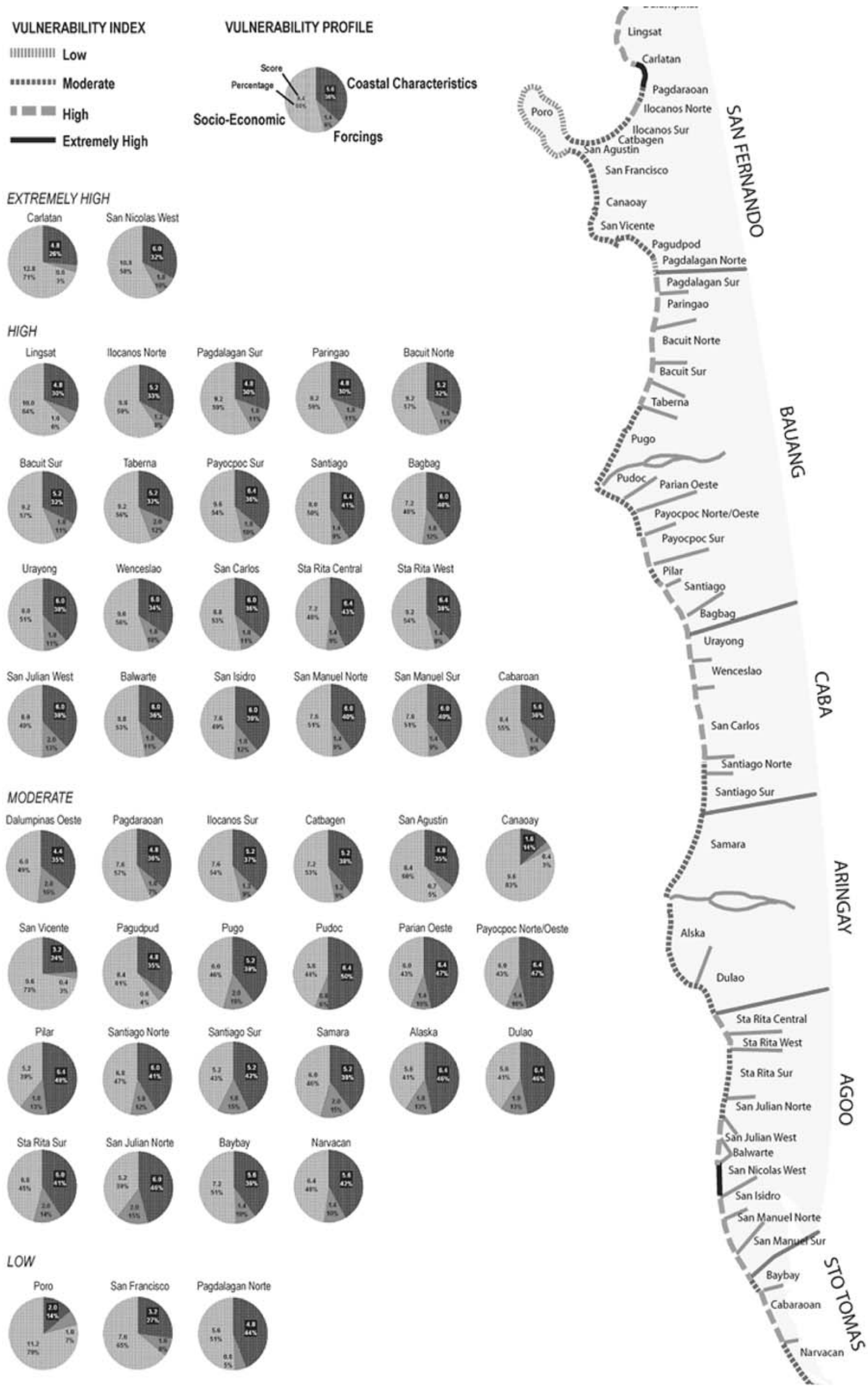

Figure 8. Vulnerability map of the southern coasts of La Union. Relative scores of the coastal characteristics, coastal forcing and socio-economic sub-indices are represented by pie charts.

In terms of coastal forcing, NW-facing areas where mining occurred in the past such as Dalumpinas Oeste in San Fernando, Taberna and Pugo in Bauang, Samara in Alaska, and Sta. Rita, San Julian Norte and San Julian West ranked highly vulnerable. Whereas, the more protected localities along coast of San Fernando City are the least vulnerable. These include Carlatan and the barangays that ranked low in the coastal characteristics sub-index. Ironically, Carlatan had the highest socio-economic scores, together with San Nicolas West in Agoo. Carlatan hosts a number of industries and like San Nicolas West, has a rich cultural heritage. Even more ironic is the fact that the barangays that were previously classified as highly vulnerable with respect to the physical variables had the lowest scores.

The combined scored for the three sub-indices identified Carlatan and San Nicolas West as extremely vulnerable to erosion. Carlatan, although low in natural and anthropogenic forcings, has the highest score in the socio-economic sub-index and also weighed heavily in the coastal characteristics sub-index. As for San Nicolas West, high scores were registered in all three sub-indices. Classified as highly vulnerable to erosion are Lingsat and Ilocanos Norte in San Fernando, barangays north and south of Bauang River (except Pilar), barangays in Agoo (except Sta. Rita Sur, San Nicolas West), and Cabaroan in Sto. Tomas—all situated along west-facing coastal segments. These areas ranked relatively high in the coastal characteristics and the forcings sub-indices and moderate in the socio-economic aspects. The rest of the barangays, mostly rural areas and situated along the flanks of Bauang and Aringay, are identified to be moderately vulnerable to coastal erosion. The least vulnerable areas are Poro and San Francisco in San Fernando and Pagdalagan in Bauang. Socio-economically, Poro and San Francisco ranked high, but low in coastal characteristics. Pagdalagan is not an industrial and commercial area unlike the two others.

Closer examination of the weighted scores of the sub-indices shows that the coastal characteristics and natural and anthropogenic forcings do not vary much. Excluding the scores for Poro (2) and Canaoay (1.6), weighted scores for coastal characteristics cluster from 3.2 to 6.4; Canaoay and Poro are atop bedrock whereas the rest are mostly on sandy coastal plain. Weighted scores for natural and anthropogenic forcings range from 0.4 to 2. What tipped the scale of the vulnerability index are the socio-economic characteristics wherein weighted scores vary from 5.2 to 12.8. This indicates the significant contribution of socio-economic information in assessing an area's vulnerability.

LIMITATIONS OF THE STUDY

Direct relationships between rates of erosion, timing and ultimate causes cannot be established with the data gathered. The time frame provided by maps and aerial photographs is limited; therefore, more interviews are needed to obtain a more statistically reliable data set. We are also constrained by the availability of secondary information, specifically the socio-economic profiles, because of poor record keeping of the offices concerned. The vulnerability index could be refined with more data.

CONCLUSIONS AND RECOMMENDATIONS

Anecdotal accounts are important sources of information on the changes of shoreline position. However, it should be filtered and tempered with other data.

Rates and primary cause/s of erosion vary along contiguous coastal segments; thus, mitigation measures, if still amenable, may also differ accordingly. The cause/s may also change through time. As coastal erosion is a complex problem, it should be studied seriously for more informed course of actions.

Uncontrolled rapid occupation of accreted coastal lands will lead to conflicts with the naturally changing landscape. The local government should, therefore, assert the public domain nature of these new lands to help lessen damages due to subsequent erosion. Since the problem transcends municipal boundaries, the actions for mitigation should therefore be agreed upon by the local government of affected municipalities.

There are three main stakeholders in the area, the marginalized group; the business group; and the government. However, the local government must at the outset protect the interest of the marginalized group, mostly fisherfolks, and look for alternative solutions without compromising or sacrificing their main source of livelihood.

Increase information advocacy to raise the level of awareness on the problem among stakeholders is vital. A shared understanding and recognition of the risk involved in coastal erosion may lead to the affected community's willingness to accept effective mitigation approaches and to support any sustainable use practice introduced. A well-informed community readily accepts the idea of relocating when mitigation through engineering structures may not be effective and relocation is the only best solution. Informed managers from all levels of the government can rechannel limited funds to other projects that can benefit the community.

Of equal importance is the need for the government to refine existing policies and formulate new ones that would specifically address coastal erosion. At present, there are no coastal laws, ordinances or decrees that directly tackle this extensive and persistent problem. Once effective policies are endorsed and approved, the next step is to have strong, political will to institute reforms.

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BIBLIOGRAPHY

Asian Disaster Reduction Center (ADRC), 2002. Philippine Disasters Datasheets.

Comprehensive land use plan of Agoo, La Union.

Comprehensive land use plan of San Fernando City, La Union.

Comprehensive land use plan of Sto. Tomas, La Union.

De las Alas, J.G. 1986. Prediction of the levels and trends of non-oil pollutants in the Lingayen Gulf. University of the Philippines Science Research Foundation. Diliman, Quezon City.

Doruelo, J.C.S., 2000. The dynamics of sediment transport off the coasts of Cavite. MSc Thesis. Univeristy of the Philippines.

Fletcher, C.H., Mullane, R.A. and Richmond, B.M., 1997. Beach loss along armored shorelines on Oahu, Hawaii Islands. Journal of Coastal Research, 13(1): 209-215.

Geomatrix Consultants, Inc., 1995. Geohazard and seismic zonation mapping of the Agoo and Caba urban study areas, unpublished report.

Kummer, D., Conception, R. and Canizares, B., 1994. Environmental degradation in the uplands of Cebu. The Geographical Review. 266-276

Mateo, Z.R.P. and Siringan, F.P., submitted. Tectonic and sea level controls of high-frequency Holocene delta switching and fluvial avulsion in Lingayen Gulf bayhead, northwestern Philippines.

McLaughlin, S., McKenna, J., and Cooper, J.A.G., 2002. Socio-economic data in vulnerability indices: constraints and opportunities. Journal of Coastal Research, Special Issue 36: 487-497.

Meimban, A. O. 1997. La Union: The Making of a Province (1850-1921), 341 pp.

Municipal development report of Bauang, La Union.

Municipal development report of Caba, La Union.

Municipal development report of Aringay, La Union.

PAGASA. 2003. Information on tropical cyclone: province of La Union (1948-2002).

PLUC-TWG. 1996. La Union Physical Framework Plan (Cooperative Provincial Land Use Plan (1993-2002).

Rivera, P. C. 1997. Hydrodynamics, sediment transport and light extinction off Cape Bolinao, Philippines. Disseration submitted in partial fulfillment of the requirements of the Board of Deans of Wageningen Agricultural University and the Academic Board of the Internationl Institute for Infrastructural,Hydraulic and Environmental Engineering for the Degree of DOCTOR. 244 pp.

Siringan, F.P., Berdin, R.D., Doruelo, J.S., Jaraula, C.M.B., Mateo, Z.R.P., Ong, J.B.T. and Yacat, M.Y.Y., 1999, Sediment transport patterns along Macajalar Bay and Cagayan de Oro River derived from geomorphic and sedimentologic parameters. Abstracts and Proceedings "Tectonics of Southern Philippines: Implications to Natural Hazards, Mineralization, Magmatism and Environmental Change", Aurelio, M.A. and Pajarillaga, N. (eds), Geological Society of the Philippines, Quezon City. pp. 28-33.

Siringan, F.P. and Jaraula, C., 2002. Land configuration changes along the Aringay-Bauang coastal zone: possible causes and mitigation measures, unpublished report.

Siringan, F.P., Maeda, Y., and Rodolfo, K.S., 2001. Short-term and long-term changes of sea level in the Philippine Islands. Global Change and Asia Pacific Coasts (Mimura and Yokoki, eds.): Proceedings of APN/SURVAS/LOICZ Joint Conference on Coastal Impacts of Climate Change and Adaptation in the Asia-Pacific Region, pp. 143-149. Siringan, F. P., and Ringor, C. L., 1997, Predominant nearshore sediment dispersal patterns in Manila Bay, Science Diliman, 9: 29-40

Siringan, F. P. and Ringor, C. L., 1996, Changes in the position of the zambales shoreline before and after the Mt. Pinatubo eruption: controls of shoreline change, Science Diliman, 7 and 8: 1-13.

Siringan, F. P. and Rodolfo, K. S. 2003. Relative sea-level changes and worsening floods in the northwestern Pampanga Delta: causes and some possible mitigation measures. Science Diliman vol. 15, no. 2, pp. 1-12.

Torres, R.C., Paladio, M.L.O., Punongbayan, R.S., Alonso, R.A., 1994. Liquefaction inventory and mapping in the Philippines: a worst case scenario. National Disaster Mitigation in the Philippines DOST-PHIVOLCS, 71-98.

Wigley and Raper, 1992. Implications for climate and sea level of revised IPCC emission scenarios. Nature, 357, 293-300.

Mapping and assessing risk and vulnerability of water-induced disasters in the Tinau Watershed, Western Nepal

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SYMPOSIUM NOTES

Introduction

Background

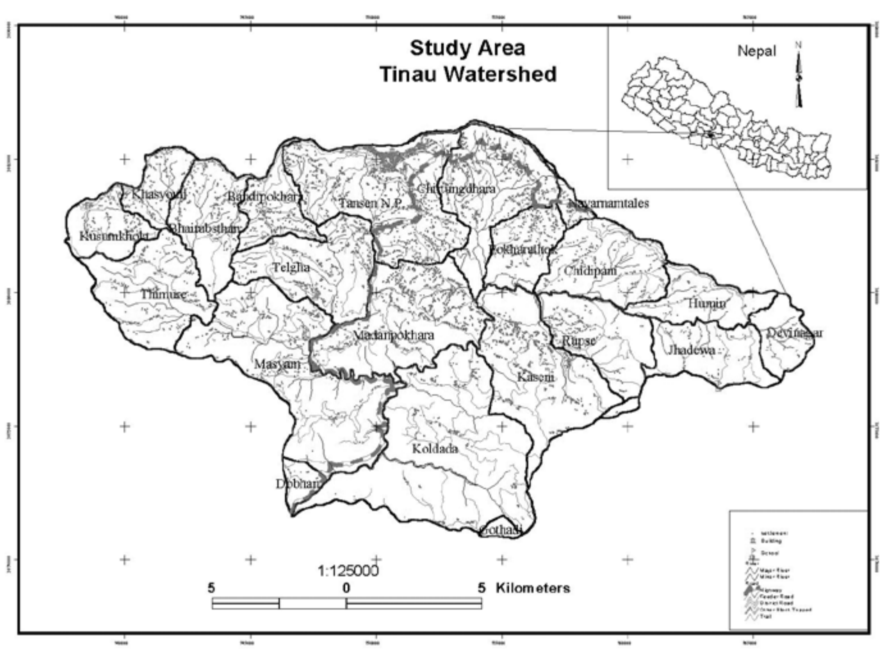
High relief, steep slopes, relatively steep river gradient, and active geology with intense monsoon rainfall make the young Himalayas as one of the most hazardous areas in the world and it frequently suffers from different kinds of water induced disasters like soil erosion, landslide, debris flow, flood, glacial lake out-burst flood, landslide dam out-burst flood etc. Against the backdrop of high population density and expansion of infrastructure resulting in changes in natural slope, river morphology and the drainage system, land use/land cover; the frequency in the occurrence of the landslide and flood hazards has been increasing in recent years. The loss of lives by flood and landslide and avalanches comprises about 29% of the total loss from all types of disasters.1 As a result of increased hazard, magnitude of lives and property at risk has also correspondingly increased. There is need to identify the areas that are susceptible to water induced disaster and comprehensive risk assessment for designing mitigation measures in order to reduce the risk and vulnerability. Such activities provide a sound basis for disaster mitigation planning and hence for allocation of financial and other resources. Risk assessment includes an evaluation of the potential occurrence of hazard events, assessment of vulnerability and potential damages, and the assessment of stakeholders' capacity simultaneously. However, there are few studies and research in landslide and flood hazard mapping with risk and vulnerability assessment in Nepal. With in this background the present research project was implemented for mapping and assessing risk and vulnerability of water induced disaster in Tinau sub watershed.

The present research project is the component of Provention Consortium research grant for disaster reduction. The project aims to identify the frequency, magnitude, and extent of water induced disasters experienced in the study area, map hazard and risk, access the socio-economic impact of water induced disaster and explore the response and recovery capacity of local people.

Project Area

Tinau watershed lies in Palpa District of Western Development Region of Nepal. It extends from 27°45'00" to 27°52'51" north latitude and 83°25'30" to 83°42'30" east longitude (Map .1). The total area of watershed is 234.2 sq. km. Elevation ranges from 330 m at the confluence of Tinau and Jhumsa Khola to 1893.4 m at Ghustung Lekh. The study area has highly rugged terrain with steep slopes and deeply incised valley of Tinau Khola, bounded in the south by the Siwalik range. The Mahabharat range occupies the central and northern part of the watershed. Being in between of Main Boundary Thrust (MBT) and Central Boundary Thrust (CBT), this watershed is tectonically very active and geomorphologically very unstable.

The sub-watershed covers complete or partial portion of 20 VDCs and one municipality. The estimated population of sub watershed based on focus group discussion is 66665. The population composition of watershed is dominance of Magar caste ethnic group. It occupies 42.6% of total population followed by Brahamin/Chhetri 31.3%, Occupational or so called "Dalit " (untouchable) caste 12.9%. Other hill ethnic caste occupies 4.6% and other caste population occupies about 2% of the total population.



Map 1. Study area

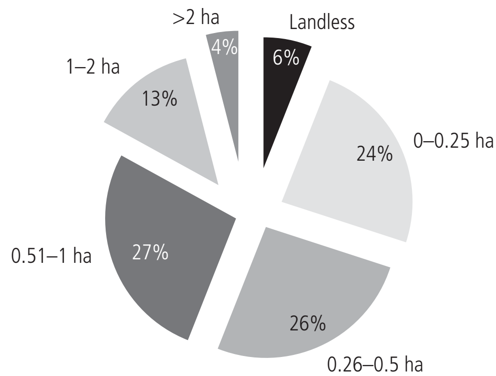


Figure1. Landholding pattern in Tinau Watershed

The main source of income of the local people is agriculture. About 92% households are engaged in agriculture as a main source of income. However the landholding pattern is not even. About 6% households are landless and 24% households are marginal having up to 0.25ha land.

Project Implementation

The main focus area of over all project implementation is landslide and flood hazard mapping and risk identification of Tinau sub watershed. During the project implementations period following activities were carried out.

Information requirement analysis

Various literatures, documents, knowledge and discussion with advisor were used as references for information requirement analysis and identification of data. Various methods for mapping and assessing community risk and vulnerability of natural disaster were reviewed and the detail work plan for this project was prepared. Checklist for observation, interview guide, schedule and focus group discussion guide were also prepared.

Preliminary field observation

A short field observation was carried out during the last week of July to obtain basic information of watershed. The verification of watershed boundary, identification of organization and institutions working in the field of flood and landslide disaster, and some secondary information collection from local level organization was done during this field trip. GPS observation of 50 sample site of landslide and flood location and major landmarks, (for RS imagery analysis) was also taken. A pilot survey of focus group discussion, household survey and RRA was conducted in MadanPokhara to check the checklist of focus group discussion and household survey. The checklist and interview guide and schedule were finalized on the basis of pilot survey.

Acquisition of secondary information

Various government and non-government organizations identified during information requirement analysis were visited. Both spatial and non-spatial data were collected from respective source as follows:

- Toposheet maps (Scale: 1: 25000) published by Topographical Survey Department, Nepal. 1958, & 1993.
- Land system, Land utilization and land capability map published by Land Resource Mapping Project, Nepal, 1986.
- Geological maps prepared by Department of Mines and Geology, Nepal, at the scale of 1: 50000.
- Digital version of IRS Satellite imagery acquired in 2001 (obtained from Forest Department).
- Aerial photos (1978, 1996) prepared by Topographical Survey Department, Nepal.
- Hydrological and climatological data of last 20 years from Department of Hydrology and Meteorology.
- The recorded information of loss of lives and properties by Disaster in Nepal (1983 – 2002) from Department of Water Induced Disaster Prevention and Ministry of Home.
- Demographic and other socioeconomic census data (2001) from Central Bureau of Statistics.
- Various socio-economic information were also obtained from District Profile of Palpa district (2000).
- The information on mitigation measure, rescue operation for landslide and flood hazard implemented by Disaster Management Committees and Nepal Red Cross Society.

Aerial photo interpretation and digital image processing

Information on channel course, landslide extent, and flood wash area were identified and preliminary distribution map of these parameters were prepared through aerial photo (1996) interpretation and digital image processing of IRS image (2001).

Field survey and group discussion

A field survey was carried out in September 2003. The field survey was carried out to map flood prone area, flood wash area, landslide extent distribution, channel course diversion; verify and update the information obtained from maps, aerial photos, and imagery interpretation. Focus group discussions at each hazard prone area with the key informants were held in order to obtain additional information on landslides and floods and also on the number of households and population. A social map on landslide and flood hazards was also prepared with the help of the local people. During the group discussions the participants were asked to show and delineate the areas susceptible to landslide and flood hazards.

Preparation and acquisition of digital database

The information collected and mapped on toposheet showing distribution of landslide, flood wash area, flood prone area, channel shifting was digitized and prepared spatial digital database. The map of geology, toposheet (1958), Land utilization map (1986), Land utilization/ land capability map (1986) were also digitized. The digital data set of river, road, landuse, settlement and administrative unit of base map were also prepared. The digital data set of contour and spot height was acquired from Survey Department.

The layers of landslide, and flood area, and channel course were prepared from aerial photo interpretation (1978, 1996) and digital image processing (IRS image 2001). The parameters layer of DEM, slope, relief, rainfall interpolated, slope aspect, distance from lineament, distance from stream, drainage density were prepared.

Preparation of hazard and risk maps

The landslide and flood hazard maps of Tinau sub-watershed was prepared using GIS based analysis. Subsequently, risk map of each hazard were also prepared (Fig. 2).

At first landslide distribution maps was prepared based on field survey and image interpretation. Eleven parameters: lithological unit, lineaments, slope gradient, slope shape, slope aspect, relative relief, drainage density, water table and drainage condition, distance from road, landuse, and vegetation density were used for landslide hazard mapping. Landslide hazard map was prepared by using the bivariate statistical method. The landslide hazard map was categorized into three categories according to the probability of occurrence of landslide as high hazard area represent high probability and low hazard area represent low probability of occurrence.

Similarly, flood hazard mapping was done using the Digital Elevation Model generated from contours and spot heights. In addition to this information obtained from land system maps, and channel morphology was also used. The flood hazard was classified in to four categories according to the probability of occurrence of flood and channel shifting.

Risk map was prepared by combining the vulnerability and the hazard maps. For the analysis of vulnerability only four sets of parameters were chosen. These included: a) population, b) land use, c) infrastructure and d) irrigation canal. Population density at the VDC level, distance from roads and trails and distance from cannel, and the land cover (based on use type) were taken in order to evaluate the degree of potential loss from the landslides.

Household survey

Based on two criteria distance from river bed and the hazard zone (the high, medium and low) five settlements were selected for intensive household survey. The household survey was conducted to differentiate the severity, risk, and vulnerability of households and the response and recovery capacity of household level with varies hazard zonation. Census of all the households was conducted in those settlements where the total number of households is less than 30. In settlements where the numbers of households are more than 30, at least 30 or 10 percent of the total households were selected for interview.

Vulnerability and Response Recovery capacity Analysis

The socio-economic and physical impact and vulnerability to landslide and flood has been analyzed in terms of the degree of losses and the socioeconomic and physical capability of the people and infrastructure to respond to and recover from the potential losses from landslides, debris flow, floods, and riverbank cutting in the watershed based on information collected from both group discussions and household surveys.

Seminars and Public Awareness Programme

One day seminar was held in Tansen with the representative of key stakeholders and organization

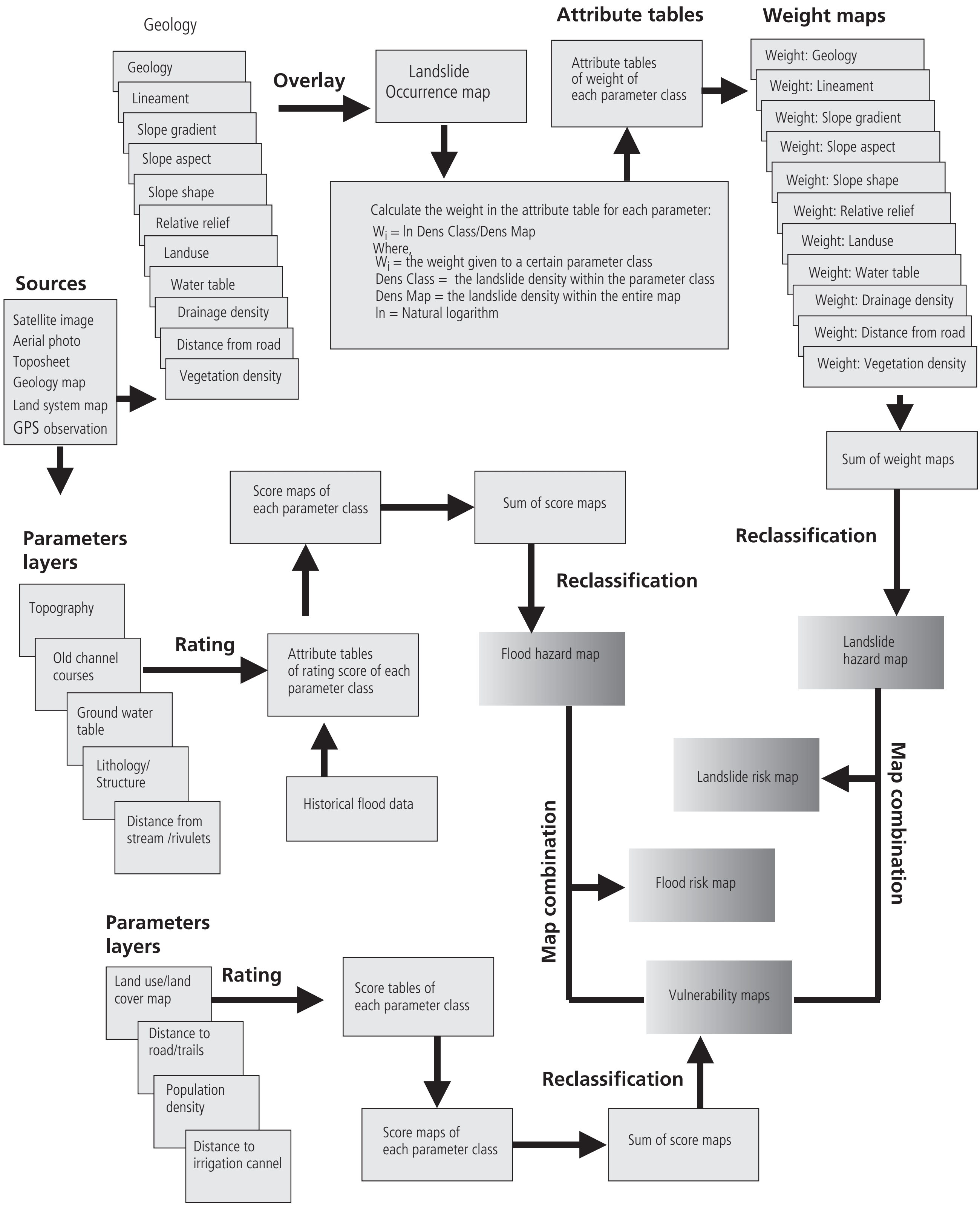


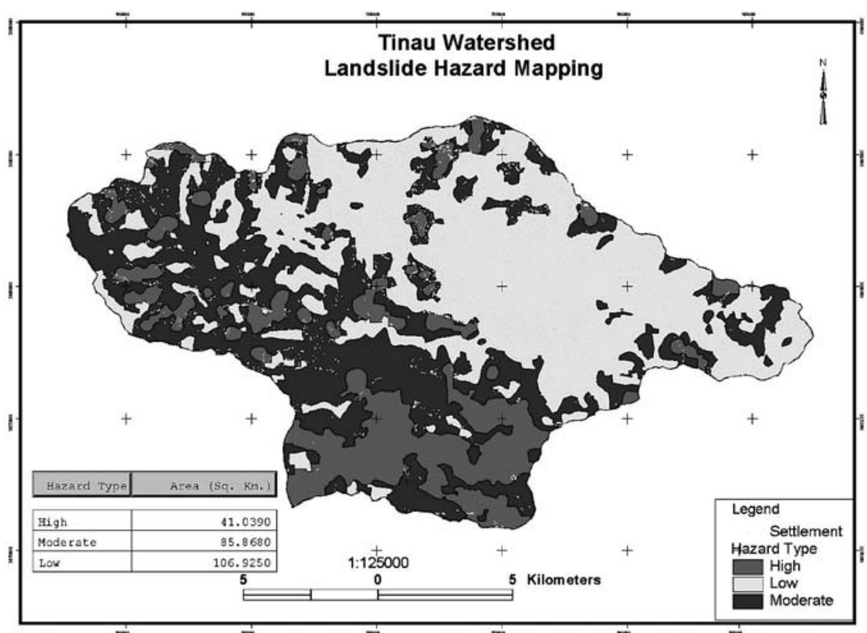
Figure 2. Flow chart for landslide and flood risk mapping

working in the watershed area, former president of identified high hazard and risk VDCs, VDCs secretary, and some members of local community development organization were invited to share the results. As per the suggestion of seminar one-day discussion programme with the local community and representatives of community development local organizations in high hazard area was organized in Madniphnat and in Chhap Koldada in order to raise awareness of local community. The discussion was concentrated to identify hazard areas and needed emergency and mitigation measures.

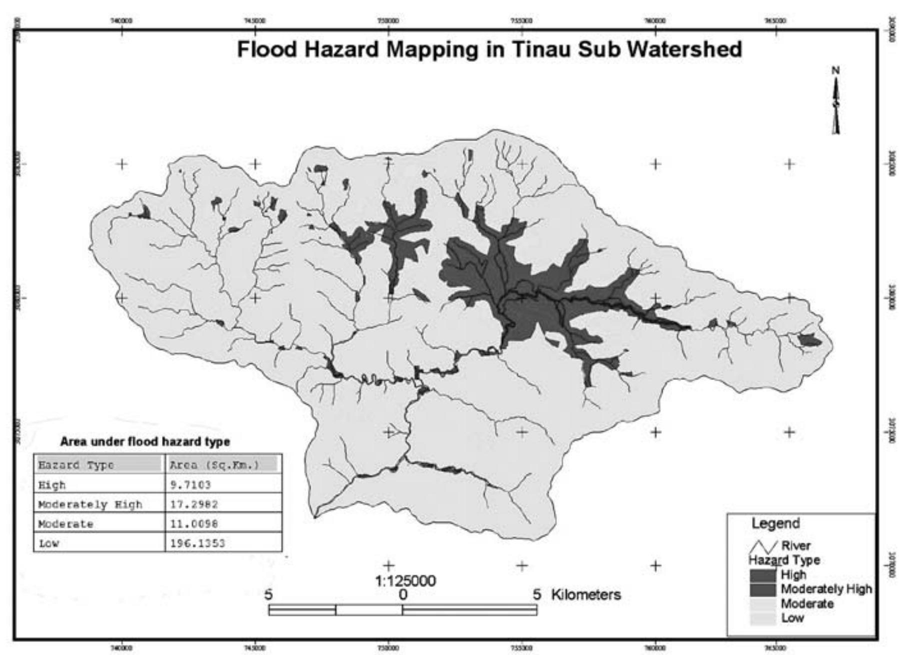
The hazard and risk maps prepared were provided to the local community. Mutual relationship was established with District Committee of Paropakar, the local social organization. Maps and major finding were provided to this organization so that community-based programme of public awareness and bioengineering measures is developed to reduce the risk of landslide in Koldada. Paropakar is working in the disaster awareness and bioengineering measure to landslide. During the implementation of project closer relationship was also been established with Nepal Red Cross Society, Palpa Branch, and Department of Soil Conservation and Watershed Management, District Office that are active in disaster management in the study area.

Results

About 202 active landslides were identified based on aerial photo/satellite image interpretation, toposheet (1993) and field observation. Out of 81 landslide scars identified in aerial photo of 1978, 63 landslide scars are found stopped. About 103 old landslide scars were identified. These landslides appear to be more dormant and more active than stabilized type. Most of the landslides are found composed of mud, soil and rock. About 55% of landslides are found depth in nature (i.e. above 3m depth) The two largest landslides in terms of the length, coverage and depth occurred in watershed with in last 40 years namely landslide of Masyam and Bausidadna of Chhap were found located in cultivated land and most destructive in nature. The landslide of Chhap appears as dormant, whereas the landslide of Masyam is active. Whereas The landslide hazard map as generated following above mentioned



Map 2. Landslide hazard map.



Map 3. Flood hazard map.

methodologies shows that about 17.6% land lie in the high hazard zone and 36.7% in the moderate hazard zone (map 2).

In terms of flood hazard zone 11.5% of the land lies under the high and moderately high hazard zone and 4.7% of land falls under the moderate hazard zone (map 3). Regarding geographical location Madni phant, the fertile valley of watershed is found severely affected by frequent flood, channel shifting and water logging. The problem of channel shifting, chute cut and neck cut is frequent in this part of region. An attempt was made to assess the impact of hazards on different land use/land cover in order to understand how the people have been managing the land resources in the light of the probability of occurrence of damaging events of landslides and floods. About 84.7% of total 27.04 km2 high and moderately high flood hazard zone lie in cultivated land, which is about 20.3% of the total cultivated land of Tinau Watershed. It is also the most fragile land of the whole watershed. In terms of distribution of cultivated land in landslide hazard zone, only 7.5% of the total cultivated land is in the high and moderately high hazard zone, which is about 20% of

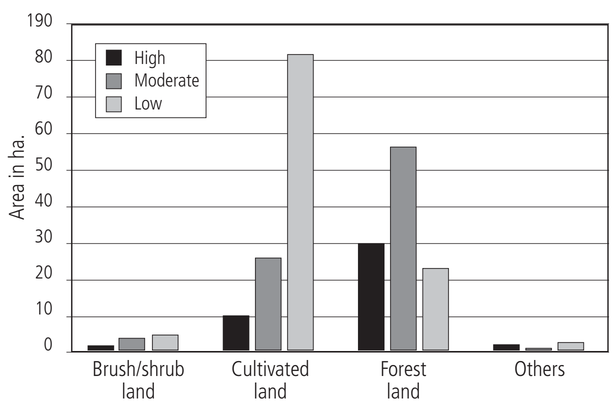


Figure 3. Landuse by landslide hazard

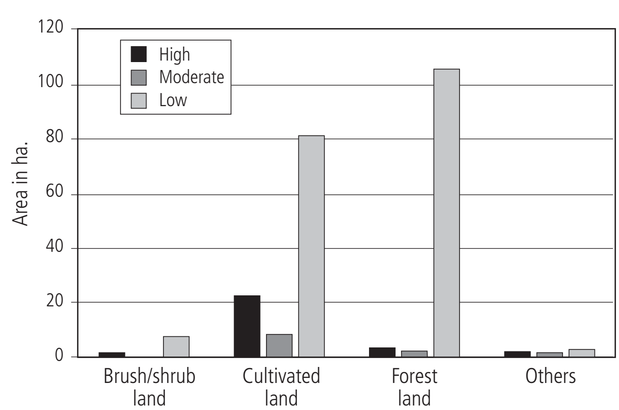


Figure 4. Landuse by flood hazard

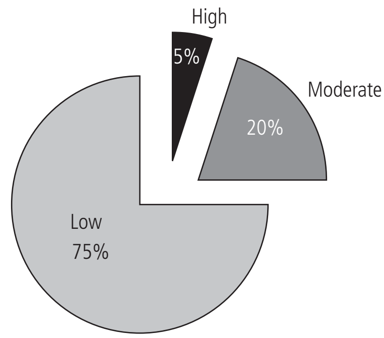


Figure 5. Distribution of house unit in different flood hazard zone

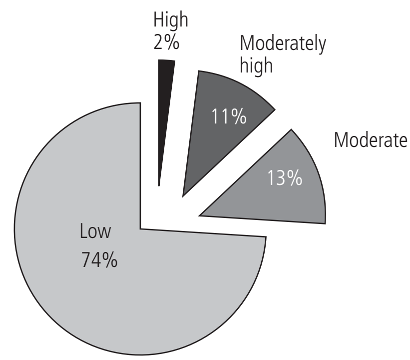


Figure 6. Distribution of house unit in different landslide hazard zone

the total high and moderately high landslide hazard of the watershed. Whereas about 73.3 of high hazard and moderately hazard area lie in the forest landuse, which, shares 27.5% of the total area of forest land.

Similarly, an attempt was made to assess the location of the house units in areas under various hazard levels. Nearly 2% of the house/buildings, i.e. 134 houses, are located in the high-hazard area and 10.8% i.e. 707 houses, in the moderately high area. About 73.74% or 4844 houses are in the low hazard area. Regarding the location of house in terms landslide hazard area, 5.4% houses are in high hazard area, 74.4% of houses are located in low hazard area and rest houses are in moderate hazard area.

Distribution of road length by road type by different hazard type is shown in Table 1. There are many active and dormant landslide scars along the Siddharth Highway. Distribution pattern shows that more than one third length of highway of sub water-shed is lie in the high hazard zone. About 0.3 km

Road type	Flood hazard				Landslide hazard		
	High	Moderately High	Moderate	Low	High	Moderate	Low
Highway	0.295	4.043	1.696	29.259	13.191	10.931	11.161
District road			2.013	2.443			4.455
Feeder road		0.32	1.501	26.396	6.3	6.997	14.834
Other road			0.211	6.746	0.865	0.609	5.477
Trail	7.355	24.873	23.101	356.349	52.159	143.017	216.191

Table 1. Length of Road (in km) by different hazard type

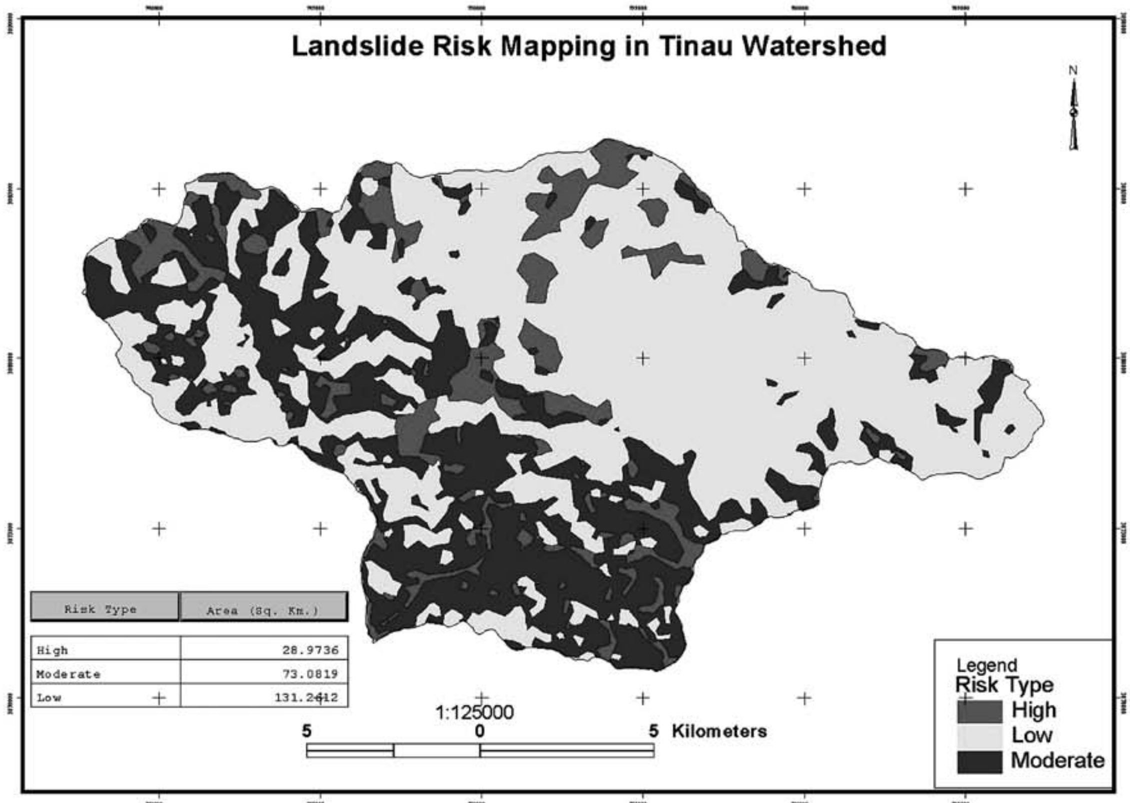
and 7.4 km of the major road and minor trails respectively lie in high flood hazard zone. About 4.04 km feeder and major road and 24.873 km minor trails are in moderately high hazard area. For land-slide hazard 13.2 km out of 35.29 km highway, 6.3 km of feeder road are in high hazard area (Table 1).

About 12.4% of the total area is under the high landslide risk zone in terms of expected loss/damage to property. Similarly, about 31.3% and 56.3% of the area is under moderate landslide risk and low land-slide risk zones respectively (Map 4). About 7.8% of total area is under the high flood risk zone in terms of expected loss /damage to property. Likewise, about 7.4% and 84.9% area is under moderate and low flood risk (Map 5).

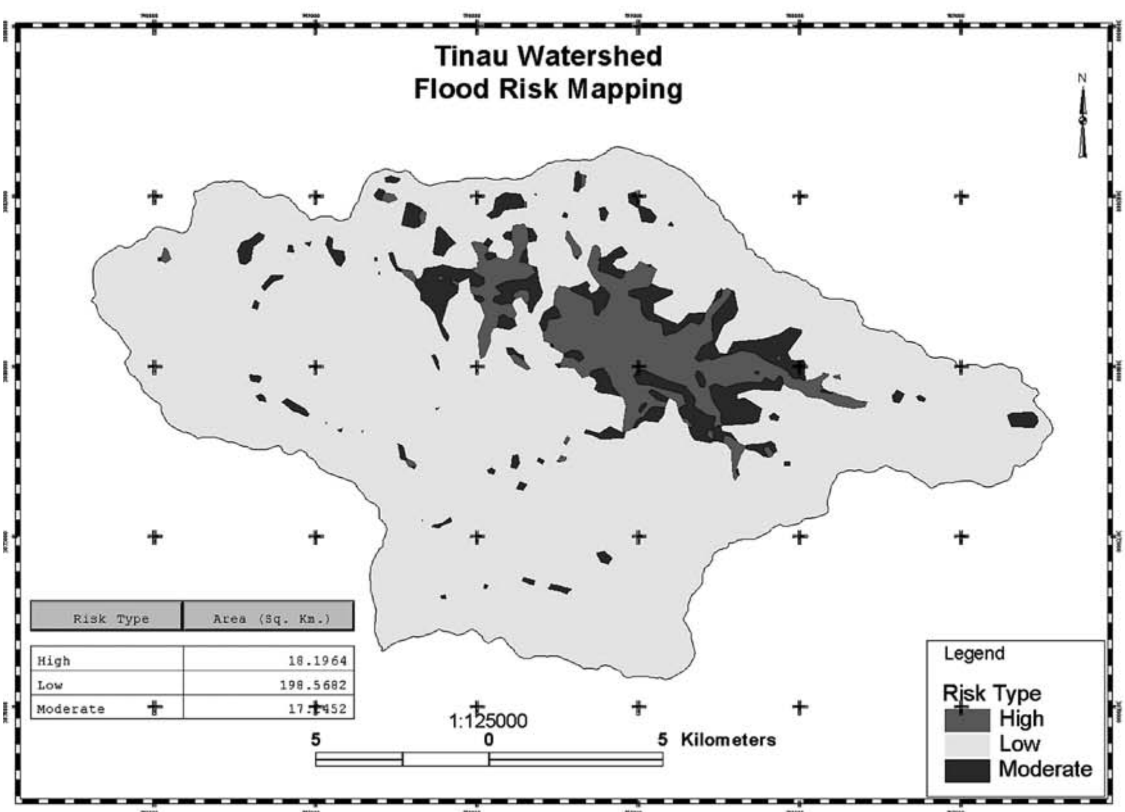
As reported by focus group discussion out of 6716 households in the watershed, 2327 households are exposed to hazards of different types. Out of them 37.26% of households belong to Magar and other hill ethnic groups, and they are found more vulner-able to hazard. In terms of economic class about 32.4% households are either marginal or small farm households. The settlement system in watershed is typical that the houses are located in the hill side and the valley and flood plain area is mainly used for cultivation. There are very few houses located in very high flood hazard zone in Madiphnat. So most of the properties such as livestock, house/building, fodder and fruit trees etc. are safe from flood hazard in this region. However the cultivated land located in flood prone area is only means of livelihood of many people residing nearby areas. So frequent flooding and channel shifting adversely affect the people whose land is located there. The canals, roads, crops and cultivated land in flood prone area are annually swept away by river flooding and regular channel shifting. In the northern part of the Madiphant some settlements are situated in very high flood risk zone. Mostly affected people form river bank cutting, channel shifting and flood in this area are poor landless tenant families. Out of 39 households of Madiphnat surveyed 12 households were of poor tenants.

The estimated value of element of risk (excluding live loss) in the watershed is Rs. 5.4 billion. The highest value in susceptible zone is Rs. 1.9 billion in Madanpokhara VDC. The loss of past major water induced hazard in watershed is found varies with the intensity of events. During the last 42 years the loss from river bank cutting is Rs.19.8 billion with per event loss of Rs. 800 thousand. Like wise the loss from major floods in last 42 years is Rs. 28.2 billion with the per event loss of Rs.2.6 million. The total loss from landslide events in past 42 years is 6.5 billion with per event loss of Rs. 300 thousands. The loss from water logging in Madiphnat since last 13 years is Rs.39 million with per annual loss Rs. of 3 million. About 86 to 98.3% of total exposed value is privately owned. The past major events of flood, landslide and river shifting, total estimated loss, per event estimated average loss and the recurrence interval of such major hazard in study area is shown in Table 2.

The damage to road and road closure due to landslide is the common phenomena of this watershed. During the past three years the total value of Highway repair after the damage by landslide is Rs 714400. The maximum loss from road damage by landslide is Rs. 420000 during the last three years. During this period altogether 39 landslide events caused the Highway closure for 446.5 hours (Table 3).



Map 4. Landslide risk mappling in Tinau Watershed



Map 5. Food risk mappling in Tinau Watershed

VDC	Duration	Period	No. of Event	Recurrence Interval	Total Loss (Rs.)	Per Event loss (Rs.)
Flood						
Chitrundhara	2038-60	22	4	5.5	2710680	677670
Bandi Pokhara	2038-56	18	2	9	214000	107000
Madan Pokhara	2018-60	42	33	1.27	116644000	3534667
Kusumkhola	2041-60	19	8	2.38	480000	60000
Kaseni	2018-60	42	33	1.27	4290000	130000
Jhadewa	2054-60	42	19	2.2	152000	8000
Telgha	2032-60	28	9	3.1	140460003	15606667
Pokharathok	2018-60	42	33	1.27	1485000	45000
Koldanda	2038-55	17	3	5.6	1253800	417950
Gothadi	2038-52	14	3	4.7	3000000	1000000
Chidipani	2018-60	42	33	1.27	9570000	290000
Humin	2018-60	42	19	2.2	1567500	82500
Devinagar	2018-60	42	6	7	385260	64210
Rupse	2018-60	42	33	1.27	231000	70000
Major Landslide						
Tansen	2038-59	21	7	3	3109100	444167.7
Chirtundhara	2036-45	19	9	2.1	1431000	159000
Bandi Pokhara	2038-55	17	5	3.4	1707000	341400
Madan Pokhara	2027-55	28	13	2.2	10936250	841250
Thimure	2032-60	28	42	0.67	4171999	99333.33
Kusumkhola	2042-60	18	16	1.13	3200000	200000
Masyam	2027-55	28	40	0.7	333333	83333.33
Khasauli	2036-57	21	28	0.75	6499080	232110
Koldanda	2038-60	22	68	0.32	28786664	423333.3
Rupse	2042-60	18	12	1.5	3264000	272000
Gothadi	2037-52	15	11	1.36	1540000	140000
Major river bank cutting/channel shifting						
Dobhan	2018-60	42	53	0.8	2863590	54030.43
Kaseni	2018-60	42	64	0.7	3040000	47500
Jhadewa	2018-60	42	81	0.5	32400000	400000
Pokharathok	2018-60	42	83	0.5	1660000	20000
Humin	2018-60	42	63	0.6	126000000	200000
Chidipani	2018-60	42	81	0.5	864003	10666.7
Madanpokhara	2018-60	42	93	0.4	23250000	250000
Rupse	2018-60	42	83	0.5	8300000	100000

Source: Field Survey, 2003

Table 2. Recurrence interval and estimated loss of major hazards in Tinau watershed

Date	Blockage duration in hrs	Landslide type	Cost (Rs.)
17/6/03	22	Rock fall	35000
18/7/03	14	slide	35000
18/7/03	3	slide	50000
17/7/03	3	slide	10000
17/6/03	2	Rock fall	3875
16/6/03	16.5	slide	12400
2/7/03	5	slide	4000
4/7/03	5	slide	4000
1/10/02	5	slide	285000
8/10/02	2	slide	110000
2/10/02	6	slide	3000
25/9/02	3	slide	1670
2/7/02	2.5	slide	NA
17/6/02	21	slide	18000
5/6/02	6	slide	NA
17/7/01	42	slide	NA
17/07/01	33.5	slide	NA
19/7/01	45	slide	NA
25/6/01	3	slide	4200
22/06/01	2	slide	420000
29/5/01	9	slide	5500
31/07/01	3	slide	4500
1/8/01	5	slide	7500
18/8/01	2	slide	3000
19/7/01	60	slide	80000
22/8/01	6	slide	9000
24/8/01	7	slide	10500
19/7/01	3	slide	4500
22/9/01	6	slide	9000
19/7/01	2	slide	3000
3/8/01	13	slide	7200
30/7/01		slide	7500
30/7/01	2	slide	3000
1/8/01		slide	3000
5/8/01	81	slide	106000
23/8/01	4	slide	10000
29/7/01	2	slide	7000
2/8/01	pattially blocked		10000

Table 3. Major events of highway closure by landslide and value of repair after the damage (2000–2003)

The strategies adopted by household to minimize the risk of landslide, flood and other geomorphic hazards include evacuation from hazard area to other area, construction of small structure to control rive bank cutting and landslide, retaining wall, and tree plantation. The local people are also adopting crop calendar and stock of certain grains/crops for future insecurity to cope with uncertain disaster in future. Similarly, in Madniphnat area the local community have settled their settlement in hillside area, and the flood plain is used for only cultivation purpose. It also helped them to safe the lives and loss of other assets from frequent flood hazard.

However the condition of poor people is found to severe. There always food deficit to the landless, marginal and poor people. The information collected on focus group discussion shows that about 17.2% households of watershed area lives in food deficiency condition for more than 6 months and 21.3% households have food deficiency of about 1 to 3 months. The household survey of high flood and landslide hazard area shows that about 53% of households have not any such food stocking mechanism due to the food deficiency. Most of the disaster stricken poor households are found earning other lands as a tenants. However, the underprivileged caster and ethnic and women headed households have to pay additional production (certain extra portion) locally called Gunjais to the landholder.

The impact of disaster between gender is also found unequal in terms of workload, decision making power, financial status, and roles and responsibilities. It has major impact on women especially in times of disaster who disproportionately assume a greater responsibility of family.

The strategies adopted by other GOs and NGOs are mostly post disaster measures and relief distribution. Some structural works have been carried out. It is only after the disaster events. Most of such efforts are found driven by the traditional relief and disaster preparedness, centralized top down approach. Contrast to it some local organization, and NGOs and District Soil Conservation office recently implementing the community based disaster mitigation programme. In this approach local communities are expected to be involved in decisions from which they were previously excluded. However, in many cases the community-based approach also found unable to address the social difference across gender, class, castes etc., which also highly differentiate the impact, response and recovery capacity of people toward disaster. The underprivileged community member like women, so called Dalit, and ethnic people are found excluded from decision-making and access and control over resources. During the period of focus group discussion, seminar and later discussion programme local people raised such issues. According to the local community member the poor and under-privileged member of community have been purposively excluding from the relief distribution. In many cases, the structural construction measures are constructed suppressing their views on behalf of elite members of community.

Lesson Learned

The GIS and remote sensing tools can fruitfully be used for landslide and flood hazard and risk assessment. The risks indicated by the combination of vulnerability maps (based on population, economic value of the property, and infrastructure) with hazard maps could be useful in prioritizing areas for the implementation of disaster preparedness plans and mitigation measures.

The failure of past relief and post disaster activities in disaster management activities shows the lack of participation of local people in the entire process of disaster management activities. There is need for the establishment of local institutions responsible for disaster preparedness. Provision should be made to strengthen such institutions through training and technical and financial support. Efforts should also be made to create awareness among the local people.

Mass poverty and low level of off-farm activities, illiteracy, and poor service facilities have contributed to the low response and recovery capacity to deal with disasters. Unless the response and recovery capacity of the local people is improved, the loss and damage are likely to increase. Therefore, disaster reduction and preparedness strategies should include components such as poverty reduction and empowerment of women and other disadvantaged groups in the community and overall development activities in sustained way.

Structural measures have been adopted in some areas in order to reduce the risk of landslides, debris flow, floods, and riverbank cutting. In the absence of construction standards and regular monitoring and maintenance of already constructed structures, the risks to disasters have further been increasing. It is in this context that equal emphasis should be given to monitoring and maintenance of the structures already developed. Similarly, efforts should be made to develop construction standards for buildings and infrastructures.

Prevailing high conflict among different groups of community in terms of resource use, decision making in community, access, share and controls over resources use or entitlement and access approach should be addressed in any disaster management activity.

Early warning system has not yet been developed. Keeping in view the lead-time of flooding between highland and lowland areas, it is essential to develop a mechanism of community-based warning system. The magnitude of landslide, debris flow, and flood events can be reduced if strong conservation measures are implemented.

Mechanisms to share the cost and benefit of conservation measures between highlands and lowlands should be introduced. It is in this context that the highland-lowland interaction should be taken into consideration while selecting areas to implement community based disaster management programmes in the future.

Reference

ADPC, 1991, Disaster Mitigation in Asia and the Pacific, Manila: Asian Disaster Prevention Center.

Carter, Nick W., 1991, Disaster Management : A Disaster Manager's Handbook, Manila: ADB.

Chettri, M.B. and Bhattarai, D. 2001. Mitigation and Management of Floods in Nepal, Nepal: MOH/HMG

Deoja, B.; Dhital M.; Thapa B.; and Wagner, A. 1991. Eds. Mountain Risk Engineering Handbook. Kathmandu, Nepal: ICIMOD. Vol. 1 and 2, 875 p.

Dhital, M. R., Khanal, N. R., and Thapa, K. B. (1993). The role of extreme weather events, mass movements and land use change in increasing natural hazards: A report of the preliminary field assessment and workshop on causes and recent damage incurred in south central Nepal (July, 1993), ICIMOD, Kathmandu

DHM(1998). Climatic records of Nepal. Department of Hydrology and Metereology, Kathmandu.

DHM(1998). Hydrological records of Nepal. Department of Hydrology and Meteorology, Kathmandu, Nepal.

Fordham, Maurren and Ketteridge, Anne-Michalle, 1995, Flood Disasters-Dividing the Community, (A Paper Presented at the EMERGENCY Planning '95 Conference 2-6 July 1995), Lancaster.

Ghimire, M (2000) Slope instability assesment, hazard and risk zonation using Remote sensing and Geographical Information System: A case study of Banganga watershed in the Mahabharata and the Siwaliks of Central Nepal, report submitted to CSSTE-AP, Dehradun, India, Unpublished

Paudel, Keshav Prasad,2001, Landslide and its Consequences in Nepal (1971-200), Seminar report submitted to Central Department of Geograpy,T.U.

Poudyal Chhetri, Meen B. and Bhattarai, Damodar (2001), Mitigation and Management of Flood in Nepal, Kathmandu: Ministry of Home Affairs/HMG Nepal.

The Integrated Land and Water Information System: ILWIS (1997). User's Guide, ILWIS Department, International Institute for Aerospace Survey and Earth Science Enschede, The Netherlands. Pp 419-420.

Tianchi, LI.(1999). Mountain hazard mitigation and risk engineering in the Hindu Kush-Himalayan Region, ICIMOD, Kathmandu

UNDP and ICIMOD, 2001, Community Risk and Vulnerability Assessment, Kathmandu UNDP, ICIMOD.

UNDP and ICIMOD, 2001, Hazard and Risk Mapping, Kathmandu: UNDP, ICIMOD.

[1] HMG/N, Ministry of Home Affairs, 2000

India

Indicators for disaster preparedness

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SYMPOSIUM NOTES

The project aims at building an instrument to assess disaster preparedness for a set of hazards (earthquake, drought, cyclone, flood, fire and epidemics) at a community level. Such instrument is expected to be highly useful for funding agencies and policy makers in making objective evaluation and monitoring of preparedness programs. It would also provide feedbacks for designing appropriate programs and be useful as guidelines for implementing agencies. The specific objectives of the project are a) to identify the key parameters involved in community preparedness b) to select a set of appropriate indicators for measuring such parameters c) to design an indexing method for combining these indicators together d) to test-trial the instrument (i.e. the set of selected indicators together with the indexing technique) adequately in different communities for verifying its reliability and e) to disseminate assessment results among those communities for their opinion and awareness. The most important feature of this above instrument is its representation of social, economic and cultural condition of people in the selection of indicators and thereby providing direct link between poverty and risk reduction.

Methodology

The project methodology can be described to be consisting of five stages. In the first stage, comprehensive literature review was undertaken to define community preparedness and suggest a conceptual framework that explains community preparedness on the basis of ten parameters. To measure these parameters, total of eighty-five indicators were identified as possible candidates. In stage-II, Delphi Analysis was carried out where a panel of twenty experts were constituted and presented with these set of indicators to select the most appropriate ones among them. Based on their opinion, total of thirty-five indicators (i.e. if all the six hazards are applicable) were finalized. In stage- III, an indexing method was developed. This method while combining various quantitative and qualitative indicators also tried to be simple and make minimum use of statistical tools. In stage-IV, the designed instrument (i.e. the set of selected indicators together with the indexing technique) was put into practical use for assessing preparedness in six communities located in three different states of India. These communities are among the most disaster prone in the country and differ considerably in terms of hazards they face and their cultural practices etc. Data collected from such communities were fed into the designed instrument for measuring preparedness. In stage V, the findings from such assessment were disseminated among the same communities for member's opinion about such assessment and also to create awareness among people about probable hazards and their present state of preparedness.

Stage-I

What is preparedness?

Preparedness as a core concept in disaster studies lacks consensus in its conceptualization.[1] It is defined in different ways ranging from action oriented steps to education. The various approaches to preparedness can be classified under three broad categories[2] ***a)*** on the basis of attributes e.g. existence of warning system, awareness, availability of resources etc. ***b)*** preparedness as scenario planning e.g. drawing possible disaster case scenarios and making plans for it[3] and ***c)*** preparedness as psycho-social processes which emphasizes individual decision making processes[4]. Preparedness can also be thought of at different levels e.g. individual, household, organization, community, country etc.[5] For example, Cottrell et al. (2001) have found that within a community even if individuals are reasonably well prepared, the community as a whole may not be prepared. Thus it is important to recognize the difference that exists between these levels as procedures for assessment can vary depending on such levels[6]. The objective of preparedness is often described to be "to enhance the ability to respond well."[7] In such conceptualization, preparedness activities are mostly oriented towards good response (e.g. warning dissemination, evacuation plan, stockpiling of essential supplies etc.) and fails to emphasize post- disaster recovery aspects. In the context of developing countries where majority of people live under poverty, post-disaster recovery however is as important as surviving the initial impact.[8] Thus preparedness for such societies must look beyond the response stage and need to include post-disaster recovery as one of its important objective.[9]

Defining community preparedness

The way preparedness is conceptualized in this study is viewing it as a state of readiness (that may be at an individual, household or community level) to face hazards at a given point of time. It is a constantly changing process. The dynamic nature of the concept can be seen from the way preparedness varies even during different times of a day e.g. people receiving warning at night are relatively less prepared for evacuation. Similarly such change can also occur due to variety of other reasons such as an official's visit, a game of football or a local festival. Community preparedness is thus defined as the state of readiness of the community to face probable hazards so that minimum of losses occur from it and smooth recovery takes place. This view of preparedness relates it to the concept of mitigation as; preparedness providing measure of effectiveness of various mitigation efforts. To illustrate further, existence of a cyclone shelter (structural mitigation) in a community if not located properly or awareness campaigns (i.e. non-structural mitigation measure) similarly if not well planned do not contribute to the overall preparedness of the community. In other words, effectiveness of these mitigational measures determines to a large extent the level of community preparedness.

Measuring community preparedness

There have been several previous attempts to measure disaster preparedness of a community with indicators though, most of such attempts are limited to specific hazard only e.g. for earthquake[10], wildfire[11], terrorism[12] etc. Cottrell et al. (2001) in their attempt have tried to assess community-preparedness for multi-hazards and have identified four parameters as important; a) population characteristics e.g. number of children, squatter settlement etc. b) building and critical infrastructures such as road, drinking water, communication network, health, sanitation etc. c) physical environment and d) social environment e.g. ethnic groups.

The framework suggested here for measuring preparedness tries to build on this work of Cottrell et al. (2001). It views community preparedness to be an umbrella construct made of ten parameters (Fig.1) which are; *a)* Physical safety i.e. how safe are the community members in view of the physical danger from these hazards? The parameter essentially tries to measure how effective structural mitigation measures are e.g. availability of cyclone shelter, its capacity, resistance of building structures for earthquakes etc. *b)* Hazard awareness i.e. awareness level about hazards which have reasonable probability of occurrence *c)* Organizational preparedness i.e. how far the community is organized to face disaster e.g. existence of disaster committee, plans, volunteers etc. *d)* Infrastructures and Services which tries to measure current state of these services and how well plans and procedures have been developed for restoring critical services as and when disruptions occur *e)* Recovery ability i.e. ability of the community members to recover from the impact of the hazard *f)* Physical environment i.e. state of environment to face hazards e.g. condition of sub-surface aquifers, vegetation cover etc. *g)* Social capital i.e. degree to which social networking and cooperation exists among community members *h)* Psychological preparedness i.e. how safe and prepared do community members feel in view of these hazards? *i)* Cultural capital i.e. cultural richness such as

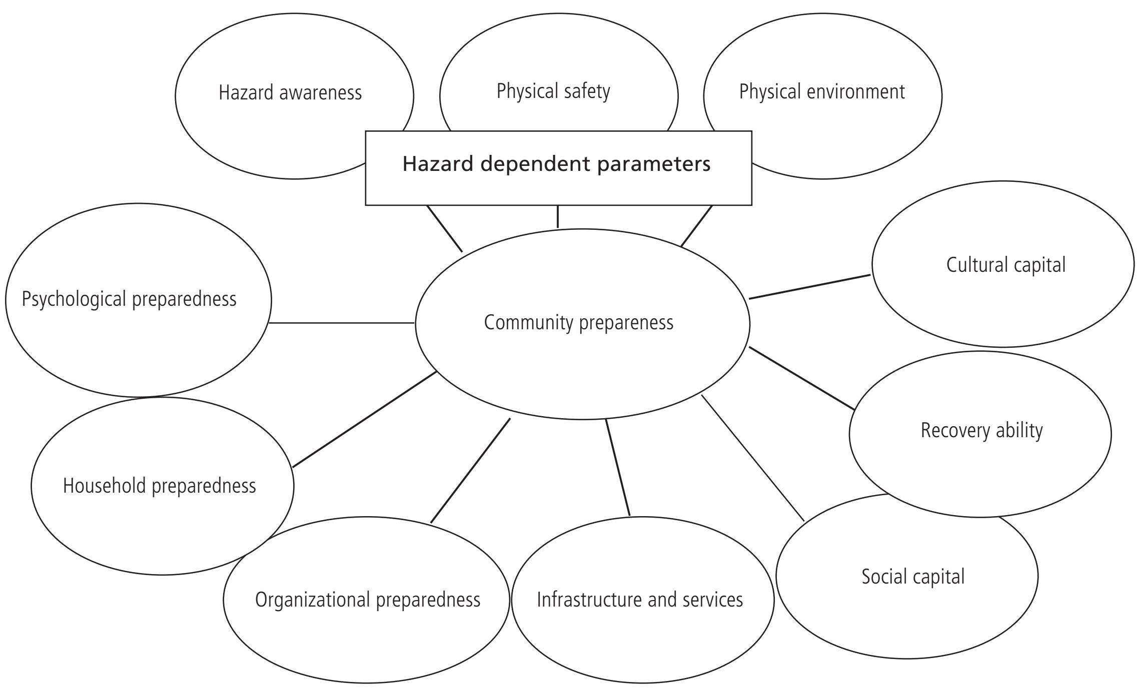

Figure-1: Community Preparedness (Suggested framework)

existence, recognition and use of traditional coping mechanisms *j)* Household preparedness i.e. preparedness at a household level. Three of the above ten parameters (i.e. physical safety, hazard awareness and physical environment) can be seen to be hazard dependant which, means to measure these parameters one needs to consider the specific hazards which are applicable for the community and based on it select indicators. The hazard independent nature of most of the parameters in community preparedness emphasize that preparedness programs should focus as much on the disaster agent as it should try and reduce existing structural vulnerabilities.

Stage-II

Delphi analysis

The framework as suggested in Fig.1 views that measuring community preparedness requires measuring the parameters involved in it and then combine them for getting overall preparedness. Literature search was conducted, resulting in the identification of eighty-five indicators (complete list of these indicators are given in project report, appendix-B) considered as potential candidates for measuring the ten parameters. Preliminary review e.g. modification and reformulation of these indicators reduced its total number to fifty-eight. To select the most appropriate ones from these fifty-eight, a panel of twenty experts were constituted drawn from different backgrounds[1] and were presented these indicators in questionnaire form for their evaluation. The exercise was completed in two phases over a period of three weeks. (Delphi Analysis) The expert's selections were subsequently tabulated to rank these indicators and determine their suitability to measure individual parameters. Subsequent review and analysis provides the following list of thirty-five indicators presented under the corresponding parameter as the most suitable ones for measuring. The numerical figures given at the end of each indicator represents its relative score (in the Delphi Analysis) i.e. number of experts choosing the indicator for its suitability.

Physical safety: The following five indicators are selected (one of which is a composite indicator) to measure the parameter though exact selection would also depend on the specific hazards applicable for the community.

- Earthquake: Percentage of houses in the community that are earthquake-resistant (20)
- Cyclone: Adequacy of the cyclone shelter i.e. maximum accommodation capacity of the shelters as a percentage of total population (20)
- Drought: Public works program i.e. readiness of concerned agencies to initiate such programs which includes response time for implementing the programs (15)
- Flood: Percentage of population with flood protection that includes non-structural measures such as flood proofing etc. (14)
- Health Care Services i.e. for all hazards: The indicator is a composite one which takes three sub indicators for its value. (20)
  - Distance of the hospital from the community
  - Structural resistance of the hospital building for probable hazards
  - Kind of hospital i.e. the category should be indicative of available facilities

Hazard awareness: Three indicators have been selected to measure hazard awareness.

- Percentage of population which attended awareness campaigns in last five years (15)
- School curriculum and adult literacy materials containing hazard information (12)
- Awareness about probable hazards (awareness here is to be considered as knowing about protection measures and how to reduce the hazard impact) (10)

Organizational preparedness: Six indicators are selected to measure the parameter.

- No. of volunteer per hundred population (17)
- Average number of training days per volunteer (17)
- Existence of disaster committee and how well different social groups e.g. minorities and women etc. are represented in such committee (15)
- Acceptance of the disaster committee i.e. percentage of population who accept that the committee is representing their interests (15)
- Comprehensiveness of the disaster plan. The plan is to be measured against criteria such as hazard analysis, vulnerability analysis, resources inventory, provision for disabled, senior citizen and children etc. (15)
- Plan awareness i.e. percentage of population aware about the plan and its content (14)

Infrastructure and services: Five indicators are chosen to measure readiness of the community in terms of infrastructure and services.

- Emergency plan for hospital i.e. if such plan exists, it is to be evaluated against criteria such as disease surveillance, alternative power, triaging training etc. (16)
- Access to warning i.e. what percentage of population can access warning through radio and television or through any informal warning networks (14)
- Emergency plan for ensuring drinking water supply during disaster (12)
- Condition of the approach road to the community (12)
- Response time for Fire station i.e. time required to reach the community (10)

Recovery ability: Three indicators have been selected to capture the parameter.

- Per capita income per month (16)
- Access to insurance services i.e. percentage of population with insurance coverage such as personal, crop, house etc. (14)
- Access to formal credit services i.e. percentage of population with access to banks and other such institutions e.g. cooperative societies for getting credits (10)

Social capital: Three indicators are selected for measuring social capital and community cohesiveness.

- Number of operational community-based organizations (16)
- Joint hazard mitigation efforts undertaken by the community in last five years (14)
- Cooperation among community members i.e. percentage of population who expect to get help and cooperation from other members when needed (13)

Physical environment: The parameter being hazard dependant, selection of indicators for it would be based on specific hazards applicable for the community.

- Drought:
  - Awareness among farmers about sustainable farming practices (14)
  - Condition of the sub-surface aquifers (9)
- Flood: Area under vegetation cover i.e. as a percentage of total area (10)
- Epidemics: Availability and quality of drinking water, level of sanitation (7)

Psychological preparedness: Two indicators have been selected to measure psychological preparedness of community members.

- Perceived preparedness i.e. percentage of population who feel they are prepared (10)
- Recognition and provision for psycho-counselling in the disaster plan (7)

Cultural capital: The parameter is represented by only one indicator i.e.

- Percentage of population aware about traditional coping mechanism and recognize its usefulness. It tries to measure how such traditions are recognized and promoted. (12)

Household preparedness: The parameter is also measured by one indicator i.e.

- Percentage of households in the community who have family plans for disaster or have taken measures such as food grain reserve, purchase of insurance or any other. (12)

Stage-III

Indexing Method

The indicators described above when analyzed can be seen to be both quantitative and qualitative in nature and for making maximum use of such indicators; they need to be indexed together. The method suggested here for indexing while emphasizing internal and external consistency also tries to keep it simple and make minimum use of mathematical or statistical tools so that such method can ultimately be expected to be used by community member themselves. The method involves three stage of indexing for a parameter. In the first stage, all the indicators are rated on a four point scale (Bad, average, good and very good). The quantitative indicators (twenty-three selected indicators are quantitative) are rated on the basis of eight designed scales[2]. The remaining twelve indicators are qualitative and have been rated directly on the basis of specific criteria. In the second phase, rating of these indicators (made in the first phase) are converted into numerical scores as follows; bad: 0, average: 1, good: 2 and very good: 3. In the third phase, the arithmetic mean of these indicator scores are calculated for each parameter and converted into percentages for getting parameter score. The average of all the ten parameters (all parameters are given equal weightage) provides the overall preparedness for the community measured in percentages.

Stage-IV

Field-testing of the instrument

The set of indicators selected and the indexing technique described above (henceforth the instrument) was put into practical application for assessment of community preparedness. To ensure that the instrument is robust and reliable under different condition, it was field-tested in six most highly disaster prone communities located in three states of India (Gujarat, Orissa and Andhra Pradesh). The selection of these communities was made on the basis of the following criteria; a) the communities should be facing different set of hazards so that findings can be generalized for all the six hazards b) they should differ from each other as much possible e.g. in their level of development, past disaster experience, cultural practices etc. c) one of these communities need to be relatively better prepared (control group) so that assessment results from other communities can be compared with it for validation. Taking the above factors into consideration, the following six communities (panchayat [3]) were selected.

- Valadia Bitta (East) in Anjar Taluka, Kutch district, Gujarat
- Manginapudi in Machlipatnam Mandal, Krishna district, Andhra Pradesh
- Mundpadar in Bangomunda block, Bolangir district, Orissa
- Gupti in Rajnagar block, Jagatsinghpur district, Orissa
- Rampar in Anjar Taluka, Kutch district, Gujarat
- Kallana in Rasulpur block, Jajpur district, Orissa

Hazard assessment

To assess community preparedness for multi-hazards requires addressing the complicated issue of hazard assessment. There are two major problems faced here i.e. a) giving weightage to probable hazards e.g. how to differentiate between a dominant recurring hazard and a hazard which is infrequent but with reasonable probability of occurrence and b) how to select hazards for preparedness-assessment given that there may exist difference between scientific assessment and the community assessment of hazards and the necessity to include them. The approach in this work to resolve the above problems has been a) to give equal weights to all hazards on the basis that all probable hazards need to be adequately prepared for and should not be discriminated on the basis of their frequency of occurrence and b) hazard selection for a community should be based both on the scientific assessment as well as that of the communities. Thus hazards selected (i.e. out of the six hazards which are under consideration) for each community in this study is based on taking both views i.e. opinion of concerned scientific agencies and that of community members.

Data collection

Data required for using the instrument were collected from different sources and through different techniques such as survey, interviews and focused group discussions. Two kinds of questionnaire surveys were conducted in each of the six communities i.e. a) among head of households and b) among general population. The second survey was necessitated for data relating to hazard awareness which required equal representation of women and children in the sample. Data were also collected from key informants such as senior citizens; opinion makers etc. and from secondary source such as census hand books, government reports, local newspapers etc. Data after being collected were put into the designed instrument and indexed and results obtained for the six communities are given here in brief.

Case-I: Valadia Bitta (East), Gujarat

Hazards considered for the community: Earthquake, drought, cyclone, epidemics and fire

The community is one village with a total population of 779 i.e. 169 households. Literacy level is around 25% and agriculture is the major occupation. The overall preparedness of the community as assessed through the instrument is 33% and the scores for individual parameters are as follows. Physical safety: 42%, hazard awareness: 23%, organizational preparedness: 39%, infrastructures and services: 47%, recovery ability: 23%, social capital: 56%, physical environment: 23%, psychological preparedness: 50%, cultural capital: 16% and household preparedness: 8%.

Case-II: Manginapudi, Andhra Pradesh

Hazards considered for the community: Cyclone, drought, fire and epidemics

The community is one village located near the popular tourist destination Manginapudi beach with a total population of 1940 i.e. 473 occupied households. The community suffered heavy losses during earlier cyclones of 1971 and 2003. Drought is also a recurring hazard here due to the ingress of saline water. The overall preparedness for the community is measured to be 37% and the scores for individual parameters are as follows; physical safety: 45%, hazard awareness: 27%, organizational preparedness: 34%, infrastructures and services: 60%, recovery ability: 45%, social capital: 56%, physical environment: 23%, psychological preparedness: 34%, cultural capital: 18%, household preparedness: 28%.

Case-III: Mundpadar, Orissa

Hazards considered for the community: Drought, fire and epidemics

The community consists of eleven villages with a total population of 4838 i.e. 1046 households. It is located in economically poor region of KBK (i.e. Kalahandi-Bolangir- Koraput districts of Orissa) from where several cases of starvation deaths have been reported earlier. Literacy level in the community is 25%. Agriculture (i.e. mostly rain-fed, 7% of the total agricultural land is irrigated) is the major occupation for community members. Drought is thus a recurring hazard here in addition to fire and cases of epidemics. The overall preparedness assessed for the community is 31% and the individual parameter scores are as follows; physical safety: 50%, hazard awareness: 34%, organizational preparedness: 17%, infrastructures and services: 27%, recovery ability: 34%, social capital: 45%, physical environment: 34%, psychological preparedness: 34%, cultural capital: 12% and household preparedness: 22%.

Case-IV: Gupti, Orissa

Hazard considered for the community: Cyclone, fire and epidemics

The community is spread over twelve villages with a total population of 8266 i.e. 1266 households. It is located close to the Bhitarakanika National Park and agriculture is the major occupation for the community members. The general infrastructural condition such as road, communication, health care etc. is very poor. The community had suffered heavy losses during the 1971 cyclone which caused more than 10,000 human deaths and since then an embankment (popularly known as saline embankment) has been constructed around the area as a measure of protection against sea water surge. The overall preparedness for the community is assessed to be 29%. The individual scores for the parameters are as follows; physical safety: 34%, hazard awareness: 42%, organizational preparedness: 34%, infrastructures and services: 27%, recovery ability: 12%, social capital: 45%, physical environment: 34%, psychological preparedness: 17%, cultural capital: 28%, household preparedness: 9%.

Case-V: Rampar, Gujarat

Hazard considered for the community: Earthquake, cyclone, drought and epidemics

The community is one village with a total population of 627 i.e. 124 households. Literacy level in the community is 35% and agriculture and fishing are the major occupations. The overall community preparedness is measured to be 36% and the individual parameter scores are as follows; physical safety: 34%, hazard awareness: 56%, infrastructures and services: 54%, organizational preparedness: 39%, recovery ability: 23%, social capital: 45%, physical environment: 23%, psychological preparedness: 50%, cultural capital: 16%, household preparedness: 12%.

Case-VI: Kallana, Orissa (Control Group)

Hazard considered for the community: Flood, earthquake, fire and epidemics

The community was taken as the control group i.e. considered for being relatively better prepared. It consists of six villages with a total population of 5782 i.e. 902 households. Business and agriculture are the major occupation for the community members and available infrastructures are reasonably good. The community is located on the bank of the river (Brahmani) and an embankment runs through it. The embankment had breached on an earlier occasion causing substantial losses to the community. An interesting feature is that approximately 350 households (i.e. 40% of total) are located in between the river and the embankment i.e. in the flood plain itself and it provides an opportunity to study how people here live with the risk of annual flooding. The overall preparedness for the community is 44%. The individual parameter scores are as

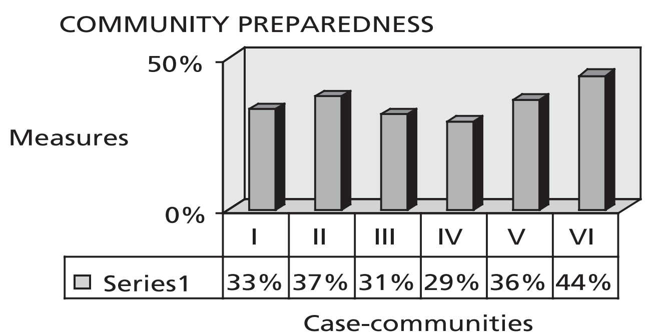

Figure 2. Graph showing overall preparedness of the six communities.

follows; physical safety: 45%, hazard awareness: 20%, organizational preparedness: 23%, infrastructures and services: 54%, recovery ability: 56%, social capital: 34%, physical environment: 78%, psychological preparedness: 50%, cultural capital: 47%, household preparedness: 27%.

Analysis of findings

The overall preparedness (as assessed using the instrument) of the six communities when compared shows that it varies between 29 to

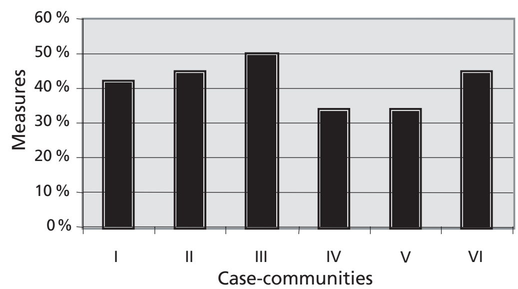

Figure 3. Physical Safety

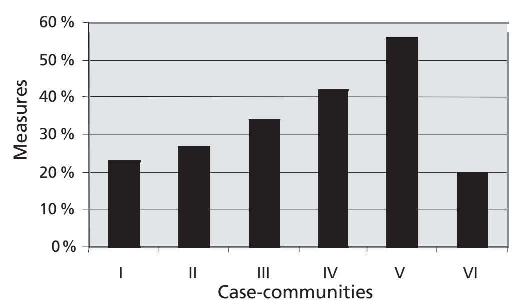

Figure 4. Hazard Awareness

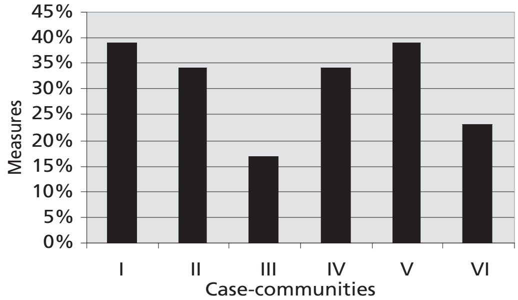

Figure 5. Organizational Preparedness

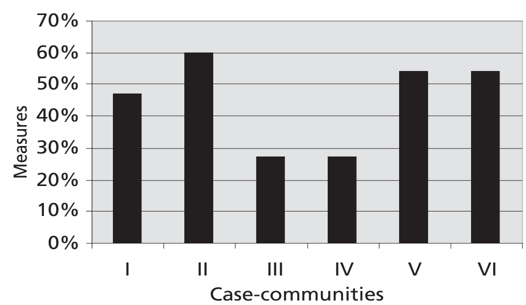

Figure 6. Infrastructures and Services

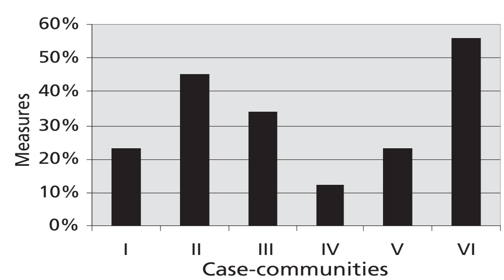

Figure 7. Recovery Ability

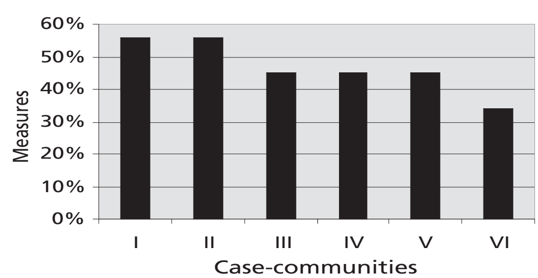

Figure 8. Social Capital

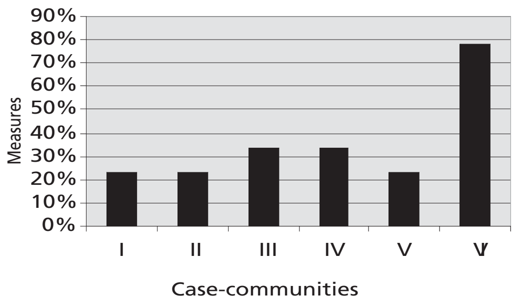

Figure 9. Physical Environment

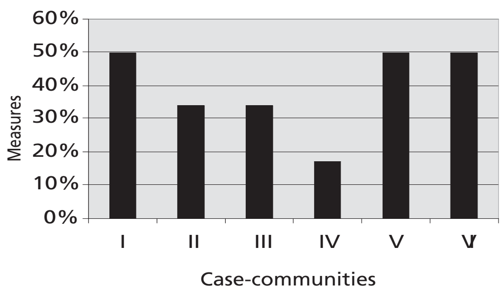

Figure 10. Psychological Preparedness

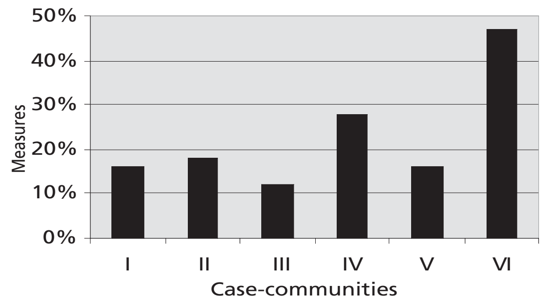

Figure 11. Cultural Capital

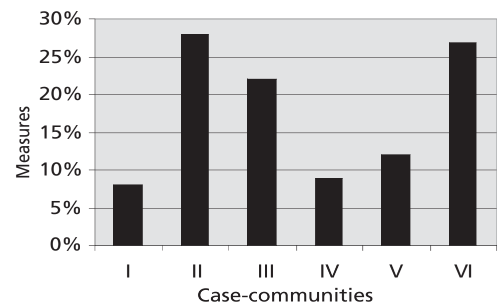

Figure 12. Household Preparedness

44%. The lowest score of 29% was for community IV (Gupti, Orissa) and the highest was recorded for community VI (Kallana, Orissa) which was also the control group or the community that was considered for being relatively better prepared. The individual scores of the parameters for the six communities when compared (Figures 3-12) show high variance in each case.

Analysis of these graphs show that overall preparedness does not follow any uniform pattern and high preparedness in one or more parameters for a community can be neutralized if it does not score well in other parameters. For example, in community-V hazard awareness is 56% which is the highest among the six but the same community scores poorly in other parameters such as physical environment (23%), cultural capital (16%) and recovery ability (23%) and as a result its overall preparedness remains low at 36%. Similarly the control group (case-VI) scores highly in four parameters i.e. recovery ability (56%), physical environment (78%), cultural capital (47%) and psychological preparedness (50%) but its overall preparedness remains limited to 44% mainly because of its poor scores in parameter such as hazard awareness, organizational preparedness and social capital. This also substantiates the view that high per capita or better recovery ability by itself does not ensure better hazard awareness or organizational preparedness and therefore such parameters also need attention. One of the most important finding from this study is that the lowest value for overall community preparedness among the six communities was found to be 29% which possibly indicates that every community carries certain amount of inherent preparedness and what is important therefore is to identify the weak areas (or the relevant parameters) which need immediate attention. At the same time existing level of preparedness in other areas need to be supplemented and raise it to an acceptable level so as to ensure minimum of losses and efficient recovery from the occurrence of these hazards.

Stage-V

Dissemination of project findings: In the final stage of the project, assessment findings were tried to be disseminated among the same communities where the instrument was field-tested. Such dissemination was considered useful for the following reasons *a)* it provides an opportunity to get feedback from the community members about assessment made *b)* it helps to create awareness among people in these communities about their own state of preparedness *c)* such assessment can facilitate action from the concerned agencies and the local administration. The strategy for dissemination focused on three major groups; *a)* senior citizens, local leaders and opinion makers *b)* school children and *c)* local administration. Interviews and discussions were conducted with the administration and local leaders for getting their opinions while disseminating the project findings. For creating awareness, posters in local languages giving essential information about probable hazards were pasted at strategic places in the community such as school, market places, community centres and other such places.

Conclusions

The field testing of the instrument in six communities and in different conditions show that the instrument is highly robust and reliable for its use. The high variances seen in parameter scores (Fig. 3-12), the analysis subsequently conducted and the general opinion received from community members about the assessment further substantiates the instrument's reliability and thus needs to be considered for practical use.

Limitations and scope for further research: In spite of the instrument's demonstrated robustness, there are however several limitations in this work e.g. the selected parameters are not the only ones possible. These parameters have also not been weighted for overall preparedness and future work must consider the weighting aspects of it. Similarly the panel of experts in the Delphi Analysis if changed, it may also bring in change in the selected set of indicators. There may be biases introduced during data collection and translation. The instrument also needs to be further tested for other hazards before generalizing to all hazards and for all developing countries. However, it is expected that with progressive use of it, the instrument gets further refined and more reliable for its use.

Reference

Cottrell, A., Cunlitte, S., King, D. and Anderson-Berry, L. (2001) "Awareness and Preparedness for Natural Hazards in a Remote Community: Bloomfield River Region and Rossville" Centre for Disaster Studies, School of Tropical Environment Studies and Geography, James Cook University.

End Notes

[1] Gillespie, D.F. and Streeter, C.L. (1987) "Conceptualizing and Measuring Disaster Preparedness" International Journal of Mass Emergencies and Disasters,Vol.5(2): 155-76

[2] Kirschenbaum, A. (2002) "Disaster Preparedness: A Conceptual and Empirical Re-evaluation" International Journal of Mass Emergency and Disasters, Vol. 20(1): 5-28

[3] e.g. see Dynes, R.L. (1994) "Community Emergency Planning: False Assumptions and Inappropriate Analogies" International Journal of Mass Emergencies and Disasters, Vol. 12: 141-58

also see Possekel, A.K. (1999) "Living with the Unexpected" Springer Verlag, Berlin: 187

[4] see Enders, J. (2000) "Measuring community Awareness and Preparedness for Emergencies" Australian Journal of Emergency Management, Vol. 16 (3): 52-58

Asgary, A. and Willis, K.G. (1997) "Household behaviour in response to earthquake risk: an assessment alternatives" Disasters, 21: 354-65

[5] Mileti, D. (1999) "Disasters by Design" Joseph Henry Press, Washington, D.C.: 215

[6] For measuring household preparedness see Kirshenbaum (2002): End note-5,

For assessment of organizational preparedness see Gillespie and Streeter (1987): End note-4,

For assessment at country level see CDERA (2001) 'Status of Disaster Preparedness of CDERA Participating States" ID number: MIPR#OHCHS60120, Caribbean Disaster Emergency Response Agency

Also see FEMA (1997) "Capability Assessment for Readiness" CAR Report, http://www.fema.gov/rrr/carnew.shtm

[7] e.g. see Tierney, K.J., Lindell, M.K. and Perry, R.W. (2001) "Facing the Unexpected" Joseph Henry Press, Washington, D.C.:27, see also Mileti (1999) End note-5

[8] see Das, K. (2002) "Social Mobilization for Rehabilitation, Relief work in Cyclone affected Orissa" Economic and Political Weekly, Nov. 30, also see Narasimhan, S. (2003) "Lessons from Latur: A Decade after the Earthquake" Economic and Political Weekly, Vol. XXXVIII (48): 8-14

[9] see Banerjee, M.M. and Gillespie, D.F. (1994) "Linking Disaster Preparedness and Organizational Response Effectiveness" Journal of Community Practice, Vol. 1(3): 129-142 also see,

Lewis, J. (1999) "Development in Disaster Prone Places" Intermediate Technology Publications, London

[10] RusselL, L.A., Goltz, J.D. and Bourque, L.B. (1995) "Preparedness and hazard mitigation action before and after two earthquakes" Environment and Behaviour, Vol. 27 (6): 744-70

[11] Rhodes, A. (2003) "Understanding Community Preparedness and Response to Wildfire Risk" paper presented at Australian Disaster Conference, Canberra, http://www.ema.gov.au/

[12] Manning, F.J. and Goldfrank, L. (2002) "Preparing for Terrorism: Tools for Evaluating the Medical Response System Programs" National Academy Press, Washington, D.C.

[13] Twelve of these twenty experts are academicians, two are from government agencies one is from UN and the remaining five are from international and national level non-government agencies.

[14] The scales were designed in consultation with experts in the field. Twenty-one out of the total twenty-eight quantitative indicators have been rated using only one scale and the remaining using specific scales.

[15] Panchayat is considered as a community. It is the lowest administrative unit in India and may consist of one or several villages.

Zimbabwe

Strengthening regional capacity for disaster management

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SYMPOSIUM NOTES

SARDC
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Strengthening Regional Capacity in Disaster Management

Lessons Learned

INTRODUCTION

Southern Africa Research And Documentation Centre (SARDC) is an independent regional information resource centre which seeks to enhance the effectiveness of key development processes in the region through the collection, production and dissemination of information, and enabling the capacity to generate and use information. There is a wealth of information about how disasters have been handled in the past and SARDC has collected such literature and compiled a Disaster Management Bibliographic Database. The World Bank Disaster Risk Reduction project was undertaken to in an effort to consolidate initial effort.

This document presents the context within which disasters occur in the African region as well as the southern Africa sub-region. It presents the regional and sub-regional policy frameworks as they relate to disaster management. The document seeks to highlight the lessons learned and makes recommendations based on experiences. This report suggests areas for further intervention based on experiences in Africa rather than import ideas.

BACKGROUND TO DISASTER RISK IN AFRICA

The African continent is vulnerable to a wide range of natural and other disasters which have adverse effects on societies, national economies and development objectives, as well as on critical human and material resources. In this context, communities at risk across Africa find themselves even more vulnerable because of several aggravating factors, including poverty, environmental degradation, inadequate exchange of data and information among countries and organizations, and inadequate co-ordination of information flow from various levels.

Africa faces serious humanitarian crises with severe long-term consequences affecting all regions. Erratic rainfall, floods, cyclones, poverty, unsustainable debt, failing agricultural policies, household vulnerability, unfair international trade regimes, civil conflicts and internal and cross-border displacement of people have all contributed to the current situation. The HIV and AIDS pandemic has exacerbated the situation.

The continent is prone to various recurring climatic events, including drought, floods, storms, cyclones and resultant impacts on health, education and infrastructure. Some of these need not be human disasters if appropriate information is available for planning and preparation. Events such as cyclones in Madagascar and Mozambique, floods across eastern and southern Africa, and droughts in the horn of Africa and the Sahel underline the vulnerability of communities across Africa and the need for long term risk reduction activities including early warning, contingency planning, information sharing and technology transfer as well as disaster preparedness and response systems.

Apart from their immediate consequences on the environment, disasters have long term impacts on society and economic advancements which in many cases provoke serious setbacks in national development programmes. Poverty contributes significantly to the vulnerability of communities at risk, and is also made worse by the effects of disasters.

A well-designed system for disaster management is crucial to Africa and to the success of its development plan, the New Partnership for Africa's Development (NEPAD). This is recognized among the key responsibilities assigned to the new Commission of the African Union in its Statutes. The continent lacks a central institution responsible for capacity building in disaster risk management, although there are a wide network of organizations involved in disaster management initiatives. There is lack of coordination of activities and dissemination of information and best practices among organizations involved in disaster management work, and yet information is an essential tool in disaster management.

Cooperation among African countries in the domain of disaster prevention and risk reduction can be strengthened by adopting regional, sub-regional and national mechanisms to improve the exchange of information, sharing of experiences and knowledge, and technology transfer.

Disaster reduction is an essential element of regional and government policy, and must be included in development plans and strategies at all levels due to its multi-disciplinary and inter-sectoral nature. This requires information access and sensitization work about the impact of disasters and disaster reduction on the results and achievements of all sectors.

Further work on disaster management should review the continent's response to crises, prospects for the rainfall season as it may affect the food security situation, as well as the continent's general state of preparedness to face any other potential disasters from a multi-sectoral perspective. Such efforts in turn, enhance sustainable use of natural resources and environmental protection, and promote poverty reduction and sound governance practices in Africa.

A demographic analysis of worst affected communities would reveal that women and children, being the most vulnerable in African society, bear the greatest burden, and their needs must be an essential ingredient in disaster management and reduction planning. This should be supported by an appropriate information base.

Furthermore, lack of information about the multi-sectoral impact leads among other things to short-sighted policies and misdirected media coverage which in turn leads to a vicious cycle of lack of appropriate information and policies, and fear.

Due to the immediate humanitarian needs associated with disasters in Africa, a wide range of organizations get involved, especially at the national level, and efforts have inadvertently been duplicated. Similarly, a lot of conflicting information, including statistics, have been published with varying intentions and meaning. All these issues point to the need for a coordinated regional network of organizations that are involved in the generation, analysis and dissemination of information on disaster management, using parameters that have relevance to the region. Capacities need to be built, strengthened and maintained for this purpose, especially at sub-regional level.

One of the major problems encountered in disaster mitigation world-wide is lack of coordinated information flow and lack of access to the right kind of information at the right time, by those who can use it, for instance in policy planning. Harmonized information, benchmarks and indicators used by NGOs, media, parliamentarians, governments and the private sector would help stakeholders involved in the same area to work towards common solutions, common policies and ultimately common objectives.

There is a need to:

- better reflect and incorporate national perspectives and priorities in sub-regional international policy settings;
- strengthen institutional capacities of sub-regional organizations to carry out policy relevant integrated assessments on disaster management;
- strengthen sub-regional institutional capacities for the generation and dissemination of a wide range of response-related products to support the interpretation and comprehensive assessment of disaster management at national and sub-regional levels;
- work in partnerships at all levels to achieve this.

Disaster Management and the African Regional Development Context

NEPAD is a pledge by African leaders, based on a common vision and a shared conviction, that they have a pressing duty to eradicate poverty and to place their countries, both individually and collectively, on a path of sustainable growth and development. NEPAD, as an agreed agenda of the African Union (AU), is anchored on the determination of Africans to extricate themselves and the continent from the malaise of underdevelopment and is rooted in the belief that a historic opportunity exists for a sustained effort to advance human development and poverty eradication.

What stands in the way of poverty and prosperity, and creates challenges for the NEPAD initiative, is the fact that the African continent is prone to disasters, natural and human-made. This can negatively impact on the expected economic growth, setting back education and health goals, and especially the planned advances through the development of infrastructure. Three cross-cutting, multi-sectoral challenges must be confronted and overcome if the Millenium Development Goals (MDGs) contained in the NEPAD strategy are to be met. These are the challenges of conflict, of HIV/AIDS and of disaster management.

This project document addresses the challenges of disaster reduction through information management and access.

The SADC Sub-Regional Context

The Southern African Development Community (SADC) recently came up with a long term visioning document the Regional Indicative Strategic Development Plan (RISDP). The RISDP, whose core focus is on poverty reduction, is a regional integration and development framework setting the priorities, policies and strategies for achieving the long-term goals of SADC. It is intended to guide member states, SADC institutions, regional stakeholders and international cooperating partners in the process of deepening integration to turn the community's vision into a reality.

In line with commitments made by member states under the Millenium Development Goals (MDGs) and NEPAD, the RISDP identifies the following priority intervention areas for sectoral cooperation and integration.

- Trade, economic liberalization and development;
- Infrastructure support for regional integration and poverty eradication;
- Sustainable food security; and
- Human and social development.

The SADC Policy Framework for Health provides a comprehensive coverage of all the key aspects of health and health services delivery in the region and proposes policies, strategies and priorities in areas such as health research and surveillance; health information system; health promotion and education; HIV and AIDS and disaster management.

Article 25 of the SADC's Health protocol proposes that member states shall

a) co-operate and assist each other in the co-ordination and management of disaster and emergency situations;

b) collaborate and facilitate regional efforts in developing awareness, risk reduction, preparedness and management plans for natural and man-made disasters; and

c) develop mechanisms for co-operation and assistance with emergency services.

Southern Africa is a region prone to various disasters, the commonest of which are drought, floods, storms, cyclones and epidemics. In the past the region has been subject to high levels of both internal and cross-border displacements of people, mainly as a result of conflicts in Angola, The Democratic Republic of Congo (DRC), Mozambique, and former apartheid South Africa.

There is a wealth of information about how disasters have been handled in the past and SARDC has collected such literature and compiled a Disaster Management Bibliographic Database.

A well-designed system for disaster management is crucial for disaster prone southern Africa. The sub-region lacks a central institution responsible for disaster risk management capacity-building, although there is a wide network of organizations involved in disaster management initiatives. There is lack of coordination of activities and dissemination of information among organizations involved in disaster management work.

Questions are being raised whether the disaster management strategies being used by governments and NGOs ought to be overhauled. Further work on disaster management should review the sub-regional response to the humanitarian crisis, and the prospects for the rainfall season as it may affect the food security situation, as well as the region's general state of preparedness to face any other potential disasters from a multi-sectoral perspective.

Such efforts should enhance sustainable use of natural resources and environmental protection, and promote poverty reduction and sound governance practices in the region.

Recommendations for the SADC Region

- Improvement of national and regional disaster preparedness & mitigation systems
- Setting up an early warning system for disaster management
- Coordination of activities amongst policy makers and organizations

- Dissemination of information amongst organizations involved in disaster management
- Establishment of a Central organization responsible for disaster risk management capacity building
- Support for the establishment of operational relationships among relief agencies, policy planners, governments, development agencies, academics and researchers
- Harmonization of national, sub-regional, inter-sectoral and institutional responses to disaster management

IMPACT OF DISASTERS ON DEVELOPMENT: SOME INSIGHTS

Droughts and floods are endemic to southern Africa, and often trigger serious hydrological imbalances, causing loss or damage to human life, crops, livestock and wildlife, infrastructure, a shortage of water for the people, as well as causing famine and disease. Drought exerts a severe impact on a wide range of environmental and economic activities.

As a result of drought during the 1994-1995 season, cereal harvests in southern Africa declined by 35 percent compared to the previous season, with maize harvests falling by 42% (SADC, 1996). During the 1991-2 drought, cereal production in Namibia dropped by 70 percent. Due to the massive crop failure the SADC sub-region spent about US$2 billion on drought relief.

Over the last two decades, heavy floods have devastated parts of the SADC sub-region, resulting in massive damage to physical infrastructure, crops and livestock, loss of lives, and public health hazards due to water related diseases. In early 2000 and 2001, massive flooding and a cyclone caused severe damage with loss of life and property in Mozambique, South Africa, Zambia and Zimbabwe. The government of Mozambique reported that GDP grew by only 3 percent compared to 6 percent predicted before the floods. Agriculture production grew by 2 percent compared with 9 percent in 1999, and livestock production fell to 4.3 percent compared to the 21.3 percent in 1999.

Rainfall trends in southern Africa 1967 – 2003

1967-73	This six-year period was dry across the entire region. Some records show a severe drought in 1967.
1974-80	This period was relatively moist over much of southern Africa. In 1974 the mean annual rainfall was 100 percent above normal throughout the region.
1981-82	Drought in most parts of the southern Africa.
1982	Most of subtropical Africa experienced drought.
1983	A particular bad drought year for all parts of the continent
1984-85	Near normal seasons, but drought strains from the previous three years were still felt in most parts of the region.
1986-87	Drought conditions returned to the region
1988-90	Near normal season.
1991-92	Severe drought in southern Africa, excluding Namibia.
1993-94	Conditions improved.
1994-95	Many SADC countries were hit by the worst drought in living memory, surpassing effects of the 1991-92 drought in some parts of the region.
1995-96	Widespread rains in most parts of the SADC region prompted forecast of a bumper agricultural yields.
1996-97	Normal rainfall for most of the region.
1997-98	Normal rainfall throughout the region including the northeast, although impacts of the El Nino were significant.
1999-2000	Cyclone Eline hit the region and widespread floods devastated large parts of the Limpopo basin (southern and central Mozambique, south-eastern parts of Zimbabwe, parts of South Africa and Botswana)
2002-03	Significant drought in the SADC region, particularly from Zimbabwe northwards

Sources: Hirji et al 2002, Division of Water   Environment and Forestry Technology CSIR, Final Report: Protection and Strategic Uses of Groundwater Resources in Drought Prone Areas of the SADC Region, Environmentek CSIR, Pretoria, 2003.

The socio-economic impact includes damage to infrastructure, displacement and death of people, particularly among adults in the prime working ages and among children under five, economic decline, increasing number of orphans and lower human development. The impact on households is devastating, with growing numbers of child-headed households and impoverished families.

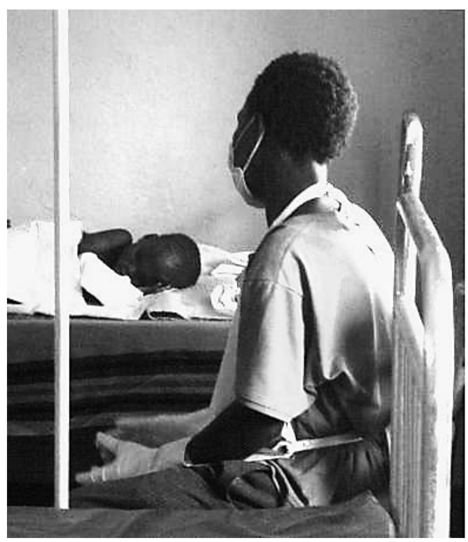
While the impact of disasters is immediately felt in the humanitarian sector, its tentacles reach far and wide, cutting across all sectors, from agriculture to education, industry and commerce to investment, environment to gender. For instance, high mortality rates among children and the productive sector of the population do not only mask demographic data such as life expectancy, but paint a negative picture of issues such as economic and human development resulting in reduced investments in the region. In addition, damage to rural communities threaten future food security and by extension the health and education sectors.

Land degradation, Zambia

Flooding, Mozambique

Dead elephant, South Africa

Flooding, Zimbabwe



Ebola, Democratic Republic of Congo

Food distribution, Malawi

WORKING PAPERS Multi-Hazards

DISASTER MANAGEMENT INFORMATION: SARDC INITIATIVE

In 1995, SARDC in partnership with the International Federation of Red Cross and Red Crescent Societies started a Disaster Management Information Project (DMIP). Its objective was to provide accessible and accurate information on disasters and disaster related vulnerability in the southern African sub-region. From December 2002 to March 2003 SARDC in collaboration with the UN-Institute of Disaster Reduction (ISDR) resuscitated the project through collection building and updating the bibliographic database. The bibliographic database containing more than 2700 records can be accessed in searchable format on the following link: *http://databases.sardc.net/wwwisis/resources.htm*

To complement these initiatives, SARDC has produced a directory of organizations involved in disaster management work in southern Africa.

Strengthening Regional Capacity for Disaster Management Project

Under the ProVention Consortium Disaster Risk Reduction project, SARDC-Information Resource Centre (IRC) implemented the project Strengthening Regional Capacity for Disaster Management covering the SADC countries i.e. Angola, Botswana, Democratic Republic of the Congo (DRC), Lesotho, Mauritius, Malawi, Mozambique, Namibia, Seychelles, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe.

The project produced a directory of organizations involved in disaster management work in southern Africa which will assist policymakers, researchers and organizations involved in disaster related work to be aware of initiatives elsewhere.

Activities Undertaken

- Reviewed disaster management contacts databases, directories and websites.
- Listed organizations involved in disaster-related work.
- Designed and distributed questionnaire to disaster-related organizations.
- Designed database for disaster-related organizations in SADC.
- Checked Websites and directories for profiles and followed up by distributing questionnaire to obtain accurate records.
- Data input, edit and compilation of database/directory.

How to access the directory

The information contained in the directory is arranged in alphabetical order first by the country and then by the name of the organization.

The following shows the database layout, sample information supplied by one of the respondents and is a reflection of the information as it appears in the directory.

Name of Organization	Disaster Management & Mitigation Unit Office of the Vice President
Acronym	DMM-OVP
Type of Organization	Government
Physical Address	Plot 25B Road Rhodespark Lusaka, Zambia.
Postal Address	P.O. Box 38963, Lusaka, Zambia
Tel.No.	260 1252 692
Fax.No.	260 1255 725 .
Email	dmmu@zamtel.zm
URL/Internet	www.dmmu-ovp.gov.zm
Name of Contact	Mwanza, Jones L .
Title of Contact	National Coordinator .
Org. Profile	The DMMU is the lead Disaster Management Coordination institution in Zambia, placed within the ambit of the second highest office in the land. The unit is strategically located to coordinate all activities pertaining to Disaster Management . Established in 1994 and became fully operational in 1998 the unit has scored a number of achievements including initiating regional disaster management training programmes. The unit currently has a strength of twenty fully trained disaster managers having undergone training at Cranfield University's CDMC.
Disaster Related Initiatives	Initiated training of Disaster Management practitioners in the country and from neighbouring countries.
Geographical Focus	Zambia
Major Keywords	Disaster Preparedness; Disaster Reduction; Disaster Response; Disaster Recovery; Disaster Prevention.
Other Keywords	Agriculture, Floods/Cyclone, Health Related, Refugees, Food Insecurity, HIV/AIDS, Forecasting and Early Warning Drought/Famine, Rehabilitation, Landmines.

The directory is available and can be accessed on the following SARDC website links

http://databases.sardc.net/wwwisis/resources.htm (as a searchable database)

http://databases.sardc.net/dima/disaster_directory_4_s_africa.pdf (in pdf)

The Directory provides an outline of disaster related activities being undertaken by organizations in the SADC region and provides a profile for the region's efforts on the world scene.

The directory will form the basis of a more collaborative framework in the management of risk and disasters in southern Africa. Both the bibliographic database and directory of organizations will work towards developing a long-term process for monitoring risk and disasters in southern Africa.

Further Disaster Information Management Initiatives

Without reinventing the wheel, SARDC proposes to put in place in collaboration with partners a sustainable mechanism that coordinates their efforts while creating a platform for enhancing debate on this socio-economic development challenge.

SARDC has a well-established Information Resource Centre with databases on disaster management, state of the environment and water resources management, as well as related programmes on gender and development, regional economic development and governance including conflict prevention, with website access and preparations for expanding "virtual library" access at advanced stages. SARDC has strong information resources at sub-regional level, and well-established capacity and experience in facilitating linkages, and establishing and sustaining development partnerships.

SARDC plans to adopt a multi-sectoral approach to disaster information management, with participation from social, policy, technical and economic sectors.

A well-coordinated continental response will require the development of a collaborative institutional and data framework to support analysis and interpretation functions, facilitate greater harmonisation at sub-regional and national levels, and create a strong base for a reporting process for the region. To strengthen the coordinated approach and address the insufficient regional level comparative data and lack of strong linkages with national assessments and reporting processes, there is a need to establish a collaborative and participatory institutional framework involving a number of institutions and sectors, and a data network infrastructure.

In response to this initiative, and to the fact that no development agenda can be successfully articulated on the continent without addressing disaster management, this project proposes a regional information initiative that also seeks to expose and act upon the interface of policy, poverty and information access in the management and reduction of disasters. The harmonization of national and regional initiatives, and inter-sectoral and institutional responses to disaster management is a key factor in mitigating the effects on people and economies.

An initiative that promotes accessible methods of information collection, analysis and dissemination while targeting disaster management organizations and policy-makers is needed, especially in bridging the gap between national, sub-regional and regional efforts.

SARDC proposes to put in place a sustainable mechanism that supports their efforts through information access while creating a platform for enhancing debate on this socio-economic development challenge. The ultimate goal is to contribute towards solutions to reduce the burden of disasters on development efforts in Africa. The project will be implemented in conjunction with sub-regional organizations, drawn from governmental institutions as well as non-governmental and private sector, and will include outreach to the media and parliaments. The geographical coverage of the project will be the African continent.

There is no region-wide disaster information centre covering the wide variety of hazard or risk conditions on Africa but there are specialized documentation centres that are expanding their activities into related fields of risk. SARDC is one such highly regarded centre. (Living with Risk, 2002)

RATIONALE FOR FURTHER PROJECT WORK

Disasters, whether natural or human-made are one of the greatest threats to the NEPAD goals of sustainable socio-economic development and poverty eradication in Africa. Changing land use patterns and global warming suggest that serious floods may recur in the future. The responses to all forms of disasters across the continent should be fundamentally informed by the intricate relationship between poverty and disaster management.

Poverty clearly can be caused by and result from disasters, and poverty is a significant factor impacting on disaster mitigation and management.

In depriving people of access to health facilities, schools and media, poverty limits their access to information and preparedness. While access to education and information can widen people's capacity to adopt and implement appropriate policies, poverty can hinder that access increasing the vulnerability of households to the impact of disasters. Thus, policies and interventions should take into consideration the interface of policy, poverty and information access.

AU members states are currently at serious risk of failing to achieve one of their main objectives, "Health for All" in the 21st Century as adopted by the World Health Organisation (WHO). As the environmental degradation and management of water resources continues to escalate, showing no signs of relenting in the region, SADC chances of achieving this goal are also diminishing.

While there seems to be a plethora of information including statistics, it is often conflicting, inaccurate or inaccessible to those who need to use it. Current information is scattered, and generally not accessible for use in mainstreaming to other sectors, and is often raw data or unusable data for the immediate purpose. Best practices are often not accessible beyond local level. SARDC recognizes efforts on related issues and initiatives are in place throughout the continent. Most of these efforts lack a sub-regional or regional context and exist uncoordinated.

DEVELOPMENT GOALS AND OBJECTIVES

Development Goal

The objectives of socio-economic development leading to poverty eradication, and consolidation and maintenance of democracy, peace and security are advanced through disaster reduction based on wide ownership and knowledge of strategies and best practices at regional, sub-regional and national levels.

Project Objective

Regional, sub-regional and national capacities to manage disasters in a coordinated manner are strengthened, through development of an appropriate institutional collaboration and data framework for information access, monitoring and assessment.

STRATEGIES FOR PROJECT IMPLEMENTATION

A well-coordinated continental response will require the development of a collaborative institutional and data framework to support analysis and interpretation functions, facilitate greater harmonisation at sub-regional and national levels, and create a strong base for a reporting process for the region. There is ***Error! No index entries found*** need to establish a collaborative and participatory institutional framework involving a number of institutions and sectors, and a data network infrastructure.

In response to this initiative, and to the fact that no development agenda can be successfully articulated on the continent without addressing disaster management, this project proposes a regional information initiative that also seeks to expose the interface of policy, poverty and information access in the management and reduction of disasters.

Implementation begins with establishment of a small working group of selected participants with knowledge of specific subject areas or sub-regions. These need not be representative as this is an informal grouping or think tank for purposes of start-up, and should be very limited in number. This working group will form the basis of a future technical advisory committee, and will work on the terms of reference for establishment of a steering committee of sub-regional representatives.

An institutional framework will be established at sub-regional levels involving the inter-governmental agency and initially one or two reliable non-governmental partner organizations from each sub-region that could be situated at research institutions, universities or non-governmental agencies that are already working on disaster-related subject areas, have an interest in information and some infrastructure, and may be at national or sub-regional level. The identification of these partner institutions at sub-regional level is key to building the regional network, and some time and analysis must be spent on this process.

During this period, a parallel process of information collection can begin for sub-regional and regional levels, based on the existing mechanisms in southern Africa and elsewhere, with categorization and cataloguing for initial database entry and website access. These mechanisms and processes will be reviewed as the project progresses, with participation from the key institutions in all sub-regions, and an appropriate regional mechanism will be developed during the course of the project. This will require a documentation working group that will develop, among other things, appropriate templates, software analysis, and a thesaurus of keywords. This group should meet at least once annually, and establish an active electronic discussion group as an ongoing mechanism for consultation and sharing of ideas.

Capacity building for sub-regional institutions including intergovernmental agencies can begin only in the latter half of the project phase, and is dependent on results of the initial implementation. This will be a beginning and will lay a foundation, as capacity building is an ongoing exercise, and may not be uniform across sub-regions as they differ in requirements and existing capacity.

The strategy envisaged includes a strong process of impact monitoring and analysis, after initial implementation processes have been established. It is essential that this be viewed as an ongoing process, with clear plans for phases, for the sustainability of the process, supporting as it does the development plans of the region.

OUTPUTS/RESULTS

1 Strong regional/sub-regional partnership and networks are established and maintained for the purpose of increasing ownership and participation of stakeholders in disaster reduction.

2 Multi-sectoral information on disaster reduction is accessible to governments and inter-governmental agencies, organizations, individuals, private sector and other stakeholders, including parliaments and media.

3 The capacity of sub-regional and national institutions to collaborate on disaster reduction strategies through information, access, exchange and analysis is supported and strengthened for purposes of reducing vulnerability.

4 Strengthening and institutionalizing partnerships, building on information capacity achieved, developing indicators for sub-regional monitoring and GIS mapping.

Annex 1

The Southern African Research And Documentation Centre (SARDC)

SARDC is an independent regional information resource centre which seeks to enhance the effectiveness of key development processes in the SADC region through the collection, production and dissemination of information, and enabling the capacity to generate and use information.

SARDC was established as a non-profit foundation in 1987, in Harare and Maputo, in response to an expressed need within southern Africa for greater access to information about the region. Its objective is to improve the base of knowledge about economic, political, cultural and social developments, and their implications, by making information accessible to governments and policy makers, non-governmental organizations (NGOs), the private sector, regional and international organizations, development agencies, parliaments, and the media. The Centre has grown to 10 departments, including five for specific programming areas and five departments offering professional services support for information resources and knowledge management, information technology, publishing, marketing, finance and administration, and project development.

Particular areas of interest related to risk reduction include the State of the Environment in southern Africa, disaster management information devoted especially to drought and other socio-economic and political issues relevant to the development process and governance that have a direct bearing on matters of risk awareness and management practices. In this respect, SARDC hosts the I Musokotwane Environment Resource Centre for Southern Africa (IMERCSA) which provides users with current information on environment and disaster management in southern Africa. IMERCSA is the leading regional centre for global reporting on the State of the environment, producing relevant databases, reports, books, factsheets a newsletters, including on shared watercourses. SARDC is also well placed to facilitate seminars, conduct briefings and undertake consultancies for information exchange on environmental issues, human development, gender, electoral processes and related aspects of information networking, including specialised work with parliaments and media.

SARDC, being a regional organization with offices in Mozambique and Zimbabwe, representation in Tanzania and an established network of partner organizations that include SADC institutions, is well placed to implement a project on an issue of cross-cutting nature such as disaster information management. SARDC has implemented widely acknowledged projects on issues that include environment and water issues, gender and democracy. SARDC's involvement in the gender arena contributed to the development of gender policy for the SADC region and to the SADC gender strategy approved by Heads of State in 1997.

Our organizational strengths cover the preparation of accurate, reliable and accessible information through working with a wide range of expertise throughout the region, and disseminating the information through relevant networks, organizations, governments, parliaments and media. We do not expect to have all relevant technical expertise in-house, but have strength in building highly motivated teams and working groups made up of individuals from different countries and disciplines. This has been used effectively, for example, in producing the Mozambique National Human Development Report for the past four years; producing a number of State of the Environment reports in the SADC region; working with UNEP to contribute to the Africa and Global Environment Outlooks as the collaborating centre for southern Africa; and working with national partners to produce national gender profiles for SADC member states.

The SARDC staff numbers 50 people including eight in Maputo, of which about 30 are professionals and the others support staff. All are citizens or residents of southern Africa, and about half of the staff at all levels at women. There are a number of students on attachment, and the most recent South-South Fellow was from Brazil.

SARDC launched its Disaster Management Information Project (DMIP) in 1995, with the International Federation of Red Cross and Red Crescent Societies, with financial support from the Canadian International Development Agency. The first phase of the DMIP sought to contribute to the UN-proclaimed International Decade for Natural Disaster Reduction (1990-1999) by improving the information and knowledge base for disaster management in southern Africa. This was achieved through documentation and dissemination of existing and new technical and non-technical information related to measures for the assessment, prediction and mitigation of both natural and human-caused disasters.

The project aimed to provide accessible and accurate information on disasters in the southern African region. The information is targeted for use by relief agencies, policy makers, non-governmental organizations, the private sector, development agencies and the media, in the region and internationally, as a resource for training and policy planning so that appropriate and proactive measures can be taken when a disaster strikes. The first phase of the DMIP, concluded in 1998, documented information on key disasters in southern Africa, including drought, floods, epidemics (such as cholera, dysentery and HIV/ AIDS), civil conflicts, storms and cyclones, internal and cross-border displacement, and factors worsening household vulnerability. Through the project, a library with computerized bibliographic and contacts databases was set up. The library's collection comprises both published and un-published information dating back to 1960. To date, the project's literature holdings number over 2,400 books, scientific papers, disaster plans and profiles, etc. The contacts database holds about 500 entries. The results have been highly appreciated and are used by individuals and agencies in disaster reduction and response today.

From December 2002 to February 2003 SARDC has been working on the bridging phase of the Project Strengthening Disaster Information Management in Africa in conjunction with the office of the UN Inter-Agency Secretariat of the International Strategy for Disaster Reduction (UN-ISDR). The project sought to update the databases with current information, promote Disaster Information Management and widen access to disaster information in Africa in general and southern Africa in particular.

Methodology Reliable and accessible information relevant to the SADC region is generated through a process of participation, networking, wide consultation and ownership, and targeted dissemination, reaching into national, regional and global policy processes. SARDC provides information and analysis of current policies and issues through special reports and news features, books, fact sheets, chronologies, policy analysis, seminars, conferences, specialist service, and website . This information is well-received because of its scope and accessibility, drawing positive responses about the quality and mix of information, analysis and documentation, which makes it available to a cross-section of society, from policy makers and parliaments to media and NGOs.

Databases SARDC has an information resource centre containing over 12,000 subject files on regional issues, a library of books and periodicals, and computerized databases of selected materials that are retrievable through he use of keywords and maintains specific bibliographic and contact databases on primary areas of interest. SARDC has an extensive website of publications and articles, and is establishing a "virtual library" of internet access to its data bases and other resources.

Institutional Capacity SARDC has 15 years of institutional experience in documenting, analysing and communicating trends in regional development, in publishing and distributing the results, and monitoring impact, and a range of qualified staff from the SADC region as well as an extensive network of regional partner organizations and contacts. Language capacity in English, French, Portuguese and Swahili. With an extensive network of partner organizations and contacts in the SADC sub-region and beyond, SARDC is strategically positioned to contribute to identifying multi-sectoral solutions and collecting/disseminating policies and good practices.

Partnerships SARDC works in close partnership with the Southern African Development Community (SADC), with SADC environment sector through a formal Memorandum of Understanding, and with the SADC Gender Unit, SADC Water Sector and others through informal agreements or contracts. SARDC also has an MOU with the United Nations Environment Programme (UNEP).

Indonesia

Multidimensional SNMR modelling for groundwater exploration

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SYMPOSIUM NOTES

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Abstract

Groundwater is an important economic source of water supply. It serves as an important source for drinking water supply and irrigation for agriculture. In the relation of managing groundwater resources, it is important to forecast of water level, quantity and other changing parameters. Furthermore, the groundwater resources are at risk to contaminants from the land surface as well as from intrusions. In many countries the land subsidence occurs when large amounts of groundwater have been withdrawn from certain types of rocks, such as fine-grained sediments.

Surface Nuclear Magnetic Resonance (SNMR) is a relatively new geophysical method that can be used to determine the presence of culturally and economically important substances, such as the subsurface water or hydrocarbon distribution. SNMR is the only geophysical method, which allows to determine water content and pore size distribution directly from the surface. In combination with electrical conductivity and permittivity SNMR will be used improve the access to the subsurface. The SNMR method is performed by stimulating an alternating current pulse through an antenna at the surface confirms the existence of water in the sub-surface.

In the future this new method may be applied as an attempt to bring long-term solutions to the water supply problems and also to protect groundwater from the degradation of aquifers. Furthermore, also will be useful as an input to design parameters used to prevent future environment problems [1]. However, in this case of course the use of other geophysical method can provide better answer.

Introduction

Groundwater is an important natural resource all around the world. To manage and preserve the groundwater resources quantifying and qualifying of groundwater and hydro-geological parameter of aquifer are provided. Furthermore the availability of groundwater resources and how can be exploited are essential for the sustained socio economic developments of any area, whether urban or rural. It is also critical to forecast the effects of hazard and risk identification concerning the condition of water resources and environment.

For this purpose geophysical methods provide a wide range of very useful and powerful tools which, when used correctly and in the right situations, will produce useful information. As the range application of geophysical methods has increased, particularly with respect to derelict and contaminated land investigation, the sub-discipline of environmental geophysics has been developed. These measurements can then be used to infer the porosity, permeability, chemical constitution, stratigraphy, geologic structure, and various other properties of a volume material near earth's surface. In application of groundwater exploration that can be employed to predict groundwater level, physical parameter of aquifer, sea water intrusion, contaminants from the land surface, land subsidence caused by human activities, mainly from the removal of subsurface water.

One of the geophysical method has been used for monitoring subsidence and decreasing water level is 4D microgravity [2]. Monitoring activity using gravity method on a nature phenomenon that relate with physical change of subsurface body can be visualize using its physical parameter (density) of rock if the change give gravity potential field that sufficiently significant to be observed on the surface. Change of groundwater level and sea water intrusion are examples of nature phenomenon that indicate existence of density change in aquifer.

The other geophysical method which may be applied for this purpose is SNMR. The SNMR has been tested on the test site to yield the geometry, water content and hydraulic permeability of the aquifer [3, 4]. Beside allows more detailed and reliable assessment of aquifers the SNMR may also be used to detect the change of water content and hydrogeological parameters caused by subsidence.

To improve the capability of the SNMR method we have carried out a research to study the response of 2D and 3D models, i. e. the SNMR relaxation signal for various locations of the antenna loop. The main aim of this research is to improve the ability of surface NMR method in determination of hydrogeological parameters of the subsurface. Emphasis of the research is the development of a program that allows to determine the initial amplitude and decay time of a SNMR signal for 3D water distribution in dependence of the pulse moment. The amplitudes are directly related to the water content, while the decay times are linked to pore size, grain size, and therefore to hydraulic conductivities. At the end we have developed 2D inversion to increase the interpretation of SNMR method.

Theoretical Background

The surface nuclear magnetic resonance (SNMR) sounding is a geophysical method that aims at determining hydro-geological parameters from magnetic resonance measurement. This method is based on the principle of the proton magnetic resonance in the Earth's filed of hydrogen 1H atom, which contained in the groundwater molecule H_2O. An NMR signal, stimulated by an alternating current pulse through an antenna at the surface confirms the existence of water in the sub-surface. The amplitudes of NMR signal are directly related to the water content, while the decay times are linked to pore size, grain size and, therefore, to hydraulic conductivities. The phases are related to the electrical conductivity; however this is only used qualitatitively (Table 1).

Measured quantity (vs. pulse moment)	Physical parameter (vs. depth)
Amplitude of the PMR signal E_0 (q)	Water content
Decay time constant of the signal T_2*	Mean Pore size
Phase shift between signal and current φ	Rock layer resistivity

Table 1. Physical parameters determined with SNMR

Methodology

The new geophysical method of SNMR is based on the principle of the magnetic resonance of protons of hydrogen atoms in the Earth's magnetic field. An alternating current pulse through a wire antenna at the surface stimulates a NMR signal. After termination of the exciting pulse the response field due to the relaxation of the precessing hydrogen is measured. The amplitudes of NMR signal are directly related to the water content, while the decay times are linked to pore size, grain size and, therefore, to hydraulic conductivities [4, 5]. The phases are related to the electrical conductivity, however this is only used qualitatively.

The geophysical method of surface nuclear magnetic resonance (SNMR) allows direct determination of hydrogeophysical parameters of the subsurface. The method of SNMR is based on the principle of the magnetic resonance of protons of hydrogen atoms in the Earth's magnetic field. Figure 1a shows spin characteristic of the proton 1H in the absence of an externally applied magnetic field. An external static magnetic field B_0 causes the nuclei to align themselves in one of two orientations with respect to B_0 (Figure 1b). Figure 1c shows the precessing of a proton of hydrogen atom. In SNMR an alternating current pulse through a wire antenna at the surface stimulates the NMR signal. After termination of the exciting pulse the response field due to the relaxation of the precessing hydrogen protons is measured (Figure 1d). The initial amplitude E_0 of the signal corresponds to the water content in the subsurface [5, 6]. The decay time T_2* (spin-spin relaxation time) of the SNMR signal corresponds to pore sizes. The fundamental integral-equation that governs the amplitudes E_0 (q) of NMR as a function of the pulse moment q is given by

$$E(t,q) = E_0(q)e^{-t/T_2^*(q)} = \omega_0 M_0 \int_V e^{-t/T_2^*(\mathbf{r})} f(\mathbf{r}) \cdot B_\perp(\mathbf{r}) \cdot \sin\theta(\mathbf{r})\, dV, \qquad (1)$$

in which ω_0 is the local Larmor frequency of the hydrogen protons and M_0 is the nuclear magnetization of the protons. The water content and the decay time for a unit volume at the point r in the subsurface are given by f(r) and T_2*(r) respectively. $B\perp$(r) states the component of the exciting magnetic field perpendicular to the Earth's geomagnetic field. The tilt angle of the protons is given by θ(r) = $0.5\gamma B\perp$(r)q. Increasing the pulse moment q ($q = I_0\tau$, where I_0 and t are the amplitude and duration time of the current pulse, respectively) increases the depth of penetration of the method.

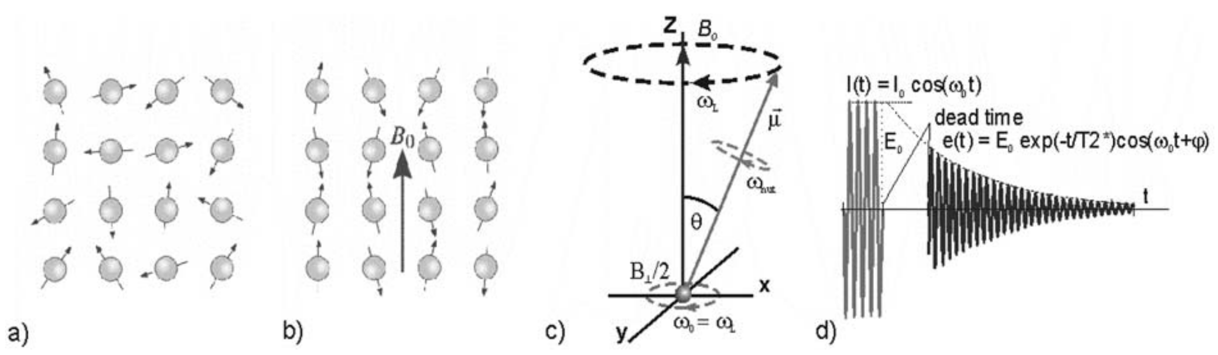


Figure 1: Spin characteristic of the proton. (a) in the absence of an external static magnetic field (b) in an external static magnetic field B_0 (c) the precessing hydrogen proton at the Larmor frequency ω_0 (d) the time diagram of the SNMR signal measurement.

Numerical modeling

Interpreting SNMR data consists in determining the water content of each layer, in the hypothesis where the underground is stratified at the scale of the loop dimensions. The inversion consists in processing the raw data for the whole set of pulse moments corresponding to the various depths of investigation. However, some parameters are well defined such as the product of the thickness of a thin layer by its water content. The development in a 3-D forward modelling of SNMR initial amplitudes and decay times are based on the work of Eikam[7], that can be used for two and three-dimensional interpretation of SNMR surveys. The formulation is reduced to a finite dimensional matrix problem by considering a finite number of cells with constant spin density (water content and decay time). The 3D forward modelling is then calculated by generating synthetic data for several of spin density distribution. This allows to analyse the spatial signal sensitivity of the method and shows the limits and problems of the 1D inversion and interpretation of 2D and 3D structures.

We introduce a 3-D forward modelling of SNMR initial amplitudes and decay times[7, 8, 9]. A prismatic three-dimensional body model is divided into small cubic cells of dimension DV = DxDyDz. The water content f(x,y,z) and the decay times T2*(x,y,z) are assumed to be constant in each cell. Then the integral equation is approximated by the finite summation

$$E(t,q) = \omega_0 M_0 \sum_z \sum_y \sum_x e^{-t/T_2^*(x,y,z)} f(x,y,z) \\ B_\perp(x,y,z) \sin\theta(x,y,z) \Delta x \Delta y \Delta z. \quad (2)$$

From this relation, the complete SNMR signal can be calculated as a function of a three dimensional distribution of the water content f(x,y,z) and decay time T2*(x,y,z) in the subsurface.

Figure 2 represents the 3D model-discretization for which SNMR model have been calculated using one turn circular loop of radius 50m in geomagnetic field of 48000 nT at an inclination of 60° and declination of 00 in a low conductive half-space. The initial amplitude for t = t_0, the start of the record, are then given by

$$E_0(q) = \omega_0 M_0 \sum_z \sum_y \sum_x f(x,y,z) \cdot \\ B_\perp(x,y,z) \sin\theta(x,y,z) \Delta x \Delta y \Delta z \quad (3)$$

The inner part of the integral is commonly written as the product of a kernel function and the water content

$$E_0(q) = \omega_0 M_0 \sum_z \sum_y f(y,z) \cdot \\ K_{2D}(q;y,z) \Delta y \Delta z \quad (4)$$

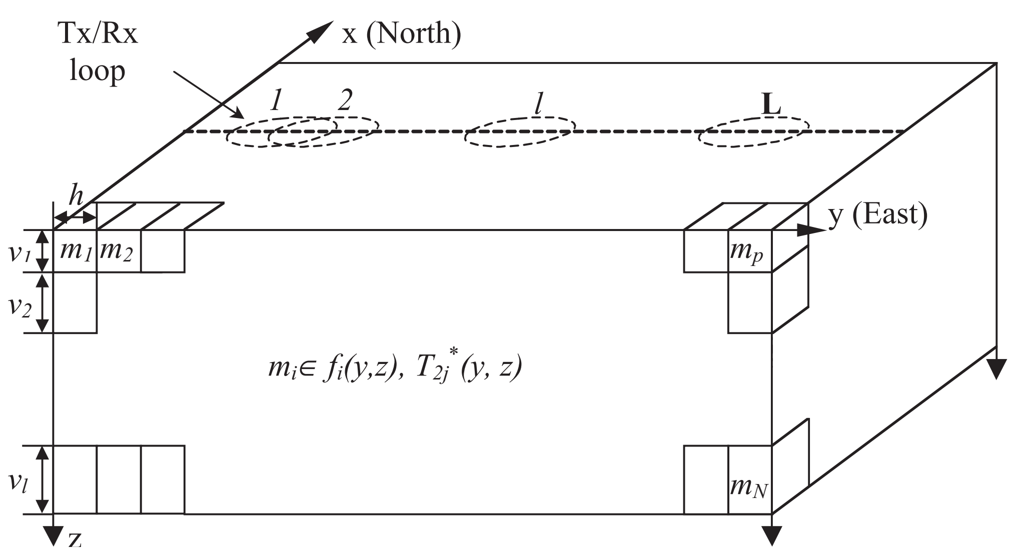


Figure 2: 3-D modeling of surface NMR measurement for *l* = 1,.., L sounding points.

For a study of 2D we assume the water content to be in 2D distributed. We obtain

$$E_0(q) = \omega_0 M_0 \sum_z \sum_y f(y,z) \cdot K_{2D}(q;y,z)\Delta y \Delta z \qquad (5)$$

Sensitivity of SNMR

The slices of a 2D kernel ($K_{2D}(q;y,z)$ in equation 5) in west-east and south-north directions for pulse moment q ranging from 1 to 20 [A.s] are presented in Figure 2-3. The kernels are compiled for a circular loop (D=100 m, 1 turn) in a low conductive media. Increasing the pulse moment q increases the depth of penetration of the method. Whereas sensitivities of west-east sections increase symmetrically, they are focused to the north in south-north sections. This effect is caused by the non-symmetrical contribution of SNMR signal[9, 10].

To study spatial sensitivity for SNMR surveys we modeled 2D sensitivities for three different field layouts. The antenna (1 turn circular loop, radius R = 50 m) is shifted at the surface for intervals of 50 m, 100 m and 150 m between sounding points each for a west-east and south-north profile. The sum of the kernels (magnitudes) of a set of measurements along a profile now gives the 2-D sensitivities to the water distribution. Fig. 2 presents the distribution of sensitivities for pulse moments q = 1, 10, 20 A.s., respectively. To evaluate the lateral resolution of each survey the 2-D kernels are compiled.

Increasing pulse moment q increases the depth of penetration as well as the lateral extension of the sensitive region. A sounding interval of 50 m (1R) with 50 m overlap yields the best lateral coverage. The consistency of lateral coverage rapidly decreases for 100 m (2R) interval for of smaller section than the 1R interval. For 150 m (3R) intervals, which would be the fastest survey progress, the sections display almost no consistent lateral coverage. Therefore only smaller intervals would be favourable for a 2D inversion of field data. However, the lateral resolution can generally not exceed the sounding intervals.

For South to North profile direction a northward shift of sensitivities can be observed. Therefore, regions of low sensitivity occur in the southern part of the profile whereas regions of high sensitivity can be observed beyond the northern profile limits.

2D Inversion

The first task of research is extending the initial amplitude 3D forward modeling code to decay times (T_2*) for SNMR. This scheme can be used for two and three-dimensional interpretation of SNMR surveys. For a better understanding and insight of the capability of the method we calculate the SNMR response of 2D and 3D models, i.e. the SNMR relaxation signal for various locations of the antenna loop.

The 3D forward modelling is then calculated by generating synthetic data for several of spin density distribution. This allows to analyse the spatial signal sensitivity of the method and shows the limits and problems of the 1D inversion and interpretation of 2D and 3D structures [9].

At the end of this research are formulation and implementation of 2D inversion. One of the critical problems in inversion of geophysical data is developing a stable inverse problem solution, which at the same time can resolve complicated geological structures. Traditional geophysical inversion methods are usually based on Tikhonov regularization theory, and they provide a stable solution of the inverse problem. For inversion of SNMR the Tikhonov regularization method was used also to minimize the number of measurements [6] without a loss of the accuracy.

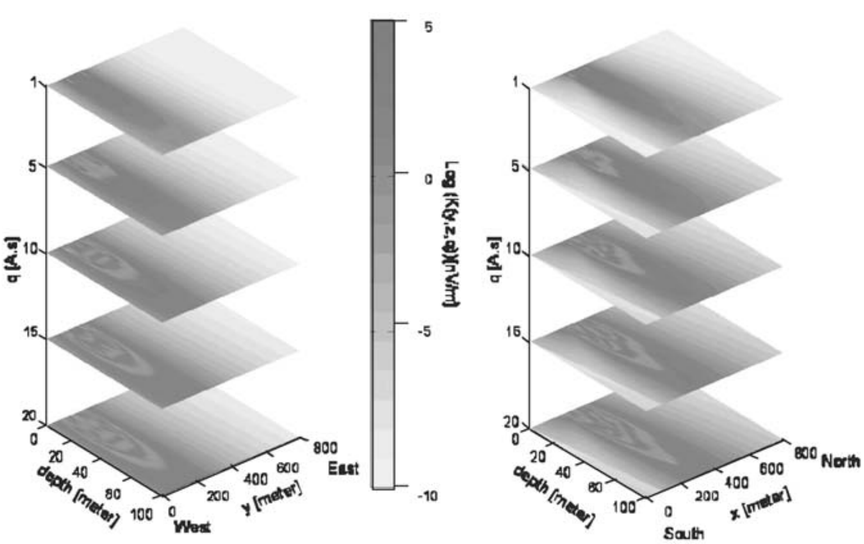


Figure 3: 2-D kernel (magnitudes) for single SNMR sounding at in west-east (left) and south-north (right) direction for pulse moments q = 1, 5, 10, 15, 20 [A.s]; earth magnetic field B_0 = 48000 nT; I = 600; circular loop with 100 m diameter, 1 turn.

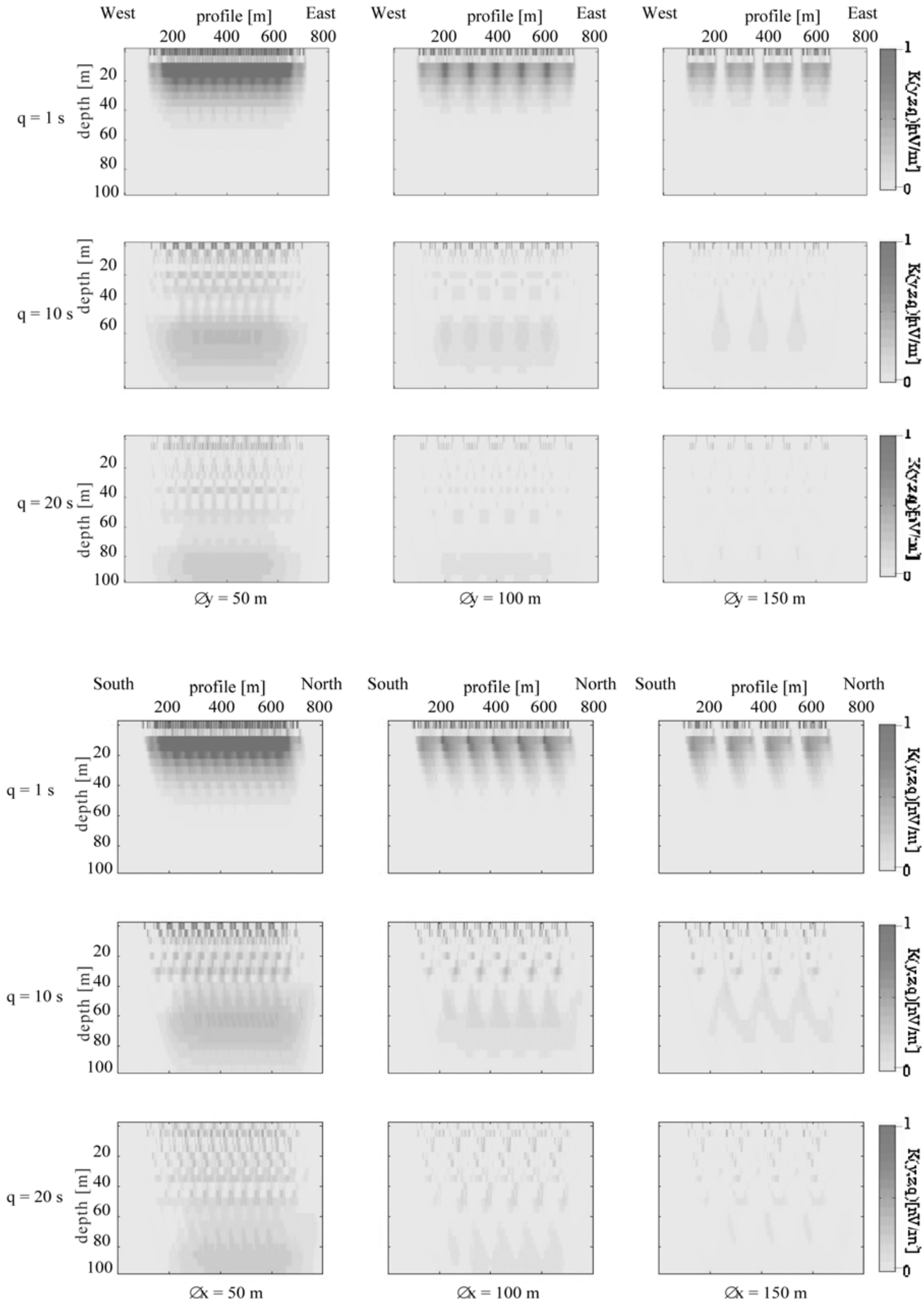


Figure 4: 2-D sensitivities for SNMR sections in west-east (top) and south-north (bottom) for sounding point intervals: 50 m (left), 100 m (center) and 150 m (right); earth magnetic field B_0 = 48000 nT; I = 60°; circular loop of radius 50 m, 1 turn.

This section describes the inversion routine which tries to find the smoothest model that fits the data to an a priori value of χ^2. The steps of process are

- a forward model, sensitivity matrix, and data misfit are calculated,
- the sensitivity matrix and data misfit are used to estimate a Lagrange multiplier a that controls the relative weighting of smoothness versus data fitting in the objective function, and
- modified Levenberg-Marquardt algorithm is used to find the parameters that minimize the objective function.

The Levenberg-Marquardt algorithm

$$\mathbf{m} = (\mathbf{G}^T\mathbf{G} + \alpha\mathbf{I})^{-1}\mathbf{G}^T\ \mathbf{d}$$

where α is the damping parameter and $\mathbf{I}$ is the identity matrix.

As a first example, we invert the initial amplitude & decay time of SNMR data, which was produced by a single water lens having water content of 40% and decay time 150 ms (Figure 5). There are 11 sounding point data of measurement and 1% gaussian noise was added to the data prior. The recovered water lens model, shown here, is a good representation of

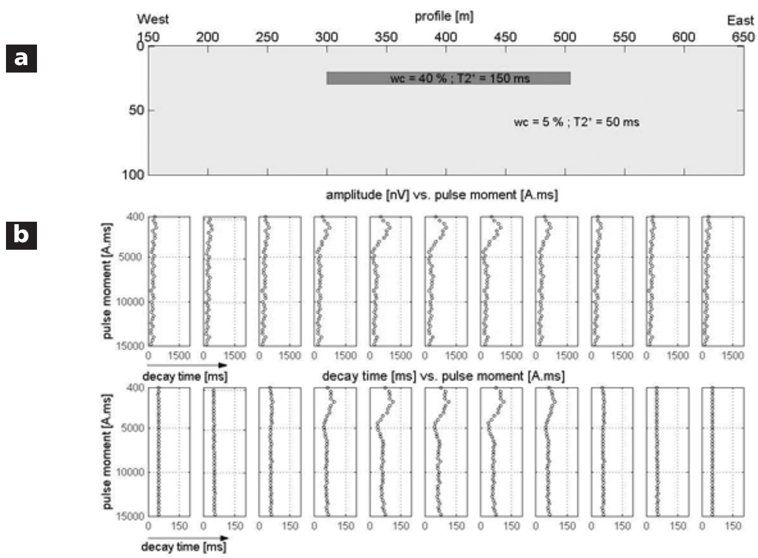
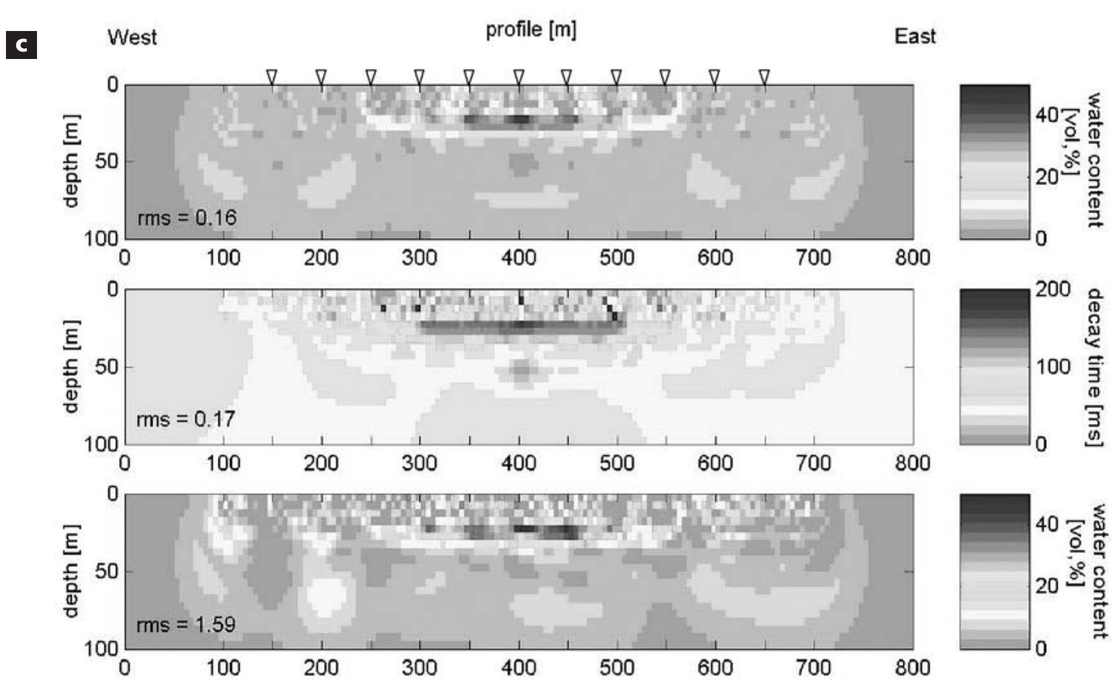


Figure 5: (a) 2-D water lens model having a water content of 40 vol. percent and decay time of 150 ms. The surrounding material is associated with a water content of 5 vol. % and decay time of 50 ms.

(b) Synthetic SNMR amplitudes;

(c) 2-D inversion result; earth magnetic field *B_0* = 48000 nT; *I* = 60°; circular loop of radius 50 m, 1 turn.



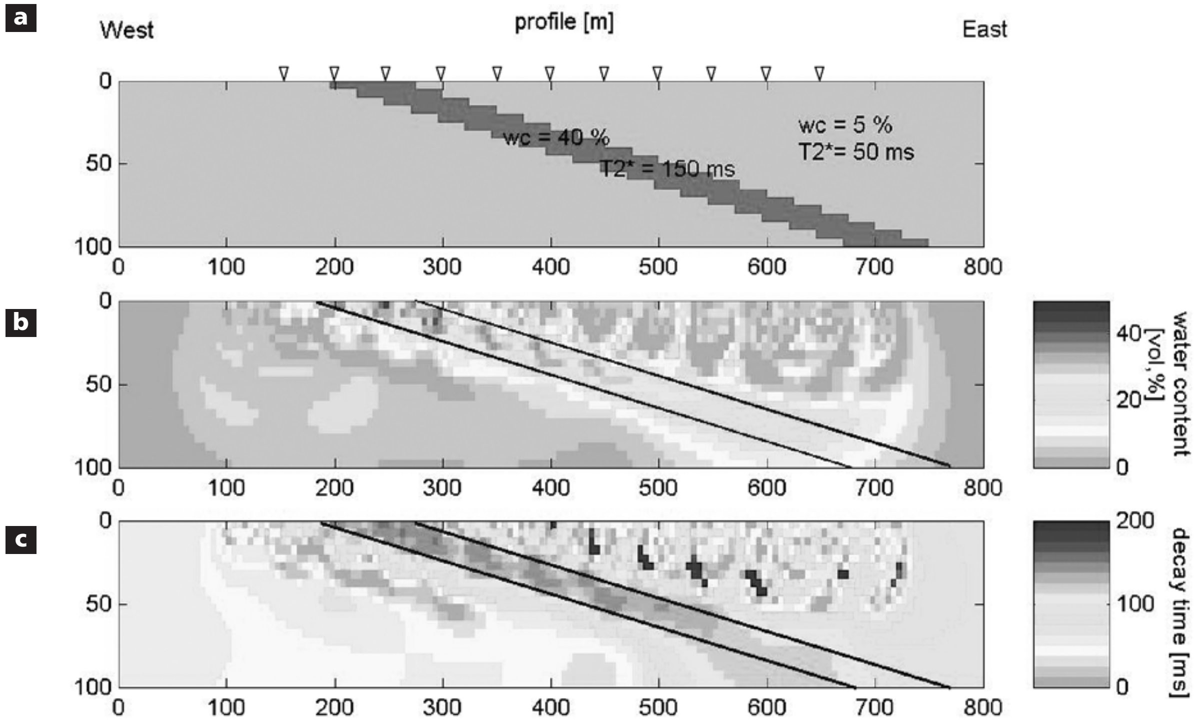


Figure 6: (a) 2-D dipping layer model having a water content of 40 vol.% and decay time of 150 ms. (b) & (c) 2-D inversion result water content and decay time

the true model. The recovered value is slightly lower than the true value.

Figure 6a shows a 2D model of a dipping bearing layer (dipping angle = 7°) striking from north to south, e.g. an aquifer underneath a hillside. The model has been computed using a grid size of _x = _y = _z = 0.5 m. A water content (WC) of 40 vol. % and a decay time (T_2*) of 100 ms is assigned to the aquifer. The surrounding material has a water content of 5 vol. % and decay time 50 ms.

The 2D inversions (water content and decay time) of the dipping layer model using a smooth inversion scheme are presented in Figure 6b & c. The smooth inversion was performed using Levenberg-Marquardt algorithm up to a maximum depth of 100 m. At a distance of 50 m to the west from the outcrop of the dipping layer no signal contribution of the aquifer is observed. Corresponding to the model the inversions show constant water content of approximately 5 vol. % and decay times of about 30 ms up to 100 m depth. At the outcrop of the aquifer (profile 150 m) the inversions indicate a slight increase of both water content (<20 vol. %) and decay times (<90 ms) near the surface. The water content and the decay times of the aquifer as well as its thickness the depth of the aquifer are in good agreement with the model. Naturally, the sensitivity of the SNMR method gets smaller with increasing depths.

Conclusions

3D modeling of SNMR data is necessary to predict the SNMR signal response of aquifers. Use this method for optimisation of field layouts for appropriate measurement on given 2D situation. 2D SNMR sensitivities are necessary to evaluate lateral and vertical resolution of 2D. We have developed a reliable technique for 2-D inversion of SNMR.

Improved inversion algorithm will be investigated consist of model parameterizations regularization schemes. This inversion will be applied for the SNMR field data hydrogeology. At the end, the SNMR can be applied to dectect subsurface water in suitable geological formation to a depth of 100 m and more depending on the presence of natural and cultural electromagnetic noise. In the future this new method may be applied as an attempt to bring long-term solutions to the water supply problems and also to protect groundwater from the degradation of aquifers.

Outlooks

It was realized that the method passed experimental stage and is on a good way to be an established geophysical technique. Furthermore, it was realized that there is broad on-going focused research in different group's worldwide and increased interest by the end users prospecting for groundwater. As a researcher in developing country, I will continue the collaboration with Interpretational program improvement, and applied some field data. Design for new field measurement.

From the 2nd MRS/SNMR workshop in Orleans-France could be considered as a meeting not only to those involved in SNMR development and application, but also for geophysicists and hydro-geologists seeking new tools for groundwater investigation. The workshop was attended more than 70 participants from 15 countries (Algeria, Australia, Burkina Faso, Chine, Denmark, France, Germany, Great Brittany, India, Indonesia, Jordan, The Netherlands, Nigeria, Russia, Spain and USA). There clearly should be something for everyone interested in aquifer characterization and localization.

What the components of learning in our project are to find out the relationship between aquifer characterizations (water content and permeability) using SNMR and disaster risk. Finally, a combination of methods is proposed by which near-surface geophysics can contribute regard to the water content and the water distribution.

References

1 Steeples, D.W. 2001. Engineering and Environmental Geophysics at The Millennium. Geophysics, vol. 66, No.1, 31-35.

2 Abdulkadir, W.G. et.al. 2002. Studi amblesan permukaan tanah dan dinamika air tanah di dataran alluvial Semarang – Jawa Tengah dengan menggunakan metode Microgravity 4D. Report of Research. Institute of Technology Bandung.

3 Yaramanci, U., Lange, G. and Hertrich, M. 2002. Aquifer characterisation using surface NMR jointly with other geophysical techniques at the Nauen/Berlin test site. Journal of Applied Geophysics 50, 47-65.

4 Yaramanci, U., Lange, G. and Knödel, K. 1999. Surface NMR within a geophysical study of an aquifer at Haldensleben (Germany). Geophysical prospecting 47, 923-943.

5 Schirov, M. and Legchenko, A. 1991. A New Non-invasive Groundwater Detection Technology for Australia. Exploration Geophysics, vol. 22, 333-338.

6 Legchenko, A.V. and Shushakov, O.A. 1998. Inversion of Surface NMR Data. Geophysics 63, 75-84.

7 Eikam, A. 1999. Modellierung von SNMR-Anfangsamplituden. MSc Thesis, Technical University Berlin.

8 Warsa, W., Mohnke, O. and Yaramanci, U. 2002. 3-D Modelling of Surface NMR Amplitudes and Decay Times. International Water Resources and Environmental Reasearch ICWRER 2002, Vol. III, Eigenverlag des Forums für Abfallwirtschaft und Atlasten e.V., Dresden, 209-212.

9 Warsa, W., Mohnke, O., Hertrich, M. and Yaramanci, U. 2003. Sensitivity study of 3-D modelling for 2-D inversion of Surface NMR. Proceedings of the 9th European Meeting of EEGS, Prague.

Action advocacy to ensure right to livelihood risk reduction and beyond

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Introduction

The livelihood security of the urban poor, which unprotected in normal times are undermined by disasters and uncompensated in post disaster recovery efforts. The urban poor perceive provision of food, water and shelter as a source of protection and support of their income earning activity. Better food means better nourishment that is reflects in their productivity. Proximity and regular supply of good water means less time spent on fetching it from a distance or waiting for it. This means more time for work. Safer shelter means safer place to work, safer place for keeping raw materials and safety of their families when they are away. Protection of livelihoods of the urban poor is a prime mover for achieving security for their future

What happens to the livelihoods of the urban poor when a disaster strikes?

Their economic and social condition renders them defenseless from the onslaught of disasters and the sustained after effects. Source, support and sustenance of their work are affected adversely. They suffer loss of income and assets. Handcarts, sewing machines and wheelbarrows are damaged and buried under fallen roofs and walls. Shelters, which double as workplaces for the poor, are destroyed. Economic links are damaged and local markets are destroyed. Worse, in the relief process their long-term needs are ignored. These sections are not able to withstand the impacts of disasters or recover like the better-endowed sections of the society. More often than not, without outside support, this section of victims is unable regenerate their livelihoods to secure their lives again. Even though the poor are known to take rational decisions in the face of disasters and are ready to invest in disaster-proofing techniques that will make their lives safe, every step they take is hinged on their livelihoods.

This paper delineates the findings of a research study, supported by the ProVention Consortium of the World Bank, and conducted by the Disaster Mitigation Institute (DMI), Ahmedabad among the slum dwellers in Bhuj, (Western India), who are still recovering from the January 2001 earthquake. The results indicate that overall social development of a region is in itself an effective risk reduction measure and outlines a roadmap for investment in human capital, social or economic, as an aid to livelihood risk reduction. This approach interlinks recovery and mitigation of disasters to existing efforts in developing countries focusing on improving its social indicators like literacy, and initiatives to create safety nets like micro –credits and micro-insurance.

Background of the study

The Stimulus

The internal and external drivers that stimulated the concept of the original research study —' Action Advocacy for Livelihood Risk Reduction and Beyond'— have been summarized into a set of three questions:.

How can we develop a framework of sustainable livelihoods in a disaster prone pocket?

What role does a need-based livelihood relief have on the lives of disaster prone urban poor?

What role does reducing risks to livelihoods have on the development of a state, country and region? What works for risk reduction and why?

Most of them are direct. The study has attempted to get the answers from the ground reality in the fourteen earthquake affected slums in Bhuj, still recovering from the January 2001 earthquake.

The target population

The approach to the research study was both quantitative and qualitative, and the interest is to make generalizations concerning livelihood recovery pattern of a group of slum-dwellers in Bhuj.

For this the study focused on 1100 livelihood beneficiaries of Disaster Mitigation Institute (DMI). in Bhuj. A brief introduction to organization is given in Box 1.

Box 1: Disaster Mitigation Institute and Human Security

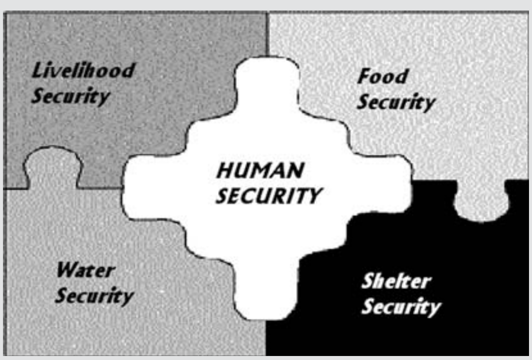
Disaster Mitigation Institute (DMI) is a community based action research, action planning and action advocacy organisation that bridges the gap between policy, practice, and research from the community to the national level. Established after the 1987-89 repeat drought in Gujarat, it has four programmes: livelihood security; food security; shelter security; and water security. Its activities are organised around its activity centres: **Livelihood Relief Fund (LRF);** Emergency Food Security Network (EFSN); Water Security Programme (WSP); Emergency Health Unit (EHU); Organisational Resources (OR); Learning Resources (LR) and Action Research and Review Services (ARRS). DMI's mission is to reduce the vulnerability of poor communities by increasing mitigation efforts through learning and action.

DMI's LRF was created as an activity centre after the cyclone that hit the western port of Kandla situated in the western coast of Gujarat in June 1998. Since then, LRF has grown steadily to reach out to victims of the Kandla

Cyclone, 2000 drought, Bhuj earthquake in 2001 and the communal riots that rocked Ahmedabad in 2002. It has given livelihood support to more than 10,000 victims of the earthquake in the three districts of Kutch, Patan and Surendranagar in Gujarat.

LRF in partnership with international aid agencies such as American Jewish World Service (AJWS), Action Aid and European Union (EU) has reached out to the disaster victims and worked for providing them long-term needs. In Bhuj, LRF focused its attention in slums that were ignored even a year after the earthquake and in-spite of abundance of relief material.

DMI accepts the wisdom that disasters are no longer a temporary dip in the development graph but a threat to the process itself. For mitigating disasters, DMI has four critical human security programmes: livelihood security; food security; shelter security, and water security. DMI's conceptual model of human security is shown in the adjoining figure. Livelihood security is consciously placed in a prominent position, as it is linked to food, shelter and water security. This model has come out of DMI's ongoing experience with regenerating livelihoods of the urban poor victims of floods, droughts, earthquakes and so on. Beneficiaries of LRF and their families are consuming more and nutritious food. They are ready and capable of investing in disaster-proofing their shelters. They can buy enough water for their daily needs. In short, they are surer of a secure future. Livelihood security, DMI has seen, is the hub around which human security of the urban poor revolves.



DMI's human security model

Sample

LRF's beneficiary group in Bhuj consists of a diverse group of livelihoods, which can be classified into four different groups: small businessmen, small-scale vendors, laborers and home-based workers. Several different professions can be categorized under these sections.[1]

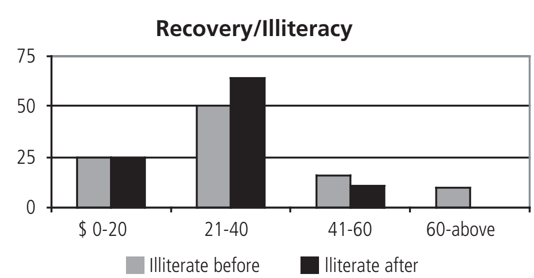
The initial list of issues was prioritized in consultation with a selected group of LRF beneficiaries.[2] After, the entire questionnaire was designed, the slum-dwellers were again consulted and their inputs incorporated. A team of slum-dwellers associated with the Bhuj Reconstruction Project (BRP) conducted the actual survey with inputs from two international students associated with DMI through its internship programme. 246 livelihood beneficiaries were interviewed. A set of case studies provided a qualitative perspective to the findings. The data is fresh and the perspective provided is from the community and inside out. The main findings and analyses have been separated and distilled into this paper.

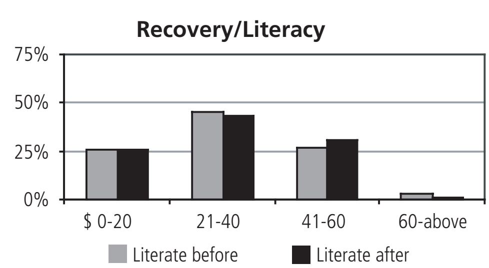
Livelihood Risk Reduction: The links[3]

How can livelihoods of urban poor that fuel their development poor be protected? The scope and the range of areas covered by the research study included the study of different influences and combinations of a wide range factors and impacts that jointly affects the livelihood security of the disaster-prone urban slums. These include a complete analysis of age, gender, livelihood types on one hand and their individual status with respect to literacy, economic recovery, savings capacity and vulnerability on the other. As explanation of each an every finding would be beyond the scope of this paper the most significant among them is summarized below.

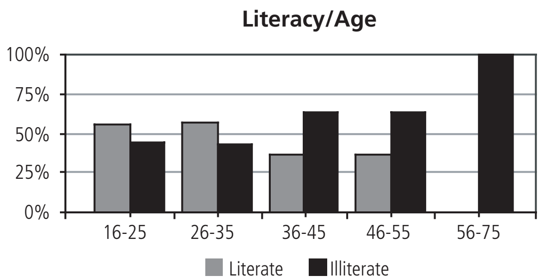
Literacy reduces risks

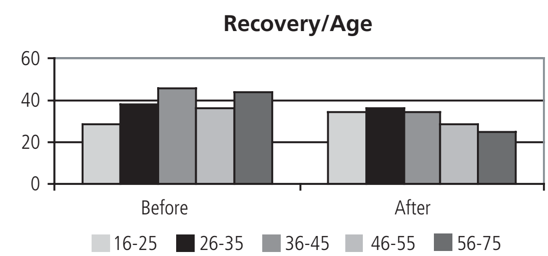
The respondents were divided into five age groups as 16-25, 26-35, 36-45,46-55 and 56-75. The educational level of the slum dwellers is quite low. Less than 35% of the sample had gained some level of education. Out of these, barely 26% had completed the primary school, 8% the secondary school, less when 2% entered the high secondary school.





There is a marked difference in recovery patterns of the literate and illiterate among the slum dwellers. In the graph 'income /illiteracy' it can be seen that there is an increase in the number of illiterate people in the $21 to $40 category and a decrease in illiterates in higher income categories. Consequently, the average income of the illiterates has shrunk from $39 per month before the disaster to $30 after. On the other hand, there is insignificant difference in average income of the literate. The average income is almost same ($35). As seen in the graph there is minimum impact of the earthquake on their income.





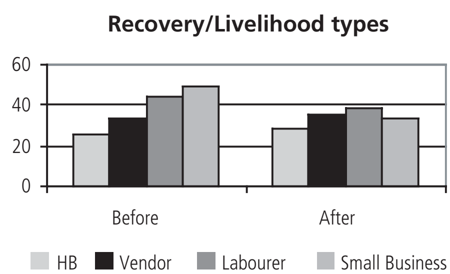
Another finding that supports the link between literacy and livelihood risk reduction is the analysis of the recovery across age groups. The younger groups also had majority of the literates from the sample. The recovery of the younger two groups was also better than the other three groups. It can be argued that the income of the youngest age group would always increase irrespective of the disaster. Therefore in comparing the above graphs the focus should be on 26-35 and the 36-45 age groups. The withstanding capacity of younger group, which is more literate, is more than the older category.

This is evidence of the significant role that literacy plays in recovery after disasters and is a crucial link between poverty and disaster risk reduction. A majority of them does not pursue education due to lack of resources and the need to earn to live. What is more striking is that even in the poorest category of the society, literacy (not only in school going terms) helps in making the right decisions, understanding markets, awareness of rights, etc. The literate, after a disaster, can better link up with the changed and emerging market and align the livelihood to benefit from it. The illiterate are not able to do so.

Hence literacy of an urban area is an important indicator for assessing the capacity of the region to withstand and recover from disasters.

Credit is crucial

Livelihoods that require less capital have recovered better compared to others. There is an increase in average income of the home-based category and small vendors compared to small businesses. In the category of small businesses, more than 77% of the respondents were men. The recovery here is crucially dependent on availability of economic capital. More than 87% of them felt that their daily needs were not covered. The adverse impacts of the relocation from the Walled City1 to the outlying areas have been most felt by the small businesses. Around 60% of them had to relocate, losing their customers.



There is a reduction in income of laborers in spite of the massive post earthquake reconstruction work in Bhuj. This can be attributed to the impact of large number of migrant workers that have entered Bhuj from the poorer regions of the country like Bihar, Uttar Pradesh and Rajasthan. These migrant are preferred by contractors undertaking the reconstruction as they can be expected to work for as low as one third of the daily wage that a laborer from Bhuj would demand.

A related finding here is the average income of women to have increased post disaster. The average income of women had increased from $26 before the earthquake $27 after, while the corresponding incomes of men had reduced from $43 to $37. The number of women who earned no income is less now than before and this section has contributed to the increase in average income of women. Women constituted a majority (73.2%) of home-based workers. These women produce food items at home, make ready-made garments, do embroidery and manage in-house stores

Surprisingly twenty percent more women now have work inside their community as compared to before the earthquake. Coupling this finding with an increase in average income there could be a conclusion that livelihood relief targeted at women have given dividends.[4]

This is the second link between poverty and risk reduction. To restart their earning mechanisms the poorer sections need capital, credit and insurance in micro quantities. They have limited capacities to save and hence methods have to be devised to address this gap.

Availability and access to low interest credit or insurance and presence of institutions and government mechanisms in urban areas is another indicator of the dimensions of the risks that poorer sections face in event of a disaster.

Intervene to empower

The last section of the questionnaire dealt with the market linkages at the micro level and the impact it has on the four major livelihood types in the slums. A vast majority felt that the competition in the markets has increased. The respondents stated two reasons for this increase.

Relocation again seems to be the main culprit in this aspect. Of the respondents, 80% of the respondents said that in their profession regulars and passers by are their main customers. Since they are now staying further away from the Walled City, (the central area in the city that has the maximum market activity, and was also badly destroyed) their customer base has shrunk. The average customers per day, when calculated from the responses, have shrunk from 15 per day to around 10 per day. The second and more significant is their claim that indiscriminate provision of similar livelihood relief materials, like sewing machines, in a limited area has tampered with their markets. Thus, humanitarian relief and reconstruction, when without coordination, and market-sterile, dampens the local markets of the poor.

Availability of reliable information of the region with regard to its livelihood pattern and the market linkages is an indicator of risk management capacity of the area.

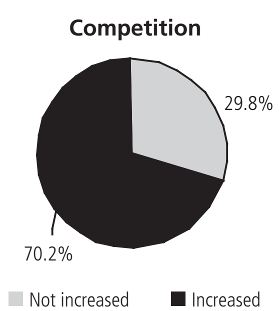
Existing vulnerability of the poor is compounded by disasters

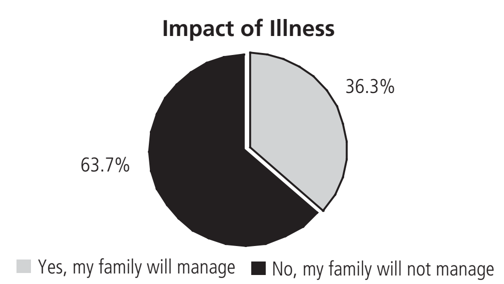
Among the respondents, more than 80% of the respondents felt that they were not able to invest in any saving mechanism. This number has increased to 85% with the laborers showing no capacity to save. Among genders, women have also shown willingness more than men to save and improve their condition.

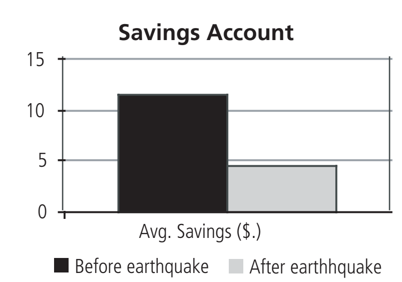
The average saving amount also has reduced from \$11.5 to \$4.5 per month. Not surprisingly, more than 87% of all the respondents said that their extra costs were not covered.

One of the most important questions asked during the survey was: 'Will your family would survive if he/she fell ill?' An overwhelming number, 63%, replied in negative.

For most of the urban poor, security is never possible as their economic and social condition renders them defenseless from the onslaught of natural disasters and their sustained after effects. Provision of safety nets by government and humanitarian agencies and adoption of saving habits by the residents of slums is an indicator of disaster preparedness of and risk minimization of the region.





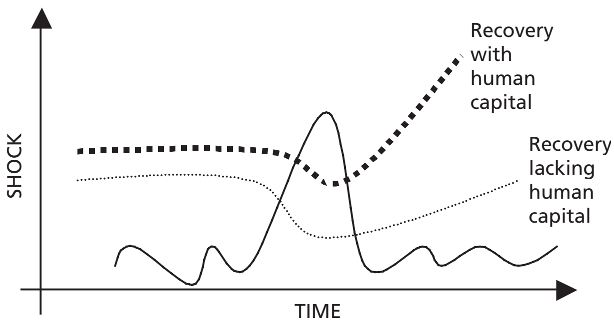


Reducing livelihood risk: the human capital approach

Even during normal conditions, the urban poor live in a dysfunctional society with their livelihoods under constant threat, daily food intake in an imbalance, and limited access to health facilities and safe water. Disasters attack the precarious security or asset base of the poor and increase its rate of erosion. Livelihoods of the urban poor feed them, keep them clean and healthy and provide them a shelter and education for their children. Unless their livelihoods are protected, their security will continue to get repeatedly erased and discarded when a disaster strikes.

The study unearthed some aspects that influence recovery of livelihoods of the urban poor in Bhuj three years after a disaster. The study shows that human capital of the urban poor, as a result of good development indicators like literacy, awareness and availability of micro-credits, can govern the post disaster recovery and reduction of risks to urban livelihoods. Post disaster recovery in Bhuj showed clear differences in recovery patterns with those with human capital clearly at an advantage (see graph). Human capital is therefore an important and crucial link to reduction of livelihood risk.

Conversely, literacy rate of the region, availability of micro-credit/micro-insurance, market linkages for products that the urban poor makes and saving patterns can be used as indicators for risk assessment of the region.



On this perspective, action steps can effectively protect livelihoods from disaster risks, and simultaneously speed up recovery is suggested below. In succeeding boxes, examples of some attempts made by organizations in the same direction are provided.[5]

1) Literacy is a crucial link between poverty and disaster risk reduction. When people in a community have the freedom to develop and the capacity to grow in the direction they chose then we say that the society is empowered. The awareness of rights and the confidence in their ability to manage crisis in their stride is the greatest contribution that literacy, and the associated skills and confidence that literacy gives, can provide to poor people affected by sudden disruptions to their lives. Initiatives for skill and versatility development must be developed for those whose occupations and livelihoods remain unprotected, uncompensated and vulnerable in low-income areas of cities. Spread of education across low-income and at risk population can reduce recovery time and efforts. The demographic profile, geography and diversity of the people demand a need based capacity building. Providing better living and working conditions for the slum dwellers and better chances for education should be a priority for most urban rehabilitation agenda actions.
2) Relief agencies should take effort to find out what the region wants and take account of their skills prior to any disaster and support and augment them accordingly. When livelihood tools are given, market links should not be missed out. When incomes are generated sustainability beyond project life should be thought of. When livelihood needs are supported the measures should be down top, inside out, sustainable, with links to the market, timely and in suitable scale. Impact of relief on local markets of the poor among the victims has to be better understood. To ensure that relief and rehabilitation should not strain the local livelihoods a strong database of livelihoods of the region should be maintained which will included comprehensive information on the livelihood type, resources available locally to support them and market linkages that exist during normal times from and to the livelihood location. This information should be made available to the intervening agencies which should take care in strengthening weaken or damaged links rather than creating new unsustainable links.

Box 2: LRF and Micro-Mitigation

LRF provides services specifically targeting disaster mitigation and recovery through livelihoods such as livelihood recovery planning and other key trainings. Examples of such activities are the literacy and basic education services sponsored by LRF in Bhuj. (Outgrowths of the study have indicated the direct link between literacy and disaster mitigation for livelihoods.) These literacy activities include early education through Child Care and Education Centers (Anganwadis) and adult literacy training. In addition, eleven capacity building cycles were conducted in Bhuj, focusing on disaster preparedness, SPHERE standards, emergency food and nutrition, safer shelter construction, among others.

LRF has a very clear and direct approach to address the issue of basing relief on need. Provision of relief is demand-based, balanced by the demonstrated ability of the beneficiary to use what he or she gets to recover and develop. For example in Bhuj, The range and variety of livelihood support that DMI has given is long. The beneficiaries were given sewing machines, shops, drums, donkeys, cows, horses, bangles, teashops, hand-pushed carts and wheelbarrows. GIS maps are being developed for low-income habitats in Bhuj that will include all the resources available, security-wise and facility-wise within Bhuj and those that are required from outside. Maps of three slum areas are ready for use.

LRF beneficiaries have joined hands with DMI to create the Chamber of Commerce and Industry of Small Businesses (CCISB), which will further assist them and other qualified relief-applicants in their continued livelihood recovery. By providing well-targeted financial and non-financial services, CCISB assists in stabilizing and strengthening the livelihoods of the disaster-affected, vulnerable poor of the Bhuj slums. The creation of the CCISB's is DMI's investment in the slum dwellers'future.

3) Access to low interest credit and insurance to urban poor can raise their asset base and improve their coping mechanisms in the short and long term. Increase in livelihood opportunities with matching access to infrastructural resources in urban slums must be a priority. Saving mechanisms that incorporate the earning and expenditure patterns of the slum dwellers have to be developed and the habit of saving have to be promoted among them. Donors should support experimental activities through venture funds. There are many reasons in favor of initiatives focusing on micro-credit/micro finance. It can achieve much in terms of smooth recovery of poor livelihoods and protecting them from future disasters.

Box 3: Linking women

Self-Employed Women's Association (SEWA) is a membership-based trade union working for income security of women for nearly three decades. Three of SEWA's initiatives in livelihood risk reduction are truly innovative and deserves mention. These include SEWA Trade Facilitation Centre (TFC), Livelihood Security Fund (LSF) and Core Sale. (Refer www.sewa.org).

- SEWA TFC: SEWA has taken several initiatives towards facilitating marketing efforts and establishing marketing linkages for poor women. STFC is a major initiative with a thrust on marketing of craft products made by them.
- Livelihood Security Fund (LSF): The main objective of this fund is to ensure that positive experiences in using new and innovative economic activities as tools to combat disasters are extended to all the disaster affected areas as measures in disaster proofing and ensuring livelihood security.
- Core Sale: In order to strengthen the livelihood of artisans, the textile workers and the handloom workers and garment workers of Gujarat, STC, Government of Gujarat and National Institute of Fashion Technology have come together to form the 'Core Sale'- an enterprise to upgrade skills, provide sustained work and employment opportunities to the workers in the informal sector. (Gujarat has a rich tradition of handicraft)

4) Disasters can be a spur for massive investment in reducing risk to infrastructure. The plans for reconstruction of Bhuj are futuristic, advanced and earthquake- proof. Four lane roads and an upcoming new airport are converting Bhuj into a prominent town in Gujarat. The benefits to the poorer sections, however, still have to filter down. During the post disaster scenario, the slum dwellers have to be empowered to exercise their rights and realize opportunities in the rehabilitation, relocation and poverty alleviation schemes. The spatial and locational needs of their livelihoods have to be given maximum importance. Special work and business areas for livelihoods of the weaker sections must be developed within the framework of the urban planning and reconstruction plans of disaster-prone urban pockets. Also, any relief, rehabilitation and mitigation efforts that reach cities should reach slums.

5) Build not use local resources. Any risk reduction measure when reaching the grassroots of the community it works for has to simultaneously be able to empower them. Fortification of human capital has to be undertaken in consultation,

communication and co-operation between the local micro and macro agencies, in the process expanding partnerships and synergy for effective and efficient implementation. There is a need to develop a symbiotic relationship between the community and outside actors. The target community should be the agents of preparedness and focal points of information dissemination to the community. Every step that is taken in the selected area should be in consultation with the community that the intervening agency seeks to serve. Once this is achieved, the community feels sense of ownership of the process, which helps the three partners (community, the local agencies and the intervening agency) to maintain a direct and transparent relationship.

6) Urban intervention of humanitarian agencies has to be up-scaled. Compared to their activities in rural disaster mitigation, the work by humanitarian agencies in urban areas (in Gujarat) is insignificant. While there are successful interventions by local organizations, mostly the urban vision is focused, sectoral and small-scale. In India, with the poverty flux clearly shifting to urban areas from rural, there is a definite need to shift from a minute intervention approach to a more wide-scale approach in urban pockets.

Box 4: Protect assets

UNDP has initiated livelihood approaches, dovetailed them into rehabilitation programmes for effective drought mitigation and consequent disaster risk reduction. These are classified into three areas that include:

- Structural Measures – UNDP in partnership with Kutch Nava Nirman Abhiyan (KNNA) has supported drought proofing with watershed development projects and repair and reconstruction of structures that were damaged.
- Non- structural measures – UNDP in association with the Government of Gujarat, and local NGO networks has set up the Kutch Ecology Fund (KEF) aimed at supporting and facilitating the planning and implementation of initiatives towards long-term recovery and drought proofing of the region.

Conclusion

The poorest in the society can benefit from the advantages of overall economic development only when their social development is in sync with the development of the country. Conversely, the improved development indicators can (a) mitigate disaster risks and (b) speed up recovery). Protection of livelihoods of the disaster prone urban poor delivers them from the debilitating impacts of the threat-hazard-disaster continuum and is a point for convergence for social development and risk reduction initiatives in urban areas in developing countries. Investment in human capital will work.

1 A partial list consists of:
Small businessmen: pan shop, tea stall, garage, barbershop, etc.
Small-scale vendors: vegetable hand lorry, chocolate and biscuit selling, etc.
Home-based workers: stitching work, embroidery, milk producing, cowherds, etc
Labourers: masonry, carpentry, scrap collection, etc

2 The objective of DMI's Bhuj Reconstruction Project (BRP) set up in January 2002 is to reach out to a large section of the slum dwellers, in 36 slums of Bhuj, people who needed immediate help but were ignored during relief.
At present, DMI works in 18 slums in Bhuj in which is home to around 32,000 people. BRP has enabled the creation of a group of motivated slum dwellers to form a network — called 'volunteers' — to work for their community. They have formed Slum Area Committees (SAC) in their respective slums to organize and work to improve their living conditions. This group played a central role in the survey.

3 The graphs in this section are adapted from the presentation 'Economic Recovery Survey' by Jeremy Drucker, Architect Planner with Bhuj Reconstruction Project (BRP).

4 The sample was comprised of livelihood relief beneficiaries of a Livelihood Relief Fund (LRF), which has a policy of beneficiary selection that is positively biased in favor of women.

5 The examples given are certain effective strategies and action steps that contribute to livelihood risk reduction (and have worked on the ground). To preempt the risk of limiting the boundary of the study to LRF, and to provide a holistic vies of the livelihood approaches in Gujarat, this section has embedded into it, innovative measures that other organizations have undertaken in other regions of the state. These include a few references to rural livelihood risk reduction initiatives as well.

Kenya

Strengthening rural community bonds as a means of reducing vulnerability to landslides

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SYMPOSIUM NOTES

The aim of this study was to investigate into the existing rural community bonds in the landslide affected areas in Kenya. This was deemed necessary by the fact that when disasters occur, community members in the disaster prone areas are affected in one way or another. The researcher found it necessary to pay attention to the important role played by the existing community bonds when a disaster strikes.

The study gathered information from the respondents by use of questionnaires and tape recorders from two administrative landslide prone districts in Kenya namely Murang'a and Meru. These districts were purposively sampled due to their repeated occurrence of landslides causing deaths and destruction of property in the recent past.

The study anticipated data on the community's perception of what landslides are, their causes, the available resources for landslide hazards prevention in the community and the existing network for disaster management in the community.

Data gathered reveals that although the community is aware of the causes of landslide, they are still vulnerable to landslides because they remain in the landslide risk areas.

Further they have continued with development activities in the areas they mapped as high landslide risk areas. Another important finding is that NGOs and the Government have not played any vital role in reducing vulnerability to the victims of landslide and the community at large. The community expressed their concern that landslides are on the increase even in areas that were not prone to landslides earlier on. It has also been established that the community bonds have weakened with time and therefore there is need for the community/government/NGOs to intervene by strengthening them.

It is hoped that the community members in all landslide prone areas will one day be at peace to be able to carry out their daily activities without being vulnerable to landslides. It is also hoped that the community will one day be able to manage landslide risks by reducing vulnerability.

Introduction

The main objective of this study was to find out how community bonds amongst the rural people can be strengthened with an aim of reducing vulnerability to landslides. Emphasis was on how to maximize the existing community bonds in landslide risk reduction.

Landslides are not a new phenomenon in Kenya. They have been occurring in different parts of Kenya since time immemorial, but in the recent years they have been on the increase in some parts of the country. Their destruction to human life and property has also been on the increase. The most vulnerable areas in kenya are: Murang'a, Kirinyaga, Kisii, Mombasa island, Nyeri and Meru. These areas enjoy high rainfall of over 1200 mm annually. Most of these areas are very hilly with steep slopes.

In the recent past, Landslides have been recurring in both Murang'a and Meru districts claiming several lives and property. Murang,a and Meru are administrative districts in Kenya. Murang'a is a district in central province of Kenya while Meru is in the eastern province of Kenya. For the purpose of this study, murang'a and Meru districts were sampled.

In this study, community members in both sites were sampled and mobilized to identify landslide hazards. This was done with the help of local leaders (chiefs, headmen, church leaders and group leaders) in the said areas. These respondents identified actual elements at risk, which included life and property. In as far as life is concerned; several people have lost their lives while others have maintained injuries. Others have to live with the trauma of the landslide experience, having been victims of the landslide or having witnessed their loved ones die in the landslides.

The community is still at risk and vulnerable to landslides. No changes or efforts have been done to improve the situation. For instance, they carry out their daily activities in the same places where landslides have occurred. Worse even is the fact that one can actually see deep cracks on the earth surface that were caused by the landslides that occurred recently.

The community members are aware of the risks involved in these cracks but claims that they have no choice but to live with the fear of landslides occurring there again. Actually, they have carried out their farm activities even on the spots where the actual landslide took place; only leaving out places where cracks are visible. All this suggests that these people are still at risk and very vulnerable to landslides. Landslides that have been occurring in these areas have destroyed a lot of property and more is at risk. In fact the community members disclosed that some of their neighbors are poor because of the impacts of the landslides, which destroy their property. Some of the property identified as being at risk include, houses, domestic animals, crops, roads, schools and arable land.

This study was carried out during a rainy season. This means that farm activities were being carried out on the farms. The researcher found people on their farms even were landslides had occurred and actually left some lose soil. Some respondents argued that it is fate to die in a landslide. That if one is destined to die in a landslide, then there is nothing one can do. Further they argued that they did not have other places safe from landslides where they could migrate to. All this talk can be interpreted to express signs of despair and hopelessness. The fact that they have seen landslides occur and claim lives and property and nothing has been done to salvage the situation has made them give up.

Landslides have been on the increase in Murang'a district, which is hilly and highly populated. Human development activities have activated this hazard that has frequently caused intensive damages to those that have been affected. The community members are vulnerable and continue to lose their lives and property.

Problem statement

Landslides are a major threat each year to human settlements and infrastructure all over the world. Kenya is not an exception of this hazard and data collected reveals that landslides are on the increase in the country. Landslides have occurred in several administrative districts and the fatal ones occurring in Murang'a and Meru districts. This study is guided by the following research questions:

- What are the causes of landslides in Kenya?
- Why are landslides on the increase in the country?
- What is the level of community participation in landslide risk reduction?
- Are the existing community bonds strong enough to help reduce vulnerability to landslides?
- What resources are available in the community to help reduce vulnerability to landslides?

Goals and objectives of the study

- ***Community mobilization for hazard identification.*** This includes definition of landslides by the community, establishing historical causes and effects of landslides, and hazard mapping.
- ***Establishing the resources available for hazard prevention in the community.*** This includes minimizing vulnerability, mitigation and recovery.
- ***Establishing network for disaster management.*** This includes intra community, NGOs and government.

Justification of the study

It is in the interest of all well wishers to help save lives and also protect property from any kind of destruction. Whenever a landslide has occurred in the named places it has left a trail of death and massive property destruction. To rescue the community members from landslides vulnerability, there was need to carry out this kind of study.

Other than trying to bring in external forces to address issues of how to address landslides in landslide areas, it is important to involve the community itself. This way they will take the project as their own and sustain it.

Whenever a landslide occurs people loss their lives and property is damaged. In order to curb this there was need to investigate into the research topic. This way lives and property will be saved and probably landslide risk and vulnerability be reduced to manageable heights.

Scope and limitation

Although Kenya experiences several hazards including famines, floods, and fires both in rural and urban centers, the study concentrated on landslides. This was necessitated by the available resources and the time frame within which the project should have been completed. However there is need for intensive research in disaster management to establish possible ways of reducing vulnerability to hazards.

Research methodology

Site of the study

As mentioned earlier, this study was carried out in two administrative districts in Kenya. These districts were selected purposively because they had experienced the worst landslide damages (which included loss of lives and massive loss of property) at the time the study was being undertaken. Also people are still vulnerable to landslides in these areas.

Sources of data

Data was gathered from primary and secondary sources. Primary data was gathered by use of questionnaires and tape recorders through individual interviews and focused group discussions. Secondary data was gathered from any relevant works done related to this study through literature review.

Sample size

As stated earlier, this study interviewed respondents through focused group discussions, Key informants and also individual interviews. There were seven focused group discussions, seven key informants, and twenty individual interviews per site. In total there were fourteen focused group discussions, fourteen key informants and forty individual interviews. All these were randomly sampled to create a representative sample.

Community mobilization for hazard identification

Community definition of landslides

Landslides are not a new phenomenon in Kenya. They have been occurring in different parts of the country since time immemorial. However, landslides disasters were not as destructive as they are today. The high destruction of property, lives and livelihood can be attributed to population increase and the weakening of community participation in the prevention, management and response to disasters.

As far as landslides are concerned today, the most vulnerable areas in Kenya are: Murang'a, Kirinyaga, Nyeri, Meru, Kisii, and Mombasa. These places enjoy high rainfall of over 1200 mm annually. Most of these areas are very hilly with steep slopes. In recent past, landslides have been recurring in both Murang'a and Meru (administrative) districts claiming several lives and property. The two districts involved in this study had the following definitions for a landslide:

- It is movement of lose soil that has no support (no vegetation to hold it).
- It is soil erosion.
- It is movement of soil under the influence of too much under ground water.
- It is a place with too much underground water that has no out let and therefore forces its way out to the surface and hence a landslide occurs.
- It is massive movement of soil.

Although most of the community members could not define a landslide using the academic language, it came out very clearly that they had full knowledge that it involved movement of lose soil and rock downhill. They were fully aware that this occurred mostly during rainy season or occasionally when people mine sand under the hills. With this, the community members ended up identifying the historical causes of landslides as being:

- Too much underground water
- An earthquake
- A curse/revenge from a supernatural power
- Intensive human activities on weak earth surface
- Heavy rainfall
- The gradient of the landscape

The respondents complained that there is a lot of underground water in their land as a result of heavy rainfall in the area. This water has no outlet and forces its way out and in the process causes a landslide. They attributed this to the fact that their landscape is hilly and with a lot of underground water.

Some had other explanations. For instance landslides are blamed on supernatural powers. Some people argued that landslides are as a result of human interference with sacred grounds. According to them, sacred grounds should be left fallow for divine purposes. Interfering with them meant annoying the gods and this is why the gods revenge through landslides. They believe that landslides are caused by gods who are on the verge of revenge for having been interfered with. This category of people needs to be educated on the causes of landslides and probably how they can be managed.

The study also established that landslides are caused by intensive human development activities on lose grounds. These activities further the weakness of the soil causing a landslide.

Hazard mapping

In this study, community members in both study sites were mobilized in order to do risk mapping, identification of elements at risk, and planning on how to reduce vulnerability with maximum reliance on the community resources. This was done with the help local leaders (chiefs, headmen, church leaders, and other group leaders in the said areas.

The respondents proved to be fully aware of the places where landslides had occurred and where they could occur in future. In places they predicted occurrence of landslides in the near future, there were big crack on the ground threatening to cut anytime. The respondents argued that it is only a matter of time and a landslide would occur in such a place. They are so vulnerable that one can almost tell for sure a landslide will occur any time. They are aware of the danger but have no other alternative other than taking refuge in safer areas when a landslide occurs in their place and return when they ***assume*** they are out of danger.

The community members are forced to relocate to safer grounds whenever it rains because their lands become impassible, and landslides occur. The safer grounds in most cases are a distance from their homes. They move to the near by safe towns until when they ***think*** they are safe. However their safety on return is questionable because a landslide can occur at anytime regardless of whether it has stopped raining or not. These people are never advised by experts to return to their homes. They just assume that since the rains have subsided, therefore it is safe to return home. This means that they could still be at risk and this is why some have been victims of landslides even after predicting that it was going to take place.

The questions to ask are: When are these people at peace to carry out there daily activities without fear? What is the social, economic and political cost of a landslide to the victims and the country at large? The respondents argued that they are hardly at peace; any loud bang or unfamiliar sound sends fear throughout their bodies. This means that they are never at ease and more so during the rainy seasons. It was also established that landslides escalate during rainy seasons.

The knowledge held by the community members about the areas that can be affected by landslides is incredible. The community seems to have learned from history about occurrence and reoccurrence of landslides. Some community members warn with certainty that a landslide will occur at a specific place. However all this knowledge has not been put into good use. Although they can map all landslide risk areas in their district, and seem to be aware of the causes of landslides, they are still quite vulnerable. They live and carry out their development activities (construct houses, carry on extensive/ unplanned farming activities) in those risk areas.

One can easily deduce that these community members are ignorant or probably are not aware of the consequences of a landslide. The truth is that the people have no option but to live in these areas. In fact some respondents argued that if they could be relocated to other safer grounds they would be more than willing to settle there. When interviewing them one sees/feels a resigned attitude towards landslide risk reduction amongst the respondents. Some respondents argued that this is fate, while others blamed the government for deserting them. All this boils down to lack of technical know how and resources to reduce their vulnerability.

Although the community members are aware of a landslide, their causes and effects no serious precautions have been taken to reduce their vulnerability to landslides. For instance they identified places where landslides could occur in future and yet people are still living there and carrying on with their development activities in the risk marked areas.

Effects of landslides

Landslides have had several adverse effects on the victims as follows:

- Loss of life (Many lives have been lost through landslides where people have been buried alive for example in January 2001, five members of the same family were buried alive. The two members of the family who survived the ordeal are still traumatized to talk about it.
- Loss and destruction of property (there has been massive lose and destruction of property whenever a landslide occurs. These loses includes, houses and belongings therein, destruction of crops, farming grounds, and infrastructure).
- Traumatizing experiences (Victims of landslides are always traumatized by the ordeal. In most cases the victims are buried alive and those who survive live in fear of going through the same again.
- In the landslide prone areas, the infrastructure is poor. There are no roads. What this means is that whenever a landslide occurs the victims/survivors cannot be rushed to hospitals. For instance in the 2001 landslide that claimed five members of the same family, two were pulled out of the wreckage alive but one died on the way to the hospital. This is because there are no roads and therefore no means of transport to the hospital. The other — a young boy then — survived to tell the tale.
- Disruption of normal life. Whenever a landslide occurs, life can never be the same again and more so for the victims. For example they have to learn to live without their loved ones, lucky survivors may relocate to other safer places if they are lucky to have some, and try to come to terms with reality.

This study was carried out during a rainy season. This means that farm activities were being carried out on the farms. The researcher found people on their farms even were landslides had occurred and actually left some lose soil. Some respondents argued that it is fate/destiny to die in a landslide. That if one is destined to die in a landslide then there is nothing one can do. Further they argued that they did not have other places safe from landslides where they could migrate to. All this talk can be interpreted to express signs of hopelessness. The fact that they have seen landslides occur and claim lives and property and no efforts have been done to salvage the situation has made them give up.

Establishing the resources available for hazard prevention in the community.

It was deemed necessary to establish the resources available in the community for hazard reduction/ prevention. This study investigated what the community had to enable them minimize vulnerability. This was done by asking the participants to name all the possible resources in their community that can be channeled to prevention of landslide hazards.

It was established that there are no funds set aside for reduction/prevention of landslide hazards. Further there are no formal plans to fight this hazard that has claimed lives and property severally in these communities.

The community members however, try to help their neighbors by giving handouts to them whenever they are affected by a landslide. For instance they give them accommodation, food and clothing until things get to normal again. They also give them psychological support whenever necessary.

As stated earlier, infrastructure in these areas is very poor. For instance there are no roads where landslides have been occurring. The dry weather paths that are there are impassible during the rainy seasons. It is during the rainy seasons that landslides have been occurring. When landslide occurs, it is very difficult to rescue the victims and more so to rush them to the hospital. The place is quite hilly, and with no proper roads. The community members have found it unnecessary to own vehicles and this makes it more difficult to save lives when a landslide occurs. People are forced to walk for long distances with victims in order to get any medical help. This is to suggest that the hospitals are very far and there are no quick means of transport.

The community members actually confirmed that victims of 2001 landslides died because of lack of medical care. It took the neighbors quite some time to pull them out of the rumbles and carry them to the nearest hospital.

It is important to note here that the rural society just like its urban counterpart has lost its traditional community bonds that tied it together. These bonds were very helpful in times of hazards because people could help one another and also look for solutions together. This study established that these bonds have weakened over time and with further frustrations from landslides one can almost conclude that they are too strained to be of great help. What this means is that community members cannot for sure count on one another for help in case a hazard strikes. This is not to dismiss totally the importance of the role played by these bonds. These bonds are very important and the study highly recommends that there is an urgent need to strengthen them and use them to reduce hazard risks.

The respondents also express their disappointments with the government. According to them, the government has not been of help and especially so where deaths have not occurred. For instance, this study established that the only thing the government did during the 2001 landslide that claimed several lives in Murang'a, was to hold a fundraising in the area. The proceeds that were realized were used to build a house for the surviving victims and support them financially, which they claimed lasted for only two months. They also received help from their neighbors for a short while and now they are on their own. The problem is that all they had was destroyed by the landslides leaving them poor.

The community blames the whole issue on the government, which they argue has neglected them. According to them, the solution to this problem would be to be relocated them to other places where they're no landslides. Others feel that they can continue living in these landslide prone areas since they have lived there for many years so long as there is a good infrastructure. Others would like to live else where but be able to access their farms as need be.

In fact the community added that the government should be in apposition to know when a landslide will occur and warn them in advance to move out of the risk areas. They added that the government should be able to warn them early enough and also share any research findings about landslides with the community. This way the community is kept informed of any possibilities of risk and vulnerability.

All these opinions do not provide a solution to this problem of landslides. There is need for all stakeholders; the community, the government, NGOs, researchers and all other well wishers to come up with a good strategy to address this problem as discussed later.

Establishing network for disaster management

This includes intra community, NGOs and government.This study established that although landslides have been destructive and fatal there is no networking between the stakeholders. For example as discussed earlier, community bonds are weak, the government seems to have ignored its role in disaster management, and the non governmental organizations have also not taken ant action in risk reduction. The result of this has been deaths and property destruction. There is need to bring all the stakeholders together to strategize on the way forward.

Lessons learned

Preparation of a landslide hazard map

- It is important to locate areas prone to landslides. This permits planners to determine the level of risk and to make decisions regarding avoidance, prevention or mitigation of existing and future landslide hazards. These techniques rely on past history, topographic maps, bedrock data and aerial photographs.
- The most effective way to reduce damage caused by landslides is to locate development on stable ground and to utilize landslide susceptible areas as open space or for low intensity activities. Land use control can be enacted to prevent hazardous areas from being used for settlements or as sites for important structures. The controls may also involve relocation away from the hazardous area particularly if alternative sites exist.
- Public education programs will help people understand the causes and the effects of landslides, identify unstable areas and avoid settling or having ay developments on them.

Monitoring, warning and evacuating systems

- Areas susceptible to landslides should be monitored to allow timely warning and evacuation.
- Monitoring and warning systems should place inhabitants on alert when heavy rains occur or if ground water levels rise.

Mitigation efforts

- Mitigation involves not only saving lives and injury and reducing property loses, but also reducing economic activities and social institution.
- To reduce physical vulnerability, weak elements may be protected or strengthened. To reduce the vulnerability of social institutions and economic activities, infrastructure may need to be modified or strengthened or institutional arrangements modified.
- The focus of mitigation policies must be on reducing the vulnerability of the elements and activities at risk.
- All members of the community should be aware of the hazards they face, know how to protect themselves and should support the protection efforts of others and of the community as a whole.
- It is important to empower the community by promoting, planning and management of its own defenses and obtaining outside assistance only where needed.

Summary, conclusions and recommendations

Landslides are one of the many hazards that occur in Kenya. Other hazards include; frequent droughts and famines, floods, fires, environmental pollution, and deforestation. As discussed in the text, landslides have been occurring since time immemorial but are reported to be in the increase and are more fatal and destructive than any other time in the Kenyan history. The study also revealed that community bonds have weakened hence the weakening of strength in reducing community's risk reduction strategy.

Conclusions

There is need to strengthen rural community bonds as a means of reducing vulnerability to any hazard in Kenya.

Recommendations

- The community should participate in all efforts to reduce risks and vulnerability to all hazards in their society. This way they contribute in helping them get helped and at the same time a level of ownership of the project by the community is created. This goes along way in making the project sustainable because the community already owns it and will take care of it.
- In order to fight hazards successfully, there is need to involve all the stakeholders in these projects. This is in line with the fact that resources are few and sometimes we see replication of projects that are done haphazardly. There is need for serious consultations amongst the stakeholders.
- There is need for proper infrastructure (roads, telephone, hospitals etc) in hazard prone areas.
- Research findings should be disseminated to the stakeholders. This may help them understand the hazard more and learn how to deal with it. The respondents requested that the findings of this study should be disseminated to them.
- There is need for more research in disaster management area. The data collected could help to come up with good policies which if implemented well, could help reduce vulnerability.

Areas of further research

Hazards in Kenya are on the increase and more destructive than any other time in the history of country. For example, landslides, floods, famine and fires have caused and continue to cause a lot of damages to property and more often cause deaths. This year alone there has been a wave of fire breakouts in the main towns of Kenya causing massive destruction of property and life. Fires in the slums of Nairobi are almost a daily routine. This suggests that those living in these areas are always vulnerable. Floods in the country are also an area of concern. For instance 'Budalangi' floods are worth some attention to establish a lasting solution to the problem. Every year a lot of property is destroyed in this district whenever it rains and people are left homeless and poor. Famines strike most of the north eastern province and some parts of the eastern province causing deaths of both people and livestock. More often victims of hazards are given handouts in form of food and later left on their own. These hazards recur almost every year and no permanent solutions have been found. This is to suggest that there are victims of hazards every year in Kenya and there are no viable plans in place to reduce this vulnerability and therefore manage disasters. As a result of this, many people in the risk areas continue suffering and becoming more and more poorer and this hinders development.

One of the greatest obstacles in this area of disaster management is the dearth of information regarding the extent of the damages caused by hazards, vulnerability and the possible solutions to these hazards that have caused people to remain poor. Further there is the problem of uncoordinated activities between those involved in this field and therefore information is not shared. This calls for intensive research in the area of disaster management to establish the causes and solutions to the increasing risks and vulnerability to hazards.

Nepal

GIS and remote sensing for flood disaster identification: a case study of the Koshi River basin in Nepal

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SYMPOSIUM NOTES

This research is conducted for flood hazard assessment and risk identification around the Koshi river area. This research is a Provention Consortium funded project for the applied research grants for disaster risk reduction program.

Floods and landslides are the most destructive types of water-induced disaster in Nepal. In July 1993, Nepal experienced a devastating flood in the Terai region, which took the lives of 1,336 people and left 487,534 people homeless. In 1999, floods and landslides killed 113 while 47 people were reported missing and 91 seriously injured. A total of 8,844 families were affected, 3,507 houses and cattle sheds were destroyed and 177,32 hectares of land and agricultural crops were ruined in the year's floods and landslides (HMG/N, 2000). The disaster caused a total loss of NRs. 3.6 million. In July and August 2002, Nepal experienced numerous landslides and floods in the Eastern and Central regions, which took the lives of 451 people and affected nearly 55,000 families. The estimated loss of property from natural disaster is about NRs. 10,000 million annually, which is about 20% of GDP (DPTC 1995).

Study area

The Koshi River, one of the largest rivers of the world, is also a major tributary of the River Ganges. Reoccurring flood events in the Koshi River causes heavy loss of human lives and physical properties in Nepal and Bihar of India every year (Pradhan, 2000). During the monsoon season, the problem of flooding and water logging occurs throughout the area.

The present study area is located in the southeastern part of Nepal. The study area extends from Chatara to Bhantabari, and it covers three districts, namely Saptari, Sunsari, and the southern tip of Udaypur (Fig. 1). The villages that fall within the project area are Chatara, Byarban, Rajabas, Prakashpur, Chakraghatti, Jhumka, Madhuban, etc. all of which border the bank of the Koshi river.

Figure 1: Location of the study area

Objectives of the study

The main objective of the project was focused on the flood hazard assessment and risk identification using tools such as GIS and Remote Sensing with detailed field survey. An important component in this study was the socio-economic data analysis which assessed local people's perception and indigenous knowledge for risk identification from floods. These objectives can be listed as:

- To identify the perception and consequence of flood disaster in local people.
- To evaluate the socio-economic impact of flood.
- To prepare detail flood hazard map and to identify the frequency, magnitude, and extent of flood disasters experienced.
- To make recommendation regarding the decision for investment and design for sustainable projects that will withstand the impacts of potential hazard events.

Regional geology and climate

The Terai plain lies in the northern part of the Indo-gangetic plain. Tectonically, the area is situated south of the Siwalik zone, separated by the Main Frontal Thrust (MFT) and extends up to the banks of the Ganges River, over which the Terai plain is assumed to be thrusted.

The study area represents most of the Terai plain of the Sunsari district. Quaternary geological study of the area revealed us five lithostratigraphic units. Sediments of the area are in general fining towards south. The upper surface is made up of boulder and pebble beds whereas the lower surface is predominantly fine clay and silt. The surficial sediments of the area can be divided into the five lithostratigraphic units (Pradhan, 2000), described in Table 1.

Stratigraphic unit	Composition	Distribution
Bayarban	Pebble with sand and few clay	Around Bayarban village
Madhuban	Fine sand, silt and clay	Around Madhuban village
Rajabas	Fine to coarse sand	Around Rajabas, Prakashpur villages
Chakraghatti	Coarse to medium sand with clay veneers	Around Chakraghatti village
Chatara	Boulder with coarse sand, silt and clay	Exposed around Chatara village in Chatara Dharan road

Table 1: Lithostratigraphy of the study area

Climate

The study area has a subtropical climate. The estimate of the Koshi alluvial fan can be described as a transistion between the dry and moderately extreme climate of the lower hilly area and the Terai flood plain. The average rainfall in winter (December to Febuary) is approximately 32 mm, whereas in the monsoon it can be as high as 550-725 mm. The mosoon contributes 70 to 80 percent of the total annual rainfall in the area. The rainy days are maximum in July and August.

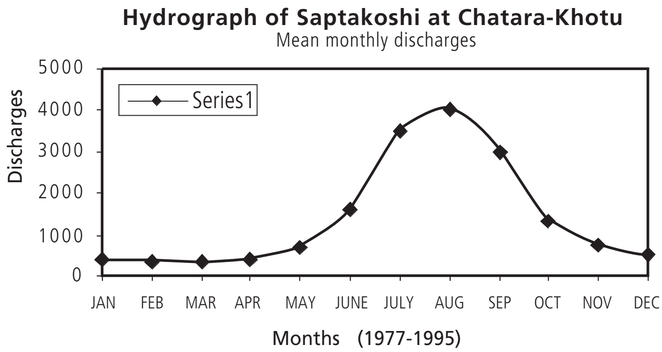

Figure 2: Mean monthly discharges hydrograph of Sapta-Koshi at Shatara-Khotu (Mean monthly discharges).

Flood analysis

Estimation of flood volume/rate is an important task for planning and design of flood regulation work and measures to be used for river protection. In order to design the flood control, irrigation and hydropower projects, the knowledge of Probable Maximum flood volume and its corresponding stage are essential.

The Probable Maximum Rainfall and the Probable Maximum Flood were computed by using Hazen's method, California's method and Weibul's method. Among these three methods the Hazen's method gives the least value and the California's method gives the highest value. The Probable Maximum Rainfall for the recurrences interval of 10, 100, 1000, 10,000 years by using California's method are 2650 mm, 3500 mm, 4350 mm, 52000 mm respectively. Again, the Probable Maximum Flood by California's method for the recurrence interval of 10, 100, 1000, 10,000 years are 10, 100 cumec, 15,900 cumec, 21,100 cumec, 26,300 cumec respectively.

Flood hazard assessment

The flood hazard mapping and assessment started with the study of aerial photograph and Landsat Thematic Map (7 bands) of Koshi River Basin. The use of satellite remote sensing method is useful in preliminary assessments during the early stages of a development planning study because of the small-to-intermediate scale of the information produced and the ability to meet cost and time constraints. Remote sensing imagery was used to assess the current status of floodplain and flood-prone areas. The delineation and characterization of the flooded areas was based on relationships between physical parameters such as reflectance and emittance from features located on the surface. Reflectance and emittance decreases as the water content or the soil moisture on the ground increases. Accordingly, the flood plain and water bodies were delineated. The important bands of the Landsat TM imagery that were used in the analysis are given below:

Band 1 – useful in determining concentration of water bodies

Band 4 – useful in delineation of water bodies

Band 6 – This band is especially useful in studying floodplain and soil moisture anomalies

The floodplain and the flood-prone areas that were delineated from Remote Sensing imagery and the aerial photographs were geo-referenced and digitized. This information was used in the production of the final maps as well as for the GIS analysis. The initial information, as obtained from Remote Sensing and Aerial photograph were later verified during the field visits to those sites. Any new and missing information was later added and amended. The new update of data from the field was later on added to the initial database to produce that final hazard map. Also, the method of participatory GIS was used, incorporating local people's knowledge of historical flood events and their impact. Accordingly, the final flood hazard map was prepared and relationships between the floodplain and the spatial features most vulnerable to flooding were analyzed which is shown in Figure 3.

As seen from the filed survey and in the flood hazard map, the flood casualties are mostly confined along the riverbanks of the Koshi River, starting from Chatara (Where the river starts to Fan outward) and near up to the Koshi barrage. The impact of the flood is more severe along the east bank that is more densely populated with high agricultural practices.

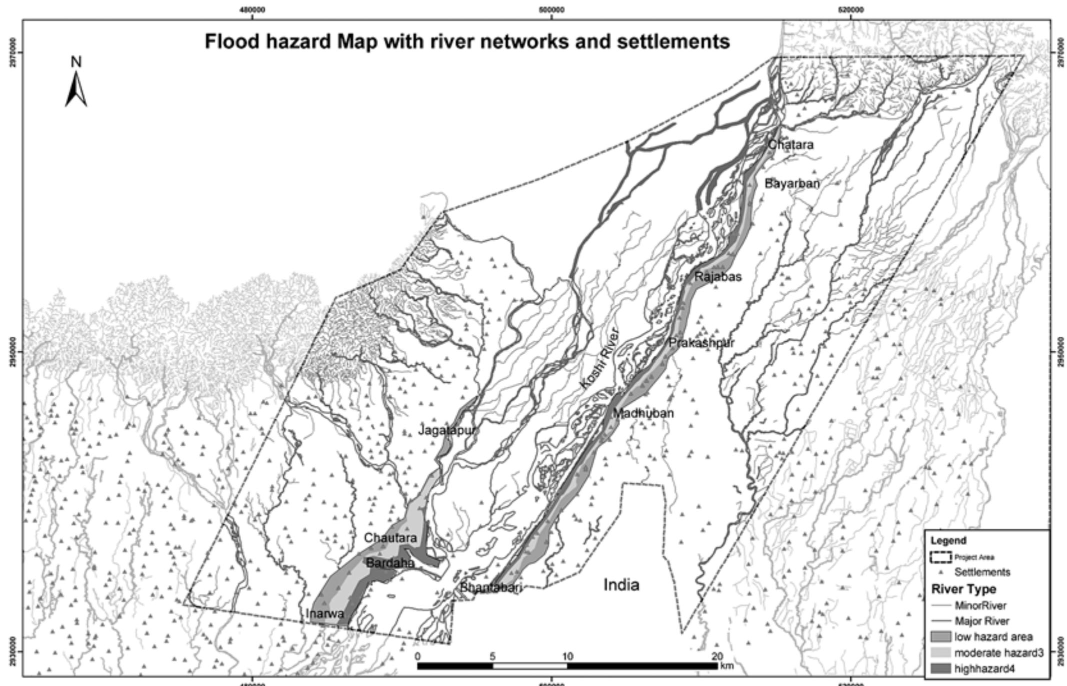

Figure 3. Flood hazard map, showing the low, moderate and high hazard zones

The bottleneck structure formed by the Koshi barrage (Koshi dam) near the Nepal-India border is also facilitating the river to accumulate large volume of water which ultimately discharges water laterally overtopping the fertile land despite the constructed dikes and leeves. Mostly Bardaha and Bhantabari area on the southern part of the map, as shown in Figure 3, frequently suffers from such inundation.

The study showed that the area could be divided into three flood probable zone, low, moderate and high hazard zone. The high hazard zone is characterized by recurrence interval of 4-7 and 10-12 years in moderate hazard area years although inundation of land and soil erosion is frequent in every monsoon season. The high flood hazard zone encompasses an area of 16.21 sq km, moderate 12.15 sq km and the low hazard zone comprises an area of 32.11 sq km respectively. Mostly the flood-vulnerable area is located on the eastern bank of the river, from Chatara to Bhantabari area. The settlements particular of the Prakashpur VDC and Varahkshetra VDC are in potential threat from flooding. Within these VDCs the most vulnerable area is in the Prakashpur VDC, around the Rajabas and Madhuvan. The people residing in the Rajabas areas fall within the probable flood high hazard zone category and are in potential risk from flooding. These areas frequently experience flooding of recurrence interval of 4-7 years although inundation during monsoon season is common. The affected settlements within those localities are Maratol, Joginia, Bhawarahitol, Koiriyonitol, Lavatolia and Bithtol. The affected settlements within the study area are shown in Figure 4.

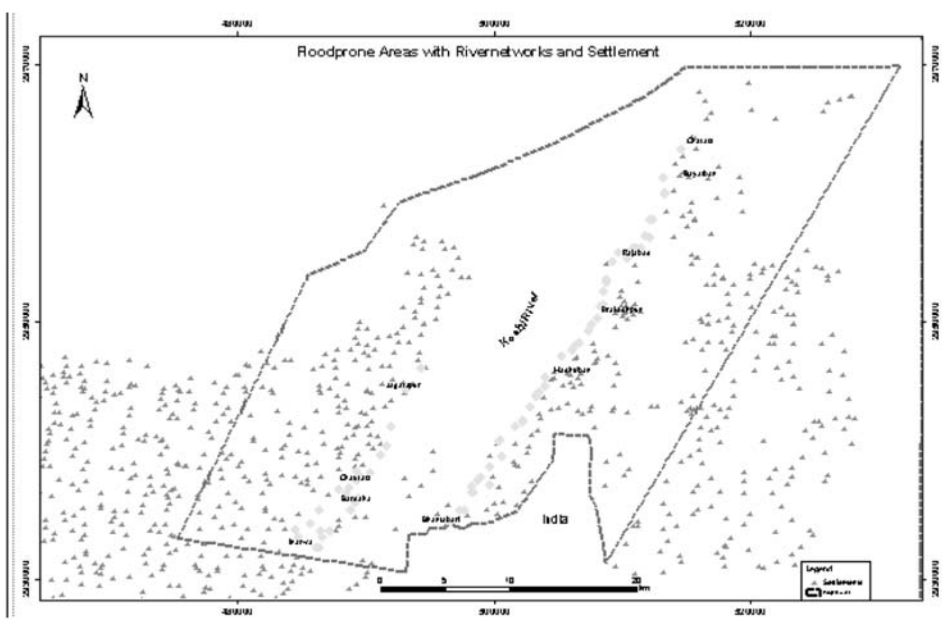

Figure 4. Affected settlements from flooding

The people in Rajabas have suffered already a large loss of life and property in 2037 B.S. The infrastructures such as dikes and spur constructed to protect from flood and rive bank erosion have also been degraded from the sedimentation of the river. Flash floods are mostly seen around the Bhantabari, Bhardaha and Hanuman Nagar area which inundates the land from few hours to 5-7 days. This has degraded the fertility of the cultivated land and even have made crop plantation vulnerable during monsoon seasons. Some protective engineering structures such as dikes are also in danger from the river sedimentation and bank erosion.

Socioeconomic analysis

The study area involves 14 Village Development Committees (VDC) of Sunsari (6 VDCs), Saptari (7 VDCs) and Udaypur (1 VDC) Districts. The project area only covers a small portion of the southern tip of Udaypur. The total population of three districts is estimated to be 1,195,915, settled in 221,436 households (2001 Census). These two districts accounts for 30.1 percent of the total population of the eastern region and 5.9 percent of the country's population. Population density of the area is estimated at 460 persons/km^2, which is extremely high compared to the national average (157 person/km^2), regional average (188 persons/km^2) and terai average (330 persons/km^2).

Of the 90 respondents interviewed, 84.4% were men and 15.6% women. Some of the female respondents were de facto heads of households in the absence of husbands. Age of the respondents ranges from 26 to 87 years with an average of 52 years. Over half of respondents are between 41 and 60 years with 28.9% over 60 years. Among the respondents interviewed 8 of them are landless. Initially, most of the people of the Koshi flood plain area are subsistence farmers/agriculturists.

The flood events of various years have done significant loss of land and property. Table 2 shows the major changes in land ownership due to flood events. Though the loss of land has not taken place at once in most of the cases it has resulted into loss of land and ultimately the livelihood of the people of that area. Due to the loss of land the people are compelled to do labor work instead of farming at nearby sub-urban areas. Other activities include jobs in herding, petty commerce, governmental/non-governmental services etc. Sixteen of the respondents have salaried employment. The 26.66% (24) of the respondents have only agriculture/farming as their occupation.

Initial land ownership	Land ownership after damage due to flood event(s)	% change in land ownership
12 Bigaha	2 Bigaha	83%
8.5 Bigaha	2.5 Bigaha	70.5%
7 Bigaha	6 dhur	99.7%
5 Bigaha	No land	100% (no land)
3 Bigaha	6 kattha	93.3%
1 Bigaha	10 kattha	50%

Table 2. Major changes in land ownership from flooding. *Source:* Field Survey, 2003

Household survey and mass meeting in the VDC was done to understand local people's perception of the flood and their traditional practices to cope with it. Among 90 peoples interviewed, most of them were ignorant about the causes of the floods and think mostly as the intense rain for the primary cause. The respondents were asked: whether the flood disaster in lowland (their area) is due to the mismanagement of watershed in upland areas? Most of them (50%) did not mention that as the reason for the heavy flood. While 30% were not sure about this and the remaining 20% told that the flood disaster in lowland, among other reasons, is also due to mismanagement of watershed at upland.

Most of the respondents could not remember the dates of the event (flooding). The respondents could not trace the dates of the flood events with greater damage out. So the precise dates could not be traced out because of the categorization of the extent of loss by the flood differed from one individual to other. The most repeated dates of flooding events were the events of 2011, 2022, 2025, 2037, 2039, 2044, and 2052 B.S. Due to heavy rainfall during every monsoon land mass wasting/flooding is experienced in the area. The majority of respondents noted that the loss due to flood increase at every 4-7 year interval. However, the devastating effect due to the flood and loss and damage of property experienced every 10-12 years time. The main problems mentioned by the respondents were problems in livelihood, loss of land and houses and properties.

These people understand that they are living in the flood risk prone area but can't move to safer places since they don't have sufficient money to migrate/invest to other places. Very few don't believe that they won't get problems from flood in their area.

The other reason they mentioned for living in those flood vulnerable area is the social attachment. "No alternative! What to do and where to go?" said one of the respondents. They do not have land at other safer places. They told that they have no other good alternative, so it's their compulsion and are forced to live there. Some view that the problem due to flood will be reduced or managed after some period. Some told that "Even though we suffer due to hardship, we do not want to leave this place because at least small piece of land is here with us and the relatives are at nearby places".

These peoples are ignorant of the early symptoms of flood and rainfall. Few respondents stated that the early symptom of the flood is the crawling of ants to the tips of the grass found in the riverbanks of the Koshi. Few mentioned that the deepening of the color of the cloud to blackness results into heavy rainfall and subsequently to flood in the River. Other few respondents told that the abnormal movement of birds is also one of the symptoms of heavy rainfall.

It has also been seen that very few people are growing bamboo at gullies and Dalbergia sisoo (Sisoo) at the Koshi flooded area to reduce or lessen the damage from flooding. However, most of the people believe that they can not control the flooding from the Koshi using their traditional methods because of very high discharge in Koshi during the monsoon season.

Local people perception for the control of flood

Almost all of the respondents believe that the effect of flood disaster can be reduced. While asked for the methods to minimize the negative effect of flood disaster they think that the following methods could minimize the extent of flooding:

- Spur and Gabion Wall construction at various risk prone areas
- The problem is due to Koshi Barrage. So, the Indian Government should provide appropriated compensation to the people and develop plans to increase the benefits from the Irrigation Canal
- Only government can do, we can not attempt to control Koshi
- Should block Koshi from both the sides (river right and left) and allow it to flow at one specific direction
- Should build gabion walls at both sides
- Should stop to stone and sand dredging practice
- Should build notch at various points where the river meanders
- Should distribute the water to 3-4 channels along the flow
- Build another Canal from Chatara towards east
- Should conserve forest along the upland areas
- Open all the gates (52) of the Koshi Barrage during heavy rainfall. This will result in reduction of the water level and the damage will be obviously reduced.

Conclusion and discussion

Flood disaster is one of the major disasters that occur every year particularly in the southern part of Nepal. The flood hazard study of the Koshi area, focused particularly around the Prakashpur, Rajabas, Bayarban, Chatara, Madhuban, Chakkraghatti, is performed with a view of risk identification and disaster preparedness for the future events. The study utilized an integrated approach of GIS, remote sensing and socio-economic data analysis as well as hydrological and meteorological data analysis. A detailed field study was also carried to verify information obtained from the RS imagery and GIS.

The Koshi River basin corresponds to a fluvial erosional system dominated powerful river which is considered to be its early mature stage. Active river bank erosion can also be seen mostly on the eastern bank of the river. The river has been migrating laterally from west to east direction eroding the eastern bank and making it more vulnerable.

Flooding in Koshi area can be attributed mainly to the prolonged rainfall over an extensive catchment area that generates high volumes of run-off, which spill out onto the river's natural flood plains and overtops the cultivated land and settlements. Such overflowed water inundates large areas for weeks at a time owing to the long response time of the catchment, and subsequent slow rise and fall of the flood hydrograph. The bottleneck appearance due to the construction of large dam, Koshi barrage downstream near the Nepal India border, has further facilitated the water to move laterally and inundating the fertile lands. The excessive sedimentation near the Koshi barrage is also considered to be the secondary cause for the lateral migration of water overtopping the fertile lands. The local people also blame the Koshi barrage for flooding their area, claiming the flooding was not as intense or frequent before the construction of the Koshi barrage.

Flooding in the study area has also been from the flash floods resulting from intense rainfall of a relatively short duration, which is also a common phenomenon in the hills and mountainous part of the area that has steep slope. The maximum annual precipitation during the monsoon season is 93% of the total precipitation and 37% of the total occur in a single event within 24 hours which generates a very high discharge rate and ultimately flooding the adjacent areas to the river bank. Eastern bank of the area is often impacted by the flash floods creating loss of land and property.

The probable maximum flood calculated using California's method for the recurrence interval of 10, 100, 1000 and 10000 years are 10 cumec, 100 cumec, 15,900 cumec, 21,100 cumec and 26,300 cumec respectively. Similarly the probable maximum rainfall for the recurrence interval of 10, 100, 1000, 10000 years are 2650 mm, 3500 mm, 4350 mm and 5200 mm respectively.

Participatory GIS method together with combination of remote sensing and field survey data interpretations were used for the flood hazard mapping of the area. Regional information about the area such as mapping water bodies and flood plain were accomplished using satellite imagery and aerial photograph. The study showed that the area could be divided into three flood probable zone, low, moderate and high hazard zone. The high hazard zone shows the recurrence interval of 4- 7 years although inundation of land and soil erosion is frequent in every monsoon season and 10-12 years in moderate hazard area. Mostly the flood vulnerable area is located on the eastern bank of the river, from Chatara to Bhantabari area. The high hazard area encompasses 16.21 sq. km and people from six different settlements are living in this area despite the threat from flooding. Similarly, the moderate and low hazard area occupies 12.15 sq.km and 32.11 sq.km respectively. The most vulnerable area is in the Prakashpur VDC, around the Rajabas and Madhuvan. The people in Rajabas have suffered already a large loss of life and property in 2037 B.S. The infrastructures such as dikes and spur constructed to protect from flood and rive bank erosion have also been degraded from the sedimentation of the river. Flash floods are mostly seen around the Bhantabari, Bhardaha and Hanuman Nagar area that inundates the land from few hours to 5-7 days. This has degraded the fertility of the cultivated land and even have made crop plantation vulnerable during monsoon seasons.

The flood has made many people homeless in the past fifty years even with loss of life and property. This has also done a significant loss of the land and has made major changes in land ownership. Though the loss of land has not taken place at once in most of the cases it has resulted into loss of land and ultimately the livelihood of the people of that area. Due to the loss of land the people are compelled to do labor work instead of farming at nearby sub-urban areas.

Records showed that the flood victims are mostly poor and homeless people. Interview with peoples depicted that these peoples are aware of the flood but lack of sufficient capital to migrate to safe place have forced these peoples to live in the risk prone areas. Some peoples are also socially attached with the areas and do not want to leave their traditional homes. Also, the existence of fertile land next to the riverbank has made people to live in the nearby areas despite the potential threat to the flooding which makes these people more vulnerable during flooding.

The flood hazard mapping done from this study will be very much fruitful for proper planning and resource location for disaster preparedness for the concerned line agencies and organization. The resulting flood hazard map, as provided to the VDC will also be very helpful for the local people to distinguish the safe and vulnerable areas from flood. The map will be helpful even for the uneducated people to understand about the existing flood and land condition, as visual display is the easiest and expressive ways for the people to comprehend and understand their existing conditions from the flooding.

The involvement of the local people for the modification and changes in the flood hazard map after its completion made the villagers to think the work as their own work and for their own benefit and has raised a feeling of ownership in them. Their willingness and readiness to form a flood fighting committee substantiates their positive feeling towards the project. Also, the commitment of the VDC committee to incorporate the flood study recommendation in their periodic plan shows their readiness for the flood disaster reduction.

Lessons Learned

1) Natural disaster has a significant impact in poverty and has always hindered economy of a developing country such as Nepal. There is a significant role between the poverty alleviation and the disaster risk reduction. Frequently occurring flood disaster is one of the main drawbacks for the poverty in the study area. Whenever the disaster occurs, the poor and homeless people are affected the most. The frequent flooding has caused a significant amount of economic loss to these peoples burdening them with more financial debts for reforms and seed money to restart the agriculture.
2) Flood victims are mostly poor and homeless people. Interview with peoples depicted that these peoples are aware of the flood but lack of sufficient capital to migrate to safe place have forced these peoples to live in the risk prone areas.
3) Greed to exploit the river flood plain properties, mostly seen around the fertile plains of the river, is one of the major factor as seen during many casualties. Some people with moderate income were seen to be living in the flood risk prone areas. Although these people have sufficient fund to migrate to safer places they still insist on living there because of the greed to occupy the land with good yield.
4) Existence of fertile land next to the river bank has made people to live in the nearby areas despite the potential threat to the flooding.
5) A proper planning for any program aimed at disaster risk reduction is successful only if it is done through active participation of the local community people, as it awares the people and creates a feeling of ownership in them. Also, it is important during the implementation of the project to involve these local people in the project and respect their thoughts.
6) Visual displays are the most effective means for information dissemination. Both the educated and uneducated people understand it. In our context, the flood hazard map was very informative and people from all the age showed interest on it which would be very helpful for these people to understand their local environment and threats from flooding. The different color rated for low, moderate and high hazard, for rivers and landuse types made people clear about their surrounding area in a larger scale, which they have not done before.
7) Initial assessment flood hazard and risk identification is very important to lessen the effects of flooding. Initial assessment of the flood hazard and the flood hazard map was very useful for the proper planning of flood risk reduction and mitigation. The study highlighted the risk prone areas from flooding. It has served as a guide map for the policymakers and stake holders working in the study area to implement any program targeted for the lessening the effects of flooding.

References

Chheetri and Bhattarai D., (2001), Mitigation and Management of Floods in Nepal, Kathmandu, HMG-MOHA

Disaster Annual Report (1995), Water Induced Disaster Prevention Technical Centre (DPTC)

Final Annual Report (2002), Nepal Red Cross Society (NRCS)

IDNR, (1995). Disaster: Threat to Social Development, World Summit for Social Development, UN, Copenhagen, Denmark, 6-12, March, 1995

Lammerink M.P., Bury P, Bolt E., (1999) An Introduction to Participatory Action Development (PAD), pla notes Bulletin vol.35

Panday, R.K., 1995. Development Disorders in the Himalayan Heights, Challenges and Strategies for Environment and Development. Panday's publication, Kathmandu,Nepal

Pokhrel, Lekhnath Nath (2002), Water Induced Disasters in Nepal and Its Management, Disaster Review Annual Report 2002, DWIDP

Poudal K. P. (2001), Mountain Environment and GIS Models and Application

Pradhan, A., (2000), Sedimentological and Environmental investigation of the Koshi Alluvial Fan, Unpublished Masters thesis, Central Department of Geology, Kirtipur

Regmi, A., (2000), Hydrological study of the Koshi Alluvial Fan, Unpublished Masters thesis, Central Department of Geology, Kirtipur

Victoria, L.P.(2002) Community Based Disaster Management in the Philippines: Making a Difference in People's Lives

Venezuela

Local and popular folklore and culture on hazard and vulnerability meets geographical information system for the risk reduction preparedness of the people of the Barrio San Antonio of Naiguatá, Estado Vargas

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SYMPOSIUM NOTES

The inteview model and interview matrix for this project were made by the team. Project photos were taken by the team.

This Project is the offshoot of the team's participation in the community preparation program for risk management which took place from 2000 to 2002 in marginal urban areas throughout Venezuela, and more specifically within the framework of the Project begun in 2000 with Mercy Corps International, which was subsequently continued, in 2002, with the support of the Corporation for the Recovery and Development of Vargas State (CORPOVARGAS), as well as with the Fire Fighters and the Civil Protection Institute for Vargas State.

From our knowledge of the region and revision of available documentation our conclusion is that in Vargas State as well as in the rest of the country risk management has been limited to attending to "unforeseen" emergencies and disasters, without the adequate use of tools to enable the development of local risk management policies, or that emphasize prevention, mitigation, preparation and alert regarding probable adverse events of a natural man-made origin. On the other hand, the risk handling models that have been implemented to date by specialized organizations lack familiarity with the local culture and history (cultural experience of risk) and with local response systems to adverse events that could be used to confront this type of event.

All the preceding has made it difficult to approach and establish an efficient relationship among the First Response Organizations (OPRs) and affected communities, whose knowledge and experience have been underestimated and underrated. Consequently, we consider it necessary to work to increase integration among the communities and organizations responsible for preparing the community to handle risks, in order to generate effective disaster prevention and mitigation strategies; participation that not only includes their coordination with respect to response strategies, but, perhaps, will influence the contents or certain programs and data sources.

The SIG is a practical tool for integrating this knowledge which will allow OPRs to analyze and easily present information on maps that is necessary for greater integration of scientific know-how and local knowledge, to thus achieve effective risk management whether by rescuing useful knowledge or providing data of interest to help understand and perhaps predict behavior in the community.

Goal

It is for the preceding reasons that the aim of this study was to compile, in the Geographic Information System (hereinafter SIG), the specialized technical know-how along with the wealth of local knowledge that exists among the inhabitants of Naiquatá, in order to establish two-way communications among the actors on both ends of Risk management (Experts – Community) so as to generate more efficient strategies and practices to prevent and reduce disasters.

From: Misión 030602 / Year: 1999-2000 / Scale: 1:5000 / Instituto Geográfico de Venezuela Simón Bolívar

Town Naiguatá before the torrential flow of 1999

Town Naiguatá after the torrential flow of 1999

Geographic location

In the original version of the Project presented to Provention Consortium the idea was to work exclusively with the Barrio San Antonio in Naiguatá, Vargas State, Venezuela.

However, in subsequent meetings with the fire fighters from the Naiguatá station the idea was born to expand geographic coverage to Naiguatá, because of the increased usefulness of SIG in their everyday work and in community preparation in the area. This recommendation seemed reasonable to us because the Barrio San Antonio is functionally and culturally integrated with the rest of the town of Naiguatá, so that any information used will also be applied to this sector as well as to other aspects. For example, with respect to the complex issue of risk management, the inhabitants of this "barrio" have a shared risk experience with that of the town.

Naiguata parish it is appraised that the zones of the coast constituted in his majority by cones of dejection and accumulated materials recently, what it makes prone to has a long history of disasters generated by diverse natural phenomena, and in December 1999 it was affected in an unequal manner, being among the sectors that suffered the most severe consequences (mudslides and floods in those areas closes to river banks), while others were almost unaffected. The project is interested in evaluating such dissimilar occurrences in space. On the other hand, we presume that there may be inter-sector diversity in one and the same community with respect to oral tradition regarding the issue of risk and disasters, differences that could eventually be translated into different ways of confronting such contingencies, a vital topic for OPRs.

Beneficed population

There are five (5) direct participants who are members of First Response Organizations (OPR):

- Two (2) from the Naiquatá Fire Fighters.
- Two (2) from the Community Preparation Unit for Vargas State.
- One (1) from Naiguatá Civil Protection.

This group of fire fighters was selected because of its interest in the project and because, since 2000, it has participated in a series of workshop within the framework of the Corpovargas project carried out by SOCSAL on community preparedness and risk management. The understanding is that these persons will then act as "multiplying agents" where they work, as well as among other entities and interested parties.

According to the National Census carried out in 1990 by the National Institute of Statistics (Spanish acronym INE), there are 9446 habitants in the town of Naiguatá, which would be the indirect participating population.

Theoretical-methodological framework

The project's theoretical-methodological framework was adapted for which we basically used certain works with an ethno-methodological approach and, above all, two working documents generated for SOCSAL by the anthropologist, Carmen Luisa Ferris, titled "Culture and risk: common sense knowledge of risk in daily life. The Naiguatá Case," and "[Abstract] SOCSAL-PROVENTION CONSORTIUM Naiquatá Study".

Bolivarian School after the 1999 torrential flow

House affected by the 1999 torrential flow

Workshop about the GIS of Naiguatá

Interview with an older member of the cofradia of the Devils of Naiguata and an older member of the community

This is based on an *"emic"* approach, characteristic of ethno-methodology which takes into account the point of view –whether or not traditional- of the inhabitants or their interpretations and explanations of characteristics, genesis or recurrence, forecasting possibilities, and behavior considered to be the most appropriate to follow with respect to risks. This personal point of view, frequently traditional or "folkloric" is called "Common Sense Knowledge", and may have its own internal coherent complexity and profitability, and may or may not coincide with conventional "Technical-Scientific" knowledge, that is, with the external "ethical" point of view imposed by specialists with academic influence or formation.

The starting point is the idea that OPRs' familiarity with local common sense knowledge will enable them to better understand motivations and forms of response among the communities with which they interact, and gives them the aptitude to converse and even negotiate in their own terms, as well as to—as suggested by certain studies—obtain valid, empirical knowledge that is useful and exact to complement the technical-scientific information that can, therefore, be used in local risk management.

While this approach has been used for other types of research (for example, that related with health or ecological issues), it is relatively new in the country with respect to risk management, although analogous or similar approximations have been documented abroad, from the sociological, anthropological or social psychology viewpoint when initially documenting this project. Even less common seems to be the link between this type of data of a qualitative nature and the use of GIS technology.

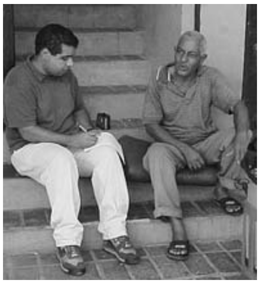
From the methodological point of view, Common Sense knowledge can be classified into three types: sensory (related with the capacity and ability to predict or perceive threats), the practical (routine, regular, frequently traditional behavior when confronting threats), and the one that includes formulas (linguistic acts and genre, frequently ritualized or that remit to ritual components, to which the power to influence the development of threats is attributed).

These variations of Common Sense knowledge also remit us to the concepts of culture, tradition, values, belief system, standards and motivation and are perhaps understandable as regards their possible origins in view of the relatively isolated and Creole nature of most of the inhabitants of Naiquatá, as well as the repeated exposure of this population to different types of threats.

In practical terms, each of these types of Common Sense knowledge, analogously to Scientific-technical knowledge, may be divided into topics that correspond to specific layers of information in the SIG and then related to variables as such or to the "Scientific Layers" that can also be visually expressed in maps or in the form of summary reports.

Given the nature of the data, beginning with the second phase of the Project, the idea is to adopt a qualitative, methodological viewpoint, with markedly ethnographic influence based one method:

Contact and research interviews applied to a non-random sample of inhabitants from different walks of life and genders, focusing on older inhabitants who have lived for many years in the town and who work in areas that presuppose the handling of important volumes of locally accumulated, empirical knowledge, since it is assumed – but will have to be verified – that this type of knowledge responds to traditions, inter-generational lines of transmission, or perhaps to the memory-appropriation of knowledge derived from having confronted such events before. Included also were local leaders, educators and members of religious fraternities (see Annex 1).



Another interview with an elderly man from the community

Data was systematized in a matrix made by the team (see below), which included the selected variables. The items that were more repeated were drawn in the map.

GIS description

As was mentioned previously, the product of this study will be a SIG in which it is hoped to combine, in addition to the specialized technical knowledge of risk, the wealth of local knowledge of the inhabitants of Naiquatá, in order to facilitate the design of more efficient strategies and practices for prevention and mitigation.

The work is being done with Mapinfo ver. 6.5 software because its functions allow quick and simple use of maps that can, in turn, be used to prepare reports and illustrations that bring to light the true meaning of the information underlying the lines and columns of data tables, contributing efficiency in decision making.

Design of the GIS

GIS will cover five (5) thematic layers described below, and efforts are being made to ensure that its design is as simple as possible in order to optimize ease of handling of the product.

Interview matrix

Tema 1: Conceptos asociados a riesgo

Entrevistado (ENT)	Riesgo	Amenaza	Peligro	Vulnerabilidad	Desastre Natural	Amenaza Natural	Amenazas en la Parroquia	Amenazas en Naiguata

Tema 2: Memoria histórica de desastres o eventos adversos

Ent	Tipo de desastre Natural (P ò CP)	Dónde	Cuándo	Víctimas	Infraestructura	Observaciones
1						

Tema 3: Susceptibilidad flujos torrenciales

Ent	Inundación	Deslaves	Flujos torrenciales	Ubicación	Frecuencia	Origen/ causa	Grado de severidad	Otra característica resaltante
1								

Tema 4: Susceptibilidad deslizamiento

Ent	Derrumbe	Deslizamiento	Ubicación	Frecuencia	Origen/causa	Grado de severidad	Otra característica resaltante
1							

Tema 5: Susceptibilidad sísmica

Ent	Sismo	Temblor	Terremoto	Ubicación	Frecuencia	Origen/causa	Grado de severidad	Otra característica resaltante
1								

Characterization

Contains fundamental aspects of the study area in order to have a clear, updated and actual view of the zone that can be handled by First Response Organizations (FRO) when preparing community risk management.

Based on statistical data from 1881 to date; is sub-divided into topics of health, education, housing and demographic data.

Technical–Scientific

Contains exact, conventional, technical-scientific data regarding natural threats present in the study zone.

Is a guide for community work, when preparing emergency prevention and mitigation plans.

At parish level 3, natural threats are being considered:

- Susceptibility to torrential floods
- Massive movements
- Seismicity

These three (3),are based on:

- Spatial location
- Degree of severity
- Origin

Natural threat from torrential floods is being considered in the town, based on:

- Spatial location
- Degree of severity
- Probability of occurrence
- Affected surface

Historical events

This refers to all the adverse events that have occurred in the Naiguatá from 1900 to 1999, which will enable the FRO to have a historical record of the threats that have affected the zone, which is fundamental for working with the community.

OPR resources

This refers to both technical data of the FRO as well as to the behavior during and after an event in the town of Naiguatá, in order to facilitate the work of the FRO in different areas. To date, the only fields in which these are available are current use, restrictions in use, and location of life lines.

Common sense

Refers to local knowledge among the people of Naiquatá, regarding technical-scientific information, either their own or traditional, adverse events that have occurred in the area, and certain aspects indicated in the layer known as FRO Resources.

GIS applications

- In the Naiguatá parish,

  Determine: location, degree of severity and period when the three natural threats occurred: torrential flows, massive movements, and tremors, based on information from the Simón Bolíva Venezuelan Geographic Institute (our "experts" who, in this case, synthesize technical-scientific data)

  Determine: location, degree of severity and period when the three natural threats occurred: torrential flows, massive movements, and tremors (this time based on opinions of the community and local residents familiar with these issues).

- In the town,

  Identifies shelter zones, vital life lines and use restrictions for soil according to experts and the community.

  Know the location of basic, public institutions (education, health), as well as other entities, stressing the coverage capacity of the different institutions or entities (in the town).

  Determine location, severity and period of occurrence with respect to the natural threat of torrential flows, as per the Simón Bolívar Venezuelan Geographic Institute.

  Determine location, severity and period of occurrence with respect to the natural threat of torrential flows, as per community opinion.

- Compare the opinion of community experts regarding the previously mentioned threats on different levels.
- Become acquainted with the historical record on adverse events that have occurred in the parish (from 1900 to 1999); type of event, places affected, date occurred, number of victims and infrastructures affected.

Overall balance of project program execution

- Revision and analysis of similar GIS experiences.
- Description of the most salient physical-natural and social aspects of the study area.
- Preparation of a theoretical-conceptual framework of common sense and risk.
- Design of the GIS.
- Implementation of a sensitivity workshop for OPRs: the purpose of the meeting was to outline Project objectives and receive feedback from these organizations in the form of information needed for interviews.
- Interviewing the different players from the community.
- Establishment of agreements with the FROs about the jeans of collecting information in the field and over time.
- Awareness building workshops at the Colegio Diego Osorio, regarding the Project and the need to manage risk on the school level.
- Request for donations of computers from different institutions.
- Preparation of a GIS user's manual.
- December 15, 2003, was the 4th anniversary of the tragic mudslides in the Vargas State which occurred in 1999. A commemorative activity was prepared with the Naiguatá Parish Board and firefighters from the Vargas State which included: presentation to the community of the results of the Project, simulation by the Naiguatá firemen of an evacuation due to fire in the Colegio Diego Osorio, and preparation by the students of a risk map of the Pueblo Arriba sector of Naiguatá.

Results of the Project

- An easy to handle SIG was designed that is adapted to the needs of the community and of the first response organizations.
- Full commitment was obtained from three of the institutions in the participating areas—Henry Iriarte, Alejandra Da Silva and Felipe Quintero—to continue with the Project, to update existing thematic layers and add new information, and to transmit this information to the area's schools and the community as a whole.
- The two directors of the San Rafael and Diego Osorio schools are impressed by the Project and want to have risk management workshops in these schools.
- Both students and teachers have been motivated to do research similar to that involved in this Project.
- Other first response institutions, such as traffic control have shown an interest in having access to the GIS and have proposed adding information from the Naiguatá Parish, such as number of victims of traffic accidents.
- The Naiguatá firefighters have seen the SIG in action and how easily it can be used to solve their technical problems, particularly everything pertaining to permits, zoning and restrictions regarding the use of space.
- Two computers will be donated in January 2004. One will be located in the Naiguatá station and the other in the central station in the office of community preparation. The donation comes from the TOTAL oil company through the nongovernmental organization Vía Tecnológica.
- Projects in schools need to be emphasized as one of the most important achievements because this is a group that is motivated to receive information and it can transmit that information not only to its peers, but also to family members.

Lessons Learned

- Common sense with respect to adverse events does not tie in actions as a set of systematically linked opinions thereby allowing them to be precisely explained. They acquire validity by resisting ongoing comparison with experience and therefore can be modified at any given moment.
- Lack of systematic explanations for adverse events is a condition which adds simplicity to information to be transmitted.
- Because natural events study area do not occur frequently, people rely on the same knowledge that has been transmitted from generation to generation, and this knowledge acquired by their ancestors has not been modified.
- The inhabitants have been accumulating observations about and knowledge of their geographic space, which has allowed them to handle themselves and/or to survive in that space.

This knowledge is the foundation for recommendations or actions that the community, either as a whole or individually, has been adopting with respect to the environment.

- We believe two basic conditions are needed in order to generate effective strategies for preventing or reducing natural disasters:
  - A constant exchange of information among the people (among different generations) regarding adverse events that have occurred in the area, a local early warning system and local response systems, in other words, a cultural life experience of risk.
  - Greater integration among communities and organizations responsibly for preparing the community in risk management, because if the specialized organization have knowledge of the cultural life experience of risk they will be better able to understand response motivations and forms among the communities with which they interact. That is, they will have a better attitude when it comes to conversing and even negotiating with communities in the same terms. When we speak of "Terms," we are referring to the vocabulary to be used, the sites where meetings are to be held, length of training, among others.
- The community's threat priorities need to be identified. For example, in the case of Naiguatá, many of its inhabitants (those interviewed) are more concerned with the day-to-day threats of crime, unemployment, drugs, among others, than by natural threats, such as earthquakes, torrential floods and landslides. In the case of earthquakes, they believe these cannot be predicted and they must necessarily suffer the consequences. In the case of torrential floods (mudslides) the inhabitants believe these will occur every 50 years, and because the last one occurred in 1999 they don't consider this to be a problem and feel that future generations and not the current generation should worry about them. The consequences of cave-ins or landslides haven't been all that serious in the area and, therefore, the inhabitants do not assign to them the required importance. Consequently, a methodology is needed to prepare the community to face threats of Nature by using examples from daily life.

Links between poverty and disaster risk reduction in developing countries

The GIS is a planning tool this Project transverses poverty and disaster risk reduction programs, not only by scientifically identifying areas not suitable for habitation or construction, but also it gives institutions in charge of community preparedness in the area a tool to become acquainted with the beliefs and cultural experiences of risk in different areas.

With precise knowledge of the natural and anthropic risks in an area, not only from the scientific standpoint but also from that of the community itself, it will be possible to carry out projects that are both more viable and sustainable over time. Therefore, this Project helps to plan the investment to be made in an area that is more in keeping with that area's geographic situation and the vision of the community with respect to all its risks. This will help to reduce poverty levels in underdeveloped countries.

The proposal was planned to obtain, more than a Geographic Information System, a tool so that any organized group for preparing community risk management can collect basic information not only in Venezuela, but in any other country by making the appropriate adaptations.

Visualization of the map makes it dynamic and the community feels the need to participate in ensuring the sustainability of the project.

The proposal will have continuity in time because the Vargas State firefighters have seen that there is a need to continue to improve and perfect the GIS–Naiguatá. This group is in the process of obtaining financing from State Government and other organizations such as Corpovargas.

On our part, because the GIS is a useful tool for the FRO we plan to replicate this experience in two communities in two other states (Monagas and Anzoategui) that have been affected by different threats of anthropic origin.

Moreover, the proposal will have continuity in time because it is linked to the "Promotion of Risk Management in Vargas State Parishes" project that SOCSAL has been developing since 2001 with financial support initially from Mercy Corps

International, and currently from CORPOVARGAS (Corporación para el Desarrollo del Estado Vargas– Corporation for the Development of Vargas State) in alliance with the firefighters from Vargas State and the Instituto de Protección Civil y Administración de Desastres de Vargas (Vargas State Institute for Civil Protection and Disaster Management).

Since the product of the research is a geographic information system it can be applied by institutions whose mission is community preparedness and risk management to any population located in marginal-urban areas of developing countries, because all the material for collecting information is in simple and practical language thereby facilitating its use and understanding by persons without expertise in the social sciences.

The components of learning in your project

Identification of areas of threat by specialized institutions and the community in general.

Awareness building and training of OPRs in handling the GIS and its advantages when it comes to planning.

Combination of two types of knowledge, scientific and common sense (formal and informal)

We would like to thank some people who help to finish this project, as: Carmen Ferris, Virginia Jimenez, Freddy Colina, Pedro Rivas, Miguel Ángel Ortega and all the team of SOCSAL and Fire Departament of Vargas.

ANNEX 1 — INTERVIEW MODEL

This is explicitly geared to key informants in the communities, both men and women and includes:

- Natural community leaders
- Social actors with different occupations (hunters, fishermen, farmers, masons, healers, fire fighters, members of communities, drivers, teachers and other professionals)
- Community promoters (inhabitants of the sectors selected in the town of Naiguatá)

Especially, but not exclusively mature people, or those with accumulated experience who –it is considered- could contribute useful information to prepare a description of the community, experiences in local organization and attention to risks, data from their own traditional wealth of knowledge relative to the topic of risks, which must be taken into account when planning social development, prevention and/or response programs.

I Identification of the interview

Date:		Time:		Duration:	
Name of interviewer:					
Context/circumstances/environment of the interview:					

II Identificatin of the person interviewed

Name:					
Place of birth:		Sex:		Age:	
Date from which the individual has resided in this locality			Places in Naiguatá where the person has lived		
Sector where the person currently lives in Naiquatá:			Address:		
TEL:			How person can be reached:		
Religion:			Occupation:		
Highest grade completed:			Role in the community:		

III TOPIC 1: Concepts associated with risk

3.1 What is your understanding of the word "risk"?

3.2 What is your understanding of the word "threat"?

3.3 What is your understanding of the word "danger"?

3.4 What is your understanding of the word "vulnerability"?

3.5 What is your understanding of the term "natural disaster"?

3.6 What is your understanding of the word "natural threat"?

3.7 Enumerate all the threats present in Naiquatá parish.

3.8 Enumerate all the threats present in the town of Naiquatá

IV TOPIC 2: Historical recollection of disasters or adverse events:

4.1 Has Naiguatá parish experienced any type of natural disaster?

4.2 What type of natural disasters have occurred?

4.3 Where? When?

4.5 Number of victims and infrastructure affected?

V TOPIC 3: Community's perception of natural threats. (COMMON SENSE)

IN THE PARISH:

Seismic susceptibility:

5.1 What is the difference between a "tremor" and an "earthquake"?

5.2 Generally speaking, would you say that there are sectors in Naiquatá parish where tremors occur more often? Yes? For example, in which sectors? (LOCATE ON MAP)

5.3 How often would you say a tremor occurs? Do they always occur with the same intensity or are there sectors of the parish where they are felt more strongly?

5.4 Have you heard of any thing or factor that might contribute to or promote tremors? What? Is this something new or have people remarked about this before? F or example, what have you heard about this among people from other eras?

5.5 Whenever there is a tremor or earthquake, have you noticed that some homes or structures such as walls, bridges etc., are more or less resistant to these movements? What have you seen or do you know about this? In your opinion which materials are "good" and withstand tremors and which are "worse" and do not? Sometimes it seems that the "people from before" knew very well how to build because there are very old buildings that are still standing, despite the passage of centuries. What do the "older" people say about this? What materials did they recommend as being the best to withstand tremors? And what type of construction "tricks" enabled them to resist more, or at least protect people from injuries or damage?

5.6 What types of signs do you recognize as occurring before a tremor? What have you heard about people who have a "kind of premonition" that something will happen? For example, in town, who is famous because he or she knew or felt that a tremor or some other threatening event was going to occur and it did? What did that person feel? What else can you add?

Susceptibility to torrential flows:

5.7 What difference is there between a "flood," a "mudslide," a "torrential flow" and a "torrential avalanche"?

5.8 Generally speaking, would you say there are sectors of Naiquatá parish where mudslides are more frequent, yes? For example, in what sectors? (LOCATE ON MAP).

5.9 How often would you say a mudslide occur? Do they always occur with the same intensity, or are there sectors of the parish where they are stronger?

5.10 Have you heard of anything or of any factor that contributes to or promotes mudslides? What? And are people just saying this now or did others say this before? For example, what have you heard about this from the people from other times?

5.11 When a mudslide occurs are some houses or structures such as walls, bridges etc., more or less resistant? What have you seen or do you know about this? In your opinion, what materials are "good" and resistant and what materials are "bad" and not resistant? Sometimes it seems that the "people from before" knew very well how to build because there are very old buildings that are still standing, despite the passage of centuries. What do the "older" people say about this? What materials do they recommend as being more resistant to mudslides? And what type of construction "tricks" enabled them to resist more, or at least protect people from injuries or damage?

5.12 What types of signs do you recognize as occurring before a mudslide? What have you heard about people who have a "kind of premonition" that something will happen? For example, in town, who is famous because he or she knew or felt that a mudslide or some other threatening event was going to occur and it did? What did that person feel? What else can you add?

5.13 Knowledgeable people can sometimes "gauge the intensity of rain", whether there will be a lot or not, or if it will last a long time or not, but looking at the changes in the environment, as for example in the "plants" either here in town or on the mountain. They can even do this from a distance. What types of "signs" in vegetation have you heard talk about in this area? (If the person says he/she doesn't recognize any signs…) Nothing? Does the mountain always look the same or have people talked about it looking different? What kind of differences are we speaking of? And nothing can be noticed not even in the type of "plants" or "branches" or sediment, earth that comes down the river? For example, if it rains a lot and the "plants" are uprooted or loosened, what is it that you most often see "come down"?

5.14 And what about the animals? Do they behave the same way? No? For example, the insects and things like that? Are any of these indications of rain or "things" associated with rain? Yes? Of what? (If the person being interviewed is giving short answers, try some other type of animal …)

5.15 Farmers often can distinguish between types of storms and rain and they even give them different names. Bearing in mind that Naiquatá is still "very traditional," what type of names or classes of rains have you heard about? How do they differ? Are there specific types of rains that are more closely related with landslides or "mudslides," for example?

Susceptibility to massive movements:

5.16 What difference is there between a "rock fall" and a "rock slide"?

5.17 Generally speaking, would you say there are sectors of Naiquatá parish where rock slides are more frequent? Yes? Where, for example? (INDICATE ON MAP)

5.18 Every how often would you say that a rock slide occurs? Do they always occur with the same intensity or are there sectors of the parish where these are stronger?

5.19 And can it happen "just like this, at any time," or does it seem to you that this occurrence "seems to repeat itself"? And does it happen "every once in a while" or is it "random"? If it happens "every once in a while," at what intervals is it repeated?

5.20 Have you heard of anything or of any factor that contributes to or promotes rock slides? What? And are people just saying this now or did others say this before? For example, what have you heard about this from the people from other times?

5.21 When a rock slide occurs are some houses or structures such as walls, bridges etc., more or less resistant? What have you seen or do you know about this? In your opinion, what materials are "good" and resistant and what materials are "bad" and not resistant? Sometimes it seems that the "people from before" knew very well how to build because there are very old buildings that are still standing, despite the passage of centuries. What do the "older" people say about this? What materials do they recommend as being more resistant to mudslides? And what type of construction "tricks" enabled them to resist more, or at least protect people from injuries or damage?

5.22 What types of signs do you recognize as occurring before a rock slide? What have you heard about people who have a "kind of premonition" that something will happen? For example, in town, who is famous because he or she knew or felt that a rock slide or some other threatening event was going to occur and it did? What did that person feel? Who else?

IN THE TOWN:

<u>Torrential flows:</u>

5.23 In your opinion, are there sectors of the town of Naiquatá where mudslides are more frequent? Yes? For example, where? (LOCATE ON MAP)

5.24 What produces these mudslides? What have you heard about this in your community? Has this always been the case? What did the people from other eras say about this? And do the people of today continue to agree?

5.25 In your opinion, every how often does a mudslide occur? Do they always occur with the same intensity or are there sectors of town where they are more forceful?

5.26 What type of signs do you recognize as occurring before a rock slide? What have you heard about people who have a "kind of premonition" that something will happen? For example, in town, who is famous because he or she knew or felt that a rock slide or some other threatening event was going to occur and it did? What did that person feel? Who else?

5.27 As to prevention, what have you heard was done "in the old days"? What materials did they recommend as being most resistant to mudslides? And what kind of construction "tricks" allowed them to resist or at least to keep the water from injuring people and causing damage?

VI TOPIC 3: Useful information for OPRs:

6.1. During the most recent tragedy in Vargas, in '99, were you in Naiquatá (the town)? What did you do? Where did you take shelter? How did you find out about what was happening? And the people? What did they do? Where did they take shelter (Indicate on map). How did the community organize itself? How did the people act to prevent or reduce damage, loss or life and materials?

6.2 With respect to other types of threats in the town of Naiquatá, how do people find out what is happening? What do they do? Where do they take shelter? (Indicate on map). How do they organize themselves? What do they do to prevent or reduce damage, loss or life and materials?

6.3 At this time, do you consider that the Naiquatá community (the town) is prepared to confront a disaster similar to that of '99, or a similar type disaster? Yes? Why? Are there information systems of early warning systems in the zone? Are there institutions, organizations, groups in the zone that might help in case of disasters?

6.4 In your opinion, are there differences with respect to safety in different sites depending on the type of threat? Yes? For example…What have you heard about them in your community?

6.5 What areas, according to the community, might be best suited for living, business and houses in the town if pertinent measures are taken? (Indicate on map).

6.6 According to the community, what areas are best suited for living, business and houses in the town, without taking any measures? (Indicate on map)

6.7 You will have seen that after a disaster it is important to both cure bodily injuries, as well as vital to give moral and spiritual support to the people. Another way is to find strength in religion. In fact, Naiguatá is very well known in Vargas state as being a community that respects religion... When things like this occur, what do people tend to do? For example, do they pray to a specific saint? [DO NOT CONTINUE WITH THESE QUESTIONS IF THE PERSON YOU ARE INTERVIEWING IS AN EVANGELIST OR JEHOVAH'S WITNESS] To which one do they pray? What do they pray for, that is, against what kind of threat is that saint said to protect people? Who else? What do people pray for? In your family, for example, whom do you pray to? And if you make it through the danger all right, how did you or do you show your thanks? And the other saints, how did you or how do you show your appreciation? Sometimes, those most respectful are the people who belong to religious communities. Do you or any member of your family belong to one? Yes? To which? Both the priest or pastor, for example, or brothers and nuns tend to give a lot of help in disasters. They give, for example, spiritual help or attend to people in their residences or churches. That is why it is important for you to know where these places are. Where is the church or meeting place for the religious communities you frequent? What other places of this type do you know? [DO NOT CONTINUE WITH THESE QUESTIONS IF THE PERSON YOU ARE INTERVIEWING IS AN EVANGELIST OR JEHOVAH'S WITNESS] In addition to the churches, is there another place where people meet to pray to a saint and is there a family that "takes care" of that place? Where are these places located? In places such as Los Corales and in the Ermita (Hermitage) del Carmen, in La Guaira, during the '99 disaster, believers saw "certain signs or changes in the saints". Have you heard of any such thing?

India

Communication strategies for industrial disaster risk reduction

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SYMPOSIUM NOTES

Background

Industrial disasters are no less devastating than natural ones. In India, this became poignantly evident during the Bhopal Gas Tragedy in 1984. The disaster took more than 2,500 lives and left more than 500000 with lifelong health effects. Following Bhopal laws and regulations have been made more stringent, but the state of industrial safety and management measures on the ground is such that there could be disasters, major and minor, in almost every corner of the country. And it would be communities near the industries which would probably bear the brunt of the damages. Even within the community, the poor are the most vulnerable and most effected by a disaster.

While damages due to such disasters, including deaths, can be avoided by tightening industrial safety regulations within industrial set-ups, another essential input is preparing the community near industrial locations for a disaster event. Even in the case of Bhopal, if the community around had the simple knowledge of how to avoid Methyl Isocyanate (MIC) fumes from entering the lungs, thousands of lives could have been saved. If doctors in local hospitals had known what the chemical was, and how to handle it, things might have been better.

It is in this background that the project looked at evolving a model for community disaster preparedness. Schools in the vicinity of an industrial estate were seen as the one of the most potent driver for such a programme. Providing information and capacity-building the students to take appropriate action during an emergency situation and channelizing this information to the community through them was the aim of the project.

Following activities were undertaken to fulfill the objectives of the project:

1 – Linking with an industrial estate and schools in the vicinity: The project began with the task of identifying the industrial estate where this project could be carried out in way to best meet the objectives of the project.

- Identification of industrial estate There are 11 industrial estates in the vicinity of Ahmedabad promoted by the Gujarat Industrial Development Corporation. Out of these, the Vatva industrial estate, one of the oldest and largest estate of Ahmedabad was identified for the project activities. The estate was suited for the project as it has many hazardous industrial units, with human settlements quite close to the estate. It is spread over an area of more than 491 hectares, and having over 1800 small to medium scale industrial units. The estate gives employment to about 80,000 people. Most of these workers are settled in the vicinity of the estate. All these reasons along with a fairly responsive Industries Association at the estate made us choose the Vatva Industrial Estate for our project activities.

  The Industries Association was approached with the outline of the project activities and the need of their cooperation. We found that although the office-bearers of the Association were responsive, they were skeptical whether the activities might project the estate and its industries as unsafe or environment-unfriendly. After a few round of discussions to convince them about the importance of the project, the necessary cooperation was extended by the Association.
- Linking with schools Vatva industrial estate has many settlements around it, mainly occupied by industrial workers and their families. It was envisaged in the project that schools would be a medium to communicate to the community about industrial disaster preparedness. The schools selected for the project were the ones which were near the estate and which had students coming from houses near the estate. The area has about 10 schools in the periphery of 3-4 km of the industrial estate; all 'private', excluding one which is run by the Ahmedabad Municipal Corporation. After a survey of these schools, finally 6 schools were selected for the project. All these schools are at an average distance of 2-3 km from the industrial estate. Mostly the students coming to these schools are from the housing settlements near the industries and many of them have the parents working in the near by industries.

2 – Survey work with industries and data analysis (through and with oriented teachers and students): This activity of the project involved several steps, including teacher/ student orientation, linking with individual industries for visits, school industrial visits, surveys etc. The activities in detail are:

- Orientation of teachers and students The 9th Std. (one section with about 50 students) of each class was selected to carry out the project activities. The purpose of selecting 9th standard students was with the premise that they will have better understanding of industry related issues than any standard below them and also comparatively less pressure of studies than 10th (when in India there is a Board examination), and hence could take part in project activities more conveniently. Only from the Municipal school the 7th standard students were involved as that school was only till 7th standard.

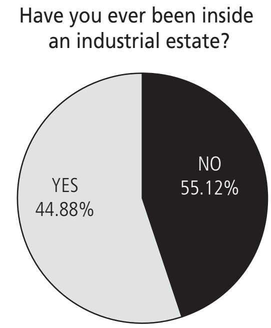
To brief and orient the students about the project, and to understand their knowledge and perceptions about industry, an orientation session was conducted in each school with the students. Emphasis of this first session was to get an idea of the perception of students had about industries. For this purpose, two exercises were carried out in which they were asked to fill a brief questionnaire and to draw a picture of the industrial estate as they see it.

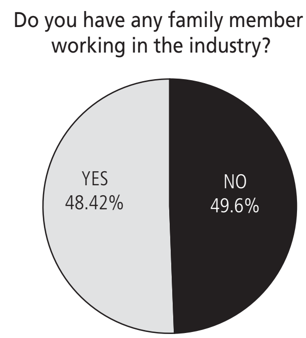
Around 250 students from 6 schools participated in this exercise. The findings of these exercise are presented graphically below and important conclusions from the questionnaire are also mentioned:

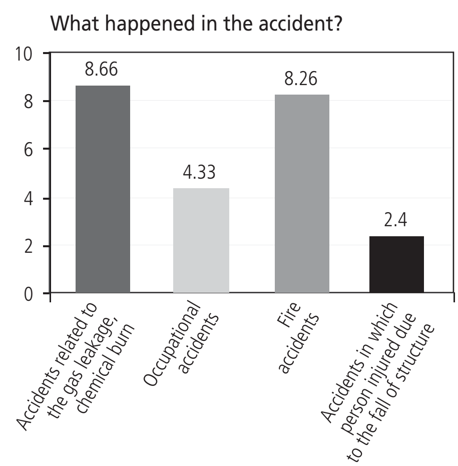
- The benefits of the industries are understood by a majority of the students and they answered that industrial estate is important in their vicinity (53.77 %) as it gives employment to many people and gives us various items of daily use.
- About 30 % students answered that they have heard about industrial accidents in the estate. Some of them had heard of gas leak related mishap, some of fire and others of injuries related to individual accidents. Thus a good percentage of children are already exposed to such information, which could apply that these occurrences are common in the estate.
- The students also answered that having industries nearby has its harmful effects (71.22 %) as it creates heavy pollution in the area which in turn affects the human health.
- The students are aware that industrial accidents can damage the environment (23.11%) and also harm employees working there (18.7%) but it seems that students are unaware about the effects of industrial disasters on the community residing near the estate.

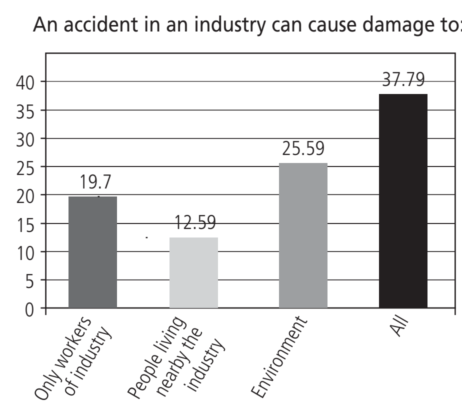
From the above survey/findings we were able to gather a good perception of the present level of awareness, understanding and perspectives of students regarding industries and industrial accidents. One of the important findings that came out of the survey was that the students are not aware about implications of industrial accidents on their own safety and that of the community living nearby.

Some survey questions and responses are presented in diagrams below:









The students were also asked to draw a picture of the industrial estate as they have seen it or as they perceive it to be. In this exercise most of the students drew houses, factory gates, chimneys with smoke etc.. Some of the students who have been inside the industries drew whatever they remembered of the industries. This helped to gain an insight into children's perception about industries.

- <u>Linking with individual industries</u> For the project activities, it was important that the students and teachers become familiar with typical industries that exist in the estate and have a general idea about how industrial operations are carried on, what kind of dangers exist and what precautions can be taken to avert any accident. Thus it was thought that the schools would link up with representative industries of the estate which will help them in better understanding and 'feel' of the industries.

  To identify and finalize the industries which could be a part of the project, the Vatva Industries Association was approached. It was felt that the Association would be able to guide us as to which industries would be most suited, and their influence would also be useful in having an industry be a part of our project. The involvement of the Association was also felt necessary as they are a major stakeholder in the issue and necessary for any mainstreaming. When we approached the Association office-bearers, they were very cooperative but had the apprehension whether the programme would focus on industries being polluting and dangerous. But we were able to convince them that our programme would be more to dispel such doubts and would result in better preparation among the community and the workers for any accident or disaster in the industry and the estate. We had several meetings with the Association and finally the industries were finalized for the project.

  The five industries finalized were: Coates of India Ltd.—manufacturer of printing inks, J.B. Packaging and Jyoti Plastic Industries—manufacturer of plastic jars, ice-cream cups, etc., Matangi Industries—manufacturer of Vinyl Sulphone Ester, Osho Pharmaceuticals —manufacturer of pharmaceutical formulations.

- <u>School visits to industries:</u> Students and teachers oriented in the initial session were taken for visits to industries. Each school visited one industry. Each student was given a survey form for the visit. They had to fill up this form at the industry through the briefings given by the industry managers and by asking questions. The survey format designed for the visit emphasized on information like accident potential of the industry and type of damage likely to result, and the working, environmental and safety norms prevailing there. The students filled the forms through interaction with the industry supervisors/managers.

  During the visit it was realized that some industry people, especially those dealing with hazardous chemicals were not open about their practices and shied away from sharing much information.

  As this was the first-of-its kind visit for school children, they not only enjoyed the outing but also the type of exposure and information they got from the visit. The students were keen and eager to learn during the visits and asked many questions of the concerned persons in the industries. For many of them this was the first time that they went inside an industry and saw the industrial processes and safety equipments inside the industry. Through the survey they were able to gather the relevant information about the industrial processes and safety mechanisms in the industries. They were also able to assess whether the industry had the potential of causing harm due to pollution or due to an industrial accident.

  After the industrial visits, a debriefing session was organized where children shared their experiences. They also made drawings based on what they saw during the visit and what struck them most.

  Another survey form was given to students based on which they interviewed their family members, neighbours etc. regarding their knowledge about industrial accidents in the estate, safety and preparedness measures etc. The results revealed that 70 per cent of those surveyed felt that there could be major accidents in the area, while close to 35 per cent had direct or indirect experiences of accidents in their work area. Only around 10 per cent of those surveyed had even a preliminary idea of what to do in disasters like gas leak or fire. Thus the relevance and need for the project was strengthened with these survey results.

3 – Collection of background material: One of the important activities that was carried on all through the project was to gather relevant background material for the project. Many libraries in Ahmedabad and offices of Factory Inspectorate, GIDC, Vatva Industries Association, Fire Brigade office etc. were visited to gather more information. A visit was also made to Gujarat Safety Council, Vadodara which is an institution involved with developing and conducting many safety related programmes with the industries in the state. Meetings were also held with Safety Managers at Gujarat State Fertilizer Corporation (GSFC) and Gujarat Alkalis and Chemicals Ltd., Vadodara. These industries have carried out community awareness programmes related to industrial accidents. Many other local, state and national level organizations like National Safety Council, Loss Prevention Association etc. were contacted for collecting background material, especially related to school and community awareness programmes. Extensive web search was also carried out to gather relevant information.

4 – Development of teacher booklet and poster After completing the visits, surveys and collection of background material, work on developing a Teacher's Manual and poster was started. The Manual adopts an activity-oriented approach for conveying the concepts as well as preparedness measures detailed in the manual. The Manual addresses the links of industry and environment, industrial estates etc, in general and goes on to give specific information about Vatva estate, its hazardous industries etc., potential threats and response mechanisms for each. A list of Annexure provides useful contacts. The draft of Teacher Manual was shared not only among the teachers of the participating schools but also with relevant experts and other key stakeholders for the project.

The poster is targeted to the general community living in the vicinity of the estate. It depicts the sequence of actions to be undertaken in case of three specific disasters—gas leak, fire and chemical spill. Most of the information is communicated visually so that illiterate community members can also become aware of the responses. The posters are being put up at common public places and also at individual schools and some industries.

5 – Teacher orientation workshop A Teacher Orientation Workshop was organized which had a very good response from all the schools. From some schools, three teachers participated (we had requested for at least one teacher to participate). The workshop oriented participants to the content and approach of the Manual. Some of the activities from the Manual were performed by the teachers to get an idea of how the activity approach helps in easier transmission of information. The teachers participated enthusiastically and made several suggestions. The topics for student Elocution, Drawing Competitions were suggested by the teachers themselves.

6 – School and community programmes for information dissemination The school programmes for dissemination involved carrying out activities through which the students themselves became aware and then further passed this message to other in the schools. The teachers oriented through the workshop undertook various activities with the students. Activities like Bulletin Board featuring news related to industrial accidents was started in schools. Drawing competition was also organized for the students.

A poster was prepared which had all the steps to be followed in case of three main industrial accidents viz. gas leak, fire and chemical spill. The instructions were mostly visual with some in words. These were put up at important community places like hospital, bus stop, post office, association building, shopping complexes etc. were they can be seen by the community. The posters had a good response with many people thronging to see it as soon as they were put.

A skit on the subject of industrial disaster preparedness based on traditional mythological characters had been developed which was first performed by teachers at the Orientation Workshop. The teachers have then oriented the students for the skit in their respective schools. The students would be performing this skit at the school for everyone and subsequently at other community places and also in factories.

7 – Concluding event A big concluding event was organized at the premises of the Ind-German Tool Room at the estate. All the stakeholders viz. the executive of the industrial association, Ahmedabad Fire Brigade personnel, representative from Factory Inspectorate, local NGOs working in this field and the schools were present for the event. The event had performance of the skit which all the schools had prepared related to measures to be undertaken in case of an accident. There was elocution contest on topics related to industrial disaster and safety. The prizes for both these categories were given on the spot by stakeholder dignitaries. This was followed by an elaborate drill by the fire brigade personnel. They demonstrated different kinds of methods and techniques to deal with accidents, especially those related to industrial accidents. Later as a mock drill, they also used smoke bombs to simulate for gas leak and asked the children to perform the right action for this eventuality. While most of the children covered their nose and mouth, they were undecided to the direction in which they should run. But soon they figured it out. But this was a good exercise to demonstrate the preparedness of the children and the community.

The best part of the event was not only the enthusiasm shown by the schools but also the participation of other stakeholders which came forward to take ownership of the activities.

8 – Feedback The feedback process for some of the components has been completed while for some the process is on. The feedback from the teachers after the orientation workshop was very positive. They liked the activity-approach and their experience of doing the activities and skit themselves. Ideas like Bulletin Board and slogan writing on kites were much appreciated and most of the schools have started implementing these in their schools. The response of students after each session, industrial visits and debriefing by teachers has also shown positive increase in their understanding of the issue and the objectives of the project. Most students have participated in the competitions organized in their schools. The feedback process for posters and other community programmes is on. The schools have assured that they would be carrying on this programme as a regular activity for their 9th standard students and in doing the community programmes whenever possible.

The Manual prepared for the project has been mailed widely and similar estates are being looked into for carrying out similar awareness and preparedness activities through partnerships.

Important elements with an impact on disaster risk reduction

Important elements having an impact on disaster risk reduction in India and worldwide which came out through this project are as follows:

- Identifying urban poor, especially those living near factories as an important vulnerable community. When we talk of poor and vulnerability reduction, most commonly it is the rural poor which come to mind. Identifying the vulnerability of an urban poor community and working towards their risk reduction has been one of the primary goals of this project.
- Utilizing education and communication as an effective tool for disaster risk reduction. Education and communication as demonstrated through this project is one of the most non-interventionist, low-resource and with widely reaching approach for vulnerability reduction.
- Demonstrating schools as an effective low-resource communication tool to widely reach out to communities.
- Involvement of schools in a large measure ensures longer sustainability of the project activities than any other approach, as schools are an already existing institutionalized structure.
- A consensus-building or enabling approach help ensuring greater stakeholder participation than one of confrontation or activism. The cooperation extended by the Industrial Association, government institutions was possible due to the friendly stance adopted by us rather than one of activist kind—ready to expose them. Taking them into confidence had enabled us to achieve much now and much more in future.

Components of learning

Learnings from stakeholder participation
The execution of the project and its outcomes heavily depended upon the participation of the key stakeholders. Some key learnings from the nature and degree of participation from different stakeholders are given below:

- Schools: Schools the prime vehicle for communication displayed a very positive response for all the project activities. At the beginning of the project, one of the apprehensions was also about the role and participation of the schools. It was felt that schools might take this as an additional burden on their already stressed curricula processes, might also be wary of sending children for industrial visits or organizing any exercises or drills in schools which affects their regular schedule. But there was a tremendously positive response from all the schools that were approached. They carried out all the activities and are keen for further processes to continue this trend. Their interest can be gauged by the fact that for the teacher orientation workshop each school sent two or three teachers, whereas we had requested for at least one.
- Industries Association: The response from Industries Association was a little shaky at the beginning but improved with time. This was primarily due to their fear of their estate being projected as an unsafe or environment-unfriendly estate. Assurances and their involvement at every stage of the project ensured that this notion was erased. The draft Teacher's Manual was shared with them so that they can be assured that nothing in the manual paints a false picture about the estate.

- Government institutions: The response from government institutions was more than positive than what we had expected. The Factory Inspectorate, GIDC, Fire Brigade shared information and provided whatever help we asked with commitments towards the future also. Thus our common notion that it is difficult to interact with state-institutions was somewhat eroded during the project activities.

A threat-aware but ill-prepared community
A significant learning from the project was that the community is rather aware of the kind of threats they have due to their close proximity to the estate, but extremely unprepared from any kind of response mechanism during a disaster event. Through the surveys done with the students where there were also questions for their family members, it came out that people knew of what kind of accidents can occur in the industries, but what were hardly aware of what they should do in such events. There was a felt need for preparedness and thus the messages from the project were well taken. There is still a lot more scope of preparedness which reaches out to all the sections of the society vulnerable to such disasters.

It was also noticed that not only industrial disaster, but the community is also unaware of responses in other disasters like earthquake, etc. Gujarat faced a devastating earthquake in 2001 and parts of Ahmedabad were severely effected. The schools were also not aware of preparedness mechanisms to handle such disasters. Thus the scope of risk reduction can be increased to include the preparedness measures for other disasters also.

Consensus-building approach helps more than a confrontationist one We felt that during our initial visits to Vatva, that there is lot that has not been addressed in the estate with regard to safety mainly because safety has not been a priority issue among the industry management. The fear of the Industries Association was also to some part associated with this. Our approach was not to confront them for these issues but try to develop a rapport with them, so that not only the project activities can take place but also we can slowly convince them about necessity of safety and preparedness. With time, the Association was completely convinced that our purpose was community preparedness and not exposing their lack of measures to address safety.

Sustainability, ownership and way forward

- Addressing the link between poverty and disaster risk reduction in developing countries

  The project aims at industrial disaster risk reduction for communities living in the vicinity of an industrial estate. In a developing country like India, the human settlements in the vicinity of the estate are mostly of workers employed in the factories inside the estate. These communities are also the most vulnerable to any accident happening in the estate due to their close proximity, as well as lack of access to information about responses and access to medical and institutional help. The project targeted one of the most vulnerable, low-income level community which has not been part of any formal or non-formal programme towards risk reduction.

  It is important that communities like these become aware of disasters that can occur in the estate and appropriate responses to cope with them. Awareness and preparedness measures by the employers or other formal institutions are not the scale or depth required. Most only prepare the worker for any accident inside the factory. This leaves the community extremely vulnerable to any disaster event, as was witnessed during Bhopal Gas Tragedy. It is also important to note that urban poor are not the ones to be addressed first whenever the links between poverty and disaster risk reduction are spoken of.

  This project has attempted to fill this information gap and prepare communities through a unique channel of information. The schools in the vicinity of the estate have more than 50 per cent of their students coming from settlements close to estate and of workers employed in the factory. The families of a large percentage of the students, belong to the lower income level of the society.

  The project at the first level has oriented the students and teachers towards awareness and preparedness exercises for different kinds of disasters that can occur in the estate. The whole school is then exposed to the knowledge through these oriented students. This message, through the children gets passed on to their individual families and further to the community through the families and other community programmes. There are posters developed in the project which pictorially depict what actions have to be taken in each disaster. These have been displayed at public places, reaffirming the message of preparedness. Drama based on traditional characters to convey preparedness messages, kite flying with safety and preparedness slogans and many such similar exercises helped in wide dissemination of the message through a variety of approaches. These are extremely low-resource approaches and those which are very popular in the lower strata of the place.

Thus by using school children to create a multiplier effect, the project has been able to reach the most vulnerable section in the most cost-effective way. Similar situations exist in industrial estates not only in India, but also in many developing countries. There are reasons to believe that this communication strategy might work as an hitherto untried but a useful approach towards industrial disaster risk reduction.

- Sustainability of the project beyond the six months

The programme would be sustainable as the manual and other information developed would be available with the schools and it will have trained teachers to sustain the effort. Hence, every new batch of students would get trained in this preparedness activity and spread the message across. This will also make the material developed as part of the project very cost-effective as it will be repeatedly utilized. The teachers and students propagating this already feel a sense of ownership to the whole exercise and would act as leaders in case of an event. While only the teachers have been directly oriented, the students and the community thereafter have been the indirect learners and beneficiaries of the project, who would sustain this preparedness exercised beyond the period.

The Vatva Industries Association which has been an active partner in the whole project, has also shown interest in sustaining the activities. There are also chances of scaling up the project as there are more than 200 industrial estates in Gujarat with very similar conditions. The options for carrying out similar activities in these estates are being explored.

- Ownership and sharing with stakeholders

The ownership of the project has slowly with the end of the six months shifted to one of the most important players in the project—the schools. Through the orientation sessions, the teacher's workshop and finally the awareness programmes by students in schools and further to community, the school management, teachers and the students have really begun to take ownership of activities of the project. This has come about due to our efforts to involve the schools not just a component of the project but taking their advise, suggestions and framing ideas for school activities through them. Schools started some of the activities like Bulletin Board, drawing competition from the very next few days after the teacher orientation workshop. They are enthusiastic about the school projects and the drama activity by the children. Although the project has ended its stipulated period, they are eagerly awaiting participation in a estate-level elocution, drawing, drama etc competition which is planned to be organized during end-January.

Other key institutions related to the project goals and activities have also started to develop a sense of ownership for the project rather than being another actor for project activities. One of the most stakeholder involved is the Vatva Industries Association, who have started feeling that this activity is beneficial for the welfare of their estate and can bring credit to them for being a safety-friendly industrial estate. The Association has proposed that an event be organized where all the key stakeholders are invited. This would help in sharing of results of the project, in planning for sustenance of the project activities and to build upon future programmes related to community preparedness. Other important institutions like the Factory Inspectorate, Gujarat Industrial Development Corporation, Fire Brigade Department, NGOs involved in such work have all participated and contributed enthusiastically in carrying out project activities. The Factory Inspectorate has shared the information about the functioning of the Local Crisis Group at Vatva, GIDC has given all relevant information needed time and again for execution of project activities and development of the Manual. The Ahmedabad Fire Brigade organized a massive drill and demonstration at Vatva and

NGOs like Unnati working in the field have shared their experiences and communication material with us.

The draft of the Teacher's Manual was shared among all of the above mentioned institutions which provided relevant inputs. Their inputs have been well-recognized throughout the project and they will also serve as channels of dissemination for the communication material developed in the project.

The event held in February served as a good platform for sharing of results, experiences and looking at ways of moving the project activities forward. The event had major ownership from within the estate. The whole premises, including the auditorium was provided free by the management of the Indo-German Tool Room. The Industrial Association came forward to bear the expenses of refreshments provided for the kids. Thus it seemed that with this a good beginning has been made.

At the state and national level, institutions such as Gujarat Safety Council and National Safety Council have provided meaningful inputs in the project. The National Safety Council has also asked if CEE could serve as a Centre to disseminate their communication material.

Bulgaria

Risk reduction through first aid capacity building of youth emergency teams

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Ivaylo Pastuhov
Aleksander Manushev

PROJECT ADVISOR

Jivka Dimitrora

SYMPOSIUM NOTES

In the second half of 2003 Bulgarian Red Cross Youth implemented a project related to transfer of knowledge and skills and awareness raising about ways of reducing disaster risk under the name 'Risk Reduction Through First Aid Capacity Building of Youth Emergency Teams'.

The project was initially planned to be implemented in 14 out of the 28 administrative regions of Bulgaria, in which exist the so-called Youth Emergency Teams.

The Youth Emergency Teams (YET) are voluntary teams of young people (aged between 16 and 25), members of the Bulgarian Red Cross Youth, which are active on the territory of particular administrative regions of the country. They have some supportive functions, related to disaster response, but their main tasks are in disaster preparedness. The Youth Emergency Teams (which became 17 in the course of the project) disseminate materials, related to disaster risk among the population, they carry out lectures and field drills in schools and different public or business organizations.

The idea behind the project was that by building the capacity of the existing Youth Emergency Teams in Bulgaria in the field of first aid, their work within their local communities will become more efficient and they could take a leading role in risk sharing. This was planned to be done by demonstrating the importance of first aid as primary step in reducing risk in emergencies and by training people in delivering first aid.

At the beginning of the project was established a team of advanced members of YET, whose role was to build the capacity of the others in the field of first aid. In July 2003 the team took part in the largest first aid competition in Europe – the First Aid Convention of Europe (FACE) – in Prague, the Czech Republic. This was the first occasion for the last few years that a Bulgarian youth team was able to participate in FACE and it was used by the project team for obtaining the latest standards in first aid. At FACE the team checked its level of training and got 11th position among all the 26 teams presented in the competition.

In the following months the team started carrying out subsequently one-day trainings of each the YETs from the different parts of the country. Because of the limited time and some budget considerations, the team was divided into sub-groups of 2 trainers each. On a rotating principle each couple of trainers travelled to several different destinations to work with the YETs based there.

Meanwhile 3 new YETs were established in the towns of Ruse, Montana and Targovishte. This was an evidence for strengthening of the YET network to which the project contributed to a large extent.

Project links between poverty and disaster risk reduction in developing countries

The project we implemented is not directly concerned with the issue of poverty, thought there is a certain link between the process of social transition in Bulgaria as a post-communist country (one of which marks is poverty) and the disaster risk reduction. As the state is experiencing a difficult period, the government's efforts are directed at meeting mainly the primary needs of the population. Unfortunately, disaster risk sharing is not among them and especially in the small communities people lack information and skills, which would help for reducing the disaster risk.

Through the current project, Bulgarian Red Cross Youth concentrated particularly on small communities, disseminating information and training particular groups of the population (mainly youth) in first aid skills.

Although the project could not fill in the gap in the population's knowledge, related to disaster risk reduction and first aid, it demonstrated a good practice in disaster transfer, through a voluntary-based approach.

Project sustainablity

The project is based on the work of 17 voluntary teams of young people, who are disseminating knowledge and skills, related to disaster risk reduction among the population. Through the first six months the capacity of these youth emergency teams was build up, so that they can continue doing their important work within the communities.

Even though these structures already exist and there is no need that funds are allocated for developing such, they still need proper equipment and funds for covering their subsistence costs.

Project ownership among a broad community and institutional base

The project is recognized by the Bulgarian Red Cross as an important activity in the field of disaster preparedness.

Currently, within the Bulgarian Red Cross, the Youth Emergency Teams are the only functional structure, engaged in disaster risk sharing, through direct work with the population.

Components of learning

The project as a whole is based on the concept of learning by doing. People are trained in practical skills for delivering first aid in case of disaster, which could prevent or reduce the disaster risk.

The success of the learning process is ensured through, training in small groups, taken at the same format at which they exist naturally in the community. This helps for strengthening the relations within the communities and developing feelings of mutual trust and belongingness.

LESSONS LEARNED

After receiving their first aid training, the YETs had to put the lessons learnt into practice. Each of the YET developed an action plan for work within the local community for building its capacity for disaster risk reduction.

In each of the project regions were carried out exercises in schools, based on an agreement with the Ministry of education and Science in Bulgaria that Red Cross youth volunteer have access to each public school in the country. Till December 2003 in the events, related to first aid, participated approximately 1600 secondary school students in all the project regions.

The First Aid Day, 13th of September 2003, was used for raising the awareness of the local communities in the project regions about disaster risk reduction and first aid measurements in cases of small-scale disasters or accidents.

In 7 towns were organized in the open simulations of first aid measurements in case of emergency.

We estimate the direct beneficiaries from the project to be about 1700 people, who attended the different public events (different than those who were reached in the schools).

The project had an impact on the standardization of the concept (and the practice) of first aid in Bulgaria.

In September 2003 Bulgarian Red Cross issued a first aid manual for the public. The project team was invited to take part in the in the editorial work on the manual and contributed a lot for its successful finalization.

Members of the team also participated in their role of advanced first aid trainers in a training film for first aid, produced after the manual, which will be disseminated for free among the population.

The project implemented by the Bulgarian Red Cross Youth team played a significant role in the field of disaster preparedness in Bulgaria. It was particularly valuable because of the community based work which was done, which is a new approach for our country.

THE SIXTY-FIVE RESEARCH GRANTS

For the ProVention program, Applied Research Grants for Disaster Risk Reduction, there were sixty-five proposals selected to receive grants of up to US$5,000. The projects were. Arranged by country, here are those projects (completed between June 2003 and January 2004) with contact information for the Team Leader, a listing of team members, and advisors.

Argentina
Armenia
Bangladesh
Barbados
Bhutan
Bulgaria
China
Colombia
Costa Rica
Georgia
India
Indonesia
Kenya
Mexico
Nepal
Nigeria
Pakistan
Philippines
Senegal
South Africa
Sudan
Tajikistan
Turkey
Uzbekistan
Venezuela
Vietnam
Zimbabwe

SYMPOSIUM NOTES

ARGENTINA

TEAM LEADER

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PROJECT TITLE

Reducing vulnerability to climate variability and change: cognitive and behavioral obstacles to rational use of information

PROJECT ADVISOR

William P. Anderson

TEAM LEADER

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PROJECT TITLE

Study of the awareness of Earthquake risk in the population of Mendoza

PROJECT ADVISOR

Engels German Cortés Turjillo

TEAM MEMBERS

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Humberto Enrique Marin Uribe
Andres Martina Cervan

ARMENIA

TEAM LEADER

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PROJECT TITLE

New methodology for seismic microzonation of the cities at the highest risk

PROJECT ADVISORS

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Mrs. Lilit Asatryan
Mr. Samvel Babayan
Mr. Artak Simonyan

TEAM LEADER

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PROJECT TITLE

The main principles of earthquake early warning system creation around critical facilities in seismic active zones

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Dr. Zaven Khlghatyan

TEAM MEMBERS

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Marine Simonyan

TEAM LEADER

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PROJECT TITLE

Preliminary vulnerability assessment method of residential stone buildings

PROJECT ADVISOR

Dr. Zaven Khlghatyan

TEAM MEMBERS

A Baldryan A Martirosyan

BANGLADESH

TEAM LEADER

Marina Parvin Juthi <cdp@khulna.bangla.net>

PROJECT TITLE

Reducing vulnerability to floods in southwest border districts of Bangladesh

PROJECT ADVISORS

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TEAM LEADER

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PROJECT TITLE

Technological & chemical hazards and the risk of bulk transportation of dangerous goods along the ship-breaking yard of Chittagong, the port and adjacent area: a qualitative analysis of the combination of risk factors

PROJECT ADVISOR

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BARBADOS

TEAM LEADER

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PROJECT TITLE

Community risk management

PROJECT ADVISOR

Miss Judy Thomas

BHUTAN

TEAM LEADER

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PROJECT TITLE

Demonstration to the Bhutan building industry: Better safety of life and cost saving by avoiding un-reinforced brick infill in RCC frames designed for seismic attack

PROJECT ADVISOR

J. Spencer Nicholls

BULGARIA

TEAM LEADER

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PROJECT TITLE

Risk reduction through first aid capacity building of youth emergency teams

PROJECT ADVISOR

Jivka Dimitrora

TEAM MEMBERS

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Atanas Tsvetanski
Teodora Sakaliiska
Ivaylo Pastuhov
Aleksander Manushev

CHINA

TEAM LEADER

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PROJECT TITLE

Vulnerability of a community's structures, people and property based on flood risk assessment

PROJECT ADVISOR

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TEAM MEMBERS

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Hu Changwei

TEAM LEADER

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PROJECT TITLE

The disaster awareness and risk management of flooded Yangtze River: A case study of 1998 Dyke Burst in Jiujiang

PROJECT ADVISOR

Guo Qiang

TEAM MEMBER

Zeng Huaide

TEAM LEADER

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PROJECT TITLE

Near source strong ground motion estimation

PROJECT ADVISOR

Asst. Prof. Dr. Wang Guoxin

TEAM LEADER

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PROJECT TITLE

Social-forestry based disaster preparedness and management in rural community of Menkong Catchment, Yunnan Province, Southwest China

PROJECT ADVISOR

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TEAM MEMBERS

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Jiao Xiaoxu

COLOMBIA

TEAM LEADER

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PROJECT TITLE

Expert system for post earthquake building damage evaluation and massive risk occupancy

PROJECT ADVISOR

Omar D. Cardona

COSTA RICA

TEAM LEADER

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PROJECT TITLE

Risk identification and reduction in NW Costa Rica: Soil liquefaction at Nicoya Peninsula and volcanic vulnerability at Arenal volcano

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Lic. Vilma Barboza

GEORGIA

TEAM LEADER

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<pronto_jm@hotmail.com>

PROJECT TITLE

Research on establishment of general concept on interaction of different disaster data

PROJECT ADVISOR

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Urban multiple disaster scenario and decision making system for vulnerable area of Madhya Pradesh, India

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Environmental monitoring of pesticide residues and heavy metals in and around Kanpur, Uttar Pradesh, India

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Action advocary to ensure right to livelihood risk reduction and beyond

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Organisational learning for community based disaster risk reduction: lessons from Disaster Mitigation Institute.

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Institutionalising Innovative Local Practices and Partnerships for risk reduction in earthquake-prone settlements of the poor: A case study in Porbandar District, Gujarat, India

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Developing & disseminating a model of community-based, disaster-mitigating developmental planning

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Community based advanced risk sharing programme

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Planning for risk reduction through sustainable siting of embankments in the Sundarbans

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Post disaster risk identification: A case of rehabilitation process of rural Kutch in Gujurat, India

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Critical Study into the government policies on disaster management in India

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Hazard resistant health delivery system

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Multidimensional SNMR modeling for groundwater exploration

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Stregnthening rural community bonds as a means of reducing vunerability to landslides

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El Niño phenomenon: social construction of risk in the Isthmus of Tehuantepec: A multidisciplinary approach

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Community disaster management with GIS in Nepal

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Mapping and assessing risk and vulnerability of water induced disaster in the Tinau Watershed, Western Nepal

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Flood disaster reduction in Karnali Watershed, Western Nepal

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Floodplain analysis and risk assessment of Lakhandei RIver

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GIS and remote sensing for flood disaster identification: A case study of the Koshi River Basin in Nepal

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Effectiveness of policies for the reduction of flood hazard in Pakistan: A case study of Nala leh, Rawalpindi City

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The development of uniform datasets for measuring hazards in Southern Africa

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Research in forest fires for South African disaster management

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Honey-hunters: Entrepreneurship or a symptom of social and economic poverty?

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Seismic conservation of historical and cultural treasures of a world city: Sizing the need and formulating an action plan for the museums of Istanbul, Turkey

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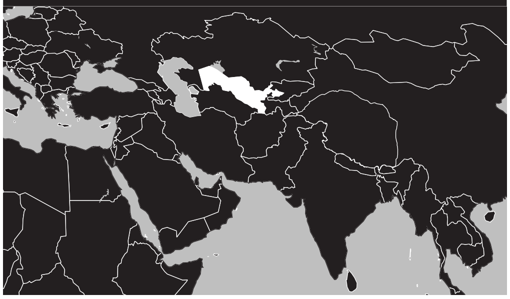

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Development of Album of technical decisions for reinforcement of self constructed residential buildings (existing and new) from local materials in earthquake prone areas of Central Asia

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Local and popular folklore and culture on hazard and vulnerability meets geographical information system for the risk reduction preparedness of the people of the Barrio San Antonio of Naiguatá, Estado Vargas

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Seismic microzonation in ancient quarter of Ha Noi based on microtremor observations

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In order to coordinate and manage the program of Applied Grants for Disaster Risk Reduction, World Bank's Hazard Management Unit (HMU) and the ProVention Consortium selected three well-respected organizations working in international disaster/emergency management:

Asian Disaster Preparedness Center (ADPC)

is a regional resource center working towards disaster reduction for safer communities and sustainable development in Asia and the Pacific. Established in 1986, the Center is recognized as an important neutral focal point in Asia and the Pacific for promoting disaster awareness and the development of local capabilities to foster institutionalized disaster management and mitigation policies.

Cranfield Disaster Management Centre (CDMC)

was founded in 1985. Its aim is to save lives and livelihoods at risk from disaster impact through the promotion of risk and vulnerability reduction, preparedness and effective disaster response. The CDMC believes that disaster risks and vulnerabilities can be reduced through the application of sound management principles and practice.

University of Wisconsin–Disaster Management Center (UW–DMC)

has served the learning needs of disaster/emergency management professionals in the developing world since 1982, working closely with experts recognized for their field experience to develop disaster management training activities with a practical emphasis. The center's goal is to help improve the emergency management performance of non-governmental organizations, local and national governments, and international organizations, through its comprehensive professional development program in disaster management.

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