Assessment of Social Vulnerability Using Geographic Information Systems: Pendik, Istanbul Case Study

Zeynep Haki, Zuhal Akyürek, Şebnem Dügün
Middle East Technical University, Natural and Applied Sciences, Geodetic and Geographic Information Technologies
06531- Ankara, Turkey
zeynephaki@yahoo.com, zakyurek@metu.edu.tr, duzgun@metu.edu.tr

SUMMARY
This study aims to develop a methodology to define vulnerable groups in terms of their social conditions for any possible hazard, with Geographical Information Systems (GIS) technology, in the case study area of earthquake-prone Pendik, Istanbul. In the calculation of social vulnerability certain indicators were estimated and used as criterion data. Criterion standardization, weighting and combining were accomplished by means of multi-criteria evaluation (MCE) methods, the theoretical background being based on the multi-attribute utility theory (MAUT). In order to avoid the subjectivity of the assessment, 10 more evaluations are utilized. The results show that, the income- and educational-level indicators are the most important factors in defining the social vulnerability. These outputs are supported with some explorative spatial data analyses to understand global trends and spatial interactions in order to be used in pre- and post-disaster planning. Besides, to determine the physical effects of basic services and transportation, some GIS Analyses are applied. The objectivity of the assessment and the complicated structure of the study data are discussed for an effective disaster management. The main outcomes of the methodology and its applications show that, the southwest part of Pendik is socially vulnerable to any possible hazard.

KEYWORDS: Social Vulnerability Assessment, Pre- and Post-Disaster Planning, Disaster Management, Spatial Data Analysis, GIS, Pendik-Istanbul

INTRODUCTION
Natural hazards are the reality of today’s world, which considerably affect people’s living conditions. As they cannot be prevented, the basic precautions should be taken before the occurrence to protect people. At this point, the preparedness for any threat is really important, which does decrease the destructive effects of the hazard for the communities and shorten recovery interventions. In terms of preparedness, identification of the community’s vulnerability gives a clear picture of at risk and susceptible groups, which can also be called vulnerable groups. By identifying these vulnerable groups, better disaster preparedness plans can be undertaken and better public awareness studies can be developed in the pre-disaster phase. Besides, for during- and post-disaster interventions, the resource allocations can be organized fairly considering the vulnerability level of the society.

Although the concept of vulnerability is mentioned in different fields, generally it has been used and described in the natural hazard research fields. The concept entered officially in this area in 1979 with a report of UNDRO (Office of the United Nations Disaster Relief). It has been stated by UNDRO (1991) that there is a combined relation among Risk, Hazard, and Vulnerability. This relationship suggests that vulnerability cannot be described without reference to a specific hazard or a shock. So, the question that must always be asked is, “Vulnerability to what?”
However, the definition of vulnerability is interpreted by UNDRO (1991) as ‘a measure of the susceptibility of structures to potentially damaging natural phenomena’, and this approach is differentiated in the recent years. In fact, by defining the vulnerability just with the structures, the effect on the individuals and communities cannot be assessed properly. For example, although the building is seen in unsafe condition in any earthquake, it is the inhabitants of that building who are vulnerable. In this respect, vulnerability is generally defined as; “… the characteristics of a person or group in terms of their capacity to anticipate, cope with, resist and recover from the impacts of natural or man-made hazards” (International Federation of Red Cross and Red Crescent Societies, 2000). As it is also understood from the above definition, it has been agreed in the literature that vulnerability has two sides. First side is the external side of risk, shock or stress to which an individual or household is subject to; and the other side is the internal side which is defenselessness, means lack of coping without damaging loss. Having these sides, the concept of vulnerability is described within five categories, which are economical, social, environmental, political, and cultural.

Besides, in the literature the concept is confused with concepts of risk, hazard, poverty, and inequality. Although, there are some similarities among these concepts, there is a delicate distinction of vulnerability from the others. For example, communities who are most vulnerable will also probably be the ones who are most at risk; however, communities that may face the same risk will not be equally vulnerable. This confusion is also detected in the concept of its assessment. However, the assessment of vulnerability involves consideration of all significant elements in the society, including physical, social, and economic considerations, and local coping mechanism. The main challenge in the assessment of vulnerability, which is determined in the literature, is to find out the ways of analyzing people’s vulnerability implicit in daily life. In other words, people’s actual living conditions must be investigated in these assessments, to understand their potentials and weaknesses, which can make them vulnerable for any possible hazard.

The International Federations of Red Cross and Red Crescent Societies are among the ones that recognized the importance of social vulnerability assessment and started a program called “The Vulnerability and Capacity Assessment” (International Federation of Red Cross and Red Crescent Societies, 2000). Disaster preparedness is a core activity of the Federation, which after 1999 they realized the necessity of defining vulnerable people in their studies. In this respect, the Vulnerability and Capacity Assessment is used to improve their understanding of the needs of people at the risk of natural and man-made disasters, and thus prepare more appropriate pre-disaster actions to cope with and recover from these hazards. The Assessment was designed by using “The Participatory Rural Appraisal (PRA)” method, which includes tools for examination of socio-economic factors of; physical world, groups of people (social mapping), institutions, time use (historical diagrams), sequences (of activities), and comparisons (on people, activities and objects).

“The Vulnerability and Risk Assessment Module” is one of the training modules of “The Disaster Management Training Programme”, which is jointly managed by United Nations Department of Humanitarian Affairs (DHA) and United Nations Development Program (UNDP), with the support from the Disaster Management Center of the University of Wisconsin, on behalf of an Inter-Agency Task Force (Coburn et al., 1994). This module examines the scope for measuring the risk of future losses and for using this knowledge to assist in the selection of appropriate disaster mitigation strategy. In the Assessment module, risk maps are used to show the spatial or geographical distribution of expected losses from one or more natural hazards. These mappings are; (a) scenario mapping (the presentation of the impact of a single hazard occurrence), (b) potential loss studies (mapping the effect of expected hazard occurrence probability to show the location of communities likely to suffer heavy losses), and (c) annualized risk mapping (calculation of the probable levels of losses occurring from all levels of hazards over period of time).

A comprehensive process of risk assessment involving hazard-mapping and vulnerability analysis is carried out in Mexico City (Blaikie et al., 1994). In order to realize this study, series of ‘vulnerability strata’ are identified. Another example is an urban vulnerability assessment methodology application in Los Angeles County. In fact, the developed methodology incorporates vulnerability analysis with “… spatial multicriteria analysis and fuzzy logic” (Rashed and Weeks, 2003) by GIS in earthquake hazards framework. The methodology, which does not consider social factors, is involved 7 stages, which of the first is the selection of evaluation criteria or measures that determine the scope of analysis. The second stage is the simulation of
earthquake hazards through which one can explore the possible effects of earthquake on a particular region according to multiple deterministic and probabilistic scenarios. The third stage is the composition of loss estimates created from each scenario run in stage two, which are transformed into comparable units through a ‘fuzzification’ process. In the next stage, these fuzzified criteria are compared pairwise using the analytical hierarchy process. The fifth stage is the aggregation of the criteria into a one-dimensional array of rules based on a fuzzy additive weighting method. In the next stage, ‘the higher-risk’ fuzzy layers are used to locate hot spots of urban vulnerability. The last stage is covered the sensitivity analysis to determine the effects of simulation parameters on the final output.

The Area Vulnerability Assessment Project, conducted by the Tokyo Metropolitan Government Bureau of City Planning together with the Tokyo Metropolitan University (Uitto, 1998), is very important for its characteristic of integrating GIS technology to the application. It compiles and synthesizes information about four types of impact (building, fire, human, evacuation) that would occur in the event of a re-occurrence of the 1923 earthquake. Vulnerability is measured on a five-point scale for 500 x 500 m grid cells covering the entire metropolitan area. This GIS-based analysis is provided measures of relative risk in different areas. It is intended to assist the authorities to formulate local strategies for disaster response and mitigation.

The above mentioned literature studies indicate that there is a need for methodological basis for social vulnerability assessment. In addition, the indicators of social vulnerability such as income levels, educational status, age or sex differentiations, kinship levels, or social support networks have to be identified. Besides that there are few researches on this topic; there is an absence of the assessment of physical factors in such studies. In fact, having spatially referenced data of the considered area, the projects on social sciences could get different perspectives, rather than just analyzing regular statistical data. This kind of data also helps to understand the causing factors of social vulnerabilities. In the analysis of physical factors, Geographic Information Systems (GIS) is a very powerful tool, with its visualization and spatial data analyses capabilities.

In these respects, this paper discusses the methodology developed to identify vulnerable groups in terms of their social conditions for any possible hazard, before it becomes real. In this study, Geographic Information Systems (GIS) technology constitutes the basis. In addition to that, multi criteria evaluation (MCE) methods, the theoretical background being based on the multi-attribute utility theory (MAUT), are utilized to obtain social vulnerability levels from census data. It is also intended to use some explorative spatial data analyses in order to analyze the global trends and spatial interactions of the study area. A case study area is selected to find out the contribution of the use of this GIS-based Social Vulnerability Assessment methodology in the determination of inhabitants’ social vulnerability, in earthquake-prone district of Pendik, İstanbul.

MATERIALS AND METHOD

Study Area

Pendik is an administrative district of İstanbul Greater Municipality, located at the southeast part of the city. As seen in Figure 1, the district surrounded by, Tuzla district from east, Sultanbeyli district from northwest, Kartal district from west, and Marmara Sea from south. Pendik is spread out to a 156-km² area, with a 7.5 km coastline (Figure 1). In addition to being among the first-degree earthquake risk zones, Pendik is selected for the implementation of the methodology for the following reasons:

- It has high rate of population increase, with a population of 389,000 in 2000, increased from 295,000 in 1990.
- It has different social groups, due to immigration of people from Black Sea, east and southeast region of Turkey, and West Thrace.
- It includes different income levels, due to the physical characteristics.
- There are many unauthorized settlements and squatter areas
- It contains important motorways, and Sabiha Gökçen International Airport.
- There are important firms located in the industrial zone.
Data Collection and Manipulation

In order to find social vulnerability levels of Pendik inhabitants, data used in the study is compiled from 1990 census data, and surveys from Pendik Municipality assistant mayors, inhabitants, and specialized academicians of the Middle East Technical University. Year 2000 Building Census, Year 1990, 1997, 2003 Neighborhood Maps (1/25,000), Year 1990 Neighborhood Units Information, transportation and building maps are the other data used in this study. Among the various social indicators which are obtained from the census data, eight variables such as employment status, reasons for not working, educational level, household size, being owner of dwelling, being owner of any other dwelling, age and sex (Table 1) are taken into account as the indicators of social vulnerability.

Calculation of Social Vulnerability

The first step in assessing the social vulnerability is to determine the social vulnerability factors on the basis of an analysis of existing studies and knowledge. Combining the social vulnerability factors is based on the multi-attribute utility theory (MAUT) and accomplished by an additive vulnerability function V:

\[
V = \sum_{i=1}^{m} a_i q_i v(q_i)
\]

where V is the global vulnerability, i.e. the social vulnerability index, m the number of factors, \(a_i\) the relative importance of factor i (\(\sum a_i = 1\)), \(v_i\) the sub-variable function of factor i, the maximum value for each factor is one, and \(q_i\) is the amount of factor i.

The relative importance of the social vulnerability factors are used as coefficients \(a_i\) in the sub variable values. The relative importance of the social vulnerability with respect to each factor is estimated on a ratio scale with a sub-variable value. The sub-variable value depicts the change in social vulnerability as a function of the factor. The sub-variable values scale all factors between 0 and 1, thereby making the objectivities commensurable (the most vulnerable value is always 1, other attribute values getting sub-variables relative to it). Sub-variable values are developed separately for each social vulnerability factor and the total vulnerability index is the weighted sum of the sub-variables. The estimation of the sub-variable values can be based equally on expertise or subjective value information (Table 1). In this study the estimation of the sub-variable values are based on subjective value information and sub-variables of “Not Applicable are not included in the summation. The \(a_i\) coefficients are estimated applying pairwise comparisons (Malczewski, 1998) carried out by experts from different disciplines.
Table 1: Selected Variables for the Study Applications

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Explanation</th>
<th>Sub-variable vulnerability value</th>
</tr>
</thead>
<tbody>
<tr>
<td>EMPSTAT</td>
<td>employment status</td>
<td>0: employee 1: employer 2: self-employed 3: unpaid family worker 9: not applicable</td>
<td>0.2 0.1 0.2 0.3</td>
</tr>
<tr>
<td>WHYNOTWRK</td>
<td>reasons for not working</td>
<td>3: retired 4: student 5: housewife 6: rentier 7: other (including disabled and prisoners) 8: unemployed 9: not applicable</td>
<td>1.0 0.6 1.0 0.4 1.0 1.0</td>
</tr>
<tr>
<td>SCHL</td>
<td>school level completed (educational level)</td>
<td>0: cannot read and write 1: can do but did not complete primary school 2: completed primary 3: completed middle school 5: completed high school 6, 7, 8, 9: completed high school equivalent 10 to 49: completed higher education schools 50 to 94: completed universities</td>
<td>1.0 0.9 0.8 0.6 0.5 0.5 0.4 0.3 0.1</td>
</tr>
<tr>
<td>HHSIZE</td>
<td>household size</td>
<td>no. of people in the household</td>
<td>0.3 0.8</td>
</tr>
<tr>
<td>OWNER</td>
<td>is member of household the owner of the dwelling</td>
<td>owner of the dwelling (1: yes, 2: no)</td>
<td>0.1(yes) 0.8(no)</td>
</tr>
<tr>
<td>OWNANOTHER</td>
<td>is member of household own any other dwelling</td>
<td>owner of any other dwelling (3: yes, 4: no)</td>
<td>0.1(yes) 0.7(no)</td>
</tr>
<tr>
<td>AGE</td>
<td>Age</td>
<td>age of persons in the household 0-6; 7-17; 18-24; 25-36; 37-54; 55-64; 65-99</td>
<td>1.0; 0.9; 0.4; 0.1; 0.2; 0.7; 1.0</td>
</tr>
<tr>
<td>SEX</td>
<td>Sex</td>
<td>sex (1: male, 2: female)</td>
<td>0.3(male) 0.6(female)</td>
</tr>
</tbody>
</table>
10 evaluations are gathered; 2 from inhabitants of Pendik, 3 from assistant mayors of Pendik, and 5 from specialized academicians, on sociology, psychology, urban planning, and civil engineering, of the Middle East Technical University. The relative importance of the factors are computed using eigenvalue method of ratio scale estimation (Saaty, 1977). The social vulnerability levels of Pendik Neighborhoods for 1990 based on authors’ subjectivity and 10 evaluations are depicted in Figure 2.

**Figure 2:** Social vulnerability levels of Pendik Neighborhoods for 1990 a) based on authors’ subjectivity b) based on 10 evaluations

**Explorative Spatial Data Analysis**

Explorative spatial data analysis for social vulnerability involves the exploration of patterns and relationships occurring in space. The spatial pattern of social vulnerability is analyzed by kernel estimation and spatial moving average methods, while the relationships are explored by using Moran’s I statistic. Since the social vulnerability values are aggregated into the aerial units of districts, explorative spatial data analysis starts with the definition of proximity matrices (W). There are several ways of defining W depending on the spatial process at hand (Bailey and Gatrell, 1995). In this study, three different criteria are used to obtain W matrix. The first matrix is based on the criterion of ‘10 nearest neighborhoods from the considered neighborhood’. The values are appointed according to the proximity of 10 neighborhoods for each of the neighborhood from their centroids. The second matrix is formed according to the criterion of ‘neighborhoods within 3 km distance of the considered neighborhood’. The values of this matrix are given, by defining the neighborhoods, which are in the 3 km radius circle from the considered neighborhood’s centroid. This 3 km distance is selected according to the general standards of people’s daily interaction zones for shopping, education and health services. The third matrix is based on the criteria of ‘neighborhoods sharing a common boundary’.

After the proximity matrices are constructed, the first explorative spatial data analysis, Spatial Moving Averages Method, is used as a part of the methodology. The purpose for integrating this method to the methodology is to estimate global variations and trends in the values of social vulnerability over the neighboring areas. In fact, with the Spatial Moving Averages Method, how the mean value ($\mu_i$) of the social vulnerability varies across the study region is calculated and presented. The smoothed estimate of $\mu_i$ is computed by using equation 2.

$$\mu_i = \frac{\sum_{j=1}^{n} w_{ij} y_j}{\sum_{j=1}^{n} w_{ij}}$$  \hspace{0.5cm} (2)

where $w_{ij}$ is the elements of proximity matrix and $y_j$ is the corresponding value of social vulnerability. The smoothed social vulnerability maps by spatial moving average for three different proximity matrices are given in Figures 3-4.
Figure 3: Spatial Moving Averages Method Results a) for the Criteria of ‘10Nearest Neighborhoods’ b) for the Criteria of ‘Neighborhoods within 3 km Distance’

Figure 4: Spatial Moving Averages Method Results for the Criteria of ‘Neighborhoods Sharing a Common Boundary’

For all the three criteria, there is one common result, which is the southwest neighborhoods are generally formed as the most vulnerable part. The least and less vulnerable neighborhoods intensively take part in the north and northwest. Among the three criteria, the second criterion of ‘Neighborhoods within 3 km Distance’ gives the most appropriate results for the further analyses. Since this criterion mainly determines the neighborhoods by their existence in a specific distance.

The global trend in the social vulnerability is also examined by Kernel estimation method, which is originally developed to obtain a smooth estimate of a univariate or multivariate probability density from an observed sample of observations in other words, a smooth histogram, (Bailey and Gatrell, 1995). For a general location in study region (s) and the locations of the n observed events (s₁, …, sₙ) the intensity, \( \lambda(s) \), is estimated by:

\[
\hat{\lambda}(s) = \frac{1}{\hat{\delta}(s)} \sum_{i=1}^{n} \frac{1}{n} k\left(\frac{s - s_i}{\tau}\right)
\]  

(5) where \( k() \) is the kernel, which is a symmetric bivariate probability density function about the origin, which is positive in the bandwidth and determines the amount of smoothing. Since this method needs to be applied in point pattern, for the area data applications the centroids of the areas are considered.

The kernel estimates of the social vulnerability values are indicated in Figure 5.
The spatial trend observed from spatial moving average method is also obtained from Kernel estimation method. As it can be seen from Figure 5, the southwestern part of the study region shows the global concentration of social vulnerability, indicating that this part of the study region contains highly vulnerable groups.

In order to explore the spatial correlation for the social vulnerability Moran’s I statistic is computed for both the study area and its sub-regions, which are obtained by aggregating two (Level 1) and three neighboring areas (Level 2), based on the Equation 6:

$$|I| \leq \sum_{i \neq j} \sum_{i \neq j} \frac{w_{ij}}{\sum_{j=1}^{n} \sum_{i=1}^{n} w_{ij} (y_j - \bar{y})^2} \left( \frac{1}{2} \right)$$

(6)

where $w_{ij}$ is the elements of proximity matrix, $y_j$ is the corresponding value of social vulnerability and $\bar{y}$ is the mean value of the social vulnerability. In the computation of Moran’s I statistic, the proximity matrix constructed based on the criterion of ‘Neighborhoods within 3 km Distance’ is used. For the whole study region Moran’s I value computed as 1, while it is calculated as 0.74 and 0.97 for levels 1 and 2, respectively.

**DISCUSSION OF THE RESULTS**

Social vulnerability levels of Pendik Neighborhoods, obtained from the proposed methodology (Figure 6), indicate that the southwest neighborhoods of the district are the most and highly socially vulnerable for any possible hazard. In addition to that the central part (also the old settlement) of the district is highly vulnerable. The spatial moving averages found based on proximity matrices of “neighborhoods within 3 km distance of the considered neighborhood” was helpful to see the smoother picture of spatial variations than a map of raw data. This result is more reasonable for showing the relationships between neighborhoods.

The kernel estimation method application, which is helpful to get a visual indication of the variation in the intensity of the considered data, is resulted with the most meaningful and usable outputs. This analysis shows that the intensity of social vulnerability locates in the neighborhoods of ‘Orta’, ‘Dumlupınar’, ‘Çınardere’, and ‘Bahçelievler’ (Figure 5).
The last method from explorative spatial data analyses is spatial correlation, which is different from the other mentioned ones, due to its features of exploring the spatial dependence of deviations in attribute values from their mean, and containing the correlation between values of the same variable at different spatial locations. The result of the correlogram, built by ‘Moran’s I’ measure and ‘Neighborhoods within 3km Distance’ proximity matrix, at 3 different levels help to estimate spatial correlation at these levels. In fact, the correlogram indicates that, similar neighborhoods, in terms of their Social Vulnerability Levels, are located in the near areas.

Some additional GIS Analyses are also performed in order to find the explanation of causing reasons of social vulnerability levels in Pendik. 1990 population distribution in Pendik is analyzed with the vulnerability levels and it shows that the most vulnerable neighborhoods are the ones which have the most inhabitants. Contrarily, the least vulnerable neighborhoods are the ones, which are the least crowded neighborhoods. When the total number of buildings distribution is obtained, a positive relationship among the neighborhood’s population, the existent buildings in that neighborhood, and the neighborhood’s social vulnerability levels is seen. In the building usage analyses an opposite relationship is seen between the neighborhood’s social vulnerability level and the number of schools in that neighborhood. Considering the number of the health centers in the neighborhoods, expect 5 neighborhoods, the number of health centers in the neighborhood is obtained as insufficient considering the level of the neighborhood’s social vulnerability level.

CONCLUSIONS

Whatever the size or the type of the natural hazards is, being prepared for them does decrease their destructive effects in the communities. Especially, identification of susceptible people is very important for the pre- and post-disaster interventions. In this respect, the subject of this study is decided as establishing a methodology for identifying the vulnerable groups for any possible hazard, in terms of their social conditions. The developed GIS-based Social Vulnerability Assessment brings easiness on the identification of social vulnerable groups from the complicated approaches. Moreover, the methodology gives a new contribution to the approach of analyzing the social indicators with comparable methods and spatial techniques.

In the calculation of social vulnerability; criterion standardization, weighting and combining are accomplished by means of multi criteria evaluation (MCE) methods. These MCE methods helped in the transformation of social indicators to comparable units, which is very crucial for such social studies. However, the observed applications that use these methods in the literature are generally applied with
measurable indicators (such as, slope, land price, location, etc.). In fact, these evaluation methods may become imperfect for the evaluation of social vulnerability, due to the characteristic of coarse grading. In addition to that, to avoid the subjective decision on these methods in the methodology, 10 more different evaluations are integrated into the case study applications. This integration is very vital for this study, because, the determination of social indicators for the vulnerability analysis is already very hard, in fact, the assessment of social vulnerability by applying comparable methods is much more crucial. In these sensible conditions, the subjectivity on the assessment cannot be acceptable. For these purposes, in the future studies these evaluation methods should be reassessed and more sensitive evaluation approaches for social indicators should be developed.

Figure 6: The flowchart of the methodology
All these social vulnerability level calculations and the integration of 10 different evaluations in Pendik resulted as; the southwest part of the district is very vulnerable for any possible hazard. In the next phase, the explorative spatial data analyses are applied and again showed that the southwest neighborhoods of the district are highly vulnerable and in strong relation to each other. Explorative spatial data analyses helped very much to understand the global trends, which neighborhoods having similar social vulnerability levels locate close to each other, and spatial interactions of the study data.

The supplementary analyses helped to determine the physical effects of basic service locations and transportation opportunities in the study area. In fact, the results showed that, there is a positive relationship among the neighborhood’s population, the existent buildings in that neighborhood, and its social vulnerability level. Besides, basic services (health, education, cultural, social, and sport) and transportation possibilities in the district showed very limited resources to serve its inhabitants for decreasing their vulnerabilities in any possible hazard. Therefore, in order to respond to these concerns, basic services should be improved in that part of the district by the authorities. Although, these mentioned basic analyses are applied in this thesis, more varied analyses should be examined in the future studies by considering a specific hazard (such as; earthquake, flood, etc.). This may also help to understand the physical structure of the considered area for a better planning for that specific hazard.

Moreover, since the methodology has flexibility for any application and hazard, local and central authorities can benefit from this methodology in their disaster management applications. In fact, by knowing the most vulnerable areas, more effective disaster preparedness plans can be undertaken, and better public awareness studies can be developed in these areas. In addition to that, for during- and post-disaster phases, implementation of these preparedness plans can be organized, due to the fact that, scarce resources can be allocated to these most vulnerable areas, considering that the disaster may affect these areas first.

Although this methodology covered some social indicators, due to its availability and overall representation of the study area, the detailed structure of these indicators should be reassessed by the sociologists, for the definition of social vulnerability. Especially, since the concept of social vulnerability is different from poverty and cannot be determined just by economical factors; in the future works the indicators, which will clarify this discrimination, should be examined and determined by the sociologists.

Therefore, whatever the difficulty caused by a hazard, which mankind encounters is, the better preparedness by identifying his/her vulnerability will definitely strengthen his/her capacity to anticipate, cope with, resist and recover from the impacts of that hazard.

**BIBLIOGRAPHY**


International Federation of Red Cross and Red Crescent Societies, 2000 Vulnerability and Capacity Assessment, An International Federation Guide. International Federation of Red Cross and Red Crescent Societies press, USA.


