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Earthquake Hazard in District Ziarat, Baluchistan: Mitigation Measures

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Abstract: The individual citizen's preparedness for the impact and mitigation of potentially catastrophic future earthquakes in Ziarat district will depend on their level of understanding of seismic hazards in the region and the collateral damages. It is based on an adequate program of civil defence which includes the measures that must be taken for the protection of people. Present study aims at suggesting mitigation measures to suggest that the respondents' age, education and occupation are statistically significant with the vulnerability reduction, that is tested on Pearson's Chi-Square test. For this purpose, a sample of 193 households was surveyed from the four union councils of district Ziarat, with a semi-structured questionnaire using the proportional allocation method. It was found that earthquake hazard mitigation measures were significantly affected by people's education level and occupation. A number of measures include the need of taking necessary measures in the study area for all age groups of population. Apart from launching essential education and training, awareness dissemination regarding highly hazardous and vulnerable areas/conditions of households at risk is indispensable.

Keywords: Natural hazards, earthquake, vulnerability, mitigation measures, Balochistan.

Introduction

The risk reduction of natural hazards is a vital challenge. It is acknowledged that disaster-related risks and threats to humans cannot be tackled solely by considering natural hazards. Societies and communities living with changing environmental conditions need to develop resilience by decreasing their susceptibilities to natural hazards (Birkmann et al., 2013).

For over five decades, there has been a drastic rise in losses resulting from natural catastrophes worldwide. There could be several reasons for the sharp increase in the rate of losses, encompassing the unplanned development of the megacities with population of more than two million which are mostly located in zones of high seismic hazards and risks (Smolka et al., 2004). The available literature reveals that the South Asian region turned to be the downtown for natural extreme events such as the floods, cyclones, and specifically, the shocks of high scales (Ainuddin and Routray, 2012; Gupta et al., 2006; James, 2008). The geophysical hazards of the world are giving rise to challenges for human settlements as well as threatening economic activities (Gaillard and Texier, 2010). It may be due to poor construction and implementation of policies, partially because of rapid urbanization that results in earthquake damages (Hossain, 2002).

Nevertheless, natural hazards are believed to be the events that lay adverse effects on vulnerable and physically exposed people that meet the natural hazards (Awal, 2015; Uitto, 1998). The natural hydro- and geo-meteorological hazards like the 2003 Bam earthquake, 2004 Indian Ocean Tsunami, 2005 Kashmir earthquake, 2005 New Orleans Hurricane Katrina and the 2009 Haiti earthquake led the exposed population to bear dramatic life hazards and peoples' property loss worldwide (Haigh and Amaratunga, 2010). At the initial stages, all the natural catastrophes were considered as God's wrath but the strongly believed phenomenon now is ultimately said to be the problem of ill-construction (Gaillard and Texier, 2010; Ainuddin and Routray, 2015). The north, east, northeastern and the western boundaries of the subcontinent of India have regularly been hit by heavy shocks that resulted in several devastations (Bilham and Hough, 2006).

Since 1500s and to date, the earthquake has been the most dangerous and destructive hazard, which is characterized as unpredictable and uncontrollable (Motiram, 2014). Noticeably, research studies on hazards that have caused extreme events leading from life losses to property damages, particularly in underdeveloped states because of the physical nature of settled cities, every second megacity in underdeveloped states is susceptible to hazards. Seventeen out of twenty worlds' mega cities confront natural hazards due to unscientific land use and poor resources (Sami et al., 2009). Moreover, the existing studies lay more emphasis on hazards or peoples' vulnerability to natural hazards, as the equation of any disaster (Disaster = Hazard + People's Vulnerability) refers to coping with both natural hazards and the interaction of individuals susceptibility simultaneously (Cannon, 2000).

Hazards are said to be environmental/natural or sometimes man-made situations that could cause

serious loss to people's lives and their properties. The loss may encompass gashes, mortalities, and also might lead to environmental, economic and social dysfunction. Natural hazards convert into forceful catastrophes when they meet some risk-driven elements. These elements could often be infrastructure, people, services or resources which are prone to a certain level of threats (Kiunsi et al., 2006). It is sometimes stunning to know that communities and governments in some disaster-hit regions were altogether unable to mitigate people's vulnerability that periodically leads to natural disasters (McEntire et al., 2010). It is impossible to build a perfect global scenario of the hazards and natural catastrophes due to their inconsistent risk nature, local situations and varying times. Nonetheless, in the case of third world states, the hazards and natural disasters are appearing more severe and frequent in general. This is somewhat due to poor construction by people and human settlements in disasters prone areas with natural occurrences like floods, hurricanes and tremors (El-Masri and Tipple, 2002). Across the globe between 1980s and 2000, fatalities resulting from only tremors have been estimated at around 158,661.

Disaster or hazard mitigation measures involve the range of pre-planned steps being taken to reduce, avoid, or even eliminate the long-term risk to humans' lives, and their properties from technological or natural hazards (Peduzzi, 2006). Mitigation is a proactive step rather than a reactive measure. Mitigation experts estimate public vulnerability to natural hazards and ensure anticipatory measures to reduce exposures and risks rather than simply waiting for an extreme strike to happen and then toiling to respond (El-Masri and Tipple, 2002).

Materials and Methods

District Ziarat has been selected as the study area because the entrie region is on an active seismic zone and therefore, vulnerable to earthquakes. It is situated 133 kilometres from the capital of Balochistan, Quetta, with (67.7256°) longitude and latitude of (30.3824°). Ziarat has been accepted as a fine resort for holidays due to its unique Juniper forest that is believed to be one of the largest forests in the world, where some of the Juniper trees are said to be more than 5,000 years old. The recent earthquake occurred on 29th October 2008 with a magnitude of 6.4 that claimed to cause unbearable damage in district Ziarat, Pishin and adjacent areas of district Quetta and Zhob. The National Disaster Management Authority (NDMA) recorded about one hundred fifty-five deaths and more than three hundred seventy-five injuries, Media and other sources reported a larger number than three hundred mortalities, around 12,000 individuals were displaced in Ziarat (IASC, 2008).

This particular study was held in district Ziarat for primary data collection while employing a multistage purposive sampling technique. Correspondingly, severely hit 2008 earthquake UCs were opted in the first stage for drawing sample size, following selection of devastated villages in the second stage and lastly utilizing proportional allocation technique for households' selection. The Arkin and Colton's (1963) formula with a 95 per cent of confidence level and with a 7 per cent of error rate was employed for drawing sample size from the population in this study. The total sample size for this study was 193 and was further divided according to proportions on union councils.

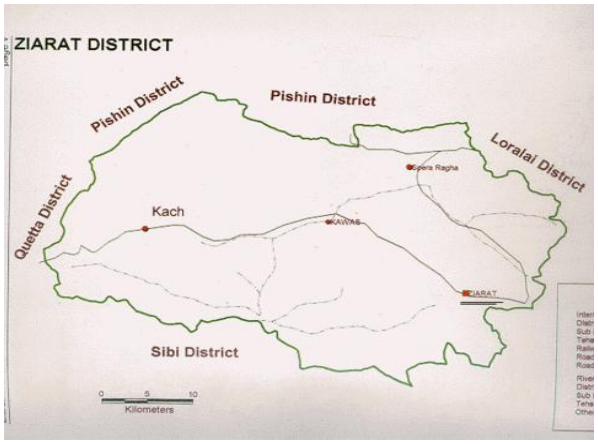


Fig. 1 Study area map.

Results and Discussion

Household Profile of Respondents

Overall, children, women and old people over 60 years of age, people with some impairments or disability, financially dependent members of households and individuals with no resources or assets are believed to be less prepared and more vulnerable to seismic hazards as compared to physically and socio-economically better population. The population of all sampled UCs in terms of the gender is almost the same. (Table 1). A region with a high ratio of female gender may have less mitigation measures knowledge due to their restricted access to information channels and consequently, they cannot generate rational information (Muttarak and Pothisiri, 2012). The ratio of the dependent population i.e. below 15 years and above 60 years of age is 29.72% and 6.73%, respectively. The highest dependency ratio of children is in UC Kawas followed by and Zaranda, Ziarat, and Manna. Another most dependent segment of the population belongs to disabled people whose number is the highest in UC Kawas (about 3%) making it most vulnerable compared to other three UCs.

Moreover, the ratio of unemployment in the study area was much higher than the employment ratio, where more than 96% of the population was unemployed, but almost all the respondents owned houses by inheritance. Almost half of the population owned assets in the form of cash, jewellery, vehicles and shops. This variable has the highest value in UC Manna (65.90%). A nominal number of households (4.14%) received remittances from their relatives. Besides remittances, some 9 per cent of sampled households had taken credits and loans.

Table 1 Profile of respondents.

Variable/ UCs	Kawas	Zarnda	Manna	Ziarat	Combined
	Frequency (%) (n=47)	Frequency (%) (n=51)	Frequency (%) (n=51)	Frequency (%) (n=44)	Frequency (%) (n=193)
Gender					
Male	240 (50.95)	330 (49.62)	295 (48.59)	248 (48.24)	1113 (49.31)
Female	230 (48.83)	336 (50.52)	313 (51.56)	265 (51.55)	1144 (50.68)
Dependency ratio					
Age below 15 Years	153 (32.48)	204 (30.67)	168 (27.67)	146 (28.40)	671 (29.72)
Age below 60 Years	19 (4.03)	56 (8.42)	40 (6.58)	37 (7.19)	152 (6.73)
Population with any disabilities					
Disabled	13 (2.76)	8 (1.20)	7 (1.15)	7 (1.36)	35 (1.55)
Employment status					
Employed	29 (6.15)	23 (3.45)	9 (1.48)	18 (3.50)	79 (3.51)
Unemployed	442 (93.84)	642 (96.54)	598 (98.51)	496 (96.49)	2178 (96.49)
House ownership and assets					
Ownership	45 (95.74)	48 (94.11)	51 (100)	42 (95.45)	186 (96.37)
Own Assets	29 (61.70)	18 (35.29)	16 (31.37)	29 (65.90)	92 (47.66)
Population Receiving Remittances					
Receiving Remittances	2 (4.25)	3 (5.88)	1 (1.96)	2 (4.54)	8 (4.14)
Credit/Loan accessibility					
Taken Credit/Loan	12 (25.53)	4 (7.84)	0 (0.00)	1 (2.27)	17 (8.80)

Note: *The figures in parenthesis are percentages.*

Remedial Measures

Some questions concerning seismic hazard remedial measures were incorporated within the questionnaire, after an extensive review of the literature. The questions were implied to evaluate whether people of the study area take safety measures after encountering the fatal earthquake of 2008 to circumvent future property and human losses. The questions were meant to assess respondents' preparedness for any future earthquake and to circumvent lethal damages, their awareness level and their action to reduce seismic hazards. For understanding preparedness, their level and awareness concerning vulnerability to earthquake hazard, the positive response with 'Yes' answers are displayed in Table 7.

Table 2 Association of education and vulnerability mitigation.

Education of Respondents	watching out for broken gas lines and fallen electric power lines	
	Yes	No
Middle	48	18
Intermediate	30	04
Higher	14	13
Illiterate	44	22
Total	136	57
Chi-Square	8.998**	

** Significance at 0.05 level

Table 3 Association of education and vulnerability mitigation.

Education of the Respondents	expect and foresee aftershock	
	Yes	No
Middle	48	18
Intermediate	15	19
Higher	16	11
Illiterate	40	26
Total	119	74
Pearson Chi-Square	7.942**	

** Significance at 0.05 level

Additionally, the table 7 depicts that 60 per cent of the respondents in surveyed UCs checkup TV, radio, social media, and online updates for emergency information also try provision of protective measures, which indicates a healthy signal regarding to earthquake hazard mitigation measures. About more than two-thirds of the respondents watch out for broken gas lines or fallen electric power lines and keep their distance from partially damaged buildings. This shows that the people of Ziarat are aware of intangible shocks of the earthquake and that they are living in a seismic zone. About two-fifths of the interviewees reported that they foresee aftershocks of an earthquake when earth-shaking lasts longer than usual, while about two-thirds of them answered that when residents of the affected area are asked to evacuate then they leave a note about their place of destination.

Almost 90 per cent of the respondents within the UCs declared that they repair pillars, profound breaks in the ceiling, and columns of their damaged houses after consulting with an expert. By following several ways of personal defensive and protective steps, the populace of the area tries to mitigate earthquake hazards to a greater degree. More than 86 per cent of the surveyed respondents added that they move away from hilly slopes so that there would be danger of falling rocks and landslides after massive earthquake shocks. Nearly all the respondents added that they get out of their houses and agreed on staying away from glass windows in case of seismic shocks which is a healthy sign of reducing vulnerability. Almost three-quarters of the respondents nodded in the affirmation that they know well about seismic zonation in the area they live in; thus, they get their home furnished and retrofit to bear with future earthquakes. Despite encountering damages from the 2008 earthquake, still the least number of respondents (little more than one-third) reported that they are equipped with an emergency kit containing all essential items including medicine and first-aid accessories and have placed it in a safe and accessible place.

Table 4. Association of occupation and vulnerability mitigation measures.

Occupation of the Respondents	Having awareness of seismic zonation of the area and getting house evaluated for retrofitting	
	Yes	No
Student	69	44
Business	06	01
Agriculture	26	06
Govt. servant	37	04
Total	138	55
Chi-Square	17.425***	

*** Significance at 0.01 level

Table 5. Association of occupation and vulnerability mitigation measures.

Occupation of the Respondents	Preparing emergency kit containing necessary items	
	Yes	No
Student	30	83
Business	3	4
Agriculture	14	18
Govt. Employed	22	19
Total	69	124
Chi-Square	10.935**	

** Significance at 0.05 level

Factors Associated to Mitigation Measures

Furthermore, some hypotheses were also tested that whether factors like respondents' occupation, age and education are statistically associated with their vulnerability mitigation measures. These hypotheses were tested by Chi-square test of the association at 1%, 5% and 10% levels of significance. The results elucidated that formal education is a key factor in awareness development and trickling information on seismic hazards. It plays a vital and decisive role in the decision making whether at the household level or community level. The researchers also believe that formal and disaster education develops awareness in people about enhancing disaster preparedness and provokes right decision makings (Shaw et al., 2004; Muttarak and Pothisiri, 2012). Our results of hypothesis in table 2 and table 3 confirm the findings with a significant Pearson Chi-Square value of 8.99 (p-value< 0.05) for education and vulnerability mitigation measures. The finding reveals that literate respondents were more careful about watching out for broken gas lines and fallen electric power lines. The educated ones also keep adequate distance from partially damaged buildings as they foresee aftershocks of an earthquake. Hence, our research hypothesis stated earlier is accepted and we can conclude that literacy level does affect earthquake hazard mitigation measures.

Table 6. Association of age and vulnerability Mitigation Measures.

Respondents' age group	Entering in partially damaged buildings even if there is the chance of aftershocks	
	Yes	No
16-30	23	69
31-50	17	66
51-68	02	16
Total	42	151
Chi-Square	5.364*	

* Significance at 0.10 level

It is additionally accepted that other than the literacy level of an individual, the occupation of a person also plays an important role in earthquake preparedness measures and choice-making for the welfare of household and community (Muttarak and Pothisiri, 2012). For this purpose, was tested the hypothesis that whether there is an association between the profession of an individual and their mitigation measures to earthquake hazards for whichPearson Chi-Square test was applied (Table 4,5). The results supported the research hypothesis and concluded a significant association (Chi-square= 17.43, p-value< 0.01) between occupation and knowledge of the vulnerability.

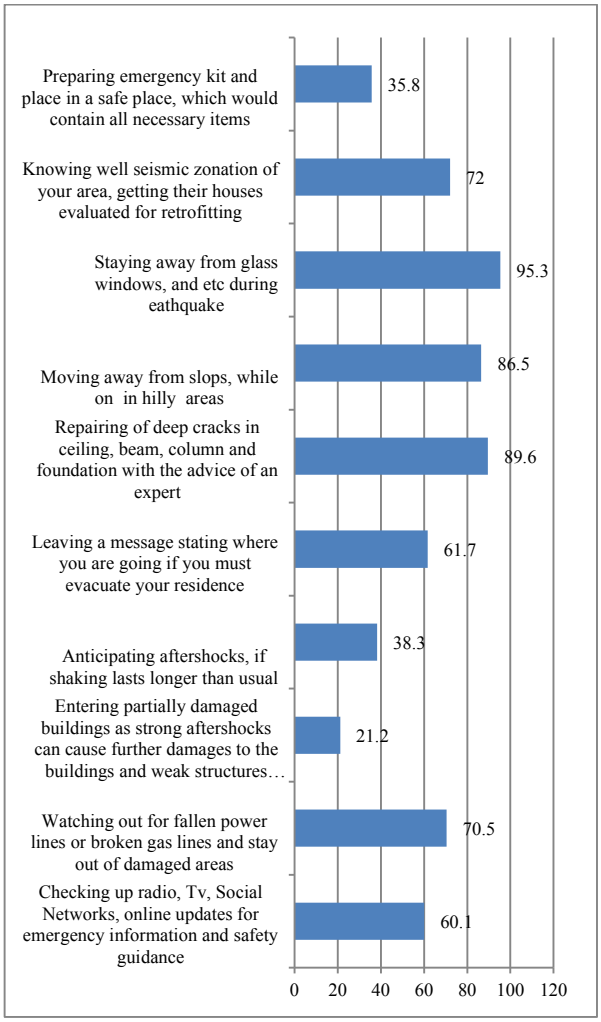
At the same time, the age of an individual also plays a vital role in mitigating vulnerability by taking effective and precautionary decision making for his household and community at the time of any disaster. This statement was tested by applying the Pearson Chi-Square test (Table 6). The results supported the research hypothesis and concluded a significant association (Chi-square = 5.363, p-value < 0.10) between age and knowledge of the vulnerability. These findings are plausible and are in line with that of Mishra and Suar (2005), who argue that the higher the age, the greater would be the level of disaster preparedness. It is aligned with the fact that perception of risk varies and preparedness enhances considerably with past disaster experiences.

Conclusion

It is concluded that in the context of the higher education level of individuals, households happen to own strong cognitive abilities, learning skills and information in responding rationally to hard times and households with high education are better prepared for mitigating the impact of earthquake hazards and risks. Moreover, the experience of the earthquake (proxied by age) and better profession equip an individual to explore better economic opportunities to undertake efficient hazard-minimizing measures. However, based on the findings it is suggested that the people of the study areas should be given necessary social and economic support for appropriate preparations and training. Disasters related education enables an individual to perceive the process of assessing hazard and mitigating it. Besides initiating

essential training programs, the spread of awareness and education regarding high seismic areas and highly vulnerable situations of households is indispensable.

Table 7. Percent of Population Taking Mitigation Measures.



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