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Revealing Households' Vulnerability to Earthquake in District Ziarat, Balochistan

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Abstract

In the recent decades, natural disasters research has received considerable attention to the multifaceted vulnerability assessment, for which a number of scholars have proposed various approaches in order to measure vulnerability of any area. However, the objective of this study is to assess earthquake vulnerability in its four dimensions, social, economic, physical and institutional at the households' level in district Ziarat, Balochistan. For which a sample of 193 households were surveyed using proportional allocation method. The paper illustrates the concept of vulnerability, its components along with their indicators and assessment by employing subjective weighting technique; and eventually developing each indicator's vulnerability factor and component composite index. The overall aggregate vulnerability index revealed that there is not much difference in level of vulnerability among the four union councils in all dimensions. Nevertheless, union council Manna was more vulnerable in context of social and economic vulnerability, Union council Zaranda was more vulnerable in terms of physical vulnerability and Union council Ziarat's vulnerability level was the highest in context of institutional vulnerability. Based on achieved results, it is suggested that the populations of the four Union Councils should be given variousnecessary social and economy generating preparations and trainings. Besides initiating essential training programs, spread of awareness and education regarding high seismic areas and high vulnerable situation of households is indispensable.

Keywords: Vulnerability, Earthquake vulnerability Assessment, Vulnerability Dimensions Subjective weighting technique, Ziarat.

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Introduction

The catastrophic tragedies of Northridge (US, California) earthquake 1994, resulting in US$14 billion, Kobe (Japan) earthquake 1995, resulting in US$ 150 billion, Kocaeli (Turkey) earthquake 1999 and 2004, 2005 tsunami, Hurricane Katrina and the earthquake of South Asia seemed to be a wake-up call for Social Scientists, Engineers, and for management Scientists to realize the impact of prevailing disasters (JörnBirkmann, 2006; Calvi et al., 2006). It is roughly calculated in the last decade, the number of affected people is greater than 3 billion, and approximately 750,000 lost their lives, which nearly cost higher amount than US$600 billion (Mayunga, 2007). The 1662 Beinjing earthquake accounted for 300,000 lives (Roger Bilham, 2009). The natural hazard like earthquakes, typhoons, debris flow and their far reaching effects have proven to be the most devastating and lethal, because of their unforeseeable nature. And there have been 1.4 million and more earthquakes on the planet per year, and around four thousands per day. Since the 1990s the earthquake alone claims taking lives of 27,000 people per year worldwide (Guha-Sapir &Vos, 2011). However, natural hazard is said to be a disaster either it lays impact on exposed and vulnerable population or unsafe conditions and physical exposures meet hazards (Awal, 2015; Uitto, 1998). The policy makers and emergency arrangements continuously facing challenges of a series of natural disasters founded by millennium, which have given raise to level of uncertainty, natural geo- and hydro-metrological hazards, such as; Kashmir earthquake (2005), Bam earthquake (2003), Indian Ocean tsunami (2005), Hurricane Katrina in New Orleans (2005) and Haiti Earthquake (2009) have led the vulnerable population, communities as well as, societies to greater losses of lives and properties across the globe (Haigh&Amaratunga, 2010). All the natural disasters at the beginning were considered as the wrath of God but now ultimately they are believed to be the ill-development problems (Ainuddin, Mukhtar, & Ainuddin, 2014; Gaillard & Texier, 2010). The West, North, Northeast, and Eastern boundaries of Indian subcontinent have continually been hit by mighty earthquakes that have led a series of damages (Bilham & Hough, 2006).

Likewise, Pakistan is located at the edge of Indian plate on west, meeting with Eurasian Plate on North and West and with Arabian Plate on

the Southwest (Ainuddin, Mukhtar, &Ainuddin, 2014; Roger Bilham& Hough, 2006; Halvorson & Hamilton, 2007). The Northern parts of Pakistan and the southwestern as well as northern areas of Province Baluchistan (Pakistan) are highly vulnerable to seismic waves called earthquakes(PMD, 2007). Since the last century, Pakistan has confronted a number of deadliest earthquakes of different magnitudes. The Quetta city of Balochistan Province in 1935 experienced an earthquake with 7.5 magnitude leaving 30,000 fatalities alone (Rehman, Lindholm, Ahmed, & Rafi, 2014). The 1945 earthquake of Makran Coast magnitude of 8.0 resulting 4,000 lives, the 6.2 magnitude earthquake of northern Pakistan 1974 causing 5,300 death tolls, and the 2005 earthquake of Pakistan 7.6 magnitude claiming 5,300 deaths (Mahmood& Ingham, 2011). In addition, comprehending factors contributing to huge losses from disasters and the occurrence of ruinous disasters are not only the natural events but also the separation of natural environment from political, economic, and social framework, as these frameworks structure livings and lives of people of different countries, communities, and societies (Blaikie, Cannon, Davis, & Wisner, 2014).

The literature reveals that Asia, in terms of both historically and contemporary is placed on top in context of effects of disasters, in the world disaster map. (Uitto, 1998). On account of its high density of population, distribution of population, poverty and variety of other natural factors contribute to generate situations of seasonal and persistent tragedies. For better understanding situation of that ilk it is worth probing the recent record and vulnerability of disaster of that particular region in Asian countries (Alexander, 2000). High intensity shocks of earthquake 6.5 Mb occurred in Chiltan Hills of Balochistan, Pakistan on 29th October, 2008. The shocks epicenters were around 60 km North and Northwest of Quetta and its tremors were recorded in some areas of Balochistan including adjacent areas of Province Sindh. Besides this, on 29th October a huge number of low intensity shocks were also recorded, and no rupture was documented on the surface of land; only few cracks were found on the ground. The mechanism of earthquake was noticed to be strike-slip. The inside earth rupture due to earthquakes indicates the trend that the obscured fault's direction is towards Southeast and Northwest (Rafi & Ahmed, 2008). However, in the context of Pakistan, there has been much work done on different disaster events particularly on earthquake hazard and vulnerability in Balochistan, Pakistan. Such researchers as; Ainuddin and Routray (2011), But these all work

focusing on urban areas of Balochistan. There is not a single work carried out in the rural area of Balochistan, district Ziarat.

1.1 Assessment of Vulnerability

Disasters and their risk reduction have turned to be a focal point for development community and humanitarians worldwide. Natural disasters have nearly affected every country of the world but most of damages and losses of lives caused by natural disasters are in third world countries. Therefore, the twentieth century was declared to be the "International Decade for Natural Disaster Reduction (IDNDR)" by the United States (UN). The disaster management community laid emphases on vulnerability and research of disaster management shifted from "hazard assessment" to "vulnerability assessment/analysis" in the last decade (Schneiderbauer& Ehrlich, 2006). The growing interest has not only limited to comprehending the natural hazards and their occurrences but also the areas that are prone to natural phenomena and their characteristics have shifted the attention of several scientists of social sciences towards the study of vulnerability and risk e.g., (Albala-Bertrand, 1993; T Cannon, 1993).

There are various schools of thoughts, views, models and concepts on vulnerability systematization in the disaster literature. However, fundamental discrepancy on conceptualizing vulnerability is either to lay focus on technological/biophysical risks and their exposure, the probability of strained social conditions or the amalgamation of the both. The different concepts about measurement of vulnerability resulted confused approach towards understanding and measuring vulnerability to environmental hazards and disasters. At this situation vulnerability may be formed in three distinguishing themes (Cutter, 1996; Dow, 1992). The first theme in the literature emphasis on technological/biophysical hazards, their exposure, sources, occurrences, hazardous condition distribution, and settling on hazardous zones (Ambraseys & Jackson, 1981; Gabor & Pelanda, 1982). The second research theme in the existing literature examines coping capacity, resistance, and resilience level of society to natural hazards and highlighting vulnerability as a social phenomenon which is entrenched in historical background, cultural, economic and social processes (Cutter, 1996; Yarnal, 1994). The third emerging theme focuses on the convergence of the two aforementioned perspectives (the technological/biophysical risks and social response) but relating to a specific geographical area where people as well

as places are vulnerable (Ainuddin&Routray, 2011; Degg, 1993; Longhurst, 1995). Above all, vulnerability models and conceptual frameworks are key steps towards developing indicators for measuring vulnerability (T. Downing, 2004).

2 Study Area and Methodology

2.1 Selection of Study Area

District Ziarat was chosen as the targeted area for this study, which is located 133 km from the capital city Quetta, with latitude of 30° 22' 56.8" and 67° 43' 32.2" longitude, and is believed as a resort amidst for holidays because of one of the largest forests of Juniper in the world, where some of the Juniper trees are said to be more than 5,000 years old. However,the recent earthquake of 6.4 magnitude that occurred on 29th October, 2008 which caused a big loss in Ziarat, Pishin as well as some area of Quetta and Zhob districts of Balochistan, Pakistan. The National Disaster Management Authority (NDMA) reported around 155 fatalities and more than 375 injuries, media reported higher number than 300 deaths, about 12,000 people were displaced in Ziarat (Balochistan Earthquake Response Plan 2008), hasmade the area an appropriate site for this study.

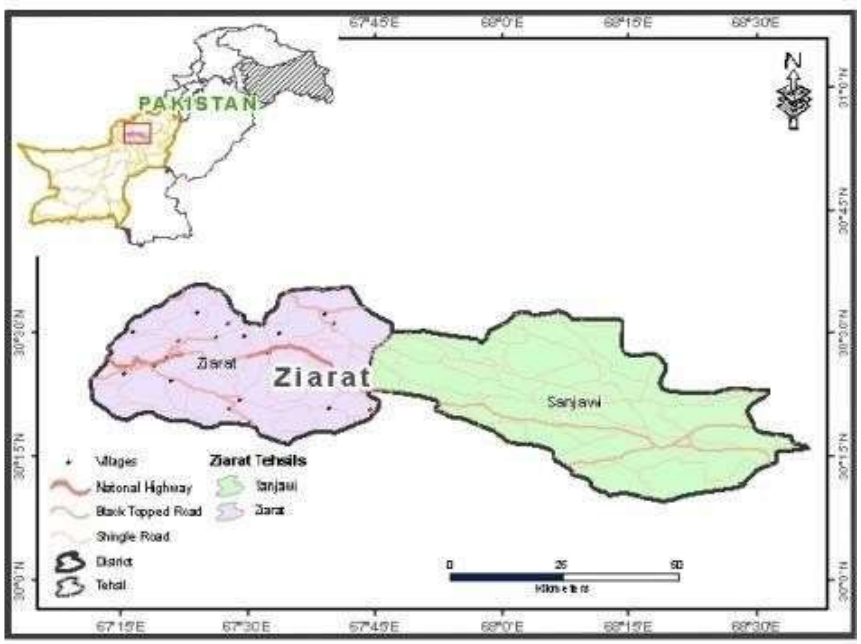

Figure 1: Map of the Study Area

2.2 Sample Size and Data Collection

The accomplishment of this researchobjective was made possible through relying on primary and secondary data with a fundamental deductive method using mix quantitative and qualitative approaches with an exploratory nature. The primary data was collected via structured questionnaires survey of 193 households'respondents and the secondary data was gathered from Balochistan Bureau of Statistics and Ziarat district profile 2011. Moreover, sample size was drawn using multistage random sampling method. Arkin and Colton's formula (1963) given below with a confidence level of 95 percent and an error rate of 7% was employed for drawing sample size from the population in this study. The sample size was further proportionally divided on four Union Councils of the district.

$$n = \frac{NZ^2P(1-P)}{Ne^2+Z^2P(1-P)} \qquad \text{(Equation 1)}$$

Where n = Sample Size
N = Population Size
Z = Confidence Level (95%=1.96)
P = Degree of Variability (50%)
E = Sampling Error (±0.07%)
Questionnaires were filled by different age groups including literates, illiterates, employees, farmers, shopkeepers, school and college teachers and students. The data is analyzed byStatistical Package for Social Sciences (SPSS).

2.3 Analytical Tools

For the achievement of the study objective through formulation of indicators is expressed through vulnerability factor index, however, each indicator was analyzed separately with a different mathematical formula.
For instance, indicators that have positive effect on earthquake hazard vulnerability are assessed with below mentioned formula.
Vulnerability Factor Index (VFI) of ith indicator = *(% value of ith indicator (actual) ÷(% value taken as the level of the vulnerability of the ith indicator).*

And, indicators that have negative effect on earthquake hazard vulnerability are assessed with this formula.

Vulnerability Factor Index (VFI) of ith indicator = *(% value taken as the level of vulnerability of the ith indicator ÷(% value of the ith indicator (actual).*

Furthermore, the quantitative and qualitative data which was acquired from primary and secondary means was analyzed through various statistical tools, by using SPSS (Special Package for Social Sciences) software.

Additionally, this study was based on (Blaikie, Cannon, Davis, & Wisner, 2014) crunch model, which takes disaster as combination of two factors: those natural happenings that generate vulnerability and the hazardous natural phenomena. The PAR (Pressure and Release) framework (Crunch Model) frequently uses the equation:

Risk = Hazard * Vulnerability.

Based on the above equation the assessment of vulnerability involves main three level of categories: underlying/deep rooted causes, which can be featured as basic and important factors of any community/society that forms vulnerability, this can be less or no access to resources and power and also takes in demographic, economic, political and nature of governance that disseminates resources and power in any society/community. The second level dynamic/variable pressures include all those activities that transform the root causes into unsafe conditions. And the third category unsafe conditions encompass physical environment, local economy, social relations and public actions and infrastructures of any community or society(Birkmann, 2006).

2.4 Selection of Vulnerability Variables and Indicators

The concept of vulnerability is termed multifaceted and therefore is divided into many contributing components. This paper attempts to reveal an extensive literature based factors of earthquake vulnerability, which are ecological, social, economic, physical, and institutional. It is nearly impossible to assess earthquake vulnerability thoroughly. However, based on secondary data each component has different variables (Table 1) with a set of defined indicators which include social indicators, economic, physical and institutional ones relating to earthquake hazards.

Table 1:Selection of Variables and Indicators for Earthquake Vulnerability Assessment

Component/ Variable	Indicator	Explanation	Impact on Vulnerability	Optimum Values
Social Vulnerability				
Age	Percent of population below 15 and above 60 years (S. Ainuddin & J. K. Routray, 2012; Cutter, Boruff, & Shirley, 2003; Cutter, Burton, & Emrich, 2010)	Extremes of age, too old or too young face mobility constraints during or aftermath of earthquakes	Positive	<15 20% >60 15%
Educational Level	Percent of people with college education. Percent of people with no high school degree/no education (S. Ainuddin & J. K. Routray, 2012; Cutter, 2003; Cutter et al., 2010)	The higher educational level is, the better understanding level will be, resulting in greater access to evacuation and decision taking. The lower educational level is, the worse will be the ability to understand warning information and access to evacuation and decision making	Negative Positive	60%
Disability	Percent of population without special physical or mental disabilities (S. Ainuddin & J. K. Routray, 2012; Ainuddin, Routray, & Ainuddin, 2015; Cutter et al., 2010)	Handicapped Men, Women and Children physically or mentally contribute to evacuation problems during emergencies	Positive	75%
Communication capacity	Percent of people communicating/ having phones (Colten, Kates, & Laska, 2008; Cutter et al., 2010)	Higher the phone users, lower is the communication gap among people during earthquakes and emergency evacuation	Negative	50%
Economic Vulnerability				
Employment	Percent of population employed (S. Ainuddin & J. K. Routray, 2012;	Employment helps in subsiding level of vulnerability of	Negative	50%

	Ainuddin et al., 2015; Cutter et al., 2008; Cutter et al., 2010)	community and households as well as contributes to community capital		
Poverty Level	Percent of People above poverty line (S. Ainuddin & J. K. Routray, 2012; Cutter, Mitchell, & Scott, 2000)	Population livingabovepoverty line has moreability to absorb losses and enhance resilience to earthquake hazards. Wealth enables communities and people to absorb and recover from losses more quickly especially in the aftermath of earthquake	Negative	90%
Income sources	Percent of Households with diversified sources of income (S. Ainuddin & J. K. Routray, 2012; Ainuddin et al., 2015; Norris, Stevens, Pfefferbaum, Wyche, & Pfefferbaum, 2008)	Households with multiple sources of income provide alternatives and help better in community rehabilitation and recovery from earthquakes impacts	Negative	50%
House Ownership	Percent of people owing houses (S. Ainuddin & J. K. Routray, 2012; Ainuddin et al., 2015; Cutter et al., 2003; Cutter et al., 2010; Norris et al., 2008)	Higher the level of ownership of the houses is, better will be the quality and maintenance of the houses.	Negative	60%
Physical Vulnerability				
Location of household	Percent of houses located less than 1km from Mountains or atthe foot. Percent of houses in periphery of the city (Ainuddin et al., 2015; Taubenböck et al., 2008)	In terms of distance of houses/ population reflects the potential losses and effects on recover if strikes by earthquakes. Less distance from mountains provide less vacant places around	Positive Negative	40%
Age of Houses	Percent of houses following buildingcodes orabove of 30 years (S. Ainuddin & J. K. Routray, 2012; Cutter et al., 2010)	After 1935 Earthquake in Balochistan, Pakistan, building codes were introduced for the first time. Houses constructed before	Negative	10%

		1938 may be more vulnerable to earthquake shocks		
Shelter Capacity	Percent of vacant rental houses/open places (S. Ainuddin & J. K. Routray, 2012; Cutter et al., 2010)	Vacant rental housings/open places can provide shelter to people victimized during or in the aftermath of earthquake	Negative	40%
Institutional Vulnerability				
Mitigation	Percent of population covered by a recent hazard mitigation plan (S. Ainuddin & J. K. Routray, 2012; Cutter et al., 2010)	Increase community safety and facilitate to develop and Implement disaster risk reduction strategy at community level. Reduces high probability of losses from disasters.	Negative	50%
Public Awareness	Percent of population with earthquake education (mock drills and programs) (S. Ainuddin & J. K. Routray, 2012)	Enhance public awareness knowledge, skills of the community for safety measures, preventive issues, and lifesaving information	Negative	60%
Services of Municipals	Percent of municipal expenditures for fire and Emergency management system and medical services (S. Ainuddin & J. K. Routray, 2012; Ainuddin et al., 2015; Cutter et al., 2010)	Strongly supports during search and rescue and emergency situation following an earthquake emergency	Negative	50%
Volunteer Groups	Percent Volunteer Groups/Population helping during and after disasters(S. Ainuddin & J. Routray, 2012)	People working voluntarily during or after any disaster commonly reduces communities' vulnerability to natural disasters	Negative	50%

The first subcomponent of the earthquake vulnerability is the social vulnerability, which illustrates various social vulnerabilities of a household/community to cope with the impacts of earthquake hazards. These social vulnerabilities are expressed via demographics of the

households/community and socioeconomic attributes of the community. The second subcomponent of earthquake vulnerability is the economic vulnerability of the households. The economic vulnerability is thoroughly depended on the economic status households.The third subcomponent of earthquake vulnerability is the households' physical vulnerability in terms of households' site, material used in construction of the household, age of the household and distance from the mountains.The fourth subcomponent is institutional one which includes providence of institutions services in terms of mock drills, spreading awareness relating specific natural disaster like earthquake, mitigation plans and trainings.

Furthermore, each indicator's value is presented in percentage to avoid statistical errors and all indicators are assigned percentage of optimum value for compiling vulnerability factor index and composite vulnerability factor index. The optimum values of indicators vary from indicator to indicator (S. Ainuddin & J. K. Routray, 2012) and can be mathematically calculated as:

Vulnerability factor index of any component is calculated as the average value of vulnerability index of all variables under that taken component.

$$Component\ Vulnerability\ Index\ (CVI) = \sum_{i=1}^{n} \mathrm{VFI/n}$$

Whereas, *n* is the total number of indicators of the taken component.

Likewise, the aggregate of vulnerability index is computed as the average value of all components. It is presented as:

$$Aggregate\ Vulnerability\ Index\ for\ the\ Union\ Councils\ (AVI) = \sum_{i=1}^{4} \mathrm{CVFI/N}$$

Whereas, *N* is the total number of the taken components

The study areas' vulnerability to earthquake is measured via four components of vulnerability such as social component, economic component, physical component and institutional component with carefully selected indicators of each component as discussed with details in table 1, and each component contributes to the households' vulnerability of earthquake separately. All four components cover area of independent domain and their indicator are measured with the above mentioned positive and negative formulas.

3 Results and Discussion

3.1 Respondents' Demographic Profile

Table 2 represents the respondents' demographic profile by union council. However, the study has illustrated the overall percentage of the four union councils, which is highly skewed towards the male respondents due to two main factors, first one is; the male dominated society and second is female are seldom allowed to come to the forefront because of traditional values. The marital status of the respondents was found slightly above than half married and less than half unmarried. Moreover, the percentage of respondents' education was varying from primary to higher level. Little more than one-fifth of respondents were illiterate, and about same proportion had bachelor and master degree each, while respondents with primary education were only 7.3%.The ratio of disabilities in the surveyed house holds was 13.5%. The table 2 further depicts occupation of the sampled respondents in terms of percentage. The respondents figured 28.0% students, 29.0% businessmen, 16.6% employed, 21.2% from agriculture field, 1.6% unemployed, and 3.6% private employed.

In terms of vulnerability to earthquake impacts, generally women, children less than 15 years of age, elderly people above 60, disabled people, economic dependent (unemployed) and those having no assets, in other word destitute population of a community/society, are considered more vulnerable compare to physically, socially, economically sound population of the area (S. Ainuddin & J. K. Routray, 2012; Cutter, 1996). The overall gender ratioof population is a bit skewed towards the females, who are generally believed to be the vulnerable population to earthquakes. The age groups below 15 years of age of the four sampled union councils are reported to have slight variations in their percentages but overall one third of the population was below 15 years of age and the age group above 60 years is computed as only 6.73% in the four Unions. Another dependent group is the disabled population, which isonly a few numbers of people in the four Union councils. The average household size (table 3)in the four Union Councils is 11.69 members.The average age of the houses was around 14 years old in Kawas, 13 year in Zaranda, 12.41 years in Manna, 12 in Ziarat and the overall average age of the four Union councils was 14 years of old.

Table 2: Respondents' Demographic Profile of Each Union Council

	Variable	UC Kawas	UC Zarnda	UC Manna	UC Ziarat	All UCs
		Frequency (%) (n=47)	Frequency (%) (n=51)	Frequency (%) (n=51)	Frequency (%) (n=44)	Overall Frequency of the four UCs (%) (n=193)
Gender	Male	44 (93.6)	51 (100.0)	51 (100.0)	44 (100.0)	190 (98.4)
	Female	3 (6.4)	0 (0.00)	0 (0.00)	0 (0.00)	3 (1.6)
Marital status	Married	31 (66)	29 (56.9)	32 (62.7)	26 (59.1)	118 (61.1)
	Unmarried	16 (34)	22 (43.1)	19 (37.3)	18 (40.9)	75 (38.9)
Education	Primary	2 (4.3)	6 (11.8)	4 (7.8)	2 (4.5)	14(7.3)
	Middle	2 (4.3)	5 (9.8)	2 (3.9)	4 (9.1)	13(6.7)
	Matric	10 (21.3)	5 (9.8)	5 (9.8)	6 (13.6)	26(13.5)
	Intermediate	9 (19.1)	7 (13.7)	2 (3.9)	3 (6.8)	21(10.9)
	Bachelor	13 (27.7)	10 (19.6)	11 (21.6)	6 (13.6)	40(20.7)
	Master	9 (19.1)	8 (15.7	9 (17.6)	9 (20.5)	35(18.1)
	M.phil	0 (0.00)	0 (0.00)	0 (0.00)	1 (2.3)	1 (0.5)
	Madrasa	0 (0.00)	1 (2.0)	0 (0.00)	0 (0.00)	1 (0.5)
	Illiterate	2 (4.3)	9 (17.6)	18 (35.3)	13 (29.5)	42(21.8)
Occupation	Student	14 (29.8)	11 (21.6)	14 (27.5)	15 (34.1)	54 (28.0)
	Businessmen	13 (27.7)	16 (31.4)	21 (41.2)	6 (13.6)	56 (29.0)
	Agriculture	13 (27.7)	10 (19.6)	12 (23.5)	15 (34.1)	50 (21.2)
	Employed	4 (8.5)	10 (19.6)	2 (3.9)	7 (15.9)	23 (16.6)
	Unemployed	2 (4.3)	1 (2.0)	0 (0.00)	0 (0.00)	3 (1.6)
	Private Employed	1 (2.1)	3 (5.9)	2 (3.9)	1 (2.3)	7 (3.6)

3.2 Respondents' Economic Profile

The households' respondents'economic condition and average age varied from union to union and the respondents' ageranged from minimum 16 years to maximum age 68 years, depicted in Table 3. Therefore, the average age structure of the randomly sampled respondents in Union Kawas was 37.40, 33 in Zaranda, 31.08 in Manna, 34.16 in Ziarat Union and the

overall four Union Council average ages of the respondents was 33.82 in terms of years. The average income in terms of Pakistani Rupees of the households also differed from area to area and also on the remittances that some of the households receive on the behalf of their relatives living abroad. However, in the Union Council Kawas the average income of per household monthly was Rs: 59070.91, Rs: 37666.67 in Zaranda, Rs: 48382.35 in Manna, 46522.73 in Ziarat and the overall mean income of the four sampled Union Councils was Rs/47729.70.

Table 3: Respondents' Economic Profile

Variable	UC Kawas	UC Zarnda	UC Manna	UC Ziarat	All UCs	F ratio
	Mean (n=47)	Mean (n=51)	Mean (n=51)	Mean (n=44)	Overall Mean of the four UCs (n=193)	F-ratio for Compariso n of means
Average Age of the Respondents	37.40	32.96	31.08	34.16	33.82	2.84**
Average Household Size	10.02	13.04	11.90	11.08	11.69	2.27*
Average Monthly Income of the Households (Rupees)	59070.91	37666.67	48382.35	46522.73	47729.70	4.80***
Average Monthly Expenditure of the Households (Rupees)	51581.55	38568.63	42882.35	45318.18	44416.23	2.05
Average House age	13.96	13.00	12.41	11.68	13.91	2.65*

Source: Author's Calculation. The superscripts *, ** and *** shows significance at 10%, 5% and 1% respectively.

3.3 Respondents' Family Occupation

The households' family occupation also differed from house to house as shown in Figure 1 which states comparison of the three categories of family occupation in each Union Council. The percentage of agriculture occupation in the all union councils is at the peak out of which in UC Ziarat the percentage is leading due to less migration from the area after 2008

earthquake compare to UC Kawas, Zaranda and Manna where several households migrated toward cities for new settlements and other occupations are less comparatively. Moreover, the Unemployment ratio is far much greater than employment ratio in all for union councils, the overall employment and unemployed percentage of the four union councils is 3.51%, Unemployed 96.49% with household ownership which is 96.37%. Among whom 47.66%possess assets and only few households receive remittances. Apart from receiving remittances many of the households have taken credit/lone also.

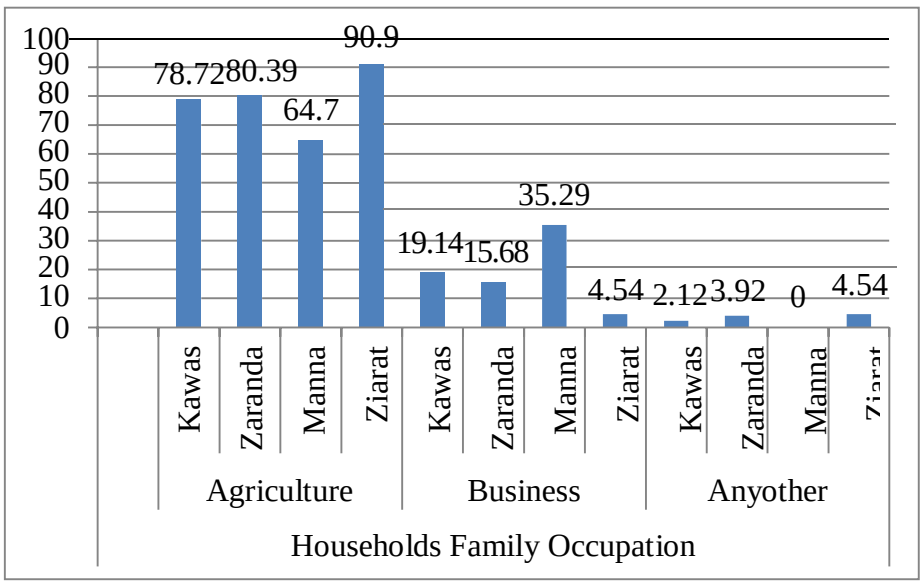

Figure1: Households' Family Occupation

3.4 Households' Locationand Community trust and awareness

The following Table 4 describes the sampled households' location, distance from mountains, open areas near houses for evacuation at the time of emergency, community meetings about earthquake disasters, community programs spreading awareness regarding earthquake vulnerability. All four sampled union council's respondents' answers are expressed in percentage in parenthesis. Houses located close to mountains, at the foot of mountains or at the edge of mountains are more vulnerable (Cutter et al., 2003) compare to those located far from mountains. The table 4 illustrates households located less than 1 km from mountains. In union council Zaranda maximum

of the households and overall76.68% households were located near to mountains out of which one third of the households were located in at the foot and only few houses were situated at the edge of mountains, which are considered more vulnerable in terms of physical vulnerability.A lot of the households had open places in the nearby vicinity, which can be helpful at the time of emergency evacuation. Besides these, Community meetings regarding earthquakes sowed almost negative result in all four Union councils. Likewise, results of community programs spreading awareness were also miserable; only 6 households' respondents said yes there are programs spreading awareness. Furthermore, the question "Does DDMA/NGO offers any training programs to people for coping with earthquake disaster?" was responded positively by a very tiny percent of respondents, with very less coordination among working institutions. Majority of the respondents vehemently encouraged and suggested drills/trainings to be initiated regarding earthquake coping strategies. Besides suggesting trainings almost all respondents have a strong communication among them during any disaster or emergency which is a positive sing of community trust.

Table 4: Households' Location, Distance from Mountain and Community trust and awareness

	UC Kawas	**UC Zaranda**	**UC Manna**	**UC Ziarat**	**Overall UCs**
	Frequency (%) (n=47)	Frequency (%) (n=51)	Frequency (%) (n=51)	Frequency (%) (n=44)	Frequency (%) (n=193)
Distance from Mountain less than 1 kilometer	29 (61.7)	44 (83.3)	39 (76.5)	36 (81.8)	148 (76.68)
Houses at the foot of Mountains	20 (42.6)	6 (11.8)	27 (52.9)	21 (47.7)	74 (38.34)
Houses at the Edge of Mountains	0 (0.00)	3 (5.9)	10 (19.6)	5 (11.4)	18 (9.32)
Open place during emergency	36 (76.6)	36 (70.6)	29 (56.9)	23 (52.3)	124 (64.24)

Community Meeting regarding Earthquake	4 (8.5)	0 (0.0)	3 (5.9)	2 (4.5)	9 (4.66)
Community Awareness Programs	3 (6.4)	0 (0.0)	0 (0.0)	3 (6.8)	6 (3.10)
DDMA/NGOs offers training to people	7 (14.9)	2 (3.9)	0 (0.0)	3 (6.8)	12 (6.2)
Coordination among working institutions	4 (8.5)	1 (2.0)	0 (0.0)	5 (11.4)	10 (5.18)
Do you Suggest any Drills/trainings?	41 (87.2)	49 (96.1)	41 (80.4)	41 (93.2)	172 (89.11)
Do People Communicate during Emergency (Community Trust)?	45 (95.7)	47 (92.2)	49 (96.1)	41 (93.2)	182 (94.30)

The source of communication among the unit of analysis varied on account of their access. The figure 2 represents different source of communication including comparison of union councils during any disaster. In UC Kawas high number of the respondents uses mobile phones at the time of emergency, and very small number of people uses landline. It is found that In UC Zaranda, Manna and Ziarat most of the communication source is the use of Mobile phones, and very less number of people use land line. The overall result has showed use of mobile phones is the highest source of communication.

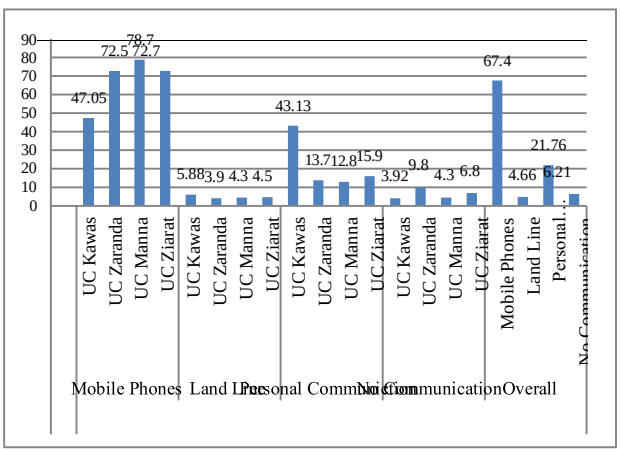

Figure 2: Source of Communication

3.5 Aggregation of Vulnerability Index

All indicators' values are presented in percent, shown in table 5 after the selection of indicators, subjective weight technique is utilized for less data (S. Ainuddin & J. K. Routray, 2012; Mayunga, 2007) to assign weight to each indicator. Therefore, a percentage weighting scale ranging from zero to maximum is formed. The closet VFI and CVFI values to zero are, the least vulnerable is the Union Council and greater the VFI and CVFI values are to zero, the higher vulnerable is the Union Council. However, the index values are interpreted in terms of percentage to clearly express the level of vulnerability of the study area. The optimum values shown in table 1are drawn from literature(S. Ainuddin & J. K. Routray, 2012) review and applied as benchmarks against the components.

3.5.1 Earthquake Social Vulnerability

Yucel and Arun (2012)Argue that the social vulnerability to earthquake includes the education level, age groups, and disabled population. Due to their inability of knowing about ground reality of any disaster and face difficulty in physical escaping during any disasters. S. Ainuddin and J. K. Routray (2012) Stress on community trust, which can play an essential role during or after an earthquake disaster. Nonetheless, the result of social vulnerability to earthquake of the sampled Union Councils households expose somewhat similar situation, but the component vulnerability factor index of Union Mannais comparatively higher than the other Union Councils which indicates higher vulnerabilityof UC Manna to earthquake disaster.Within the social vulnerability component,the vulnerability factor index value of this study revealed that the UC Manna, where a small group of population has high school education, is the most vulnerable union council to earthquake as compare to other unions (Kawas 2.27, Zaranda 2.24, and Ziarat 2.31).In terms of education, Mileti (1999) has stressed that the lower education level is the deciding factor which boosts the hurdles in comprehending necessary information. The education level is crucial in connection with the requirements of disaster trainings that express the important precautions need to be taken before an earthquake disaster, andYucel and Arun (2012)have also stated that earthquake disaster trainings well perform for the support of social behavior of an individual while encountering the earthquake disasters and education is paramount for the actions taken to lessen the impact of disaster in terms of injuries and

fatalities.However, The dependent group (children below 15 years of age) is the second major factor that puts a community to high vulnerability level and the VFI value (1.62) of UC Kawas revealed its highest vulnerability level than the other UCs (Zaranda 1.53), (Manna 1.38) and (Ziarat 1.42).In assessing households' vulnerability, above 60 years of age group is also considered because above 60 years of age population is dependent at the time of emergency evacuation during any disaster. As discussed by (Yeletaysi, Ozceylan, Fiedrich, Harrald, & Jefferson, 2009) that age, particularly elderly and too young individuals, has been identified as another contributing factor to vulnerability. As the elderly and young population are more dependent and suffer from mobility constraints.Flanagan, Gregory, Hallisey, Heitgerd, and Lewis (2011)Arguein the catastrophic event of Katrina the sub vulnerable group was the elderly and young population.In this regard UC Kawas is the least vulnerable union comparatively (Kawas VFI 0.27), (Zaranda VFI 0.56), (Manna VFI 0.43) and (Ziarat VFI 0.47). In terms of disabled population UC Manna is the least vulnerable union VFI value (0.01), where only 1.15% population was found disabled, and is a plus point for the area compare to other unions (Kawas 0.04, Zaranda 0.02 and Ziarat 0.01 population is disabled who cannot help themselves at the time of earthquake or emergency. The social vulnerability result has also exposed higher community trust in all Union Councils during any disaster or emergency.

Table 5: Results of Earthquake Vulnerability Index

	UC Kawas	UC Zaranda	UC Manna	UC Ziarat
Component Indicators with their Vulnerability Factor Index	Percent Value (VFI)	Percent Value (VFI)	Percent Value (VFI)	Percent Value (VFI)
Social Vulnerability	n = 47	n = 51	n = 51	n = 44
1. Percentage of people with high school and above Education	17.62 (2.27)	17.89 (2.24)	14.99 (2.66)	17.31 (2.31)
2. Percentage of Population < 15 years of age	32.48 (1.62)	30.67 (1.53)	27.67 (1.38)	28.4 (1.42)

3. Percentage of Population > 60 years of age	4.03 (0.27)	8.42 (0.56)	6.58 (0.43)	7.19 (0.47)
4. Percentage of population with any disability	2.76 (0.04)	1.20 (0.02)	1.15 (0.01)	1.36 (0.01)
5. Percentage of population communicating during emergency (community trust)	95.7 (0.52)	92.2 (0.54)	96.1 (0.52)	93.2 (0.53)
Composite vulnerability factor index (mean)	**0.94**	**0.98**	**1.01**	**0.95**
Economic Vulnerability				
6. Percentage of Population Employed	27.7 (1.81)	19.6 (2.55)	13.9 (3.59)	15.9 (3.14)
7. Percentage of Population above poverty line	17.5 (5.14)	19.25 (4.68)	10.33 (8.71)	25.45 (3.53)
8. Percentage of households with multiple source of income	25.53 (1.96)	19.6 (2.55)	19.6 (2.55)	22.72 (2.20)
9. Percentage of Population owing house	95.74 (0.63)	94.11 (0.64)	100 (0.0)	95.45 (0.62)
Composite vulnerability factor index (mean)	**2.38**	**2.60**	**3.87**	**2.38**
Physical Vulnerability				
10. Percentage of households located less than 1km from Mountains	42.6 (1.07)	11.8 (0.30)	52.9 (1.32)	47.7 (1.19)
11. Percentage of Households>30 years	4.2 (0.42)	2 (0.20)	4 (0.40)	9.1 (0.91)
12. Percentage of vacant/open areas nearby households	76.6 (0.78)	70.6 (0.85)	56.9 (1.05)	52.3 (1.15)
13. Percentage of Houses not made of Cement as construction material	85.11 (1.42)	100 (1.67)	100 (1.67)	90.9 (1.52)
Composite vulnerability factor index (mean)	**0.76**	**0.45**	**0.93**	**1.08**
Institutional Vulnerability				

14. Percentage of population not covered by Mitigation plan	84.1 (1.68)	100 (2.00)	94.1 (1.88)	88.7 (1.77)
15. Percent of population without earthquake education (mockdrills and programs)	85.1 (1.42)	96.1 (1.60)	100 (1.66)	93.2 (1.55)
16. Percent of municipal expenditures for fire and Emergency management system and medical services	22.3 (0.67)	19.5 (0.77)	21.75 (0.68)	27.67 (0.54)
17. Percent of Volunteer Groups helping during or after disasters	53.2 (0.94)	56.9 (1.14)	43.1 (1.16)	56.8 (0.88)
Composite vulnerability factor index (mean)	**1.18**	**1.38**	**1.35**	**1.19**
Aggregate Vulnerability index/composite index	**1.32**	**1.35**	**1.79**	**1.40**

3.5.2 Earthquake Economic Vulnerability

Poor population generally suffer greater crises more occasionally than population that are economically sound because the poor have very little income, a few production options, limited range of resources with less or no savings. They are more prone to vulnerability on account of their slow recovery from any disaster (Cannon, Twigg, & Rowell, 2003). The economic status of the households plays an indispensible role in the compensation of the losses because of disasters. The level of households' vulnerability increases as the income level of the house holds decreases. Therefore, households' income can be a positive aspect at arriving more resilient and better shelter (Yucel & Arun, 2012). However, the economic vulnerability result of district Ziarat has revealed alarming situation of the all four union councils (CVFI values 2.38 Kawas, 2.60 Zaranda, 3.87 Manna, and 2.38 Ziarat) and among the economic vulnerable union council, the VFI value has indicated UC Manna the most vulnerable compare to other three Unions. And within economic component UC Manna is the most vulnerable area in terms of employment 13.9% of the population is employed, percentage of above poverty line is only 10.33%and in multiple source of incomehouseholds are only 19.6% population has multiple source of income. The current economic situation has increased community's vulnerability and compare tothe other UCs but it is least vulnerable area in household

ownership, where all of the population owns the houses. Ownership of households is one of the essential components of vulnerability. And the disaster impact level is potentially greater in rural settlements, due to the existence of dominant forms of houses(Cannon et al., 2003). Populations with high economic rate are less vulnerable to any natural disasters as they can quickly recover from material losses compare to those who are suffering rom economic constraints in one or other forms.

3.5.3 Earthquake Physical Vulnerability

Yucel and Arun (2012)Argue that physical vulnerability to an earthquake mostly pivots on the non-structural and structural menace to the houses. The result presented gloomy physical condition of the households due to households' location close to mountains and some even at the foot of mountains. in case of Wenchuna earthquake destruction in China , households located in mountainous regions in the rural settlement received major damages due to landslides rather than houses collapse (Liu, Ruan, & Shi, 2011). And composite vulnerability factor index (Average) (1.08) in terms of physical vulnerability, UC Ziarat is the most vulnerable union. And within the physical vulnerability component UC Manna, where half of the houses are located less than 1km from mountains, makes the community prone to earthquake impact, 9.1% households in UC Ziarat are above 30 years of age, which lasted in 2008 earthquake destruction and received some internal cracks with lack of open areas nearby and with almost all of the houses constructed with Mud, put the community to a high vulnerability level.These households may not tolerate another shock and can easily be damaged.

3.5.4 Earthquake Institutional Vulnerability

In the earthquake institutional vulnerability the study has evaluated mitigation plans, mock drills, municipal expenditures and also volunteer groups/population active during or after any disaster. The composite vulnerability factor index(average) of all four union councils' institutional vulnerability to earthquake has indicated that the respondents are somehow equally vulnerable to earthquake but the composite vulnerability factor index of the union council Kawas has presented its least vulnerability to earthquake compare to other unions. Within the institutional vulnerability component UC Zaranda, where all randomly sampled respondents denied being coved by any mitigation plan, is most vulnerable union in all and in terms of

earthquake education (mock drills/ programs) all respondents of UC Manna denied being given any earthquake education (drills/programs), and that can be a negative sign for the community's survival. However, UC Ziarat is not as much vulnerable as other union councils in terms of municipal expenditure, where municipal spends less amount of its budget on emergency management systems. And UC Manna is most vulnerable to earthquake impacts in terms of volunteer groups' activeness, where some volunteer groups/population is functional to rescue the victims of earthquake.

4 Overall Vulnerability Index

The overall earthquake vulnerability aggregation index of the four union councils households in term of their level of social, economic, physical and institutional vulnerability to seismic shocks have depicted a gloomy side of the district Ziarat. The respondents' households AVI (Aggregate Vulnerability Index) values have revealed the highest vulnerable union councils of district Ziarat. The AVI value of union council Manna (1.79) has exposed that thehouse holds of Manna are the least capable of coping with earthquake disaster on account of their lowest high educationrate 14.99%, least employment rate 13.9% with few economic activities for generating incomes and high institutional vulnerability have contributed to the union council Manna's vulnerability in its four dimensions comparatively.The AVI value of UC Ziarat (1.40) indicates that the union council is also highly vulnerable to natural disaster earthquake. UC Ziarat is said to be the downtown of district Ziarat, where education level is slightly higher 17.31% than education level of Manna and being the downtown of district Ziarat, union council Ziarat is economically comparatively sound. The AVI value of UC Zaranda (1.35) exposes its moderate degree of vulnerability to earthquake compare to UC Manna and Ziarat. But earthquake's impact would be greater on its institutional side where it is critically prone to earthquake disaster and the AVI value of union council Kawas (1.32) is the lowest value in terms of vulnerability. The area was also least affected in 2008 earthquake on account of its distance from mountains, level of education, high communication among people, high employment rate and better volunteer services. However, comparing the overall results of the rural area of Balochistan district Ziarat with the urban area of Balochistan, Quetta city in terms of resilience to earthquake disasters(S. Ainuddin & J. K.

Routray, 2012), the results revealed that the urban social, economic, physical and institutional vulnerability to earthquake is lesser than the rural due to high education rate, less economic constraints, more opportunities to disaster education, households materials, public awareness, and active institutions' services have led the urban area towards somewhat resilience and decreased vulnerability.

5 Conclusion

This dissertation paper has revealed the multifaceted concept of vulnerability and its contributing independent domains with essential indicators to earthquake vulnerability assessment in the rural areas of province Balochistan. The households' vulnerability to earthquake disaster of the Union Councils of district Ziarat is assessed through developing a survey questionnaire including socioeconomic and demographic profile of the areas and by adopting subjective weighting method by assigning weights to various components' indicators. Vulnerability components to earthquake disasters were adopted based on extensive literature review and the relative values are also drawn from secondary data.The vulnerability results have revealed that immediate reforms and noticeable improvements are highly needed in the four independent domains (Social, economic, physical and institutional) of vulnerability in the Union Councils. Despite experiencing disastrous earthquake in 2008, people were found unaware of social, physical, economic or institutional coping strategies due to economic constraints, low education level, and lack of preparedness program/trainings. Therefore, it is recommended that the populations of the four Union Councils need to be taken out of economic constraints by giving them various necessary social and economy generating skills. Based on the results discussed it is also suggested that earthquake preparation trainings and promotion of education are to be taken as a crucial part of basic trimmings. Besides initiating essential training programs, spread of awareness regarding high seismic areas and high vulnerable household's situation is very crucial to reducing people's vulnerability to earthquake disasters.

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