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EXTENT AND CAUSES OF EARTHQUAKE HAZARD: A CASE STUDY OF QUETTA, PAKISTAN

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Abstract

This paper attempts to identify the major causes, effects and remedies of earthquake hazard in Quetta, Balochistan. Earthquakes, like other extreme natural events occur recurrently in certain geological formations. These are generally caused by structural deformation like folding, faulting, plate movements etc. Earthquakes have caused tremendous damages to life and property in the past. The study area is one of the vulnerable localities in Pakistan. For detailed and intensive investigation, three sample sites have been selected randomly in the Quetta valley, namely, Pashtoon Bagh, Samungli and Khair Bakhsh villages. The data for the last thirty years have been collected to look into the major causes and effects of earthquakes and suggested remedial measures to ensure safety for human lives and reduce the damages to the property.

The paper is divided into seven sections. Section one deals with the detailed introduction of the study. Section two explains the environmental background of the study area, whereas section three is about the methodology adopted for carrying out this study. Section four reveals the earthquake records in Pakistan, while section five assesses the earthquake hazard in the study area. Sections six and seven are given to summary and recommendations, respectively.

Introduction

In Quetta, as a result of its specific geological structure, earthquake is a serious and recurrent extreme natural event (GoB, 1976; Kazmi and Jan, 1997; Shams, 2006). Taking these facts into consideration, this study has been conducted, to find out the causes of earthquake, its impacts and finally to summarise and suggest policy recommendations for reducing the impact of earthquake hazard. Earthquakes are differently defined by different seismologists. However, the most workable definitions of earthquake are: i) "An earthquake is the vibration of the earth, produced by a rapid release of energy" (Longwell and Flint, 1962; Bates and Jackson, 1987; Tarbuck and Lutgens, 1987). ii) "Earthquake is a sudden motion or vibrations in the earth, caused by the abrupt release of energy build up within the earth over a long period of time as a result of tectonic forces" (Smith, 1992; Alexander, 1993; EVRC-2, 2002).

The earthquakes usually originate a few kilometres beneath the surface of the earth at a point called the seismic focus. From the seismic focus the vibrations spread in all directions. These reach the surface first at the point immediately above the seismic focus. This point is called the epicentre (Anwar, 1998; Khan, 2001; Rafi, 2002). It is at the epicentre that the shocks of the earthquake are first experienced and on the ground it seems to spread outwards as waves spread

from a stone thrown into a pool of water. As the vibrations spread outwards from the origin their intensity slowly and gradually diminishes (White, 1974; Anwar, 1998). The intensity of earthquake is distributed outward from the epicentre in the form of concentric circles. With the help of these circular lines, it is possible to identify the areas of the same intensity around the epicentre. The lines of these concentric circles are known as isoseismal lines (Ahmad, 1976; Burton, 1978; Montgomery, 1986). These lines are often very irregular in shape because the damage depends in part upon the nature of the foundations on which the buildings and other infrastructures rests as well as upon their distance from the epicentre.

This study is aimed at identifying the major causes and impacts of earthquake hazard in the Quetta valley, Balochistan. Earthquakes occur very frequently in the study area. These vary widely in their nature, magnitude and intensity. Quetta lies in the active seismic region, therefore, earthquake rock the area from time to time (Map 1). The worst earthquake that hit the Quetta valley was that of May, 1935, when more than 80 per cent of the city was destroyed. Recently, another earthquake on 27th Feb, 1997 hit the Quetta, Mastung, Much, Sibi, Loralai and other parts of Balochistan. Besides other damages, 80 deaths were recorded.

The study Area

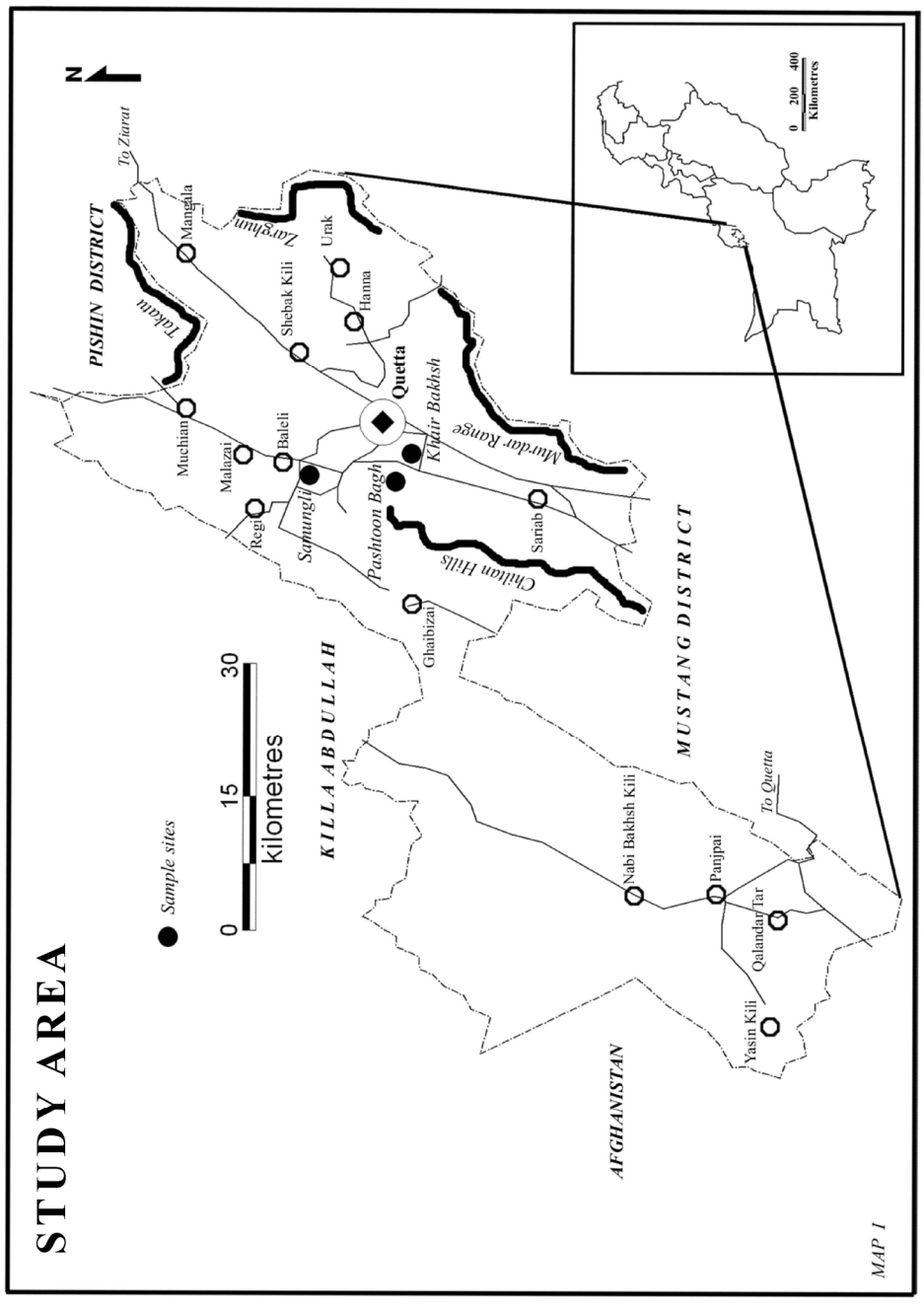
Quetta district derives its name from the Pashto word "Kawatta" now spelt as "Quetta" which means a fort. In the beginning, the town was located within the walls of this fort. Myth attributes the origin of the name to a son of Persian emperor Afrasiab. The total area of the district is 2,653 sq km. Geographically, it stretches between 29^0 48' to 30^0 27' sorth latitude, and 66^0 14' to 67^0 18' east longitude. It is bounded on the north by Pishin district, on the northwest by Killa Abdullah, on the east by Ziarat, on the south by Chagai and Mastung districts, and on the west by Afghanistan.

In general the topography of the district is mountainous which is intersected by long narrow valleys, consisting of flat alluvial plains with pebbly slopes rising on either side. The remarkable feature of Quetta is its location, which is surrounded by different hill ranges. On the north lies the Takatu range, whereas the Zarghun and Murdar ranges lie on the east. The Chiltan range lies in the south, separating Quetta from Mustang district. The Mashlak range bounds the western periphery of the Quetta valley. The general elevation of the district ranges from 1,200 to 3,500 meters above sea level. The average slope of the valley is 48 meter per km (Rafi, 2002).

The climate of Quetta district is generally dry and cold. Being situated outside the range of summer monsoon, the rainfall is irregular and scanty, which varies from year to year. In spring and summer seasons, there is very little rainfall (GoP, 2001). The highest precipitation occurs during the months of January and February. Sometimes, snowfall also occurs in March. The summer season remains moderately warm. July is the hottest month with maximum and minimum temperatures of 36^{0}C and 20^{0}C respectively. Winter season is cold and dry and persists from October to March., but January is the coldest month with mean maximum and minimum temperatures of 11^{0}C and -3^{0}C respectively.

Methodology

To achieve the objectives of the study, three sample villages were selected, randomly. These are Khair Bakhsh, Samungli and Pashtoon Bagh (Map 1). For the detailed study, both primary and secondary sources of data were used. Prior to field- work, intensive literature review was carried out, in order to


STUDY AREA
N
PISHIN DISTRICT
To Ziarat
Mangala
Zarghun
Urak
Tarkani
Shebak Kili
Hanna
Quetta
Khair Bakhsh
Murdar Range
Muchian
Malazai
Baleli
Regi
Samungli
Pashtoon Bagh
Sariab
Chiltan Hills
Ghaibizai
KILLA ABDULLAH
MUSTANG DISTRICT
Nabi Bakhsh Kili
Panjpai
To Quetta
Qalandar Tar
Yasin Kili
AFGHANISTAN
Sample sites
0 15 30
kilometres
0 200 400
Kilometres
MAP I

understand the nature of earthquake hazard, general causes, distribution, effects and remedies. For this purpose relevant books, research journals and newspapers were reviewed in detail. Primary data were obtained through questionnaire survey interviews and personal observations. Questionnaire survey was carried out by using random sampling techniques. For the collection of primary data, besides observation, three types of questionnaires were used, i) an individual household, ii) the whole village and iii) the line agencies.

Questionnaires for the individual household were filled from the general public of the three sample villages. Questionnaires for the whole village were filled with the help of community leaders and elderly people in the form of group discussion. At least two questionnaires for the whole village were filled from each of the three selected villages. Individual questionnaires were filled from 16 per cent households. The questionnaire was designed to collect information regarding population, housing, trade, commerce, transport, agriculture, and damages caused by earthquake hazard. During the field survey, data about the damages to the physical, social and economic environment caused by the earthquake hazard were also collected for the last 30 years. Data about earthquake protective measures, emergency relief supplies, evacuation and rehabilitation were obtained, both from the respondents and line agencies.

Secondary data were obtained from Geological Survey of Pakistan, Quetta District Census Report (DCR), Quetta Development Authority, Environmental Protection Agency etc. Location map of the study area was prepared with the help of topographical sheets No.34 N/3 and 34 N/4. Seismic zones of Pakistan and magnitude of different earthquakes from 1905 to 2002 were obtained from Geophysical Centre, Quetta. Data regarding earthquakes and Quetta building codes were also obtained from Geophysical Centre, Quetta. The collected data were finally analyzed and presented in the form of percentages, ratios, averages and tables.

Earthquake Hazard in Pakistan

According to the theory of plate tectonics the outer layer of the earth's crust is composed of almost a dozen major and minor slabs called plates (Longwell and Flint, 1962; Kazmi and Jan, 1997). These plates are moving continuously either converging or diverging or sliding one another. The slow ongoing plate to plate interaction produces majority of the earthquakes in the world. The movements of the two adjacent plates i.e. Eurasian plate and Indian plate (on which the Indian subcontinent lies) is very important as for as the earthquakes in Pakistan and India are concerned. The Indian subcontinent,(of which Pakistan is a part) located on the boundaries of two continental plates, is very prone to earthquake (Huda, 1967). Therefore, Pakistan like other countries of the subcontinent occasionally fall victim to earthquakes.

In Pakistan earthquakes usually occur in the mountainous areas and very few in the plain areas. The most active earthquake zones are the Salt range, Hazara basin, Potwar plateau, Chaman range, Kirthar range and Hindu-Kush range. Pakistan is characterised by extensive zones of high seismicity. It contains several seismo-tectonic features generated by integrated network of active faults in the region. The collision mountain ranges, where active faults are common, experiences high seismicity, whereas stable platform is characterised by relatively low seismicity.

Causes of earthquake in Pakistan

The main causes of earthquakes in Pakistan are the active faults, which

have been categorized by Huda, (1967); Kazmi and Jan, (1997), as under:

- Transverse faults that mark the western boundary of the Indo-Pak subcontinent.
- Strike slip faults which occur mainly along the margins of the structural arcs and oroclines, and are to a large extent involved in the formation of various syntaxes.
- Thrust or reverse faults traverse the zone between each set of strike slip faults.
- Traces of geo-fractures which appear as lineaments of various dimensions. These four categories of faults constitute 72 active faults, which are given in Table 1.

Impacts of earthquake hazard in Pakistan:

No part of Pakistan can be said to be completely safe from earthquake hazard, however some areas are more vulnerable than others (Farah and Jong, 1979; Khan, 1993; Khan, 2001). Seismically, Himalayan belt is more active in Pakistan. During 1905-1964, Pakistan has experienced 80 shocks, out of which 73 had their origin in Himalayan belt having magnitude and frequency distribution as follows:

Magnitude	*Number*
8.0-8.9	4
7.0-7.9	23
6.0-6.9	46

When it was compared with the world distribution of annual shocks on Richter scale (Huda, 1967), the following conclusion were drawn:

Magnitude	*Number*
9.0	0
8.0-8.9	2-3
7.0-7.9	18
6.0-6.9	150

Amongst many earthquakes that occurred in Pakistan, two earthquakes are very important in terms of associated damages. These earthquakes are the recent earthquake of October 2005 and that of May, 1935. The incident of October 2005 was unprecedented. The death toll according to official sources reached over 73,000 and more than 3.3 million people left homeless. The earthquake of 1935, which hit Quetta, Kalat and Mastung was also very destructive. Approximately 30,000 people were killed and buried under the debris (GoP, 2003; ADB and WB 2005). The most recent severe earthquake in Pakistan occurred in Astore valley during November, 2002, when 23 human lives were lost and about 35,000 people were affected.

Mitigation measures adopted in Pakistan

Historically, speaking the earthquakes have been causing great damages to both life and property in Pakistan. At national level, various line agencies are responsible to identify various ways and means to minimize the earthquake damages (Ahmad, 1976; Ali and Ahmad, 1993). In 1974, an earthquake of an intensity of 6 at Richter scale occurred in Kohistan district of NWFP. Although, the intensity of earthquake was not high, yet the casualties and damages reported were very high. The cause of large-scale destruction in 1974 was, because the area of Kohistan is mountainous and the jolts are usually more intense in mountainous region as compared to the plain areas. It claimed more than 5,000 lives in Kohistan district. Many villages in the area were razed to the ground, due to the rolling down of debris from the nearby mountains (Khan, 2001). The Geological survey of Pakistan interprets seismologic and geodetic data in terms of tectonic and other geological factors, which control earthquake events. A seismicity monitoring system is maintained by the geophysical centre, along with the meteorological services. A seismological bulletin is also regularly

Table 1
Pakistan: Active Faults (F)

1. Reshun	2. Upper Hunza	3. MKT
4. Hamran	5. MMT	6. Raikot-Sassi
7. Harban	8. Sassi-Dassu	9. Shinkiari
10. Indus (Darband)	11. Nowshera	12. Kund (Manki)
13. Peshawar Basin F	14. Attock (Khairabad)	15. MBT (Parachinar-Cambellpur-Murree F.
16. Jhelum	17. Kallar Kahar	
18. Uchchali	19. Salt Range Thrust	20. Kalabagh
21. Surghar Thrust	22. N. Bannu Basin F.	23. S. Bannu Basin F.
24. Sora Rogha	25. Mandana kach	26. Chaudhwan
27. Domanda	28. Takht-e-Suleman	29. Moghalkot
30. Manikhawa	31. Kingri	32. N. Kakar Khorasan F.
33. S. Kakar khorasan F.	34. Chukhan Manda	35. Zhob
36. Mekhtar	37. khalifat	38. Kohlu
39. Tatra	40. Harnai	41. Barkan
42. Ghazaband	43. Bhalla Dor	44. Mach
45. Chiltan-Takhatu	46. Quetta	47. Johan
48. Kirthar	49. Surjan	50. Jhimpir
51. Hab	52. Pab	53. Sonmaini
54. Ornach-nal	55. Hudishi	56. Chaman
57. Panjgur	58. Hosab	59. Awaran
60. Bazdar	61. Jhal Jhao	62. Ras Malan
63. Aghor	64. Nai Rud	65. Ormara
66. W. Makran Coast F.	67. Kulmir Sunt	68. Ladgasht
69. Ahmadwal	70. Dalbandin	71. Mashki Chah
72. Rann of Kutch F.		

Source: *Kazmi and Jan, (1997)*

published by this organization.

Water and Power Development Authority (WAPDA) also monitor a network of stations in the country. The geodetic branch in the Survey of Pakistan is responsible for repeat precision measurements of horizontal and vertical displacement along active faults, identified by Geological Survey of Pakistan. The ministry of fuel, power and natural resources promote geological research aimed at earthquake hazard minimization, with the close co-ordination of the ministry of science and technology. The disaster relief cell in the cabinet division also mobilizes resources in case of disasters. The Government of Pakistan has established an organization at the federal level called as Earthquake Rehabilitation and Reconstruction Authority (ERRA). This organization is largely responsible for relief and rehabilitation activities. The provinces have also been advised to establish Provincial Earthquake Reduction and Reconstruction Authorities.

An earthquake engineering and coordinating cell has been established at UET, Peshawar and Department of Civil Engineering, University of Engineering and Technology, Lahore. Efforts are also made to coordinate the activities of various organizations engaged in earthquake studies in Pakistan (Ahmad, 1976). Short courses related to seismicity and earthquake engineering are being

initiated for field engineers and post-graduate students. Mitigation courses related to earthquake and other natural hazards are also being conducted at the Department of Geography, Urban and Regional Planning, University of Peshawar. It seems that a positive move towards minimization of earthquake hazard has been initiated. Pakistan is trying to be benefited from the experiences of regional countries at the level of SARC and CENTO.

Earthquake Hazard in the Study Area

Causes of earthquake

Like other parts of Pakistan, the causes of earthquake in Quetta valley are the presence of active faults, which are passing throughout the Quetta valley (Rafi, 2002). The geologists are of the view that a fault exists down town of the Quetta city, which passes from north to south direction. A famous strike slip fault i.e. Chaman fault is situated in the western part of Quetta valley (Kazmi and Jan, 1997; Khan, 2001).

Besides these active faults, the underlying thick gravel bed with hard surface and alluvium deposits particularly in the eastern side of Quetta city aggravate the earthquake hazard in Quetta valley (Rafi, 2002).

In the light of the existing fault system, the shear waves may amplify largely over soft alluvium portion. The fundamental phenomenon responsible for the amplification of motion over soft sediments is the trapping of seismic waves due to impedance contrast between sediments and the underlying bedrock. This structure is horizontally layered, which create trapping affect and only body waves are travelling up and down in the surface layer. So this trapping also affects the surface waves and thus may reverberates forward and backward. This may produce resonance patterns, which is very damaging within this region.

Impacts of earthquake hazard in Quetta

Earthquake is a frequent and reoccurring phenomenon in the Quetta valley, which has caused tremendous damages in the past (Table 2) and is a serious threat to man and his property in the future too.

Earthquake hazard has many impacts on the economy and social set up of the study area. The study related to the impacts of earthquake hazard in the study area is based on field survey (2003) in which the losses in the last thirty years have been recorded from the respondents of the three sample villages. The study found that earthquake damages were high in Samungli, followed by Pashtoon Bagh, whereas meagre in Khair Bakhsh. According to public response and perception survey, all the respondents were of the view that earthquake is a natural hazard and can not be controlled. In the study area, impacts of earthquake are categorized as under:

Human losses: During an earthquake, human beings are the direct affectees. It is because of the fact that earthquake is a quick process and does not allow any time for evacuation. The loss to human life was high in the study area because most of the houses were made up of mud which has no resistance to earthquake waves. “Nature does not kill man but it is the house constructed by man himself, which leads to the burials of mankind”. Within the last 30 years i.e. from 1972 upto 2002, 6 persons the study area lost their lives, due to earthquake hazard. The casualties were greater in Pashtoon Bagh followed by Samungli and Khair Bakhsh. These villages are located on the piedmont of the Chilthan hills. In Samungli 9 persons were injured. According to the respondents most of the casualties occurred, during 1997 earthquake.

Damages to houses: Earthquakes have also caused tremendous damages to the houses in the study area, thereby inflicted heavy economic losses. The damages were mostly to Katcha houses followed by Semi-Pucca. The analyses revealed that damages to houses were directly proportional to casualties. Among the affected houses, 28 per cent were totally damaged, 40 per cent were partially damaged , while damages to the extensions (walls) were 32 per cent. It will be more appropriate to describe the damages to the houses with respect to their building structure i.e. Katcha, Pucca and Semi Pucca (Table 4).

Village Khair Baksh is located at the slope of Chiltan hill, which is seismically active, but according to the field survey, no damage to houses occurred, during last thirty years. However, the entire village consists of mud houses, and a severe earthquake in future may ruin the whole settlement.

Damages to agricultural Land: Earthquake has a severe impact on crops and causes great damages to agricultural land in the study area. The way the earthquake damages the agriculture land is interesting to note. The respondents were of the view that when earthquake

Table 2
Quetta: Impacts of Earthquake Hazard

Date(G.M.T)	*Lat(N)*	*Long(E)*	*Mag.*	*Remarks*
31-05-1935	29^0 5'	66^0 8'	7.5'	Felt area was approx. 1,00,000 sq. miles max intensity was X-XI. 30,000 victims. Cities of Quetta, Kalat and Mastung were completely destroyed.
09-02-1955	30^0 5'	67^0 0'	6.0'	Felt in Quetta. Seven persons were Killed.
16-03-1978	33^0 6'	73^0 3'	5.3'	Felt in Quetta and Peshawar, one person killed and considerable damage occurred at Noshki.
12-12-1981	29^0 9'	67^0 1'	4.7'	Felt in Quetta, 6 persons were killed 12 injured and many kacha houses were destroyed in Karkh village.
03-03-1990	28^0 9'	66^0 3'	5.8'	Felt at Kalat, Surab, Khuzdar, Mastung and Quetta. 11 persons were killed while, 40 injured. Hundreds houses were destroyed.
16-11-1993	30^0 8'	67^0 2'	5.7'	In Balochistan felt at Quetta. At least 150 houses destroyed in Pishin area.
27-02-1997	30^0 0'	68^0 2'	6.2'	In Suleman Range felt at Quetta, Mastung, Mach, Sibi, and many other parts of Balochistan. Few areas of Sindh, and Punjab 80, persons killed and many injured. Considerable damage occurred in Harnai.

Source: *GoP, 2003*

Table 3

Quetta: Human Casualties, 1972-2002

Village name	*Death Toll*			*Injuries*			*Total*
	Male	*Female*	*Total*	*Male*	*Female*	*Total*	
Pashtoon Bagh	3	1	4	5	2	7	11
Samungli	1	1	2	5	4	9	11
Khair Baksh	-	-	-	-	-	-	-
Grand total	4	2	6	10	2	16	22

Source: *Field Survey April, 2003*

occurs it blocks the *kareez** network due to ground subsidence, which ultimately affect the standing crops. About 100 per cent of the respondents were of the view that earthquake causes damages to agricultural land. However, they were not sure about the total cultivated area, affected by earthquake.

Damages to livestock: In an agro-based economy livestock is considered as an important part of the economy. The havoc of earthquake has not only hit the physical structures but also buried the livestock under the debris. According to the field survey, total livestock casualties were 13 (1972-2002), about all of them were reported as dead. The losses incurred to the general public as a result of earthquake hazard runs into lacs of rupees. The villagers were compensated @ Rs.20, 000 per buffalo, 10,000 for cow and 2,000 each for sheep and goat.

Summary and Conclusion

Earthquake is a natural hazard, which is geographically limited and is associated with certain active seismic zones. Being a process of enormous intensity, it severely affects mankind physically, socially and economically. Earthquake hazard may lead to collapse of houses, destruction of infrastructure and disruption of communication links as well as burial of human settlements. Although, the movement of plates mainly causes earthquake, a number of other factors also contribute to the intensity as well as havoc created by earthquake. The

Table 4

Quetta: Damages to Houses (per cent)

Village name	*Katcha*			*Pucca*			*Semi-Pucca*			*Total houses*
	F	**P**	**Ext.**	**F**	**P**	**Ext.**	**F**	**P**	**Ext**	**(per cent)**
Pashtoon Bagh	-	8.3	-	-	-	-	-	-	-	8.3
Samungli	1.75	-	0.75	-	-	-	-	-	10	12.5
Khair Baksh	-	-	-	-	-	-	-	-	-	-
Grand total										20.8

Source: Field Survey April, 2003.

***** It is an underground irrigation channel.

study found that on the basis of geological structure, earthquake zones can be identified however, accurate prediction of the occurrence of earthquake is impossible. Earthquake as a process cannot be stopped or reduced; however, damages associated with it can be reduced to a considerable extent.

The analysis revealed that in the Quetta valley, the major causative factor of earthquake is the presence of active faults in the area. Due to the movement of different plates the stored up energy within the earth's interior tries to find weak points to escape and these weak points available for this energy is the extensive faults system in the valley. Besides this, it was found that there are a number of intensifying factors, which exacerbate the severity of earthquake hazard. The analysis further revealed that in the past, earthquake has caused considerable damages in the area and is a serious threat to the human life and property in the future as well. It involves heavy damages to lives, agricultural land, infrastructure and livestock. The denizens of the study area are the hard hit physically, economically, socially and psychologically by earthquake hazard.

The most severe earthquake of the study area was found to be that of 1935 in which 80 per cent of Quetta city was completely destroyed. The recent severe earthquake in the study area was that of 1997. About the future earthquake, respondents were of the view that God knows better however, the causative factors in the area identified by this study are still there. Government had taken various steps to reduce the damages associated with earthquakes. It was in 1976, when Quetta Development Authority prepared building codes, on the basis of certain earthquake resistance formulae. These building codes have not yet been implemented properly. Despite a number of possible measures none of them is adopted by the community in the study area. In order to reduce earthquake hazard vulnerability, there is an urgent need to adopt long-term strategies with revising and implementing "Quetta Building Codes" along with proper landuse management and other regulatory policies.

Recommendations

i. Earthquake hazard mapping

There is a need for improvement in the seismic hazard maps, based on the recent available information. For rapid assessment of earthquake impacts, the Geological Survey of Pakistan should undertake an integrated, multi-hazard

Table 5:

Quetta: Livestock Damages

Village Name	*No. of live stock died*	*No. of live stock injured*	*Total casualties*	*Economic loss(Rs)*
Pashtoon Bagh	6	-	6	64,000
Samungli	7	-	7	84,000
Khair Bakhsh	-	-	-	-
Grand total	13	-	13	148,000

Source: *Field Survey April, 2003*

vulnerability and risk mapping exercise to provide rational measures for the reconstruction process and landuse planning.

ii. Technical assistance

Advisory services are needed at appropriate level to provide technical assistance at the door steps of those living in the earthquake prone areas. This assistance must include guidance in construction and coping with the disastrous situation. In this way, the affectees will suffer only minimum possible damages to their lives and properties.

iii. Creation of awareness

Currently, it is need of the day to create and inculcate the awareness and consciousness amongst the general public, regarding mitigation of earthquake hazard.

iv. Implementation and improvement of building codes

Baluchistan Development Authority should revise and strictly implement Quetta Building Codes. The Authority should also formulate landuse regulation in the study area and adopt long-term measures instead of short-term remedial measures.

v. Integrated efforts

Accurate prediction of earthquake is not possible. However, based on the geological structure, Seismologist working at geophysical centre should carry out seismic and micro zoning of the area. Earthquake as a process can not be stopped or reduced; however, its damages can be minimized to a considerable extent by adopting certain mitigation measures such as earthquake hazard mapping, technical assistance, landuse regulation, building codes etc. All these activities cannot be carried out by a single organization. It is therefore, recommended that all the concerned organizations should carry out coordinated and integrated efforts to fulfil the huge responsibilities of reducing earthquake damages.

vi. Properly trained personnel

Government should periodically arrange appropriate training programmes for the seismologists and staff of other related organizations. The Government has recently established ERRA, however, there is a dire need of properly trained managerial and technical staff to fulfil the mandated task of rehabilitation and reconstruction. It is obligatory on ERRA to strengthen the management system, to identify gaps and areas that need improvement, keeping in view the recent earthquake experience.

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