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VALUATION OF AWARAN, BALOCHISTAN, PAKISTAN, EARTHQUAKE: HAZARD ASSESSMENT AND MITIGATION

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Abstract-The Balochistan province is saturated south west part of Pakistan, 24 September 2013 the 7.7- magnitude earthquake hit on Thursday afternoon at the depth of 20km (13 miles) north-east of district Awaran, Balochistan, Pakistan, the Geological Survey of United State (USGS). The Awaran district were completely demolished by the earthquake there were approximately 825 people killed several were injured and the many houses were totally flattened. This research has created on the assessment of Provincial Disaster Management Authority's (PDMA) responses to Awaran earthquake and the awareness of effected families, 20 locals of Awaran has been interviewed which their opinions were designated for this research. The analysis over the interviewed discloses that most of the people were satisfied from the PDMA's or any other response over the Awaran earthquake.

Keywords: Awaran Earthquake, Hoshab fault, Makran Accretionary Zone, Subduction Zone, Tectonic, Hazard.

1. INTRODUCTION

The Natural disasters are stirring everywhere the globe annually, the earth quakes are most destructive phenomena in the world. An overwhelming earthquake with 7.7 magnitude occurred in Awarn District (according to Pakistan Meteorological Department (PMD) and United Sates Geological Survey (USGS) at the sundown (16:29:50 Pakistani Usual Time (PST)) on the 24th September 2013 in southwestern (SW) Pakistani Balochistan (Monalisa and Jan., 2015*)*. geologically the plate Tectonics movement is considering the major cause of earthquakes. Comparatively the impact of earthquake disasters is much greater in number than any other natural disasters. Every year, there are about to million earthquakes on Earth. There are sufficient countries which faced this curse but particularly the Asian countries faced several numbers of earthquakes. But, reportedly, beyond twenty-five worst earthquakes China faced eight of those (According to UNDP survey on climate in 2000-2002). The Awaran earthquake, fault-plane resolution one of the leading episodes, the major shocks on the 28 September 2013, the aftershock dispersal posed that the NNE-SSW-approved to the left-lateral strike-slip or oblique fault at Awaran Fault (AF). (Quadri., Quadri., 1998 and Kazmi [2], Pakistan also appearances a severe earthquakes disaster, relic has exposed that in the history of Pakistan is certainly situated adjoining highly active fault zone that could enclose to risk more than 170 million people living at that belt in the country. Earthquakes endeavors mainly crashed to the northern and western section of the realm sideways with border of Indian plates to Iranian and Afghan Micro plates. (Nowroozi and A.A., 1972), also the Chaman fault in western margin beside Afghanistan and subsequent to Kalat with trace to Quetta and Mekran range are believed to be the red zone areas for earthquakes in Pakistan owing to major tectonic circumstance (Avouac., et al. 2014). In 1935 powerful earthquake which demolished the Quetta city with the magnitude of 7.7 and slayed 30,000 to 60,000 people (Murtaza A., 2013), In the 1945 earthquake in coastal belt of Pakistan that slayed 4000 people with the magnitude of 8.1 (Munir KA., 2014. In the 2005 earthquake was very much destructive which occurred in Kashmir and killed 80,000 people with the magnitude of 7.6 to 8.0. (USGS), So, Pakistan was completely targeted place of earthquake in history and these are also being occurred in today's globe. A number of earthquakes occurred in Balochistan, frequently it occurs in Coastal areas but also land areas have been hit by earthquakes. The earthquakes in Balochistan bent by tectonic plates (Verma., et all 2013), which were very much destructive such as the 1935 earthquake in Quetta. In 1945 the costal belt earthquake considered the seismic waves generated due to Arabian plate subduction, and the recent earthquake in 2013 of the Awaran earthquake because of this subduction which extend the Hoshab Fault, that were the great destructions. Historically it is drastically hit by earthquakes and it has been one of the most effective places.

2. HISTORIES OF EARTHQUAKES IN PAKISTAN

Since 893 A.D till 1929, 11 major earthquakes have occurred the surrounding in these belts include the Pakistan. Following are the historical earthquake in Pakistan. {Pakistan Meteorological Department (PMD) and USGS}.

Table-2.1 Record of Major Earthquakes in Pakistan

Year	Magnitude	Death	Place
893	8	150,000	Shah Bandar, Sindh Coastal Area
May 2, 1668	7.6	50,000	Shah Bandar, Sindh Coastal Area
June 16, 1819	7.5	3,200	Allahbund, Sindh- Gujrat Border
Sep 24, 1827	7.8	1,000	Lahore, Punjab
Jan 24, 1857	8	1,000	Kahan, Balochistan
Jan 22, 1865	6	1,000	Peshawar, KP
1883	6	1,000	Jhalawan, Balochistan
1889	8	1,000	Jhalawan, Balochistan
Dec 20, 1892	6.8	1,000	Qilla Abdullah, Balochistan
October 21, 1909	7	100	Sibbi, Balochistan
Feb 1, 1929	7.1	100	Sibbi, Balochistan
Aug 24, 1931	7	----	Sharigh Valley, Balochistan
May 31, 1935	7.7	60,000	Districts of the Balochistan
Nov 27, 1945	7.9 or 8 Tsunami	4,000	Makran-Coastal area
Dec 28, 1974	6.2	5,300	Districts of the Khyber
Oct 29, 2008	6.4	216	Quetta, Balochistan
Jan 18, 2011	7.2	2	Balochistan

Balochistan Province almost suffered the all earthquakes which were prevail in that territory but due to inferior population of province and shorn of construction, Balochistan has dwelled fairly infallible from these earthquakes. **S**ince 1931 till to 2013 this active belt has been capitulated under many considerable earthquakes alongside to tsunami in 1945 at the coastal tract of Balochistan, (PMD).

Coastal region of Sindh is also one an active seismic zone, a great number of fault due to subduction of two major plate from Ahmedabad and Bhuj proceed to Ormara onward Makran Coast and another crucial fault from Ormara to Gulistan about 80 km and extend to west of Quetta to Jalalabad and the revolving east wards underneath Himalayas hills through Kohistan as a contribution to Haryana in India and beyond, it is called Karakoram fault. (Kazmi and Jan., 1997).

2.1 The 1935 Earthquake in Balochistan

At 3:02 AM highly magnitude earthquake occurred in the Quetta locality and surrounding zones. The magnitude of earthquake had 7.7 in any extent centrally located 30,000 and 60,000 people expired this huge destruction. This league one of the deadest earthquakes that impact South Asia, at the series of natural disaster that is the 23rd deadest earthquake ubiquitous to date. (PMDA and USGS). Fig. 2.1 is showing the epicenter location of 1935 Quetta Earthquake and also seismicity in and around Pakistan.

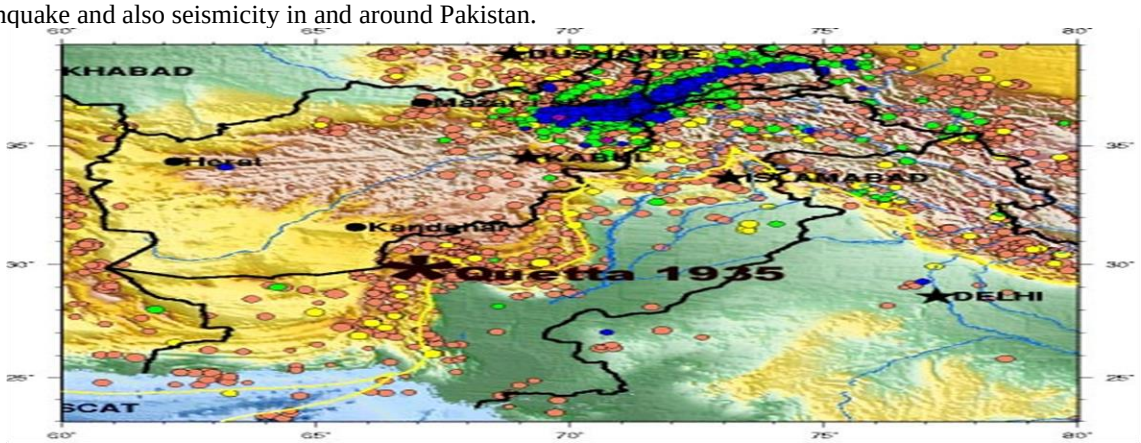

Fig. 2.1 Epicenter Location of 1935 Quetta Earthquake

Given below are few glimpses of destruction caused by the above given earthquake.

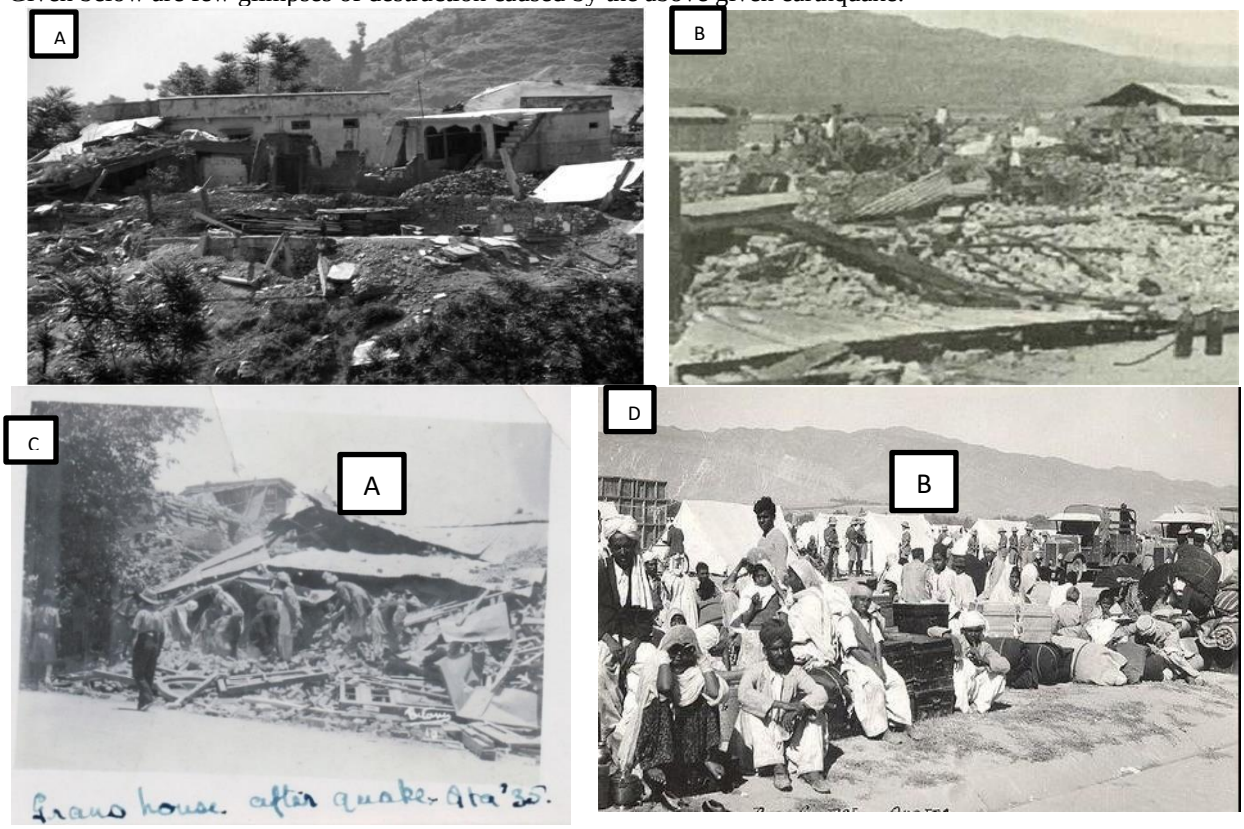

Fig. 2.2 Destructions in Quetta after 1935 Earthquake (source by Pakistan meteorological Department). (a, b and c) The damaged caused by earthquake; (d): The displaced people after the earthquake triggered the Quetta city

Fig. 2.3 Destructions in Awaran Balochistan after 2013 earthquake. (a) to c: The damaged caused by earthquake; (d): The displaced people after the earthquake triggered the Quetta city

2.2 Tsunami in 1945

In 28 November 1945 at the 1:56 am a gigantic earthquake in the Makran Coastal belt of Pakistani Balochistan. It became the huge and pestiferous Tsunami zone of Northern Arabian Sea in the Indian Ocean (USGS). The notorious epicenter stood at 24.5 N 63.0 F to the northern Arabian Sea, approximately 100 km south of Karachi. The earthquake was 8.1 magnitudes. In this inordinate fortune the 4000 people were died. The documented population of effected belt at that interval was about to 10,000.

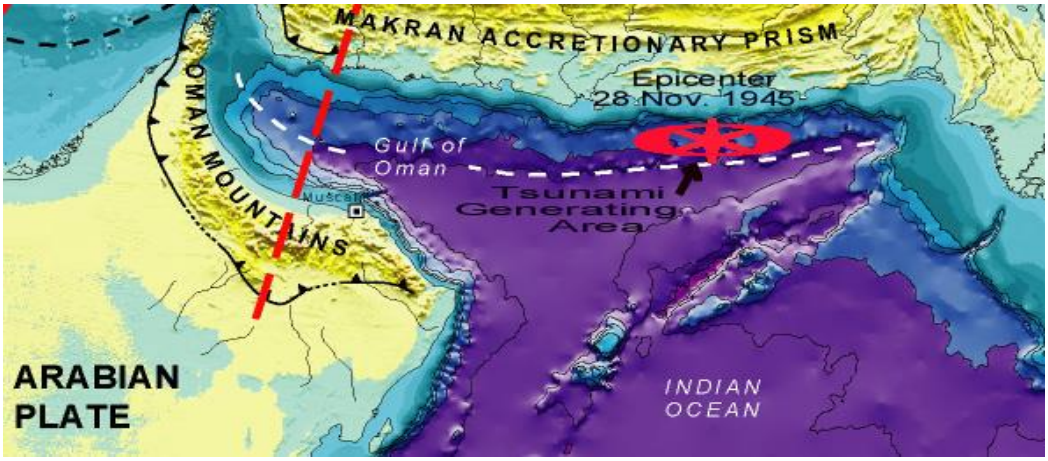

Fig. 2.4 Epicenter Location of 1945 Tsunami Earthquake, Makran-Coastal (Arabian sea-potential of Tsunami generation along. drgeorgepc.com)

2.3 Kashmir Earthquake in 2005

7.6 magnitude earthquakes in Kashmir corridor at the Indo-Pak border and portion of north western Pakistan occurred on 8 Oct 2005, as reported to official figures at least 73,000 massacred and there were more than 3.3 million people displaced (USGS and GSP).

2.4. Seismic Hazard Risks in Pakistan

The earthquake movements in Pakistan are basically absorbed in way of north and western belt onward the boundary of country attributable to Indo-Pak plate with to the Iranian and Afghan micro-plates (Nowroozi and A.A., 1972). The Chaman fault situated pole position in to existence at Pakistan's western boundary with Afghanistan in contrast to Kalat to the northern Makran series sketched to Quetta and then towards to Kabul Afghanistan (Kazmi, A H, Farah, A and KA 1979). A fault is also active at the distance of the Makran Coastal belt and it has scientifically understood that the Arabian plate is subducting into the Eurasian plate and the major fault has been created by the earthquake of 2013 that because of Hoshab fault and this fault has been extend to west ward and his zone formed the margin amongst the Arabian and Iranian Micro-plate wherever the farmer subduction beneath the latter (Kazmi, A.H. & M.Q. Jan. Geology and Tectonic of Pakistan,1997).

Thrust territory run laterally at the Kirther, Sulaiman and Salt range, there are four nominated faults and around at Karachi segment and other chunks of the deltaic Indus and Makran Coast (Rana and Kazmi., geology of Pakistan). The headmost is the Allah Bund fault that contributes through Shahbundar, jah, Pakistan steel Mills, then run wound up eastern parts of the city and trimmings near cape Manz, this fault has been causes extensive impairment in the past many centuries in the positioned areas.

The demolition of Bhanbar in the 13th span and the damage to Shahbundun in 1896 were produced by this active fault, and further one originated from the Runn of Kutch, the next one is the Pub fault which has saturated end of Arabian sea near Makran Coast and the preceding one is located in the inferior to Dadu district near Surajan and near of Karachi. (Kazmi, A.H. and Rana, 1982; Kazmi and Jan, 1997).

3. THE AWARAN DISTRICT

The research is entirely about the 2013 earthquake in district Awaran Balochistan, which is situated south west of Pakistan, the latitude of 26° 45' 55" and longitude of 65° 23' 12" from the east to west.

3.1 Geography and Climate

District Awaran is situated in central of Balochistan and also SW to Pakistan. It is bounded in the north-west by Kharan district, at border to north-east with Khuzdar district, some areas at east and south escorted with Lasbela district and in the west amidst to district Panjgur and into the bargain to the district Kech. The administrative division of the district is 21,630 square Km. The climate of Awaran regime is mostly hot during the summer perhaps cool in winter, dust tempests are experienced throughout annually.

Tempest becomes very harsh subsequently June to September locally known as Liwar (hot air) and the days in Summer are hot but the nights are ordinary. The winter season is cool, very limited rains in this zone. The rain falls broadly throughout the months of April to July as reported by meteorological figures thus the district credibly placed in "Semi-arid hot at summer and mild winter climatically. The rainfall at this area is revealing and uncertain, normally it begins to April to via July, minute rainfall is furthermore recorded throughout December to January.

3.2 Demography and Housing Population

Awaran district has quite limited population but have a huge land in the province, followed by the 44 years since 1951 to 1995, the population of the area has approximately increased 530%. This is one of the rising situations. It also needs to control the quick growth of population that will critically affect development in the district.

The normal house hold size in the district was 6.6 in 1988, whereas it was probable to be 6.5 in 1991. This displays that there was hardly any variation in the house hold size since 1981 to 1991. since 1980 housing survey the most (78%) of the housing parts were single-room. The two-room housing parts were only 14%. Gathering in terms of persons per housing unit & person per room remained six and five separately. For safety and prudish reasons all houses have a multiple wall.

In nearly 1981 entirely houses were occupied by the owners themselves, and few houses were assumed free or rent. After establishment of the district the appointed offices were open at the district headquarters; therefore, some houses were rented for offices, no precise figures regarding the tenure were accessible.

3.3 Drinking Water and Hygiene

The leading sources for drinking water are unoccupied surface wells and springs. The Public Health Engineering Department (PHED) has finalized 34 water supply systems in the domain, whose definite reporting seems much little than the claimed i.e. 60.7% of the population. Local Government & Rural Development (LG&RDD) is correspondingly providing community hand pumps at the highly needy belt, whereas involving the community up to March 1996, LG&RDD has fitted 25 hand pumps in Jhal Jhao and 209 in Awaran urban such as Peerandar, Mashi and Theer Tej. This system has been very fruitful for the people in the area, no suitable sanitation system happens in the region, there are only some housing units have latrine facilities exist.

4. SEISMIC NARRATIVES OF AWARAN EARTHQUAKE

The Pakistan Metrological Department (PMD) provided the seismic observatory data which examined the following different constraints of the premier shock:

Date: 24.09.2013
Time: 15:29:50 PST
Magnitude: 7.7
Epicentral location: 27.09° N, 65.61° E
Focal depth: 10 km.
(Monalisa and Jan, 2015*)*.

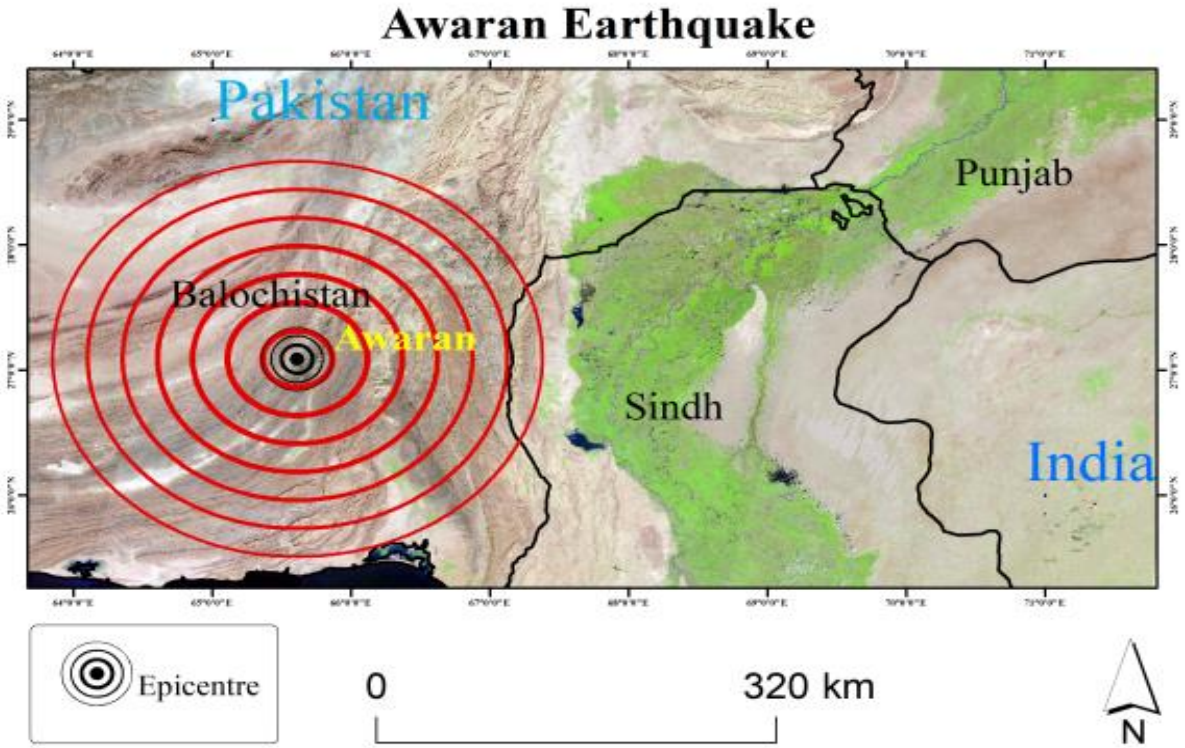

Fig. 4.1 2013 Awaran Earthquake Zone

5. THE TECTONIC SETTING

Geological evidences proved that the tectonic of southern and central Pakistan replicate a multifaceted plate boundary (Qureshi., et al 1993). An Indian plate transparencies northerly side to the Eurasian plate cutting-edge to the east, then Arabia plate actively subducting with northward underneath to the Eurasian plate at the Makran range at western Pakistan (Kazmi and Rana, 1982). This is very slow motion but it is continuous being, this motions naturally outcome in north-south to northeast-southwest promoting huge strike-slip fault that's great reason and also sign at the origin of the Awaran earthquake thus that took support from the Chaman fault - Ornach Nal fault, absolutely through the earthquake possibly arise to the southern-most components because of these active fault, additional the geological evidences will mandatory to recognize the exact fault associated by ensue event.

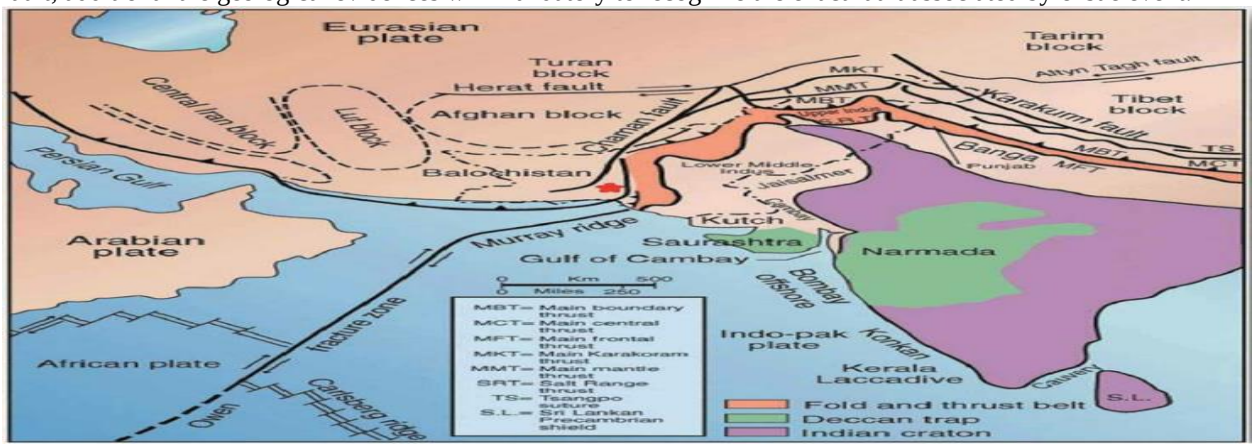

Fig. 5.1 Tectonic Settings of Awaran Region (MonaLisa and Jan, 2015)

The Geological Survey of United States (USGS) described that on Tuesday 24 September 2013 at 11:29:48 UTC. the earthquake happened at the depth was alerted 15 km (9.3 mi). The earthquake has reported taken about a minute, producing shock in areas of south part of Pakistan.

Table 2 showing the different active Faults in south-western Pakistan specially in Balochistan . The 24 September, 2013 Awaran Earthquake and the Chaman (No. 62), Ghazaband (No. 60), Ornach-Nal (No. 35), Aghor (No. 34), Ras Malan (No. 33), Hudishi (No. 31), Awaran (No. 29), NaiRud (No. 23) faults shown in table. (Kazmi and Rana).

Table-5.1 Major Fault Zones in Balochistan

1. KIRTAKA F	23. NAI RUD F	43. JHIMPUR F	64. SARUAB SARAB TANGI F
2. SAINDAK F	24. GURANGATIIF	44. RANN OF CUTCH	65. JOHAN F
3. WA SHAP F	25. JHAL JHAO F	45. TALHAR F	66. MACH F
4. MASHKI CHAH	26. KAPP F	46. SURAN F	67. MUSHKAF F
5. DALBANDIN F	27. BAZDAR F	47. LAKHNI F	68. BIBAI F
6. AHMADWAL F	28. PIRANDAR	48. BHIT JANT F	69. GOGAI F
7. BAN F	29. AWARN F	49. KHUDE F	70. TAKHATU F
8. USMAN	30. LALAANDARI F	50. KIRTHAR F	71. CHINGAN F
9. GARPUK RASKOH F	31. HUDUSHU F	51. GAJ F	72. MALIK SALAR F
10. MUKAK F	32. SISTAG F	52. KARKO F	73. MANA F
11. LADGASHT F	33. RAS MALAN F	53. ZARDAK F	74. ZIARAT F
12. MASHKHEL F	34. AGHOR F	54. KOTRA F	75. KHALIFAT F
13. KHARAN F	35. NA ORNACH F	55. GANDAVA F	76. HARNAI F
14. GARRUK KHARAN F	36. SONMANI F	56. LEHDO F	77. TATRA F
15. SIAHAN F	37. BELA F	57. NANGU F	78. TADRI F
16. GQANI RIVER F	38. KULRI F	58. PANGRAN F	79. BARKHAN F

17. RAHGAI RUD F	39. WINDAR F	59. KALAT F	80. KOHLU F
18. PUNJGUR F	40. MOR F	60. GHAZABAND F	83. KINGRI F
19. HOSHAB F	41. PAB F	61. BHALLA DHOR F	84. MANKHAWA F
20. KULMIR SUNT F	42. HAB F	62. CHAMAN F	85. CHAUDHWAN F
		63. CHILTAN F	

The geological study claimed that earthquake occurred because of strike slip fault type motion mostly shallow crustal depth, the position and mechanism of active zone or read zone are reliable by separation within the Eurasian plate overhead and originated Makran Trench Subduction zone also known Makran Accretionary Prism or Makran Subduction Zone, the geology of Makran mountain series to a thick sequence of sandstone, mudstone, shale and minor conglomerate of the costal belt of Makran region. (Blandford, 1872). He was also reviving that the Makran system of mountain his divided in to three different systems, firstly highest dominantly sandstone, which he coined of Higlaj system as Makran system is also have upper part of Gwader formation and the lower part is Talar formation, it has mapped in several areas. The cost of makran between the jiwani and the hingal river. Mostly of capes, headlands or hill overlooking, the shore as Ras Saknni, Ras Oramara, Ras Jiwani, Gwadar and jabal haro. mainly of rock are Astola island. (Vredenburg,1925). The occasion occurred privileged the variation zone among northward subduction of the Arabian plate beneath with Eurasian plate and also northward collision of the Indian plate to the Eurasian plate (Kassi et al., 2013).

6. HAZARD ASSESSMENT AND MITIGATION

Both secondary and primary data used for this particular research. The research approach is explanatory in nature. Primary data is the collected by the affected people through key informant interviews, we make checklist and distributed among 20 affected people to know their perception about the stakeholders and PDMA's response after the earthquake. Although the research was all about the practical approaches in different sources government non-government organizations and also well approached the scientific research organization, somehow, we utilized reliable and authentic sources such as, BBC news, Down newspaper, Jung newspaper express newspaper, magazines, research papers, NGOs report, etc. So there are some area where were we used secondary data. The research evaluated from all historical earthquakes all over the world and also Pakistan subsequently the Balochistan specially the Awaran district; the research further analyzed the scientific evidences of the earthquake and also the general responses of different organizations. After collecting primary to secondary data, research analyzed the overall condition of Awaran earthquake.

The research describes the geoscientific and historical background, affected of earthquake and also the awareness for the people about earthquakes. Father, it describes information about the overall earthquake of Awaran which occurred in 24 September 2013, research had grass rote information about the overall response of this earthquake and the government and or non-government organization sectors have done effective role for the recovery of Awaran people. Someway, it described the huge experience that how to deal natural disasters in the affected area and how to respond to the impacts of natural disasters, and also make sufficient to distinguish the point out of the institution regarding concern issues, however, during the research visited the concern area and have accomplish interview some of the effected limitation regarding the response of the maintained earthquake.

6.1 Proposed site for construction

The earliest history of district Awaran is the same as of Khuzdar and the southern area of Balochistan province. As declared in the gazetteer of Jhalawan. "Sir T.Holdich, assumed that Karteros departed by the Mula Pass. District Awaran covered a big area nevertheless the area possibly available for cultivation extremely limited. The topographical part with in secretarial boundaries of the district is 2,162,948 hectares. The area actually not reported is 55.5%. The statics displays that the reported area in Awaran is 963,388 hectares. i.e. 44.5 percent. Cultivable excess is lone 0.7 percent.

Possible area presented for cultivation is 87,612 ha (4.1 %). The area surely further developed for agricultural purpose.

6.2 The Pakistan Development Management Authority (PDMA) Response

Awaran earthquake extremely affected in that area, however, the initial response has been taken places by area people and further taken by provincial government. The organization started the compagain to rescue the public from effected areas. Accordingly, within first 24 hours the government was mobilized in Awaran. After that the different organization touched for rescue and help but the most effective response came from PDMA by providing shelter, food, water etc with regular steps. Accordingly the PDMA took the step by facilitated doctors, medical etc. After that the international Red Cross came to help by giving treatment such was providing medicines, taking them

in various hospitals eg. In Karachi and also given temporary base medicines camp. Moreover, the most responsible organization of this incident PDMA tried to facilitate the effected persons and according to website of PDMA, the basic and necessary things have been provided by PDMA on daily basis.

The rescue was the first step of PDMA, in which it provided the below medicines and treatment materials for Awaran people.

Doctors	52
Paramedics	63
Ambulances	37

Also 4.5 million rupees have been granted by PDMA for health of Awaran people.

These were the basic and very important steps have been taken by PDMA for health.

Total distribution of materials by PDMA are calculated as:

MI 17	80.36 Tons
Trucks distributed	1098
Total Ration	5243
Total Tents distributed	37022
Total patients treated	12742

6.3 Contribution of International Federation of Red Crescent Societies

The contribution Pakistan Red Crescent Society (PRCS) with the provision of international federation of Red Cross with the help of Red Crescent Societies (IFRC) is considering a disaster Relief emergency fund for rejoinder. The Pakistan Red Crescent society (PRCS) established appreciated emergency services after Awaran earthquake.

PRCS has NFIS after the Disaster Preparedness (DP) stock in realm on standby to contribute approximately 30,000 families. FRCS similarly provided trust for affected areas, public especially for Awaran where it provided 30.000 million. More it gave 1000 NFL kits and 1000 food parcels to assist roughly 7000 affected people in Awaran.

CONCLUSION

A certain earthquake contingency has unrestricted magnificent seismic energy in NE-SW direction laterally the Chaman- Ornach Nal Fault contribute to Makran Subduction Zone (MSZ), conversely that has augmented the increased the all tectonic stress towards the north and southeast, in future that absolutely cause countless seismicity in these territory, the probability of the great destructive earthquakes in the future initiating unpredicted damage. It is, consequently, recommended that an operative National Seismic Hazard Study database ought to examine with importance on accurate delineation of high danger zones at the tectonically.

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