7-2020

Geospatial Analyses of Seismic Hazards and Risk Perception in Libya

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Geospatial Analyses of Seismic Hazards and Risk Perception in Libya

A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy in Geosciences

by

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July 2020
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ABSTRACT

Libya is not considered a highly active seismic region. However, several earthquakes of magnitude >5.0 have occurred there. This dissertation analyzes the seismicity of Libya in order to better understand earthquake hazards, related geomorphic features, and the current evolution of Libyan perceptions of seismic risk. The first article developed a baseline of past and current seismic inventory in Libya, which represented an assessment of Libya seismic hazard by translating, analyzing, and compiling historical sources and archaeological data. This study shows that Libya has experienced earthquakes in varying degrees since ancient times. Through the spatial and temporal distribution of earthquakes from 1900-2019 strongly suggest Libya can be divided into three seismologically active regions. The second article uses remotely-sensing images to identify seismogenic surface features in different locations in the country. Different geomorphic features are identified and classified through multi-scalar techniques and represent the crucial procedure in identifying potentially hazards seismogenic features. The final article uses the administration of survey instruments to assess post- and pre-event perception of seismic hazard and risk in Al-Marj – a city razed in the 1963 earthquake. Demographic, educational, economic, hazard, and vulnerability questions in addition to Likert-scaled responses are used. This study finds that the correlations between demographics and Likert-style responses revealed the differences in perceptions between age, education, technology, and gender categories, in addition to the general lack of belief in the use of seismic predicting. When natural hazards in Libya like earthquake recurrence are better understood, then the potential consequences of injury, damages, and deaths may be assessed, and an overall plan to decrease risk can be created and implemented.

Keywords: Earthquakes, Seismic History, Seismogenic Features, Risk Perception, Libya.

ACKNOWLEDGEMENTS

This dissertation is the result of the unwavering support of many around me along with this experience, so I am endlessly thankful for them.

First, I would like to thank my outstanding advisor and mentor supervisor, Thomas Paradise. He has taught me many things about seismic activities and related geomorphologic features, and hazard and risk perception. I am also grateful that he has been opened to discussing problems and provided the important sources for my research, and that he has been extremely patient with me. I appreciate the support and guidance that he gave this work from the beginning through the final revisions.

I would also like to thank my committee members of my advisory, comprehensive examination, and dissertation committee: Aly, Davidson, Holland, and Tullis for their academic support. Thank you to the University of Benghazi _ Faculty of Arts and Science – Al-Marj where the survey was carried out by Basma Suliman and thank you to Omran Elshaab and Mohamed Alhamrosh to assisted in carrying out the survey to the survivors and residents of Al-Marj. I am grateful for financial support for this research from the Libyan Transitional Government - Ministry of Higher Education and Scientific Research.

Finally, thanks to my family in my home country; it is exciting to be the first in my family to earn a Ph.D.! And most importantly, I owe a sincere debt of gratitude to my husband, Khaled. He has supported and believed in me in many endeavors. This journey truly would not have been completed without his constant support and interest. Though this journey has taken longer than we both expected, I am excited to move on to see what the next stage in our life brings.

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CHAPTER 1: Introduction

1.1. Natural Hazards and Disasters

Hazards in general are defined as threats to humans and their properties (Slovic, et al., 1985), and natural hazards are natural occurrences of phenomena or dangerous events over which humans have no control (Steckler et al., 2018) Natural hazards are geophysical or Hydro-meteorological events, such as volcanic activity, earthquakes, landsliding, flooding, drought, and, blizzards (Petak & Atkisson, 1982). They have the shared characteristic of posing danger to the different societies of the earth, however, such danger is not only the result of natural processes (Alcántara-Ayala, 2002).

The term 'natural hazard' sometimes creates a kind of ambiguity or confusion. Though it has been used with different implicit meanings, the term has developed with understanding of the components that react to include hazardousness. Natural hazards represent the possible interaction between a society and extreme natural events. When natural hazards constitute a threat to individuals, they become natural disasters. In other words, hazards represent potential events while disasters result in actual events, so only after a natural event occurs is it termed a 'natural disaster'. Such a process continually exists, representing an intrinsic power with which all societies must cope and manage in one way or another (Tobin & Montz, 1997).

Traditional approach of natural hazards attributed all or almost all their destructive responsibility to the processes of the geophysical world. This view meant that the main cause of large-scale destruction and death has been ascribed to the extreme nature rather than including the human world. Thus, the physical world has been considered as an external force separated from human forces. For instance, Burton and Kates (1964:413) defined natural hazards as "those elements in the physical environment, harmful to man and caused by forces extraneous to him."

However, early researchers, in fact, concern themselves with the human dimension. White (1974) and many other scholars established hazards research as a human-based discipline although the definitions and classifications they created were oriented toward physical extremes. Soon and through their contributions, it was recognized that the system of human-use could not be ignored. Thus, by the 1970s natural hazards were defined more liberally: "The concept of natural hazards is somewhat paradoxical; the elements of a natural geophysical event (e.g., wind and storm surge of a hurricane) are hazardous only when they prove detrimental to human activity systems" (Baker, 1976:1). Then, the initial challenge to the dominant hazard paradigm appeared (Waddell, 1977; Torry, 1979).

Since the 1980s and early 1990s, more steps were being taken toward human explanation of natural hazards which were seen as the product of an interaction of physical and human forces that in combination determine the significance and impact of disasters (Smith, 1992; Middleton & O'Keefe, 1997). Smith (1992) in his book discussed that natural hazards were produced by a conflict between geophysical processes and humans; thus, hazards lie at the association between the natural event and the human use systems. The United Nations International Strategy for Disaster Reduction in 2009 defined natural hazards as: "any natural process or phenomenon that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption or environmental damage." Smith (2013) argued that this description focuses on the hazards unaffected by human actions, so he suggested that though all natural hazards are produced by physical forces, certain events and their results may be influenced by human activities.

1.2. Earthquake Hazards

Several million earthquakes occur annually worldwide with an average of 18 earthquakes ≥7.0 magnitude. An estimated 801,629 deaths have occurred (2000–2015) as a result of earthquakes (USGS, 2020).

Deformation at the Earth's surface, mostly adjacent to tectonic plate boundaries, is the manifestation of forces that acting deep within its interior. Geodetic and seismological measurements provide the fundamental data for understanding mantle dynamics, lithospheric processes and crustal reaction, as well as for improving numerical modeling for forecasting disastrous events such as earthquakes and volcanos. Significant advances have been made in earthquake research and risk reduction. However, the nature of big seismic events presents extant research needs. Predominately with more widespread occurrence than volcanic hazards and consequent loss impact that is much higher than that of even more widespread subsidence and landslide hazards (IGOS, 2004). In earthquake science, research requirements include documenting the location, slip rate, and earthquake history of dangerous faults; understanding the dynamics and kinematics of active fault systems on interseismic time scales and its relation to constructing probabilities of occurrence; and predicting strong ground movements and non-linear surface layer response (NRC, 2003). Such contributes to better seismic risk management and prediction on a global basis.

1.3. Scope of Work

Libya is located at the south-central Mediterranean coast, and on the northern boundaries of the African continent and has been seismically active as consequence of the relative motion of the African and European tectonic plates. However, the related geomorphic features and zones where surface faulting and landscape change may occur, and public perceptions of earthquake risk are still poorly identified and understood. This underscores the necessity to study past and active seismicity and its perceived occurrence and danger in Libya, and to Libyans.

This dissertation investigated the seismicity of Libya in order to better understand earthquake hazards, related geomorphic features, and the current evolution of Libyan perceptions of seismic risk. The study provided a comprehensive view of the seismicity of Libya in the country and region. The earthquake history of Libya is crucial in the evaluation of future seismic activities since past earthquakes suggest where future earthquakes will occur, and how great the magnitude, using remote sensing to map related seismic features, and to assess risk perception in the hopes of identifying individual and community behavior toward future earthquakes. Also, it is a significant step in creating Libya's first national earthquake policies in effective mitigation and structural construction standards, and to assist in the preparation for future hazardous events and risk analysis. Results of this study are not only expected to contribute to the greater understanding of the seismic activity in Libya, but to advance knowledge of large scale earthquakes in Libya, North Africa, and Mediterranean Basin.

This dissertation covers three distinct concentrations within identify and understand seismic hazards and disaster risk reduction: (i) create a baseline of past and current seismic inventory in Libya, which represents an assessment of Libya seismic hazard; (ii) create a current archive inventory of geomorphic features related to seismic activity that is identified through conventional remote sensing methods, including faults, scarps, graben complex, en echelon faulting, strike-slip faults, and offset wadi channels; and (iii) create an assessment of current risk perception through the administration of survey instruments. The targeted respondents for the survey would involve stratified samples from the city of Al-Marj and its surrounding district.

CHAPTER 2: Study Site

Libya, a country in the Maghreb region in North Africa, is bordered by the southern coast of the Mediterranean to the north, Niger and Chad to the south, Egypt and Sudan to the east, and Tunisia and Algeria to the west. Libya lies approximately 18° and 33° North of the latitude and 9° and 25° East of the longitude, with an area of 1,759,540 square kilometers, of which more than 90% is desert (Al-idrissi et al., 1996). The country extends about 1,525 kilometers east and west and as much as 1,450 kilometers north and south (Conant & Goudarz, 1967). At 1,770 kilometers, Libya has the longest coastline of any African country bordering the Mediterranean Sea: considerable distances between the two main cities of Tripoli, the largest city and capital, and Benghazi, the second-largest city at opposite ends of the country (LB, 2004) (Figure 2.1). Most of the agricultural activities in the country are limited to a long narrow strip along the Mediterranean coast, low mountains and sparse oases in the desert. The prevailing climatic conditions are typical of the Mediterranean region along the coast characterized by variability and unpredictability. The rainfall is erratic in quantity, frequency, and distribution, and it is dry in the extreme desert interior (Al-idrissi et al., 1996). The population of Libya in 2018 is about 6,754,507 people according to Central Intelligence Agency (CIA, 2019).

2.1. History

The name " Libya" has been used since ancient historical times. It is mentioned in ancient Egyptian books and texts four thousand years ago. The name was in classical times used to denote all Africa or Africa west of Lower and Middle Egypt which was home to several Libyan tribes that were famous in the history of Pharaonic Egypt (Bates, 1970). When the Greeks came to North Africa around the seventh century BC, they called the word Libya on all the areas surrounding their five cities in Cyrenaica (Benghazi, Tocra, Al-Marj, Shahhat, Susah) which was known as Pentapolis, and then expanded their use of this name until they called it all

Figure 2.1: Libya location. Cartography by author, 2019.

the areas they knew in the north Africa between the Nile River in the east and the Atlantic in the west (Bolkma & Al-Qaziri, 1995). The official use of the word Libya in its geographical concept in the field of international politics began with Italy's attempts to control the country (Sharaf, 1971).

Libya has a long culture history as a center of Phoenician, Carthaginian, Roman, Berber, and Arab civilization. At the beginning of the recorded history in the region, the residents of Libya were possibly descendants of the same people who lived there during the Neolithic time. Herodotus, writing in the fifth century B.C., mentioned that Libya was inhabited by two indigenous races, the Libyans in the littoral areas and the Aethiopians in the interior (Rizkana, 1964). The Aethiopians correspond to the ‘‘Negroid and African element’’ of the population. The Libyans, from whom the current Berbers are descended, were people of Mediterranean inhabitant who were also found in different parts of southern Europe. Until the time of the Phoenicians, the first to establish trading posts in Libya around 1000 B.C. (Halsall, 2019), the Libyans still lived in a Neolithic age of development, but they had instituted small agricultural communities. The Garamantes were one of the largest tribes that sedentary and lived in Fezzan, where they raised cattle. Between the eighth and 12th centuries B.C., the Phoenicians colonized Libya. They inhabited, in large numbers, in western Libya and introduced more efficient methods and improved implements for agriculture (Rizkana, 1964). At the same time, a powerful colony of Greeks was settled in northeastern Libya at Cyrene (Figure 2.2). In the third century B.C., the Carthaginian Empire extended into Libya, and then the Roman Empire influence began after about 150 B.C. Under the Romans, the conservation method and irrigation brought new life to agriculture. In about 644 A.D., The Arab influence began in Libya, and in 1551 Libya became a province of the Turks, whose power controlled the country until 1911. In 1911 Italy stated war on Turkey, and in 1912 Libya became an Italian colony. A large-scale development program with the concession of large tracts of land was launched to Italian settlers from 1930 to 1940. In the early years of World War II, Libya became a battlefield, and in 1943 the Allied forces occupied the region. After World War II the country was under the control of the United Nations, then Libya received its independence on December 1951 (Goudarzi, 1970).

Figure 2.2: The temple of Zeus in the ancient Greek city of Cyrene, NE Libya. Photo by Stanley (2010).

2.2. Geological Evolution

Libya, located on the Mediterranean foreland of African Shield, expands over a platform of cratonic basins (Figure 2.3). These basins were active during the late Tertiary and Holocene periods (Al-Heety, 2013). Except for the narrow coastal strip and the ranges of the mountains that it overlooks on the south side of Baraka and Tripoli, Libya is part of the Sahara Desert, most of which share its history and geological composition, with some local exceptions. Thick layers of sediment are found everywhere on top of deep and poorly understood Precambrian igneous and metamorphic crystalline basement rock (Burollet, 1963) that make up the African continent in general. This base appears on the surface in some places where the erosion factors can remove the morphological formations that were covered. Directly above the basement rock,

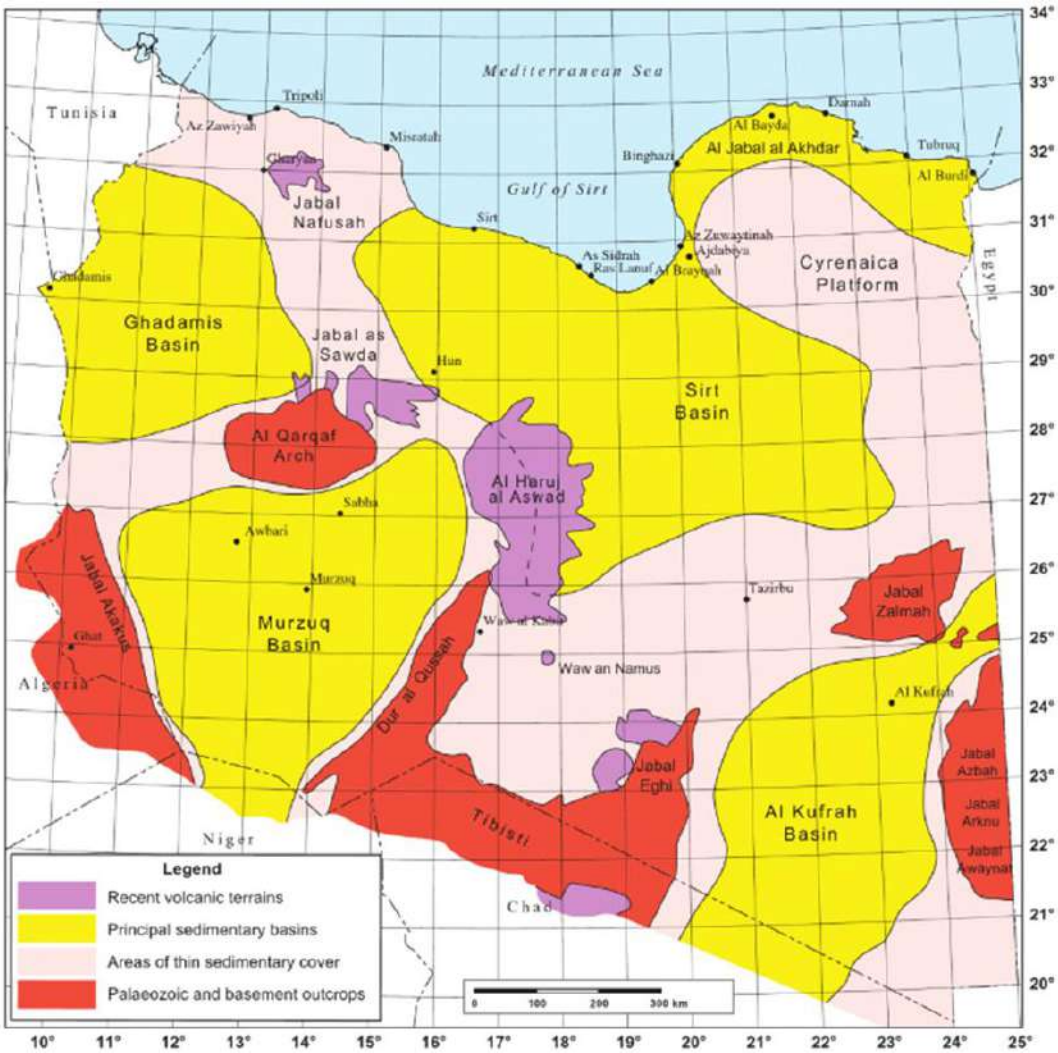

Figure 2.3: The four principal geologic basins in Libya (Hallett & Clark-Lowes, 2017).

there is a thick layer of the first geological time rocks (Paleozoic) (Klitzsch, 1963) including layers of limestone and clay rocks, and other layers of sandy sand with continental origin. All these layers were not affected by the folding or tectonic movements except in limited areas (Sharaf, 1971), especially in the north-west, where the base of the Atlas Mountains is formed (Lobeck, 1946). However, these layers were heavily influenced by the various erosion factors, which caused many depressions, and in the appearance of many rocky hills that remained prominent above the surface of the earth, after the erosion around them was reduced to less formation than hardness. It is possible that the entire region was exposed in the third time to some ground movements that resulted in changes in the level of the surface of the earth, and the emergence of some torsions and refractions, particularly in the era when the Atlas mountain ranges. Much of the northern Sahara, until the early Cenozoic, was part of the ancient Eocene Sea, extended at least as far south as lat 23° N. In the area of Libya in particular, the ancient Gulf of Sirte was greater than it is at present. It was a huge arm to the south, extending to latitude of 25 north. It included a large section of the current basin of Fezzan (Sharaf, 1971). During the early and middle Eocene, shorelines of northern Africa slightly regressed. A carbonate stage covered most of the marine domains, but the western and southern Sirte gulf then exhibited intercalated evaporitic sedimentation (Burki & Abu-Khadra, 2019).

In fact, the third time is the most important geological times in terms of the tectonic movements that occurred during it, which had a large income in shaping the manifestations of the surface of the desert in the image that still exists so far. The third time also witnessed some volcanic activity in various parts of the desert and in the mountain range in Tripoli, as evidenced by the volcanic cones, whose remains are still represented in the mountains of Awainat, Arkno, Tibesti and Tamo, in the area of Mount El-Suda and in some parts of Al Jabal Al Gharbi (Sharaf, 1971; Goudarzi, 1980).

2.3. Geological Formations of Libya

2.3.1. Precambrian

The most important Precambrian rocks are the volcanic rocks that are found on south-central and west-central Libya, especially in the mountainous areas such the Tibesti region (Guiraud et al., 2005), the Kufra Basin (Lüning et al., 2000), Jabal Eghei, and Jabal Fezzan (Goudarzi, 1970), where erosion processes and some ground movements can reveal these rocks and show them on the surface (Sharaf, 1971), the most important of which is granitic (Goudarzi, 1970).

2.3.2. Paleozoic

By the beginning of the Paleozoic, large areas of Libya had been peneplaned as evinced by Precambrian rocks wherever uncovered (Goudarzi, 1970). During the Late Silurian Caledonian orogeny initially, uplift and erosion defined the limits of the Paleozoic basins of Libya. Deposition of mostly continental siliciclastics during the Cambrian and marginally marine to marine siliciclastics during the Ordovician and Silurian continued (Carr, 2002) without interruption from west to east the country (Bellini & Massa, 1980). During Cambrian times the initiation of sedimentation and marine transgression was diachronous. Over a large region, Fluvial or estuarine sandstones were deposited over wide basins in the Hassaouna Formation of Libya (Guiraud et al., 2005). Cambrian and Ordovician rocks are exposed in the Murzuk basin, in Jabal Eghei, in the Tibesti area, in the Jabal Awenat-Jabal Arkenu area, in southern Libya (Goudarzi, 1970).

2.3.3. Mesozoic

Thick layers of sandstone belong to the early formations of this era, and they cover most of the southeast part of the country, but they disappear in many places under the modern sand and gravel formations, and from these rocks, It is formed most of the Hamadat regions in Fezzan. In the north of the country there were few Triassic, Jurassic formations, but in very limited places. The Cretaceous creations are the largest geological formations in the region of Tripoli (Sharaf, 1971). Several hundred meters of sediments was deposited in deep and shallow troughs along the Mediterranean shores during the Mesozoic. The thickest exposed Mesozoic section exists in Jabal Nefusa escarpment of northwestern Libya where the escarpment exposes Triassic, Jurassic, and Lower and Upper Cretaceous rocks (Goudarzi, 1970).

2.3.4. Cenozoic

The ages of this era are widely represented, especially in northern Barka and in most of the lands extending from the Gulf of Sirte in the north until near the line 26° north of the south, which was covered by the ancient Gulf of Sirte until the early third time (Sharaf, 1971). Paleocene beds cover the major part of the Hamada al hamra' plateau. They are exposed along the Hun graben faults and south in a long narrow strip west of the AI Haruj al Aswad. Also, Paleocene rocks have been identified near Jabal Dalma close to the Egyptian border. The formation of the Eocene in the south and west, in Tripolitania, in the Sirte area, and extend to the south in Fezzan near the Tibesti foothills (Goudarzi, 1970; Guiraud et al., 2005). These rocks are also the basis of the base of the region of the Green Mountain and the Meusean plateaus extending south of it. Eucene rocks also show small patches on the green mountain itself to the west of the town of Marawah and on its outer slopes and in some aspects of its deep religion (Sharaf, 1971). Rocks of the Oligocene Series crop out in Cyrenaica and in the Sirte basin. The Miocene era consists of the rocks of most of the plateau and hills of the north of Barka, and these rocks continue to stretch in a wide range to the west, which consists of extending south of the Gulf of Sirte, but the scope gradually narrowing to the west until it disappears Almost at Wadi al-Kabir (Goudarzi, 1970).

2.4. Landscape

Libya occupies a great area of the Sahara Desert. This desert is a vast plateau extending across north Africa from the Atlantic Ocean in the west to the Red Sea in the east. In fact, the landscape of Libya is not different a lot from the rest of the desert areas that surround it. As it is a part of the vast plateau, and this plateau gradually descends as we move north to the end of the Mediterranean coast in the north (Figure 2.4). It is gradually being completed in some areas, as in the area around the Gulf of Sirte, and suddenly in other areas, with the northern edge of which there are existing or very steep cliffs, such as in Al Jabal Al Akhdar (the Green Mountain) and the Al Butnan and Dafna Plateau in the east, and in Al Jabal Al Gharbi in the west. Thus, while the northern sides of Al Jabal Al Akhdar and Al Jabal Al Gharbi descend abruptly towards the coast or the coastal plains separating it from this coast, the southern slopes of the same mountain the slope gradually descends towards the desert (Al-Haram, 1995).

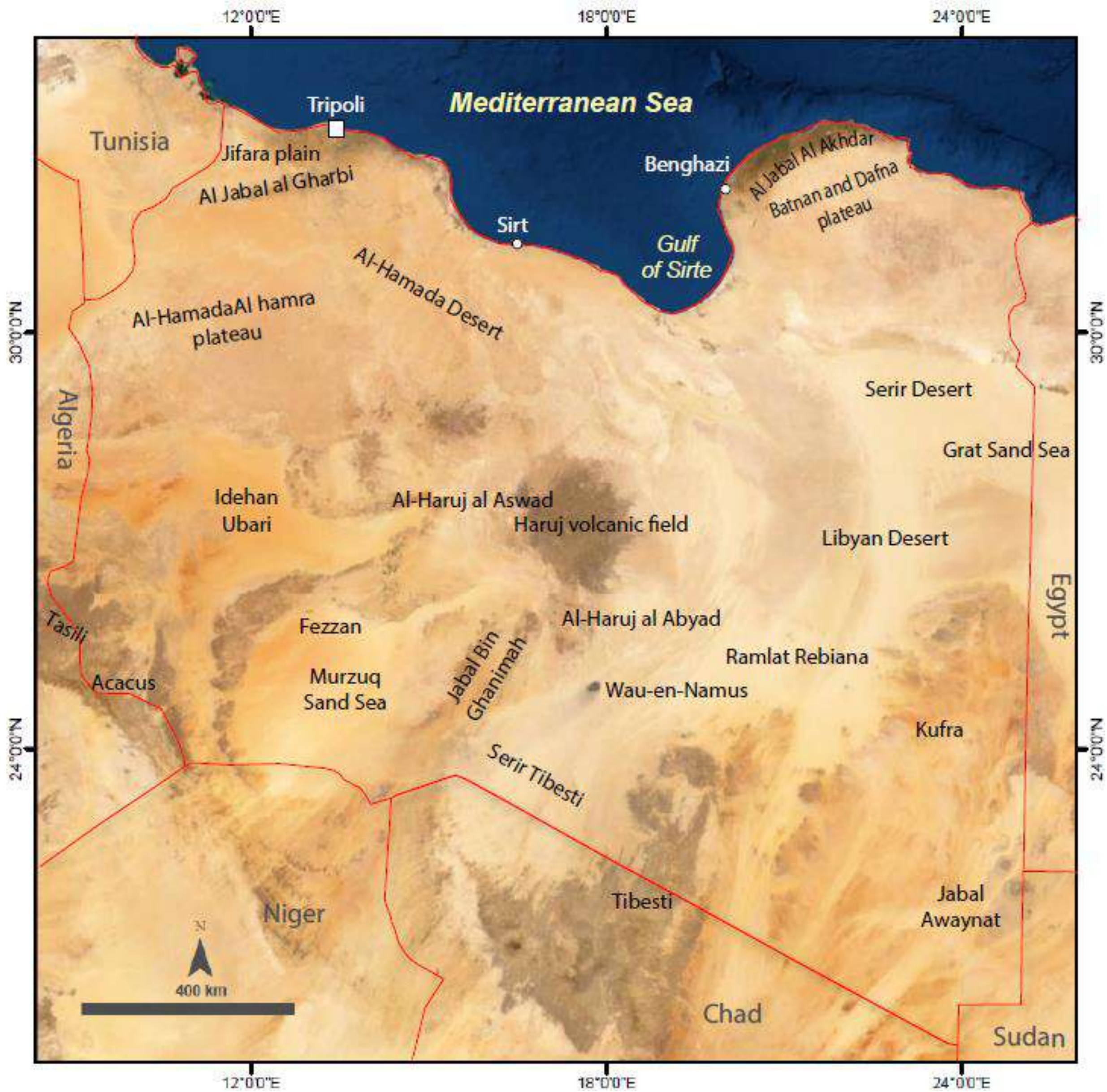

Figure 2.4: Satellite image of Libya shows main landscape. Cartography by author, 2019.

Although Al Jabal Al Akhdar and Al Jabal Al Gharbi (Figure 2.5, 2.6) range seem from the sea side, as if they are two great mountain ranges, the launch of the word Mountains is much to exaggerate because of their low altitude, compared to the Atlas mountain ranges or other world's largest mountain ranges. The average height of Al Jabal Al Akhdar and Al Jabal Al Gharbi ranges from 800 to 700 meters only, while the plateau of the Batnan and the Dafna that connect to the green mountain to the east and continues to extend next the coast to the Egyptian border, is much lower than that, only 200 meters above sea level (Sharaf, 1971).

The northern borders of the three previously mentioned areas, the area of Al Jabal Al Gharbi in the west and Al Jabal Al Akhdar and the plateau of the Batnan and Dafna in the east, are parallel to the coast in general, but may directly overlook the sea in some places, while exist among them in other places coastal plains whose wide differ from place to other. In Tripoli, for example, the range of mountains extends for a distance of 500 km south-west north-east, separated by Jifara plain, the largest coastal plains in Libyan territory, its area is up to 17000 km^2, a triangle of form, the width of the north to the south about 120 kilometers at the Tunisian border, and narrow as we turn east until the mountains meet the coast directly in the town of Al-Khums (Al-Haram, 1995). In Al-Jabal Al-Akhdar, the coastal plain between the edge and the sea takes triangle shape, and the maximum width of the plain is 50 km (Jawdah, 1973). Then gradually diminish whenever we turn north until it disappears immediately after Talmitta, and from this city to the borders of the Egyptian region, we find that the edge of the plateau directly oversees the sea, except in limited places where the edge be away from the sea in a small dimension which allows only small areas to be exist, as in the area where Derna was dimension which allows only small areas to be exist, as in the area where Derna was established.

If we leave the coastal plains in the north and through the mountainous areas that are supervised by the south, we move to a semi-desert desert that ends in the south in the real desert, which occupies more than one million square kilometers. However, this transition is gradual so that we can consider the areas directly south of the mountains, represented by the Balat area in Barka and the Qibla area in Tripoli, as transitional areas between the mountains on one hand and the desert on the other, in terms of surface features, climatic features, or animal and plant life forms (Sharaf, 1971).

Figure 2.5: Al Jabal Al Akhdar is located immediately south of the coastal belt in the northeastern region of Libya. It extends on the coast belt to about 300 km and rises to about 881 m above sea level. Photo by Shelmani, 2006.

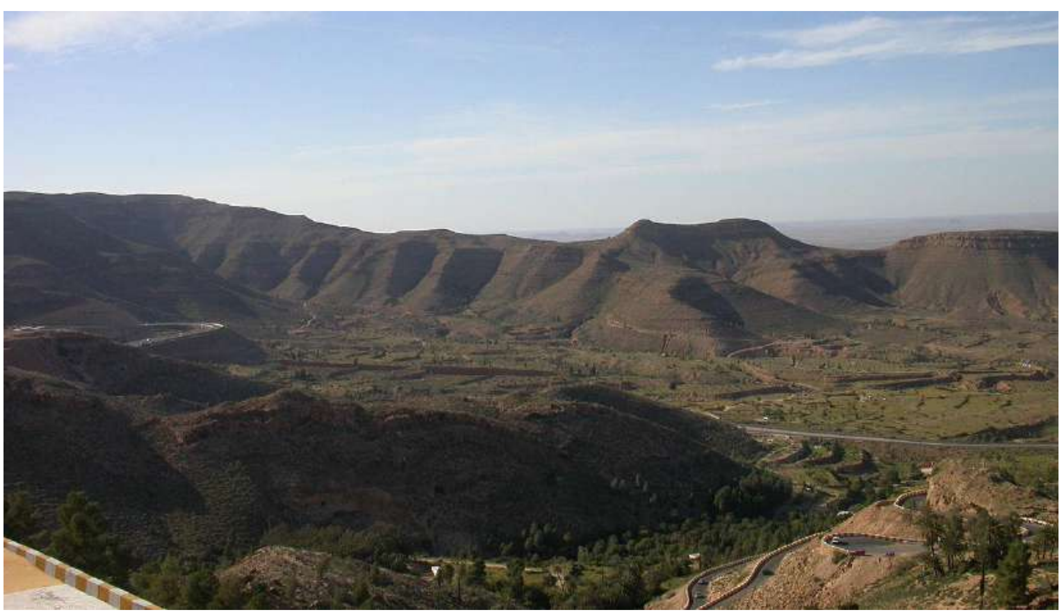

Figure 2.6: Al Jabal Al Gharbi stretches around 500 km and rises to about 750 m above sea level in western Libya (WT-shared, Antmon, 2008).

The desert itself, as we have mentioned, is only part of the Sahara Desert. Although this desert is usually described in the general studies as almost the level of the surface, this is not true if we look at the different parts of the look at some detail, if we look at the deserts of Libya alone, we find that it includes a number of Terrain manifestations that differ in terms of sea level, or in the type of formations of the Earth, in this desert there are some areas that consist of mountainous areas whose elevation is more than the elevation of the Green Mountain or the mountains of Tripoli, these mountains are Jabal Awaynat in the far south-east of the country on the Egyptian-Libyan border, then the mountain range which defines the basin occupied by the province of Fezzan on the eastern side of the East, and includes the mountains of Al-Haruj al Aswad (Black mountain) and Al-Haruj al Abyad (White mountain) Also, mountains that limit the same basin from the west and south, and consists of the mountains of Tasili, Tamo, and Tadrart Acacus (Al-Haram, 1995) (Figure 2.7).

In the Libyan desert there are also a number of low basins, some small and some large. The existence of these ponds has helped the emergence of many oases, due to the ease of access to underground water. The oases are located in two ranges, one in the north and its general extension between the east and the west about latitude 29° north. It starts at Jaghbub Oasis in the east and then extends westward and includes the oases of Gallo, Oujlah, Marada and Jafra and ends at Ghadamis Oasis near the Tunisian and Algerian borders. Second range located in the south, between latitudes 23° and 26° north. It includes two large groups, the group of Kufra oases , and the group of Fezzan oases, followed by the Ghat Oasis (Sharaf, 1971).

Figure 2.7: Sand dunes, rocks, and mountains in Tadrart Acacus, a desert area in southwestern Libya. Photo by Galuzzi, 2007.

Figure 2.8: Wan Caza dunes part of the Sahara Desert of Fezzan. Photo by Galuzzi, 2007.

In addition to the oases mentioned above, the lowlands of the desert also include a group of valleys that were once the real rivers of the desert, when the desert rains were much heavier than at present (Jawdah, 1973), such as the empty valley that penetrates gently from the east to West of latitude 30 north, ending in the Gulf of Sirte near El Agheila, and then the valley of the Great Bay, which descends in Tripoli from south to north, and ends in the Tawergha Marsh, which runs along the western coast of the Gulf of Sirte (Sharaf, 1971).

In addition, there is a great difference in the type of formations that cover the surface of the earth in different places of the desert. In some areas, the surface of the desert covered by layer of fine sand spread in wide areas, and sometimes it forms chains of dunes that appear in low hills, and there is an area of this kind extends in a great range around the Egyptian Libyan border to the south of the oasis of Jaghbub, which called the Great Sand Sea, and there are other areas of the same type covering large areas of the surface of the deserts of Libya, especially in the area of Kufra and Fezzan (Figure 2.8) and other southern oases. Other wide areas are covered with a layer of coarse sand or fever and zest, which stretches for a distance, between the Jalu Oasis in the north and the Tazirbu Oasis of the Kufra oases in the south, and in small area in eastern Fezzan. On the other hand, large expanses are characterized by a rocky surface that is not covered by sandy or gravel deposits especially in the western parts of the country. These areas are known as "Hamada". The area extends from the Qibla region (south of Al Jabal Al Gharbi) in the north to the northern edge of the basin of Fezzan in the south where it is called Red Hamada, the southwestern part of which is called Tinghert (Al-Haram, 1995).

2.5. Climate

Within Libya different climatic zones have been recognized (Figure 2.9), which can be Summarize to three climatogeographic zones: (1) the Mediterranean littoral, extending of about 45,000 square kilometers, the most suitable for agriculture; (2) a semidesert area of about

100,000 square kilometers which is mainly grazing; and (3) a desert area containing several fertile oases (Goudarzi, 1970). Since the land of Libya extends between 18° and 33° North, the dominant climatic influences are Saharan climate and Mediterranean climate. The climate is Mediterranean in most of the coastal lowland, with warm summer and mild winter. The weather is cooler in high lands, and frosts often occur at maximum elevations (Meqily, 1995). For the mean daily temperature ranges, Cyrenaica region has a mean daily temperature of about 21°C, but it increases from the coast to the interior and from west to east. However, it also decreases with increasing elevation in Al Jabal Al Akhdar area. In the Kufra and Tazerbo areas, in the south, the mean daily temperature is usually about 30°C in the summer months and about 5°C in the winter (Fookes et al., 1993). The desert interior, despite the relatively high elevation, has long, excessively hot summers and high diurnal temperature ranges because of the permanence of cloudless skies and extremely dry atmosphere (Meqily, 1995). On 13 September 1922, the highest official temperature of 58 °C (136.4 °F), considered to be a world record, was at the town of Al-ʿAziziyah, located southwest of Tripoli (Mildrexler et al., 2006; Cerveny et al., 2007; El Fadli et al., 2013). However, in September 2012, this world record figure was overturned by the World Meteorological Organization (Cerveny et al., 2007; El Fadli et al., 2013). Precipitation is limited, and the dry climate results in a year-round 98% visibility (Zboray, 2013). More than 90% of the annual precipitation is during the cold half of the year (Meqily, 1995). Less than 2 % of the country receives enough rainfall for settled agriculture, the heaviest precipitation occurring in the Jabal al Akhdar territory, where the annual rainfall is 400 to 600 mm (15.7 to 23.6 in) (Zboray, 2013), and about 250mm on the coastal plains. The rainy season is from October to March, and December and January are the wettest months (Fookes et al., 1993). The Sahara receives 50 mm (1.97 in) or less. In some places, decades may pass without having any rainfall at all, and even in the highlands precipitation rarely happens, about once every 5–10 years. In the mountain region of Uweinat, for example, the last recorded rainfall was in September 1998 as of 2006 recording (Zboray, 2013).

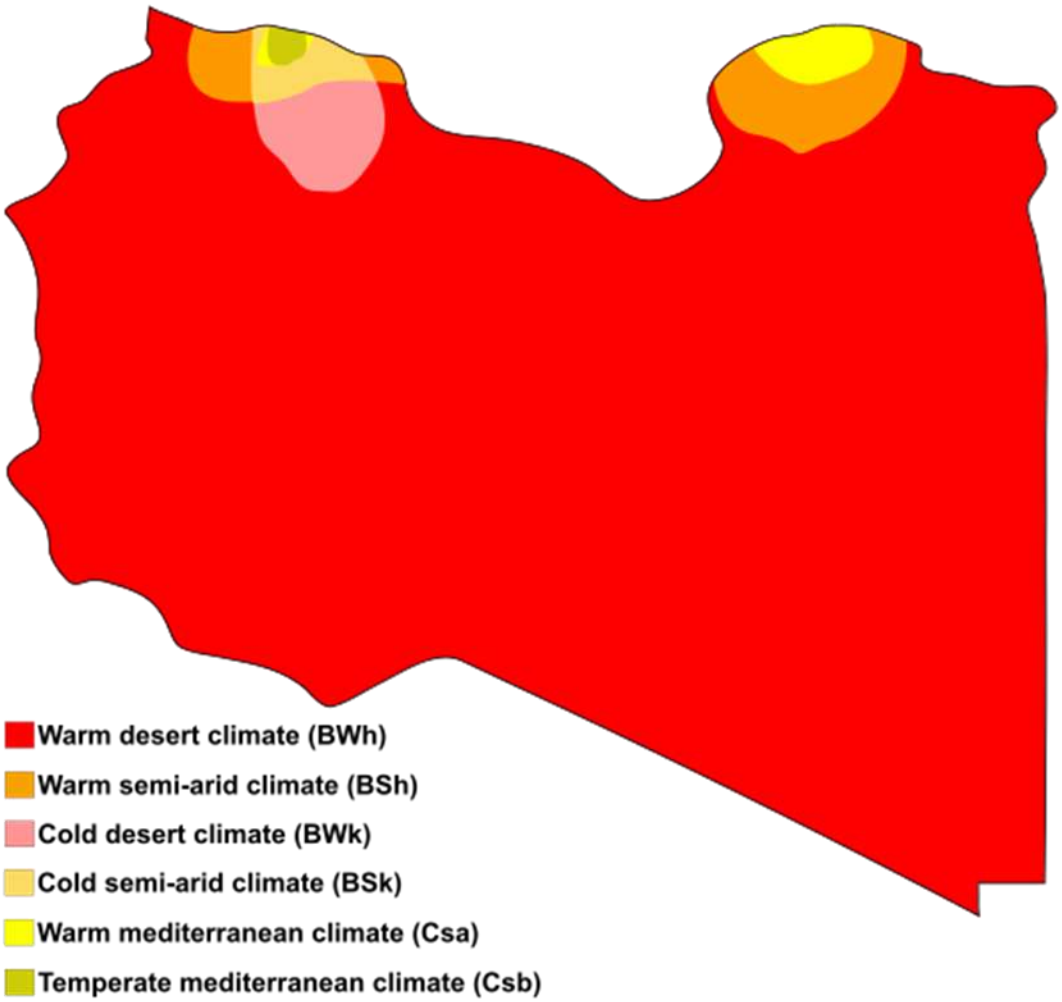

Figure 2.9: Libya map of Köppen climate classification (Zifan, 2016).

2.6. Population

Based the latest United Nations data (2019), the population of Libya is 6,777,452 people living on an area of 1,759,540 km2. It is clear the big disparity between the vast area and its limited population (3.8 persons/km^2). The geographical distribution of the population of the country is dispersed and perverse which indicates weak population concentration and low population density (Al-Kikhia, 1995). The inhabitance is concentrated very narrowly along the coast where 90% of the people live in less than 10% of the area, and population density is about 50 persons per km^2, but goes down to less than one person per km^2 in other places (WPP, 2019). Most southern and central regions emerge as population-free except for some small and scattered settlements represented in the scattered oases in the Sahara Desert in Ghat to Kufra and from Ghadamis to Jaghbub. In this vast area, which cover more than three quarters of the country, there is no significant population concentration if we exclude the convergent and regular population centers along some of the valleys of the Fezzan basin and its depressions where the city of Sabha, the most important urban center in the south, mediates this concentration of population. (Al-Kikhia, 1995).

The population of Libya witnessed a fluctuating growth during the 20th century. This fluctuation was linked to the factors affecting growth in general, including the political and security effects of the unrest, such as the situation of the war from the beginning of the century until the middle of the century, and the consequent displacement and emigration of insecurity. Such has been the main factor in population change or growth, which has made the population growth rate and geographical distribution variable due to environmental and economic factors (Al-Qaziri, 2012).

Al-Qaziri (2012) identified three distinct phases of population growth in Libya:
First: it extended from the beginning of the century until 1936 (the end of the Italian war in Libya) and is characterized by negative or declining growth of the population because of the war. Followed by the slow growth phase extending to 1954, where the security situation witnessed a general trend towards relative stability; however, the requirements of life have not yet stabilized due to the dominance of the results of the first phase and the results of the First World War, and the lack of administrative stability of the country in addition to continued resource poverty before the discovery of oil. Followed by the rapid growth stage and extending to the year (1984) and saw administrative and security stability in addition to the discovery of oil, which helped a lot on the recovery of the economic situation, which supported the possibilities of life and improved

standard of living. The fourth phase, which can be added to the above, is the next stage, beginning in 1984 to this period, the country has been dominated by economic, social and even political conditions, which may have been reflected in the rate of population growth. The deterioration of income levels, or at least the stability of a broad sector of the population and consequent economic policies closer to austerity, especially since the mid-1980s, and the spread of social and economic patterns that have contributed to changing the social structure and its inherited foundations, Women work outside the home, and most of the boys enrollment slide or youth education institutions in addition to the low fertility rate and thus low birth rate.

Oil discovery has transformed Libya, a desert and sparsely populated country, causing dramatic demographic changes (Zoghlami, 1979). El Mehdawi and Clarke (1982) and Lawless and Kezeiri (1983) described and analyzed the growing polarization of the population in the north-west and north-east coastal regions of the country which contain the two largest cities, Tripoli and Benghazi. Their study shows that spatial duality has been obviously intensified by strong rural to urban migration and by an increase in interregional migration as well. Internal migration in Libya is urbanward movement-more precisely, movement to major centers the concentration of new development programs in certain urban centers has been the major reason of the development differential between the regions. Consequently, the regions that include the most substantial urban centers have become the most prosperous, and the other rural regions have become less developed or even depressed. This has been the main reason of the rapid growth in both rural to urban migration and interregional migration. The residents of the less developed regions have continued to move in increasing numbers to the regions which are prosperous and more developed. The big majority of migrants who moved from these less developed regions are represented by rural inhabitants who have changed their place of residence and their career. They left their job in the rural sector to seek employment in the service and industrial sector. This led to decline the agricultural production. Albergani and Vignet-Zunz (1982) showed how the colonial invasion and occupation that were followed by the

Second World War threatened the Bedouin of the Jebel Akhdar with extinction through the mass migration of a devastated rural population. Also, the advent of oil and the high levels of the salary available in urban centers further encouraged this tendency (Lawless, 1989).

2.7. Politics

In 1911 the Italians supplanted the Ottoman Turks in the area around Tripoli, and they did not relinquish their hold until they were defeated in Second World. That was an Italian colony from 1911 to 1948. (Blanchard, 2010). Then, Libya passed to UN administration and accomplished independence as the United Kingdom of Libya under king Sayyid Idris in 1951 (Naylor, 2015). By this achievement Libya was in the first country to have full independence under U.N. auspices (Goudarzi, 1970), and the first and only country created by the General Assembly of the United Nations. In 1969 a military coup overthrew King Idris led by Muammar al- Gaddafi who assumed leadership and began to espouse his political system at the country (Paoletti, 2011).

As in several Middle Eastern and North African countries, unrest erupted in Libyan cities in early 2011. In mid-2011, the Gaddafi regime was toppled, and it was replaced by a transitional government known as the National Transitional Council (NTC). In 2012, the NTC gave power to an elected parliament, the General National Congress (GNC). In June 2014 voters chose a new parliament to replace the GNC - the House of Representatives (HoR), which relocated to Tobruk in the east after fighting broke out in Tripoli and Benghazi in July of the same year. The UN brokered an agreement among a wide array of Libyan political parties and social groups in October 2015. This agreement is known as the Libyan Political Agreement (LPA). The Libyan Political Dialogue Members, which included representatives of the HoR and defunct-GNC, signed the LPA in December 2015. In September 2017, the UN Special delegate Ghassan Salame announced a new roadmap for national political reconciliation. In September 2017, the UN Special delegate Ghassan Salame announced a new roadmap for national

political reconciliation. The roadmap called for modifications to the LPA, a national conference of Libyan leaders, and a constitutional referendum and general elections. In November 2018, Salame’s recalibrated Action Plan for Libya was supported by the international partners. The plan aimed to break the political deadlock by holding a National Conference in 2019 in Libya on a timeline for political transition. The National Conference was delayed after a failure of the parties to implement an agreement mediated by Salame on February 27 in Abu Dhabi, and the subsequent military action "Libya National Army" by Khalifa Hafter against GNA forces in Tripoli that began April 3 (CIA, 2019).

2.8. Economics

Before the discovery of oil, agriculture was the major contributor to GDP, and even in 1968 it was still the major sector in terms of employment; so it has been given prominence in government planning (El Mallakh, 1969; Allan & McLachlan, 1976). Oil and its rapid exploitation and development have had a significant impact on Libyan society in general and on the economy of the country in particular. With oil exports began, new wealth has entered Libya. This has affected all sectors of the economy and especially the agricultural sector; there have been changes in the use of land and considerable movements of population (Allan et al., 2015). The Libya's economy depends essentially upon revenues from the oil sector, which account for over half of GDP (CIA, 2019). Libya has the largest proven oil reserves in Africa continent, and it is an important contributor to the global supply of light, sweet crude (CABL, 2015). During 2010, oil production accounted for 54% of GDP when oil averaged at $80 a barrel (WBL, 2018). In addition petroleum, the other natural resources are natural gas and gypsum (LFF, 2019). The World Bank defines Libya as an 'Upper Middle Income Economy', along with seven other African nations (DS, 2008). Fundamental revenues from the energy sector, combined with a small population, make Libya one of the highest per capita GDPs in Africa (LFF, 2019). This allowed the country to provide an extensive level of social security, particularly in the sectors of housing and education (LAJR, 1996).

Libya imports about 90% of its cereal consumption requirements, for example, the imports of wheat in 2012/13 was approximately1 million tonnes. The wheat production was estimated at about 200,000 tonnes in 2012, and the government prospects to increase cereals production to 800,000 tonnes by 2020. However, natural and environmental conditions limit agricultural production potential in Libya (GIEWS, 2019).

2.9. Hazards and Disasters in Libya

2.9.1. Desertification

Desertification is a critical environmental problem, involving the degradation of land in dry sub-humid, semiarid, and arid areas. It is caused primarily by climatic variations and human activities (UNEP, 1991; Zhang et al., 2008). According to Millennium Ecosystem Assessment (MEA) (2005), desertification is caused by a combination of factors that vary by location and change over time. There are many natural and human factors that cause land degradation and desertification in Libya (Ben-Mahmoud et al., 2003). Through geologic time, there have been considerable climate changes on the African continent where wet and dry ages succeeded. Dry ages led to the Sahara Desert development, and the present climate of the region is a continuation of the dry climate, with a general tendency to more droughts in the past years. Therefore, the frequent water and wind erosion are both cause and effect of land degradation and desertification in Libya (Emgaili, 2003). Libya is experiencing a serious land degradation and desertification problem because of its particular geographical position and extreme climatic changes. Climatic conditions badly limit agricultural production in the country. The average annual rainfall distribution is presented as per the aridity zones of Libya in Table 2.1. Climate change predictions for North Africa which include Libya indicates rising temperatures with potentially great impact on the regions already stressed resources involving water and food

(IPCC, 2007). Importantly, global climate change may further exacerbate the rate of dry land degradation and possible desertification (MEA, 2005).

Table 2.1: Aridity Zones of Libya.

Aridity zone	**Average annual rainfall (mm)**	**Land area (000' km2)**	**% Total area**
Very dry	< 50	589	90.8
Dry	50 – 200	130	7.4
Semi-arid	200 – 400	26	1.5
Sub-humid	>400	5	0.3
Total		1750	100

Source: (Saad et al, 2011).

Although the small number of the country population, the concentration in the northern regions caused human pressure on natural resources (such as vegetation, water, soil), poor management and over exploitation of natural resources by entities or/and individuals, mainly led to desertification, especially in marginal areas, which resulted in serious environmental problems such as pollution and lowering of the groundwater table, intrusion of seawater into fresh water, degradation of agricultural land and low productivity of many crops (El-Tantawi, 2005). Anthropogenic factors causing deterioration of soil and vegetation in the country include: (i) overexploitation of water resources (ii) deforestation and the removal of natural vegetation (iii) rangeland conversion cropland (iv) over-grazing in marginal lands (v) misuse of the soil on arable land and urbanization (El-Tantawi, 2005; Emgaili, 2003; CLGP, 2003). In recent decades, Libya has witnessed enormous development in the sectors of agriculture and industry; however, such development has caused negative effects on local ecosystems, especially in sensitive and fragile areas due to change in production methods, and the growing need to provide food for the growing population. This consequently led to pressure intensification on the limited natural resources which has led to escalating land degradation and desertification problems as in Al Jabal Al Akhdar (Figure 2.10).

In recent decades, Libya has witnessed enormous development in the sectors of agriculture and industry; however, such development has caused negative effects on local ecosystems, especially in sensitive and fragile areas due to change in production methods, and the growing need to provide food for the growing population. This consequently led to pressure intensification on the limited natural resources which has led to escalating land degradation and desertification problems. All these factors principally contribute to the problem of desertification in Libya (Saad et al., 2011).

Desertification directly or indirectly consequents in a variety of negative environmental, economic and social impacts (Nahal, 1987). As a result, the productivity of forest, natural pastures, and agricultural land is decreasing. Moreover, deterioration of the pastoral environment causes a significant decrease in the productivity of livestock (Saad et al., 2011).

2.9.2. Floods

Compared with some other places in the world, disasters caused by floods are not common in Libya although flash flooding can be disastrous. However, in terms of spatial distributions, Libya is considered a flood-prone country. Libya is among African countries that face larger economic losses due to floods (Li et al., 2016). In the past, many floods took place. Before the erection of the barrages in the valley of Derna, a flood caused many human and financial losses in 1959; as well as in 2001, within few hours rain fell reached 190 mm causing floods in the Sub-region of Darnah. Also, in 1984 the floods that took place in Wadi Al Qattara covered the area of Al Fuwaihat and almost reached the University of Garyounis. Every year the plain of Al-Marj is covered with water. Also, the flood that occurred in one of the wadis in Jardas Al Ahrar caused human losses (UPA, 2008). Heavy rainfall and thunderstorm have hit the southwestern region of Libya causing heavy flooding in Ghat (Figure 2.11). The rainfall started on 28 May 2019 and intensified on 5 June (UNICEF, 2019). The municipality of Ghat was

Figure 2.10: Two satellite images show how climate change, deforestation, and population growth have significantly changed Al Jabal Al Akhdar vegetation cover from 2006 to 2019 in southeast Massah city in Al Jabal Al Akhdar region. (Google Earth, 2019).

severely affected, including Silila, Ghat, Ta’ala, Albakat, Alfiywat, Al-Sharika, Saya, and Al-Siniyah. The water levels did not recede for days and varied between 0.5 to 2 meters depending on the area. Human casualties have been reported due to this flood (OCHA, 2019). Over 20,000 people were affected: four deaths (including three children and one adult), 30 people suffered minor injuries, and about 4,250 people have been displaced from their homes to nearby areas (UNICEF, 2019). There was severe damage in infrastructure, telecommunications networks, and farmland vital for livelihoods. Ghat hospital was partially flooded and service provision was affected. The risk of running out of fuel and domestic commodities because of infrastructure damage was reported (OCHA, 2019).

The dangers of floods taking place in the region of Al Jabal Al Akhdar, especially as there are many wadis which drain the heights of Al Jabal Al Akhdar ; including the wadis of Al Khalij, Al Khabtah, Al Haishah, Al Maalaq, Al Baqar, Al Dafnah, Al Butnan, Derna, Bumsafir, Karsah, Al Atharun, Al Naqah, Morqos, Al Injeel, Al Mahboul, Al Qala'ah, Al Batoum, Al Haseen, Al Dab', Al Houlah, al Mashhour, Jarjar Aowma, Al Lawlab, Al Kouf, As Salloum, As Soudan, Zazah, Al Qattarah, Bel Aridah, Al Bab, Al Farigh, Smalous. After the construction work implemented in many barrages in the risky area of the Benghazi Region, there is a probability that an earthquake may occur causing the cracking of these barrages, dams and weirs consequently causing a strong flood in the low parts of the valleys (UPA, 2008).

Figure 2.11: Two photos show devastating floods hit Ghat District in southwestern Libya from 28 May to 5 June 2019. Photo by Ghat District Government.

2.9.3. Earthquakes

Compared to other regions, and countries, Libya is generally not considered a high seismological active region, however, Libya has experienced earthquakes in varying degrees since ancient times. Earthquakes that took place and caused much and comprehensive destruction are relatively few and limited in Libya. Throughout the long history, only the larger earthquakes are usually recorded or noticed. It is possible to say that the oldest and greatest earthquakes that took place in the country have been drawn from the historical and archaeological studies. These studies showed that the Cyrenaica region in north-eastern Libya, saw severe and destructive earthquakes, the first of which was in 262 AD and caused the complete destruction of the city of Shahhat killing most of its people. The second earthquake that occurred in the same city happened in 365 AD (Goodchild, 1968). Sabratha -- located on the Mediterranean coast about 70 kilometers (40 Miles) west of Tripoli -- was hit by tremendous, destructive earthquakes between 306 and 310 A.D., and again in 365 A.D (di Vita-Evrard, 1999). Several major earthquakes occurred in Libya where many towns and villages were destroyed before the 1900s: in the Sabha Territory and the adjacent Fezzan Province (704), Tripoli (1183, 1656, 1685) (Ambraseys, 1984), near the Libyan-Egyptian border in the Libyan desert near Siwa (1811) (Kebeasy, 1980), and in Murzuq in the Fezzan Region (1853, 1860) (Ambraseys et al., 1995).

The 1935 Hun Graben earthquake 7.1 (Ml) has been described as the strongest earthquake in Libya, and one of the largest earthquakes in Africa’s history (Johnston, 1989; Suleiman & Doser, 1995). The coast of northeastern Libya in Al-Jabal Al-Akhdar area continues to be a seismically active region. In 1963, Al-Marj was razed by an earthquake of moderate magnitude (5.6 Ml) (Figure 2.12) (Gordon & Engdahl, 1963; Minami, 1965). The coastal zone of northeastern and northwestern Libya continues to be a seismically active where several tremors of 4 to 5.7 magnitude were recorded between 1990 and 2019 (USGS, 2019).

Figure 2.12: The photo shows the damage of the 1963 Al-Marj earthquake (Sulfium Forum, 2010).

CHAPTER 3: Literature Review

Natural hazards are among the significant threats to humans in the twenty-first century. Almost every week communities come across a natural disaster in one part of the world or the other, and they raise considerable debate as to determination both ultimate cause and responsibility for them. Humans of different nations and cultures are increasingly affected by vulnerability to the consequences of serious environmental hazards. However, history has clarified that the negative impacts of natural events such as earthquakes, floods, hurricanes, or drought are not felt equally by populations residing in the affected areas. The ability for many individuals to adapt successfully to the crises is determined predominantly by the ways that people are able to voice their needs and views towards government. Social, political, and economic factors are mainly what determine how individuals structure their lives -- not the natural environment. In this meaning, natural disasters are the result of two factors: the social, political, and economic processes of exclusion and marginalization which are rooted within a region’s history, and the direct impact of the environmental hazard itself (Wisner et al., 1994).

As a method of explaining the causes of disasters, one should look beyond the environmental triggers of a crisis, so more analysis is needed for the socio-political systems, both local and international, that create people’s vulnerability to disasters. If the international community is to influentially address the crucial natural disasters in the modern era, disaster dissecting should acknowledge that these crises are never purely natural occurrences. They are rather deeply rooted within the power structures of international relations and diminish people’s flexibility to adapt environmental hazards in dynamic processes (Southard, 2017).

Furthermore, although globalization has proven a powerful factor in promoting human development, it has also created a great amount of vulnerability and risk in the daily life of many communities. Families every day across the world are resettling to urban centers in search of new work (Southard, 2017). Rapid urbanization and unorganized development increase the number of people at risk, something which the 2001 Gujarat Earthquake, India indicates. This quake killed around 18,000 people, injured another 167,000, and destroyed approximately 400,000 houses (Jain et al., 2001). These are results predominantly based in patterns of urban settlement, but not in the nature of the quake itself.

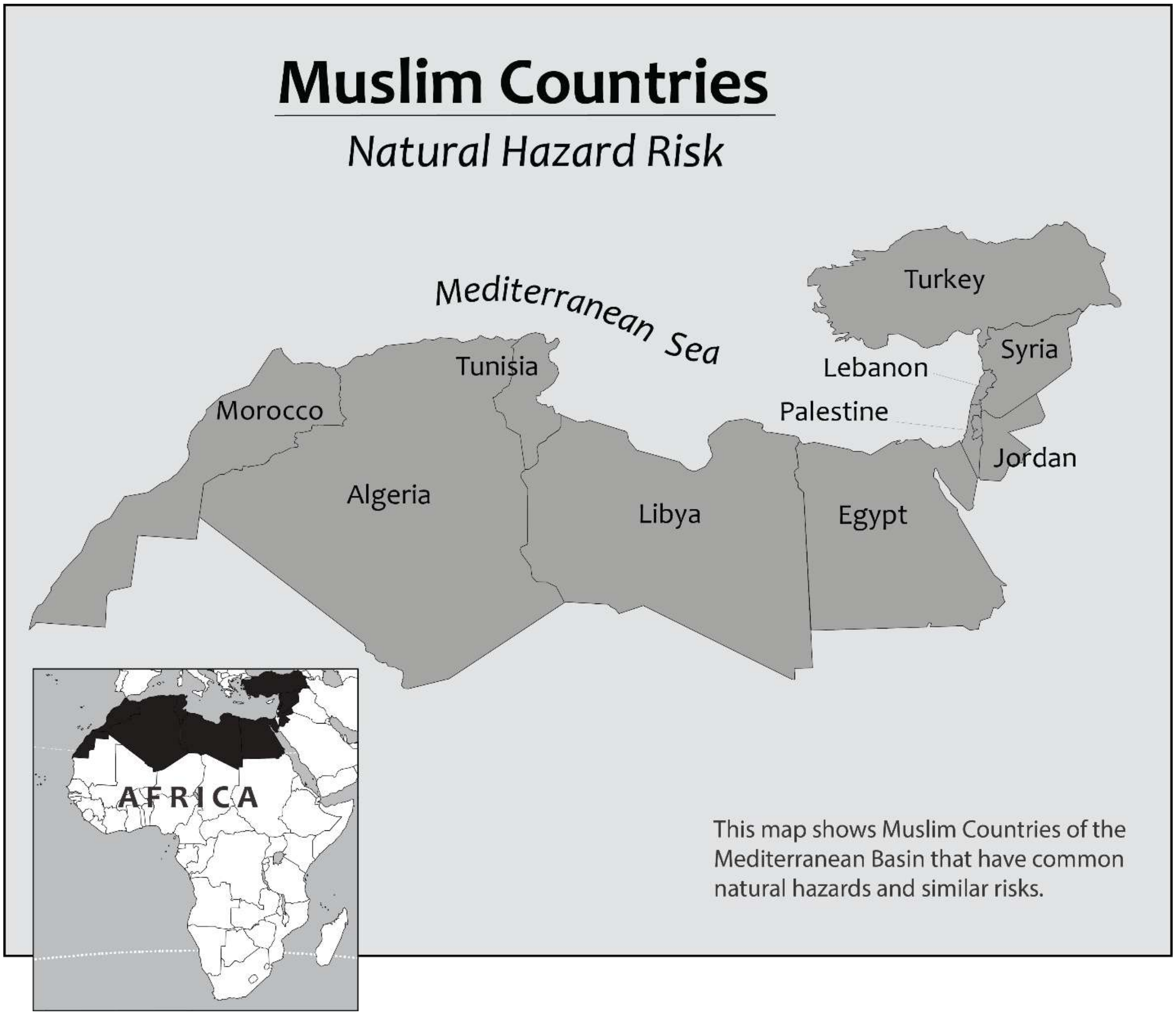

Figure 3.1: Muslim Countries in Mediterranean Basin. Cartography by author, 2019 .

In the Mediterranean, geophysical and hydro-meteorological hazards both share common features because of the common geological history and climate. The Mediterranean Sea also forms a dividing line where developing and industrial nations meet, and where the gap in gross domestic product per capita has widened during past decades. While the geophysical and hydro-meteorological hazards have contributed to serious environmental degradation on either side of the Sea in the 20th century, the social, political, and economic factors have varied and will continue to cleavage during the 21st century. Focusing on the Muslim countries of the Mediterranean, these factors similarly have affected the different degrees of vulnerability of urban centers to natural hazard risk and perception (Figure 3.1).

3.1. Natural Hazard Risk and Vulnerability

Risk involves "quantitative measures of hazard consequences expressed as conditional probabilities of experiencing harm" (Slovic et al., 1985: 91). When a risk is impacted by human actions such as where they reside and how they build, vulnerability will increase or decrease according to these actions (Maskrey, 1989). The vulnerability that is of concern here is associated with natural hazards, and it is defined as:

> "any physical, structural or socioeconomic element to a natural hazard is its probability of being damaged, destroyed or lost. Vulnerability is not static but must be considered as a dynamic process, integrating changes and developments that alter and affect the probability of loss and damage of all the exposed elements" (Maskrey, 1989:1).

It also concerns the predisposition and preparedness of a community to experience fundamental damage as a result of natural hazards (Clarke & Munasinghe, 1995). Highly vulnerable individuals may be badly impacted by a relatively weak magnitude natural hazard, while less vulnerable individuals weather disaster better (Cannon, 1994). In Libya, for example, the city of Al-Marj (population of 13,000 in 1993) was hit by an earthquake of magnitude 5.3 on 21 February 1963. This earthquake was one of the worst natural hazards in Libya, not because of its magnitude, but because of the loss of life (Minami, 1965); because of the poor structure of the buildings, the city was completely razed. Many houses collapsed killing 300 and injuring 375 people; moreover, 12,000 individuals were made homeless (Ambraseys, 1994). Losses to human lives and properties are attributable not only to unusual intensity of a natural hazard but to poor quality of the homesteads.

In natural hazards research, there is notable increase in the writing about vulnerability (Wilches-Chaux, 1992; Alcántara-Ayala, 2002; Cutter et al., 2003; Degg & Homan, 2005; Mamadraimov, 2010; Cherif et al., 2017), but it is fair to mention O'Keefe's work (1976) because he was one of the first when he explained how the frequency of natural disasters and hardship people are increasing in underdeveloped countries.

Vulnerability can be measured with any number of methods, but it is commonly identified as a susceptibility for loss, quantified with morbidity, death-rate, or economic loss (Wisner et al., 1994). For Varley (1991), vulnerability is an indicator of the degree of social and self-protection available to possible victims. It is clearly connected to the ability of households or societies to cope with and recover from external events and especially to shocks and sudden changes (Alcántara-Ayala, 2002). Since losses geographically differ, over time, and among various social groups, vulnerability also differs over time and place (Cutter et al., 2003). Within the hazards literature, vulnerability has several different connotations, relying on the research perspective and orientation (Dow, 1992; Cutter, 1996; Cutter, 2002). There are three major tenets in vulnerability research:

1) the identification of condition (an exposure model) which makes individuals or places vulnerable to extreme natural events (Anderson, 1995).
2) the presumption that vulnerability is a social condition, an analysis of societal resilience or resistance to hazards (Wisner et al., 1994; Hewitt, 2014). The work of Wisner et al. (1994) arose from an alternative approach that emerged in the last forty years. The approach puts the major emphasis on the diverse ways in which social systems act to generate disasters by making people vulnerable.
3) the synthesis of potential exposures and societal resilience with a particular focus on specific regions or locations (Turner et al., 2003; Cutter, Mitchell, & Scott, 2000).

From the perspective of hazards and disasters, vulnerability is the conceptual connection that links the relationship between people and their environment to social institutions and forces, and the cultural values that contest or sustain them. Therefore, combining elements of environment, society and culture in different proportions, the sense of vulnerability provides a theoretical scope that covers the multidimensionality of disasters (Oliver-Smith, 2013).

3.1.1. Factors Influence Natural Disaster Risk

Wisner and his colleagues (1994) emphasized that the crucial point about understanding why disasters occur is that it is not only due to natural events, but also, they are the product of social, political and economic factors. In treating disasters there is a danger as something peculiar as events that deserve their own particular focus. It is excessively risky separating natural disaster from the social frameworks which influence how hazards impact people, that way putting much emphasis on the natural hazards themselves, and not enough on the surrounding social environment.

From this context, natural disasters are the complex physical appearance of underlying social, political, and economic imbalance, such as weak regulatory practices and irregular urban settlements that make a society less resilient to natural hazards (Oliver-Smith, 2013). Often such inequalities force people to accept unsanitary and unsafe living conditions. The outcome of such trends is to exacerbate the devastating effects of a hazard, and that both during its occurrence and throughout the process of recovery, heightening the vulnerability of the low-income or marginalized populations affected. This is particularly the case in politically and economically underdeveloped countries whose governments do not have the capacity to respond or to implement institutional forms of civilian security and support (Cannon, 1994; Southard, 2017). In addition, Hewitt (1983) and O’Keefe et al. (1976) argued that individuals' behavior in the face of natural hazards is contextual and constrained by social, economic and political powers more than by the risk perception of those individuals.

Political incentives differ to mitigate natural disaster risk interact with intrinsic differences between countries. These differences may include (but are not limited to): imperfect citizen information, the strength of civil society; economic stability; the institutionalization of government performance and democracy; international pressures; as well as ethnic polarization (Southard, 2017). Governments play an important role in make some improvements to disaster reduction measures and development of proper building code standards, for instance. However, in some communities, these building codes are failing largely because of the incompetency of government organization and oversight. The usage of inferior construction materials was the primary cause for about all of the cases in which buildings collapsed when an earthquake in the western part of Turkey (1999) razed large areas of Gölcück and Izmit to the ground. If the Turkish building codes were been strictly observed, loss of life could have been reduced or avoided in most cases (Munich, 1999).

By analysis how agency and power may form a society struck by disaster, one acquires a deeper understanding of the socio-political root causes of communities' vulnerability to disaster. Colonialism shapes one of the greatest examples of this process. It has created both past political trends and the current ideologies and prejudices deep-seated in a community. Thus, vulnerability is centuries in the making. Colonialism engenders obvious historical consequences that affect different communities' possibility for economic stability, which in the end lead to limiting the capability of marginalized and oppressed demographics to adapt under modern natural crises. Nevertheless, a complex collection of factors, many of which are interdependent and overlapping, has a significant role in determining how individuals and nations can choose to respond to the outbreak of a natural hazard (Southard, 2017).

In the economic framework, because of financial circumstances some people may have to accept a job in a dangerous region to enhance family incomes, while others may be forced to inhabit areas of high-susceptibility to disaster (Southard, 2017). Poor and socially disadvantaged people are usually the most vulnerable to and impacted by natural hazards which reflect their social, economic, and political environment. Disasters, in turn, are a source of transient distress and suffering and a factor contributing to constant poverty. At the household level, poorness is the most important factor that determines vulnerability, in part reflecting location of housing (e.g., on steep slopes, floodplains, riverbanks, or contaminated land), primary kind of occupation, and level of access to financial and other resources (Benson & Clay, 2003).

Different factors are central to assessing a people's risk and vulnerability in relation to disaster: where they reside and work; the government protection level from hazards; collective predisposition to face natural threats; the knowledge base of a society; as well as an individual or population's wealth; age; gender; class; ethnicity; migrant status; and overall health. Several more conditions also determine the vulnerability and severity of risk which people face, and each of these components plays a dynamic interdependent role with others to cause the modern disasters we see these days (Southard, 2017).

3.1.2. Vulnerable Urban Area

Assessments of hazards, vulnerabilities, and urbanization show another factor that influences natural hazards particularly in developing countries. Many have experienced urban growth and thus increasing the vulnerability in the areas affected by natural hazards (Steckler et al., 2018). Furthermore, the high density of the urban populations in these areas renders effective rescues and recovery virtually impossible (Spence, 2007), and that means greater possibilities of death, injury, and structural damage.

a) Rapid Urban Growth and Natural Hazards Risk

On a global scale, urbanization is taking place at an unprecedented speed. More than half of the world's population lives in urban areas. Figure 3.2 views the global growth of the urban population from 1950 to 2010 and what the United Nations (UN) projects for 2030. Over 1 billion people these days live in appalling conditions in cities and towns, and their numbers are increasing. And most of this population, whose basic needs are not always provided, is at most risk from and increasingly affected by environmental hazards (IFRC, 2010).

From The Centre for Research on the Epidemiology of Disasters (CRED) database (EM-DAT), the trends of large-scale disasters of the last decade seem that regions that are more urbanized tend to have fewer numbers of deaths from natural disasters, yet higher economic losses. This applies especially in high-income nations that well-governed cities. Whereas, in urban centers in low-income countries, there is a huge deficit in provision for the services and infrastructure that reduce disaster risk for much of the people in these centers (IFRC, 2010). In many developing countries, population growth has been a major factor for the rapid growth of the big cities and for informal housing residences (unplanned urbanization), which are highly vulnerable to any geophysical (earthquake), and hydro-meteorological (storm, flood) disasters (UNEP, 2002).

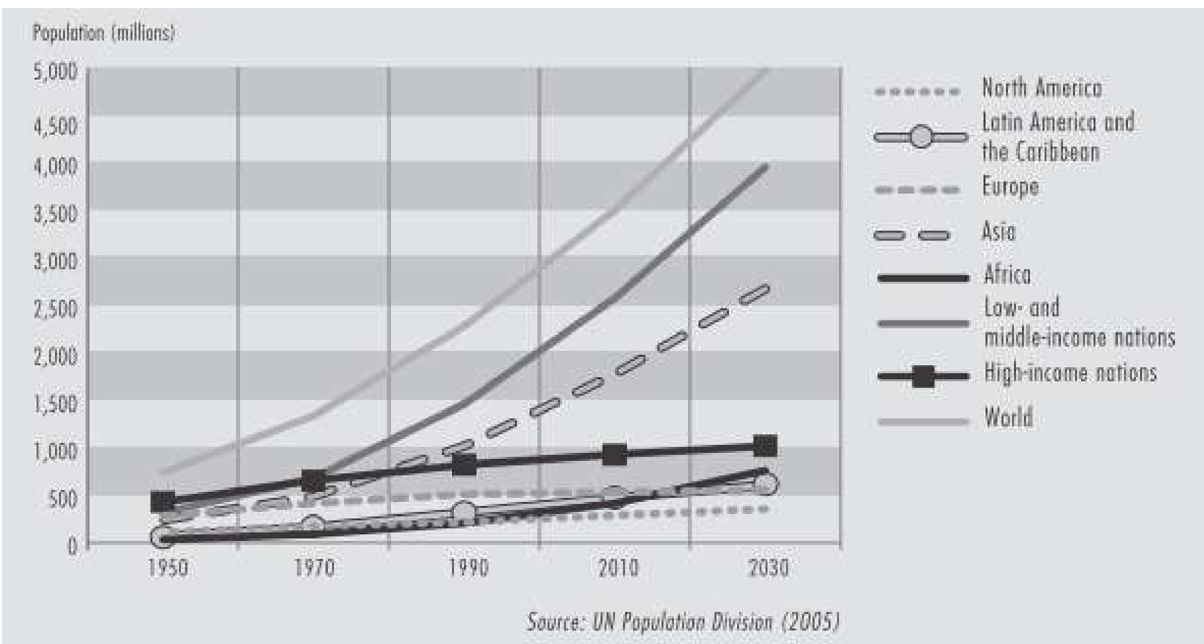

Figure 3.2: Global growth in urban populations, by region (IFRC, 2010).

b) Population Growth and Urbanization Trends: Mediterranean Muslim Countries

Past population increases and the expected population growth are crucial for evaluating future vulnerabilities to disasters. The demographic data in the Mediterranean region indicates two different patterns: between 1850 and 2017 the population in North African countries increased eleven-fold (except Egypt, which was 17-fold) while that of the East of the Mediterranean Lebanon increased 17 fold and Jordan 38-fold (Brauch, 2003; UN, 2017). From 2017 to 2100 major population increases have been projected in North Africa (+133.4 million) especially in Egypt (+101.2 million) as well as slight increases Libya (+1 million). Eastern countries are also expected to experience population growth (+39.6 million), but a declining population has been projected in Lebanon (-1.732 million).

The urbanization trend has been projected to increase rapidly in North Africa from 24.7% in 1950 to 67.2% by 2030, and it has been projected that the total net population growth will be in cities (UN 2002 in Brauch 2003). Between the years of 1950 and 2000 the most rapid increase in urbanization rate happened in Libya from 18.6% to 87.6% and also in Lebanon from 22.7% to 89.7%. Moreover, the UN expects that about 93.9% of the population in Lebanon and 92.0% in Libya will be urban by 2030. In 1950 the highest urbanization rate in North Africa was in Egypt with 31.9%, but by 2030 it will be the lowest with 54.4%. Such trend is reflected in the growth of major urban centers in the Mediterranean area. Mitchell (1999) assessed for 1995, among the world's 20 largest metropolitan areas the third highest density was for Cairo with 37,726 persons per km2. The increase of formal housing without building permits has been greater than the government capacity to control it. This has resulted in "unplanned, low-quality, and high-density developments deprived of infrastructure and basic services (Yousry & Atta, 1997). This rapid urbanization makes Cairo highly vulnerable for natural disasters. The 12 October 1992 Earthquake in Cairo caused more than 550 fatalities, almost 10,000 injured, over 300 houses experienced total or partial collapse, and 6,500 others were badly cracked (Degg, 1993).

3.1.3. Disasters Trends in the Muslim Countries of the Mediterranean

Brauch (2003) investigated facts of natural disasters for the years 1975 to 2001 reported in the EM-DAT data base, and of data listed by the (IFRC, 2001; 2002) for all disasters for the Mediterranean region for the years from 1980 to 2001. In terms of natural disasters reported during these 27 years, about Muslim countries, Turkey with 63 events comes in the second place, and Algeria (36) and Morocco (23) in sixth and seventh. But, in terms of the number of people killed caused by these events, Turkey was in the lead (27,375), followed by Algeria in third place (4,124), and Egypt in fifth place (1,386). Also, with regard to the number of affected persons, Turkey takes fourth place (2,580,392) followed by Algeria (1,154,355). However, Turkey was reported with the top 10 countries of the world in terms of disaster mortality in 2011 (Guha-sapir et al., 2012).

Around the Mediterranean countries most persons died from earthquakes where Turkey ranked first (26,087), whereas most individuals were affected by drought and famine, followed by earthquakes, floods and wind storms. From the 1980's to the 1990's the number of individuals killed by all disasters increased for Turkey, Egypt, and Morocco. In Turkey the earthquakes of the 1990's affected more than 2 million people. In North Africa, from the 1980's to the 1990's the number of persons who were reported as affected by natural disasters increased for Egypt, Morocco and Algeria while it decreased for Tunisia that had been hard hit by severe floods (Brauch, 2003).

For the listed natural events during the years from 1975 to 2001, the geophysical disasters in the area caused most fatalities especially in Turkey and Algeria, while the hydro-meteorological disasters (winter storms) in Syria and Morocco caused a rising number of affected people. The time span is not enough to draw conclusions on long-term trends for the Mediterranean region, but the August-September 1999 earthquakes (7.1) and the heavy flood in Algeria in November 2001 (7.2) have indicated an increasing vulnerability of urban centers to natural disasters (Brauch, 2003).

3.1.3.1. Geophysical Disasters

a) Earthquakes

History proves that earthquakes are among the most devastating natural hazard and have caused extensive human and economic losses particularly in developing countries. Many developing countries in earthquake-prone regions face a tough problem: how much of their limited resources should they use to reduce natural hazards? And how do they prepare for them? This issue is difficult because major natural hazards are infrequent, and it is not clear when a natural event may happen, how large it could be, and how much damage it may cause. Furthermore, these countries have profound immediate needs, including such continuing rapid transformations as urbanization (Steckler et al., 2018).

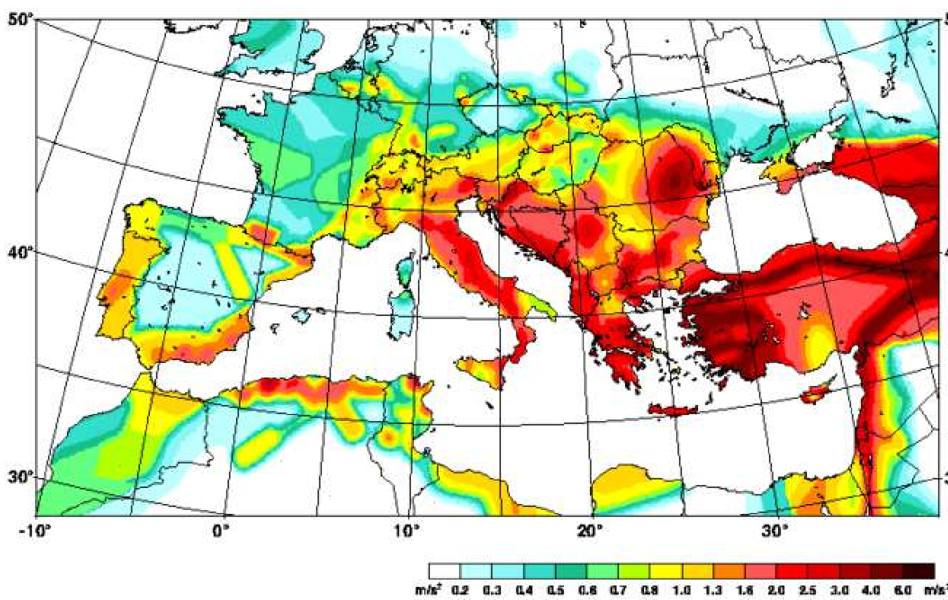

Figure 3.3: Seismicity in the Mediterranean Basin (GSHAP, 1997).

The many earthquakes in the Mediterranean Basin are because of the continental collisions between the northerly-drifting African Plate with the Eurasian Plate and other small plates: Arabian, Adriatic and Iberian (Royden, 1993; Mantovani et al., 2002) (Figure 3.3). The distribution of surface earthquakes throughout the Mediterranean region displays the clear concentration of seismic activity along the Italian peninsula and over the Greek islands, and the most dominant earthquake pattern is stretching from the west coast of Greece to south Turkey (Ruffell, 1997). During the 20th century, according to Wagner (2001) around 60 major earthquakes were recorded in the Mediterranean region, 20 of them in north-western Turkey. During that century they caused at least 250,000 fatalities especially in the coastal areas that have grown rapidly and experienced most material devastations. The earthquake in August 1999 in Western Turkey was among the most fatal natural events in the Middle East region (Brauch, 2003).

b) Landslides

In many mountain regions of the world, landslides constitute one of the most common natural hazards and pose a great threat to both human lives and property (Khattak et al., 2010). Several natural and human-made factors that can cause a landslide, but generally earthquakes and rainfall are considered as two major mechanisms (Keefer, 1984; Crosta, 2004). Continuous aftershocks can cause subsequent landslides. This is an additional problem following an earthquake forming in closing highways and railroads which are needed to evacuate survivors or bring assistance to the stricken region (Coch, 1995). Many earthquakes generated strong tsunamis, some of them being reaching long distances in the East Mediterranean basin (Papadopoulos et al., 2007).

3.1.3.2. Hydro-meteorological Disasters

a) Tsunamis

In the eastern Mediterranean, seismic sea waves have been reported in written history a few thousand years ago with early cuneiform texts describing the flooding of Ugarit, a city along the Syrian coast by a sea wave (Salamon et al., 2007). Many historical documents indicate that a very large tsunamigenic earthquake hit the eastern segment. In Alexandria and Bab-Al-Bahr in Egypt, the sea flooded the coastal zone and resulted in devastation to port facilities. The wave extended to Acre, Palestine, where the sea inundated the shore and people were swept away and sunk by the huge wave (Guidoboni & Comastri, 1997). In addition, the lower of the three tsunami sediment layers in Dalaman, SW Turkey, could be attributed to the tsunami that occurred in 1303 (Papadopoulos et al., 2007).

b) Floods

Flooding is another dangerous natural hazard that threatens some parts of the world, and the risk of it would increase in a warmer climate, according to the recent regional and global projections (Intergovernmental Panel on Climate Change (IPCC, 2012). Consequently, improving adaptation and mitigation strategies to cope with flooding has become a strategic theme in national (e.g. HOlistic analysis of the impact of heavy PrEcipitations and floods and their introduction in future scenarios, the Spanish project HOPE) and international (e.g. HyMeX: HYdrological cycle in the Mediterranean EXperiment) (Drobinski et al., 2014) climate programs.

Nevertheless, many uncertainties in characterizing the present and future evolution of floods still exist. Recent IPCC reports (2012, 2014) still view significant uncertainty linked with future projections of extreme precipitation (Turco et al., 2017), and these uncertainties are even greater when considering flooding and interaction with communities in the context of increased vulnerability. By the increase in population and in vulnerability, the impacts are exacerbated, especially in centers where there is already pressure from inhabitance (Ceola et al., 2014). This is the case in the Mediterranean countries, where the population is concentrated on the coast, often in locations exposed to natural hazards (Cortès et al., 2017).

Between 1975 and 2001 in North Africa, there were 38 floods with a total of 2,924 victims. Yet the flood in November 2001 in Algiers was among the most fatal natural events in North Africa; about 921 persons (31%) died. The persons most affected by floods were in Egypt (229,868), the most people who died in Egypt due to floods were 673. The flood hit Egypt in 1994; the most affected areas were in Durunka, Asyut, Sohag, and Quena. In the Eastern Part of the Mediterranean region, Turkey had the highest number of flood events, in which 450 people were killed and 92,157 were affected (Brauch, 2003).

3.2. Remote Sensing of Natural Disasters

The world's first photographic image of nature was taken around 1826 by the French Joseph Nicephore Niepce (1763-1833) (Gernsheim & Gernsheim, 1952), and the first aerial photograph was taken by the Parisian photographer Gaspard Felix Tournachon (1820-1910) from a balloon above Paris in 1858. However, the real advantages of remote sensing were not apparent until World War I, and became even more substantial in World War II (Jensen, 2007). Beginning in the mid-twentieth century, remote sensing effectively began with the launch of the first Landsat satellite in 1972 (Williams et al., 2006). With the develop in remote sensing science, a lot of quality and valuable information about biophysical characteristics and human activities has been used in different research disciplines.

In the event of a natural disaster, the scientific community energetically and quickly developed more advanced remote sensing methodologies, which link remote sensing with spatial measurements and accessory data for faster analysis, more accurate mapping, and more effective forecasting. Moreover, remote sensing represents unique and valuable information to observe changing conditions in the atmosphere and on the Earth surface, as well as at a several of spatial and temporal scales (Chen et al., 2012). Remote sensing provides either needed reconnaissance or quantitative and sustained measurements by offering accurate, frequent and almost instantaneous data. Under challenging situations, such as the large area extent of impacted areas, the potential shortage of on-the-ground access because of damaged infrastructure, remoteness, or sociopolitical reasons, remote sensing is often the only way to see what is happening on the ground. While it is not possible to prevent natural disasters, it is possible to manage potential disasters to reduce loss of life through a four-part process of mitigation, preparation, response, and recovery (Lewis, 2009).

As remote sensing undergoes further technical evolution (Chen et al., 2012), its applications are increasingly used in disaster management, from risk modelling and vulnerability analysis, to early warning, to damage assessment caused by natural disasters (Lewis, 2009). From a landslide-inventory-based and GIS-based framework, Chau et al. (2004) analyzed systematic landslide hazard in Hong Kong by employing historical landslide data of the area, coupling with geological, geomorphological, climatic, population, and rainfall data. Tarolli et al. (2012) used high-resolution digital terrain models (DTM) to extract geomorphic features related to shallow mass-wasting processes (landslide crowns, bank erosion). Their study area is in a part of Rio Cordon Basin, which is in the Dolomites, a mountainous area in the Eastern Italian Alps. Based on two-step robust Digital Elevation Model (DEM) matching algorithm, (Rui et al., 2017) presented a landslide detection method in variable mountainous areas. DEM matching presented two challenges: determining the alignment between the surface features of the two DEMs and assessing the matching transformation parameters. The researchers detected landslides in the elevation change map, and their experimental result stated that large-scale landslides can be detected based on robust DEM matching.

Remotely sensed data has been extensively applied to volcanoes (Hooper et al., 2012). Various work include observations of inflation and deflation of inferred magma chambers (Lu et al., 2000; Fialko & Simons, 2001; Pritchard & Simons, 2002; Wicks et al., 2006), faulting (Amelung et al., 2007), sill and dike intrusion (Jónsson et al., 1999; Fukushima, Cayol, & Durand, 2005; Pedersen & Sigmundsson, 2006), and eruption (Froger et al., 2004; Yun et al, 2007). The new generation of X-band SAR satellites provides a unique opportunity for Solano-Rojas et al. (2017) to monitor deformation in the Popocatepetl Volcano in Central Mexico by using Interferometric SAR (InSAR). They presented deformation results from 2012 to 2016 obtained, and they complemented the deformation analysis with seismic and GPS information. Estimates of lava volume and effusion rate are critical for assessing volcanic hazard, and the choice of specific methods depends on the accessibility to the volcanic areas to make field measurements and how often they can be repeated. Because Volcán El Reventador (Ecuador) is inaccessible except few locations in its caldera, Naranjo et al. (2016) used both planimetric field and topographic satellite radar-based measurements of lava flow thicknesses and volumes for activity between 2002 and 2009 at El Reventador. The use of Synthetic Aperture Radar (SAR) interferograms allowed the retrieval of the compound lava flow field shape and show that it was subsiding by up to 6 cm/year in 2009 (Naranjo et al., 2016).

3.2.1. Remote Sensing in Seismology Research

Remote sensors data has been used in seismology research very early, with the first appearance of satellite images. The first application was related to structural geology and geomorphology. Clark (1978) used aerial photographs (high-altitude, oblique, taken at 60,000 feet by the U.S. Air Force) to find active faults. He studied the Garlock Fault in the Mojave Desert of Southern California. In some parts of the southern parts of the USSR, Trifonov (1984) examined three aspects of air and space images application in neotectonics: survey, study, and mapping of neotectonically active zones, study of the deep-seated structures of active areas , further seismic risk studies.

Gupta et al. (1994) processed and analyzed a pre- and post-earthquake LISS-II sensor data set of Uttarkashi area to detect the surface effects of the Uttarkashi earthquake of 20 October 1991, and he observed that there were areas on the post-earthquake image were higher while others were lower, such as water ponds, than on the per-earthquake image. Also, he found that along the Ganga River there was an evident change in discharge of the river after the earthquake. However, because of the spatial resolution of data available from the IRS-LISS-II sensor at that time was not high (36.25m), individual earthquake induced landslides were not clearly identified. Whereas, later, the IRS-1C-PAN sensor with a high resolution (5.8 m) provided a special opportunity to map earthquake induced surface changes and landslides. Saraf (2000) studied change deformations after the Chamoli Earthquake hit Himalaya, India in

29 March 1999 (M = 6.3). He mapped landslides induced by this earthquake comparing surface deformations by using IRS-1C-PAN pre- and post-earthquake images. A pseudo color transform (PCT) approach for earthquake damage assessment was successfully evaluated on IRS-PAN per- and post- earthquake data set to accurately identify the landslides and to assess quantitative damage. Earlier Saraf (1998) used IRS-PAN pre- and post-earthquake remote sensing digital data sets of two different dates to study the Jabalpur earthquake (22 May 1997) induced changes. Pre-earthquake IRS-LISS-III digital data was also used to understand structural framework of the study area.

In addition, different geophysical phenomena are recorded in the interference patterns which are formed by differencing two synthetic aperture radar (SAR) images. The fringes created by the topographic relief can be removed by using a digital elevation model (DEM). By comparing pairs of images spanning different periods of time, it has been possible to discriminate between geophysical signal and interferometric artifact. Massonnet et al. (1993; 1994; 1995) applied this pair-wise logic to the region around the 1992 Landers, California earthquake using SAR images acquired by the ERS-1 satellite. The map of the coseismic displacement field generated by this technique brought new insights into the nature of deformation caused by earthquakes (Peltzer et al., 1994; Zebker et al., 1994). Peltzer et al. (1994) used the interferometric map created by Massonnet et al. (1993) to analyze the coseismic surface displacement field in the vicinity of the fault trace. Price and Sandwell (1998) studied the same earthquake area by using different method which brought out short-wavelen features to reveal previously unrecognized strain patterns.

A new seismic remote sensing methodology was used to determine the earthquake source process and near-source strong ground motions. Dreger and Kaverina (2000) developed a regional distance finite fault method that use near- realtime broadband TriNet data recorded for the recent October 16, 1999 Mw 7.1 Hector Mine, California, earthquake to define the gross properties of the earthquake source process.

Satellite remote sensing systems provide spatially continuous information of the tectonic field, and they can assist to the understanding of specific fault systems. Combining ground network data with remote sensing provides a better understanding of displacements, and slip models validation that is cast in a regional position of tectonic strain. Cakir et al. (2003) utilized combined tectonic landscape observations and Synthetic Aperture Radar (SAR) data to define an improved model of the displacement associated with the 1999 Izmit Turkey Earthquake, at the eastern end of the Sea of Marmara. Talebian et al. (2004) used ENVISAT radar data to map surface displacements due to the 2003 Bam, Iran Earthquake, where they detected >2 m of displacement depth on a blind strike-slip fault, in which no surface morphological features were present or identified.

Similarly, Fu et al. (2004) used satellite images to uncover the geomorphology and geometry of an active fault associated with 26 December 2003 Bam Earthquake in southeast Iran near the towns of Bam and Baravat. They identified and mapped the active fault that ruptured during the earthquake by employing three-dimensional (3D) pre- and post-earthquake images created from Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) visible and near infrared data.

Satellite remote sensing observations are providing insights into how much energy is released by earthquakes and other deformation modes and how stress is transferred between fault systems from depth and to the surface. Argus et al. (2005) used synthetic aperture radar (SAR) interferometry and global positioning system (GPS) geodesy to distinguish between interseismic strain accumulation and anthropogenic movement in metropolitan Los Angeles.

Earthquake prediction has been an area of intense scientific research. The scientists consider many geophysical and geochemical phenomena as an earthquake precursor. The current earthquake space research supposes that such disastrous natural phenomenon highly relates to deformation, surface temperature increase, gas and aerosol exhalation, and electromagnetic disorder in the ionosphere (Tronin, 2006). The remote sensing applicability in monitoring temperature changes have increased the potential of its use for earthquake prediction.

The employments of satellite thermal Infrared measures as earthquake predictors have been suggested. Ouzounov and Freund (2004) studied solid Earth–atmosphere interactions and possibly solid Earth–seafloor interactions prior to major earthquakes. They analyzed infrared (IR) emissivity, land surface temperature (LST) and sea surface temperature (SST) data provided by Moderate Resolution Imaging Spectroradiometer (MODIS). An evidence for correlations between solid Earth processes and atmosphere/ocean dynamics prior to strong earthquakes was found, particularly for a thermal anomaly (LST) pattern which is apparently related to pre-seismic activity. Many attempts to determine the thermal anomaly and detect the pre-earthquake anomalous thermal infrared signal were made (Tramutoli et al., 2005; Tramutoli et al., 2015).

AVHRR (Advanced Very High-Resolution Radiometer) data was used first to study the relation between the thermal anomalies of soil surface and the occurrence of earthquake. Then, several studies have been done, using different types of Geo- Stationary and Polar Satellites data (Bellaoui et al., 2017). By analyzing 7-year series of AVHRR satellite thermal images for Middle Asia, Tronin et al. (2002) indicated the existence of positive thermal anomalies which were related with the large linear structures and fault systems of the Earth's crust. The thermal anomaly was located near Beijing in China, and in Kanto area in Japan. Tronin et al. (2004) identified the presence of thermal anomalies on the earth surface in the basin of the Kamchatka river by analyzing a sequence of IR images, and well observations on the Kamchatka peninsula.

Huang et al. (2008) used thermal infrared data from MODIS sensor to study the relation between thermal anomalies and seismic events around the epicentre of the Sichuan earthquake (occurred on May 12, 2008: MS~8.0) in China. Their results showed that the temperature was higher 3-5 degree prior to the earthquake and the anomaly disappeared after the earthquake. On a collection of six years of MODIS satellite data and observed data of ambient temperature, Bellaoui et al. (2017) used robust satellite technique approach (RST) to predict 21st May 2003 Boumerdes, Algeria earthquake. They note that there was a connection between time and location of thermal anomaly. After compare the thermal anomalies results with the ambient temperature variation measured in three meteorological stations of Algerian National Office of Meteorology, they confirmed the significance of robust satellite technique as a highly effective approach for prediction and monitoring the earthquakes.

3.3. Risk Perception

"Perception is a process by which individuals organize and interpret their sensory impressions in order to give meaning to their environment . . . people's behavior is based on their perception of what reality is, not on reality itself" (Buffett in Robbins & Judge, 2013:166). Risk perception is the reaction of an individual or a social unit toward a natural disaster, and this response is a result of their culturally-related perceptions formed from experiences, training, and education (Jung, 1959). Some studies have tried to measure the perceptions of risk under the supposition that individuals realize risk as death probability. According to anecdotal observation of scientific practice, risk represents different things in various contexts (Crouch & Wilson, 1982; Fischhoff et al., 1984).

Fischhoff et al. (1978:2) proposed a significant question "How safe is safe enough?" in his study of attitudes towards technological risks and benefits. Building on and extending this study Slovic, Fischhoff, and Lichtenstein (1985) explored perception of risk by developing psychological risk taxonomy to understand people's awareness and predict societal response. By creating their own methods to assess public opinion about risk, they explored the relationships among risk characteristics and a small number of factors derived from them. The researchers connected the characteristics of risk to people's risk perception and their desire for mitigation and regulation. Fischhoff et al. (1993) later emphasized that statements about other people's understanding have to be disciplined by methodical data. They argued that inaccuracies in people's risk perceptions can injure them. Furthermore, inaccuracies in what diverse risk managers think about those perceptions can hurt those people. Freud in 1916-1917 designed a mental topography to characterize the complicated interaction of the psyche and reality, trying to explain how people take in impressions and order them according to their relationships to impulse and instinct (Freud, 1963).

3.3.1. Theories of Risk Perception

The most widely held cause of risk perception is the knowledge theory: the often implicit notion that people understand technologies (and other things) to be dangerous because they know and realize them to be dangerous. The second commonly held theory of risk perception comes from personality theory. In discussions it is frequently heard the personality indicates that individuals seem to be without differentiation in their risk-aversion or risk-taking tendencies: some persons love to take risks, so they take a lot of risks, whereas others are risk averse and try to avoid as many risks as they can (Wildavsky & Dake, 1990). Other explanations for public perceptions of potential hazards follow two kinds of economic theory. The first explains that the rich are more prepared to take risks resulting from technology because they benefit more and are somehow protected from crucial consequences. Presumably, the poor feel the opposite. In "post-materialist" theory, the reasons are reversed. Because precisely living criterions have improved, the new rich people become less interested in what they have (luxury) and how they got there (capitalism) than in what they think they wanted to have (closer social relationships), and what they desire to have (better health) (Douglas & Wildavsky, 1983).

Other explanations for risk perception are based on political theory. These versions view the arguments over risk as conflicts over benefits, like holding party or office advantage. The vision of politics as clashing interests associates struggles to different positions in society. In such approaches, the hope for explanatory power to the perception of risk is placed on demographic and social characteristics such as age, gender, social class, adherence to political parties, and/or liberal conservative ratings (Wildavsky & Dake, 1990). Another set of explanations for public reactions to danger that views individuals as the active organizers of their perceptions comes from cultural theorists. They have proposed that individuals choose what and how much to fear, in order to support their life way. From this viewpoint, choice attention to risk, and preferences among various sorts of risk avoiding or taking, goes with cultural biases. So, ideologies require deeply held beliefs and values defending different patterns of social relations (Douglas & Wildavsky, 1983).

3.3.2. Approaches to Risk Perception Study

There are two major approaches to risk perception study: the realist approach and the constructivist approach (Renn & Walker, 2008). The realist approach to risk could be explained as the thought that brings perception as close as possible to the objective risk of an action or an event. It supposes that there is an outside objective world with risks that could be recognized and acknowledged (Wachinger & Renn, 2010). The problem solutions of perception are thus simply ones of more information and a better understanding of the risk. The risk is not questioned, but do likelihoods or even probabilities form real phenomena? On the other approach, constructivists debate that risk is not objective, and they argue that risk is subjective and socially constructed (Jasanoff, 1998).

People’s response relies on how they understand the risk from rare and extreme threats. Individuals or societies who are with low perception of the threat to themselves are likely to behave poorly when faced with natural hazards’ threats, while those who are with a high risk perception tend to react in a positive way. As a result, planned measures to prevent disasters are geared toward the extreme dimension of natural events and include particular, technocratic, directive and control measures such as hazard-based land-use planning, engineering structures, and hazard awareness campaigns (Gaillard & Texier, 2010).

Attributing natural disasters to outside forces away from any kind of possible human control or reduction greatly affects not only risk perception but risk management, modifying their much-needed participation in the mitigation process or contribution in decision-making. Lee (1981) asserted that communities accepting some level of blame for natural hazard effects, such as faulty architecture and inadequate policies, were more potential to be active in community decision-making and mitigation, which often reduce future risk. This realization that the individuals' or communities' impact can modify risk may be the key to effective event mitigation and/or preparation (Rosa, 2003).

3.3.3. Factors Influence Risk Perception

Risk perception may be influenced by different factors. One perspective of risk looks at the costs in relation to the possible benefits. This focuses on the economic context of the individuals. This point of view considers the economic factor as one of the primary determinants in risk perception, the possibility of benefit despite its potential risks (event or outcome) (Jaeger et al., 2001). In spite the fact that a specific location or context may lead to a certain risk, it is also true that the same location or context can come up with benefits. Many studies have discussed how the balance between risks and benefits estimated by the individuals can be a determinant factor that influences risk perception (Fischhoff et al., 1982).

In addition to economic considerations, other factors may influence risk perception. Some people feel connected to a specific place in a way that the risk factor is part of their identity. This situation appears more common in the case of ‘natural hazards’: in Yungay in Peru, for example, despite the risk from earthquakes, people didn’t want to move from their homeland (Oliver-Smith, 1996). For this reason, they accept and coexist with the hazard, and they also develop an emotional link with it, which decreases its potential risks (Wachinger & Renn, 2010). In addition, some political tendencies, ideologies, and other social affiliations that involve a value force may have a crucial function in defining people’s risk perception. A paradigmatic instance can be found in some parts of Australia, in which a strong nationalist feeling reduced the perception of a continuous risk of drought (Heathcote, 1969).

Freud (1963) discussed that the function of faith and religious indoctrination can impact our individual and collective psyche. The converse of fatalism has long been applied to pre-industrial and traditional communities in Middle-Age Europe and to the modern so-called developing nations by several scholars such as Schneider (1957), Burton and Kates (1964), Kates et al. (1973), Burton et al. (1978), and Akasoy (2006). In this issue, Chester et al. (2008) expand early studies and emphasize that looking at disaster as acts and punishment of God reflects the approach which controls disaster studies and the way catastrophic events are analyzed. This view asserts victims' guilt, which is to be punished by extreme natural events. Such a realization of disasters is often related with fatalistic and submissive attitudes that the proponents of the hazard paradigm quickly linked with a very low risk perception. This allegedly leads to helpless or unsuitable behaviors in the face of natural hazards (Gaillard & Texier, 2010).

Dake (1991) in his study of orienting dispositions in risk perception, discussed that in fundamentally religious communities, the culture role may be substantial in directing community response, when views of preordination dominate their understanding of hazard and risk. Gaillard and Texier (2010) argued that we can never detach religion from the larger picture because it always reacts within social, political, and economic constraints in the people's vulnerability construction in the face of natural hazards. People do not evaluate risk in simple terms, but in terms of the threat of hazard or religious and cultural vision. Their assessment balances a large array of benefits and losses for their daily life.

In the context of major religions, this approach has also been considered, such as Christianity during the January 1951 awakening of Mount Lamington eruption in the northern division of Papua (Belshaw, 1951), Buddhism in the causal thinking after the 2004 tsunami wave in Sri Lanka (Levy et al., 2009), or Islam in the understanding, attitudes, and perceptions of the survivors of the 1971 Burdur Earthquake in Turkey, the tsunami as supernatural retribution versus natural catastrophe in Southern Thailand, and earthquake preparedness of households in Jeddah, Saudi Arabia (Demirkaya, 2008; Merli, 2010; Azim & Islam, 2016).

3.3.4. Islam and Risk Perception

In Muslim communities, like any other religious community, the faith significantly forms the perception of risk, and the individuals of the community tend to interpret their experience with religious enthusiasm. Also, Azim and Islam (2016) added that the omnipotence and supremacy of Allah is the solid foundation of Islamic belief. It is believed that the causes of all natural events are related to Him. Haque (1987), for instance, studied the floodplain communities of Bangladesh, and he found that about 97% of the flood displacees believed that their future counted on Allah, and that around 95% of the study respondents prayed to Allah as their first solution to common and catastrophic suffering at hand or those imminent when they had experienced repeated flooding (Paradise, 2006; 2008).

In Muslim societies or countries where the poor people represent large factions that often are marginalised, and where power at individual or community levels is obviously absent, it has been widely written that these poor factions tend to accept all natural events (however rare or cataclysmic) as the 'will of Allah' and to reject active accountability (Ittelson et al., 1974). On the contrary, Hartmann & Boyce (1979) highlighted that this massive sense of a lack of power or control under Islam was more a caste function than faith. They found that in relatively rich Muslim communities the wealthy tend to believe that God supports those who help themselves, while the poor tend to believe that God provided them this position. As mentioned by Azim and Islam (2016), since Saudi Arabia is a rich country, the households have better economic status than many other Muslim countries vulnerable to natural disasters like Morocco, Indonesia, or Bangladesh, which are vulnerable to earthquake.

3.3.5. Risk Perception in Muslim Countries of the Mediterranean Basin

Prior studies on risk perception in the Muslim countries of the Mediterranean region are limited. Homan (2001) investigated culturally sensitive approaches to risk and the perception of natural hazard in Egypt by a fieldwork survey administration conducted in five communities: El Kattamia, central Cairo, El Gamaleyya, Barnasht, and Gerza affected by the October 1992 Dahshur Earthquake (for more details about the earthquake see Degg, 1993) . Responses indicated the ways that people reconcile other-worldly and worldly phenomena to derive a holistic perceiving of the issues involved in explaining hazard events. Many responses, however, are more sceptical of ideas that progress from science. Hence, they believe the earthquake was related to God. They heard about the natural process of the ground to crack and cause earthquakes, but they do not believe this themselves. Homan tried to identify why people understand things in certain ways. The possibility, for instance, may be that people are reluctant to accept scientific explanations due to the fact that they are refused access to them. His argument here was "to deny people access to scientific knowledge, as has sometimes been the case with Third World mitigation projects, in the fear that it will violate local interpretations and ways of living is censoring at best and increasing marginalisation at worst." (p.16).

Paradise (2005) studied earthquake risk perception in Agadir, Morocco as a case study of a Muslim country where two moderate earthquakes destroyed the city in 1960. He surveyed survivors and longtime inhabitants. Paradise reviewed the Qur'an, Hadith, and classical and modern Tafsir texts to assess persons and groups perception of earthquake risk. This research found that Islam often overshadows the perceptions of individuals who have experienced earthquakes contrasted to others who have not. As a result, Islam can weigh heavily on individual's perceptions more than their experience. He also mentioned that in predominately Muslim countries, the respondents remarkably believed that there was no significant reason to prepare for quakes, since a person would not recur as long as they were sincere to the tenets of the Qur‘an and understood Allah’s infinite dominance of the magnitude and frequency of natural disasters. Paradise in his Agadir study (2005, 2006) as well observed that gender formed a minor role in the relations. Women respondents were more likely to fear earthquakes and more fervently to damage than men. Male respondents were less afraid and generally considered themselves more knowledgeable of the causes of earthquakes.

By using the semi-structured interview form, Demirkaya (2008) examined the knowledge, attitudes, and perceptions of the survivors of Burdur Earthquake in Yazıköy and Yarıköy that occurred in 1971. After analyzing the gathered data, the findings indicated that residents, who experienced the 1971 earthquake and who now live in Yazıköy and Yarıköy, have various perceptions about earthquakes. One group responded that earthquakes are natural processes as a result of internal energy of the earth rooted in the natural structure of the earth. The other group of the participants stated that it is supernatural processes, and this group included individuals who ignored moral rules, poor faith and religious practice. Demirkaya found that the participants' knowledge is not based on scientific grounds, their attitudes towards earthquakes reflect local cultural and fatalistic elements, and their social and economic condition plays an important role in their understanding of earthquakes.

Natural hazards form crucial threats to humans in one part of the world or the other. Individuales of different nations and cultures are increasingly affected by vulnerability to the consequences of serious Natural hazards. However, history has clarified that the negative impacts of natural events are not felt equally by populations living in the affected areas. Various factors determine how individuals structure their lives -- not the natural environment. The reaction of individuals toward a natural disaster is a result of their culturally-related perceptions formed from experiences, training, and education.

CHAPTER 4: Methodology

The research takes on a pragmatic approach, which is appropriate for using mixed methods, techniques, and procedures of research that best meet the plan and goal of the research and the needs for collecting and analyzing data (Creswell & Creswell, 2017). Elements of a constructivist approach were incorporated as the research focuses on the specific contexts where people live and work to understand the historical and cultural background of the participants in this seismically active region. The research agenda have **three** components: a) historic seismic record, b) current seismic related geomorphology, and c) risk assessment of Al-Marj residents. Using a multiple methods approach enables the researcher to represent a comprehensive assessment of the seismic activity in Libya from the past, during the present, and into the future. Creating historic research archive by analyzing conventional geologic and historic hazards research is important to understand the past seismic frequency and magnitude. Then, by using remote sensing a current archive inventory of geomorphic features related to that past seismic activity on local topography were created. The survey instrument administration is the third method that will identify current opinions and beliefs that can affect future behavior at the family, local, and regional scales.

4.1. Historic Research Archive

To understand the past seismic frequency and magnitude, it is fundamental to assess a region's seismic history. Samplings from a broad series of papers dealing with the evaluation of seismic potential (e.g. Kelleher et al., 1973; Allen, 1976; Shimazaki & Nakata, 1980) detect the general belief in a reconstituted uniform principle. Simply stated, guiding principle is that the historical and more ancient seismic event is a crucial key to the seismic future. The degree to which this is valid determines the predictive value of studying historical and ancient seismicity. The study investigates the historical record of seismicity within this region to see whether enough moderate and large earthquakes have occurred over longer time scales in the earlier historical past. An investigation of this kind of research would require careful study of contemporary local documents, which would require access to various archives and knowledge of Arabic, Italian, French, and German.

Historical records include written sources, archaeological evidence, and oral sources. Within the scope of seismology «historical records», as a first step, is defined as any type of evidence that is coming from the past. As a second step, the kind of this evidence can be distinguished according to different criteria, none of which is free from imperfection but rather indicates to the aim and the strategy of the investigation. A various level of authority can be determined to the records. This forms a typical historical investigation task. Usually, the criteria concern the records scope, with consider to the institution which has produced the source. In fact, earthquake records vary depending whether they are official documents released by institutions or calculations written by individuals with documental objective (Guidoboni & Stucchi, 1993).

These records in order to be properly used need a specific approach. The historical method has based itself as the best working method in historical seismology and, its application consequently is obviously recommended with the awareness of the problems that this method might put in the results gained. Historical earthquakes in the past have been analyzed by several researchers such as Ambraseys and Melville (1982), Helly and Pollino (1984), and Guidoboni (1985). Their work indicated that a professionalism inheritance which is surrounding the historical discipline can usefully be claimed demanded from the seismological side, and that for accurate and unambiguous data is observed (Guidoboni & Stucchi, 1993).

It is now recognized that for earthquake prediction is based on increasing knowledge of earthquakes and their causes and their effects as well. Most of seismicity estimation is probabilistic and the probabilities may be assessed from observed occurrences of earthquakes. However, comparing with the geological time scale involved in the seismicity of a region, the length of time that is covered by seismological data is very short (Ambraseys, 1971).

Ambraseys (1971) argued that in a given period, small events are more in number than large earthquakes, which are critical but rare events, and are not easily counted if the period of observation is not large. Consequently, despite the significant volume of data for earthquakes, a much longer period of observation is necessary to permit a meaningful statistical analysis. Such can only be achieved by using data for earthquakes prior 1900 and by choosing seismic regions which have long and well historical records of earthquakes.

Historical seismological investigations have provided an enormous amount of data, the quality of which is sort of heterogeneous. Guidoboni and Stucchi (1993) suggested a scheme of process for updating the macroseismic data set. The scheme begins with reanalyzing and fully take advantage of all the data already available from the seismological compilations. After this analysis, new historical examinations can be proposed in order to improve the quality of the available data or fill gaps.

The investigation of written sources forms the most significant part of historical seismology. Indeed, expanding the time-window on earthquakes is not only possible when documentary data are available over a long period, but it also could be done with the lack of written records which has already stimulated new, by original approaches for investigating the past in other fields: for example, archaeological evidence and ethnographic sources can provide beneficial data for earthquake investigation (Guidoboni & Stucchi, 1993). Ambraseys (1995) investigated the seismicity of Egypt, Arabia, the Red Sea region, and the surrounding areas of Ethiopia, Sudan, and Libya relying on archaeological evidence, historical sources, and instrumental data. Their study covered the earliest times from 184 BC to 1992 AD. The data was analyzed in a geographical and historical context and then placed in a geophysical framework. The macroseismic data recovered from the sources was interpreted using the methods that were described by Ambraseys and Melville (1982). This interpretation included central location, evaluation of the maximum observed intensities, and a calculation of the earthquake's magnitude. The assessment considered population distribution, communications and the accessibility of historical documents, in analyzing the evidence for individual events and the completeness of the data as a whole. The reassessing historical evidence was to locate seismic events in time and space, both of which are the most fundamental distinguishing features. They created maps show mislocated evets (Ambraseys, et al., 1995).

4.1.1. Written Sources and Archaeological Evidences in Libya

The observation and description of the effects of earthquakes in Libya which commenced in early antiquity, i.e. since 3rd century A.D., can be found as Greek and Roman sources, both texts and epigraphic material. The contributions that deal with earthquakes that occurred in Libya in ancient times relied upon historical data or archaeological data, and some used both. The first laborious openings were revealed destruction and collapse by Italian archaeologists in Cyrenaica in the area that covered the ancient cities of the Pentapolis. A seismic event was inevitable to be offered as the interpretative key of these phenomena, and it was found recorded among the notices collected in the excavation diaries and in the first editions of Cyrenaica monuments (Bacchielli, 1995).

The interest in archaeological sources with regard to seismic effects is not new. De Rossi (1874) formulated some hypotheses based on observations in paleo-christian excavations in Rome. These hypothesis were followed by similar observations by Lanciani (1918), also in Rome. Several contributions were formulated including, for example, the hypothesis by Marinatos (1939) on the extinction of the Minoan civilization In the Aegean region.

In the following years, this theory was widened and developed (Stucchi, 1965; Goodchild, 1966, 1968; Stucchi, 1975; Bacchielli & Martelli, 1981) in the number of seismic events and in the recognition of the structures destroyed, but also drastically reassessed (Roques, 1987). The earthquake of 365 A.D. was generally consent by scholars (Lepelley, 1984; Jacques & Bousquet, 1984; Di Vita, 1995) and supported by credible archeological documentation and recalled in epigraphic and literary sources. Also, for the earthquake of 262

A.D., the elements in favor are enough to guarantee broad margins of possibility (Cameron, 1992; White & Monge, 1992).

Significant elements in the process of acknowledging a Cyrenaica earthquake in the second half of the fourth century A.D. are two coin-hoards during the excavation of the Roman Theatre which is a part of the Sanctuary of Aesculapius at Balagrae (El-Beida). One of them, a hoard of 259 small bronze coins, was found in May 1956 in a humble house of late antiquity that was built in the ambulacrum of the Sanctuary theatre of Asclepius at Balagrae (El Beida) (Goodchild, 1966). The small house was later destroyed by a quake that produced one victim, whose skeleton was found by Sinesio Catani in May 1917 (Bacchielli, 1995) (Figure 4.1).

The second coin-hoard, 243 small bronze coins, was found under the date 14 October 1916 also by Sinesio Catani in a small room that was constructed in late antiquity along the south side of the Lower Plateau of Agora in Cyrene (Goodchild, 1966). A few dozen meters from the modest house, several skeletons show found under the columns of the Northern Stoa, again in 1916 (Bacchielli, 1995) (figure 4.2). The skeletons position under the drums of the columns may allow a connection with Building B6 which destroyed by an earthquake in the second half of the fourth century A.D.

In addition, ruins found in Temple of Apollo in Cyrene, Guastini (1916) suggested that a violent earthquake caused damage in the Baths of Trajan where the excavators found that the columns and walls seem to have turned on themselves and the vault fell, landing all the sculptures (Figure 4.3). Di Vita-Evrard (1999) has reported evidence of important seismic destruction affecting the archaeological site in Sabratha. The event has been ascribed to the 365 A.D. Earthquake. Such information, if systematically collected, may also be of value in determining the occurrence rate of destructive seismic events like the 1935 earthquake in the Hun Graben area.

Figure 4.1: Balagrae (El Beida): an earthquake skeleton' victim was found in May 1917 by Sinesio Catani. The excavations of the ambulacrum in the Sanctuary Theatre of Asclepius (Bacchielli, 1995).

Figure 4.2: Cyrene: several skeletons were found under the columns of the Northern Stoa in Agora (Bacchielli, 1995).

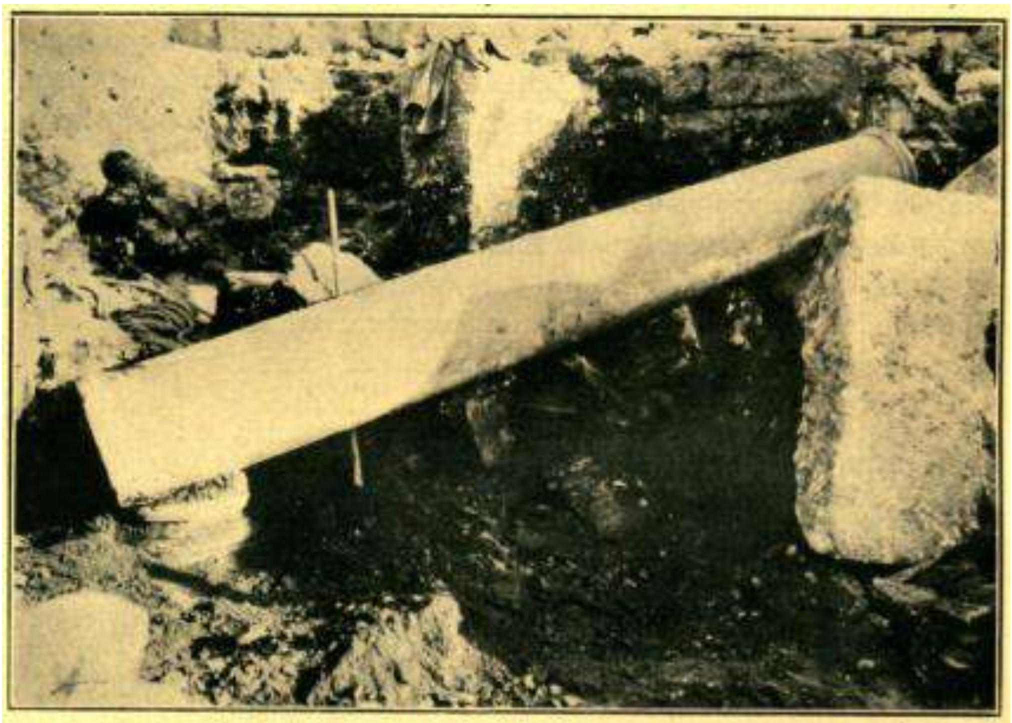

Figure 4.3: Removal of Rubble at Cyrene (Guastini, 1916).

Decisive confirmation of Cyrenaica's involvement was given by Demetria’s inscription where the text dates back to the second half of the 4th century A.D. In Necropolis North of Cyrene, there is a painted Greek Christian inscription which was found in the necropolis at Cyrene, which reads: ‘’Demetra, daughter of the landowner Gaius. She lies here with (?) this tomb, [buried?] after her son Theodulus. They died in the fields at Myropola, as the result of an earthquake […]’’ (Guidoboni et al., 1994). One of written historical sources on Libya’s past earthquakes is a flysheet. The earthquake of 1685 in Tripoli, retrieved through the bibliography on Libya by Minutilli (1903), was mentioned in Bono book (1982). The event was reported in the flysheet contained an anonymous letter sent from Tripoli to a merchant in Ancona in which there is a description of the earthquake.

4.1.2. Newspapers

Newspaper reports of earthquakes are an important source of information from the nineteenth century onwards, and the understanding of nature and the background of newspaper data is significant component in the revaluating historical earthquakes process from such data

(Musson, 1986). Of the British press, *The Times* was indexed from its beginning in 1785, and the French *Gazette de French* was used by the nineteenth century compiler, Alexis Perrey. The collections of Arabic newspapers are very few and incomplete, but some of them have been recovered for specific earthquakes. In Chicago, a systematic search was made through certain Cairo newspapers: *al-I'lam* (1886-1888); *al-Muktataf* (1887-1927); *al-Mu'ayyad* (1900-1906); the *Egyptian Gazette* (1895-1927 and then unsystematically up to 1955); and *al-Ahram* (for 1958-1974). The Saudi Arabian newspapers *Umm al-Qura* (1925-1960) and *Saut al-Hijaz* (1932-1941), were also read, yet they contain no earthquake reports (Ambraseys et al., 1995). Hundreds of newspapers reported the event of 1963 earthquake on the same day and through the week of the event. The reporting of the Al-Marj earthquake by *Fergus Falls Daily Journal*, *The Daily Telegram*, and *The New Mexican*, for instance, are worthy to note. These reports provide a whole description of the event with the most notable effects in the epicentral area and ancillary detail.

However, as with any method, researchers wishing to employ newspaper must contend with a number of limitations. Musson (1986) discussed the way that newspapers have reported British historical earthquake. He found that although newspaper data provide a sufficient basis for studying many historical earthquakes, the quality and geographical spread of such data varies with time. The main limitations outcome from the fact that newspaper data has not been published with scientific purpose; therefore, it cannot be treated as complete unless in isolated cases, and it may be generalized form limited observations.

4.2. Remote Sensing and Seismology

A wide range of remote sensing methods is applied now in seismology. In earthquake science, both satellite remote sensing and incorporated ground measurements (ground-truthing) can help meet diverse research requirements for baseline and time-series data (Cakir et al., 2003; Tralli et al., 2005). These requirements include (i) recording dangerous fault and scarp locations, earthquake history, and slip rates; (ii) understanding the dynamics and kinematics of active fault systems on interseismic time scales, which assists in constructing probabilities of earthquake occurrence; (iii) describing the three-dimensional material of fault systems, their reaction to the physics of earthquake nucleation and deformation; and (iv) predicting nonlinear surface layer response and strong ground motions, including fault rupture, liquefaction and landslides (NRC, 2003).

It was not possible to measure short term processes before and after the earthquake. It was a simple extrapolation of airphoto geological explanation methods into space. The modern model of this method is active tectonic analysis with alignment analysis applications. Time series of alignment distributions on the Earth's surface are investigated pre-earthquake and post-earthquake. The present situation of remote sensing application for earthquake investigates indicates some phenomena, related to seismic activities, including surface deformation (Fujiwara et al., 2000), surface temperature (Dey & Singh, 2003; Ouzounov et al, 2006) and humidity, atmosphere temperature and humidity (Pulinets et al., 2006), gas (Dey et al., 2004) and aerosol content (Okada et al., 2004). Various evidence of gas and aerosol content changes before seismic events are reported for ground observations. Horizontal and vertical deformations that are scaled from tens of centimeters to meters are recorded after the shock. The Earth's surface deformations are recorded by the Interferometric Synthetic Aperture Radar (InSAR) technique with confidence. Pre-earthquake deformations are in fact small, on the order of centimeters. Currently, a few cases of deformation mapping pre-earthquake using satellite data are known. Future progress depends on precision longwave SAR systems with medium spatial resolution and combined with the GPS technique. Earthquake prediction methods are developing using thermal infrared (TIR) surveys.

4.2.1. Deformations

One of the essential directions of remote sensing application for seismic analysis is deformation mapping (Massonnet et al., 1994; Price & Sandwell, 1998; Joyce et al., 2009). In seismic cycles (Ruegg et al., 2001), surface deformations are divided into three phases: pre-seismic, co-seismic, and post-seismic. While co-seismic deformations are estimated to meters, pre-seismic movements are measured in centimeters. Post-seismic deformations are also evaluated to centimeters, but subsequent landslides can increase deformations to meters. Most current investigations are focused on co-seismic and post-seismic deformations (Chlieh et al., 2004). A typical example of high-resolution satellite images application for surface deformation is given in Figure 4.4.

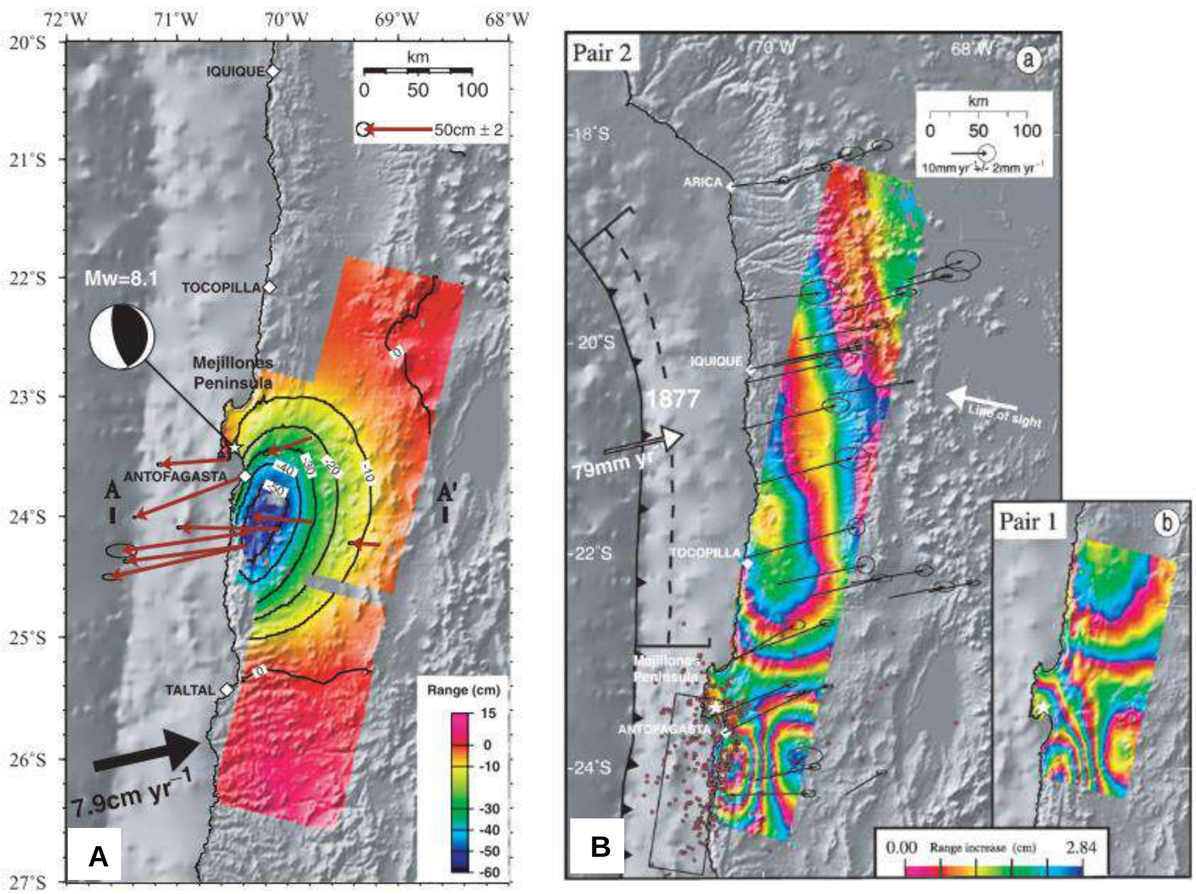

Figure 4.4: Surface deformations mapping for the 1995 July 30 Antofagasta earthquake. A) Unwrapped co-seismic interferogram and GPS measurements of the earthquake. B) Post-earthquake interferograms. (a) Interferogram beginning 71 days after the earthquake. (b) The first image used to calculate this interferogram was taken 6 hours after the earthquake (Chlieh et al., 2004).

a) Optical Sensors

The first remote sensing application in seismology was concerning to structural geology and geomorphology to find active faults (Clark, 1978). In order to the significance of the active faults and studies for better understanding of geodynamics and seismic hazard assessment and analysis, the International Lithosphere Commission launched in 1989 the Project II-2 "World Map of Major Active faults", which was led by Trifonov. ''The Project was accepted as a contribution of the International Lithosphere Program (ILP) to the United Nations' decade of natural disaster reduction'' (P. 1). The project was divided into two group projects: (i) Western hemisphere, led by Machette, USGS; and (ii) Eastern hemisphere, led by V.G.Trifonov. Later, the Project II-2 was combined with the Global Seismic Hazard Assessment Program (GSHAP). That gave a possibility to utilize the Project results for seismic hazard assessment and seismic zoning (Trifonov & Machette, 1993; Trifonov, 2004).

Deformation mapping with optical sensors and systems as a technique to measure horizontal movements and displacements was developed recently, after the InSAR deformation method. The technique that uses in optical satellite images is based on a sub-pixel correlation technique (Van Puymbroeck et al., 2000). SPOT panchromatic images were applied to the Chi-chi earthquake, 1999, in Taiwan (Figure 4.5) (Dominguez et al., 2003). This technique allows to do measurements with an accuracy of about 0.5 m. The displacement field that is obtained from such technique can be used to map co-seismic ground deformations and measure slips on the faults.

Lineament Extraction and Stripes Statistic Analysis (LESSA) has become a new step in the application of optical data sensors in seismology. Time series of alignment distributions on the Earth's surface are examined before and after an earthquake. Important changes were recorded before an earthquake in alignment distributions (density, direction) (Arellano-Baeza et al., 2006).

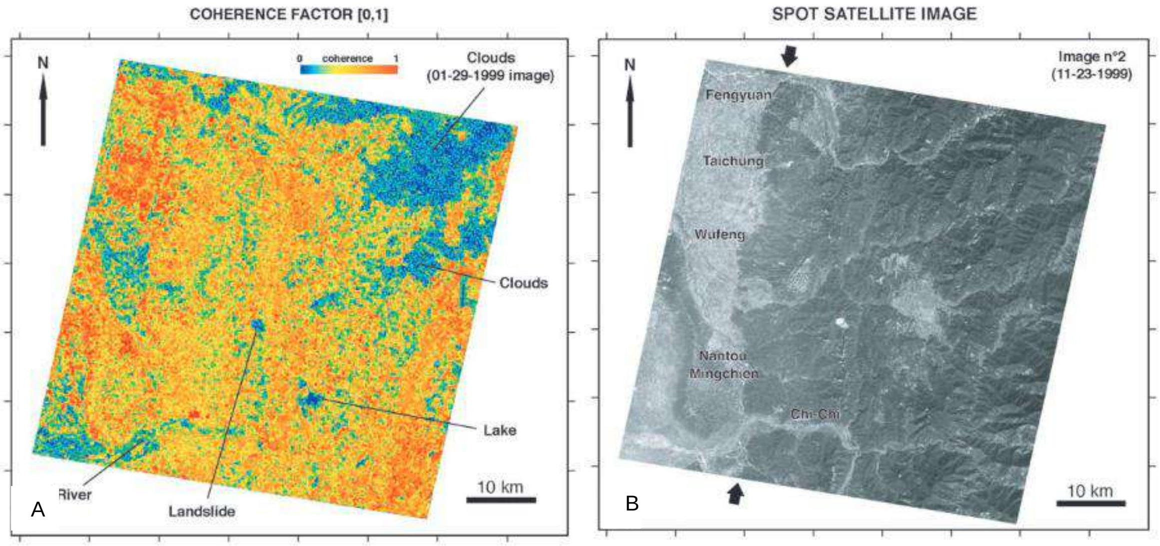

Figure 4.5: Horizontal coseismic deformation of the 1999 Chi-Chi earthquake measured from two panchromatic SPOT satellite images (pixel size 10 m), (A) acquired 8 months before the earthquake (23 November 1999) and (B). acquired two months after the earthquake (29 January 1999. A major landslide triggered by the earthquake is visible near the center (Dominguez et al., 2003).

However, due to cloud problems, the application of optical methods for deformation mapping has limited use now, so it does not provide long time image series for analysis. Moreover, the physical basis of optical sensor applications for deformation mapping before the tremor are not obvious. In the nearest future, the main trend of optical sensors will be related with post-seismic deformation mapping, especially in epicenter regions, with high resolution satellite systems (A. Tronin, 2010).

b) Interferometric Synthetic Aperture Radar (InSAR)

Since the launch of ERS-1 in 1991, geophysical applications of Interferometric Synthetic Aperture Radar interferometry (InSAR) has become a widely used technique for measuring changes and investigating small-scale features in the deformation field associated with earthquakes (Massonnet & Feigl, 1998). Satellite interferometry depends on multitemporal radar observations. In InSAR method, the phase differences of two or more SAR images are used to calculate the differences in range from two SAR antennae that have slightly different viewing geometries to targets on the ground (Talebian et al., 2004). As a result, surface displacements in range of centimeters and millimeters can be measured. The InSAR results show significant deformation signatures associated with subsidences, fractures and faults. The interferogram also clearly indicates deformation on the Earth's surface related to earthquakes.

The first application of satellite interferometry for earthquake research was demonstrated by Massonnet et al. (1993) to study the sequence of extensive shallow earthquake 7.3 Mw near Landers, California, on June 28, 1992 pre-seismic images post-seismic scenes were used (Massonnet et al., 1994; Peltzer et al., 1994; Massonnet & Feigl, 1995; Zebker et al., 1994). Similar images have been obtained for significant earthquakes of the last decade: 2008 Iwate–Miyagi and 2011 Fukushima–Hamadori, Japan (Nissen et al., 2014), 2015 Gorkha, Nepal (Kobayashi et al., 2015), 2015 Gorkha, Nepal (Feng et al., 2015), 2016 Kumamoto, Japan (Kobayashi, 2017), 2016 Kaikōura, New Zealand (Wang et al., 2018; Xu et al., 2018). These cases demonstrated pre-seismic, co-seismic and post-seismic deformations and ground displacements.

First results with pre-seismic deformations in the Tokai region, Japan (Figure 4.6) were indicated on the multiyear InSAR data in the study of Kuzuoka (2004). The Tokai region, well-known seismic gap, located about 200 km southwestern Tokyo, at the conjunction of the North American plate, the Philippine sea plate, and the Eurasian plate. The vertical deformation that was recorded on the base of InSAR data coincided with ground leveling and GPS observation (Kobayashi & Hashimoto, 2007). The subsidence continues to this time, but an earthquake has not happened yet.

The study of Tsai et al. (2006) showed that surface deformation began at least three year before the 1999 Chi-chi earthquake in Taiwan. ERS-2 radar images were used to identify possible precursory surface deformation in the main fault area before the Chi-Chi earthquake. The surface deformation was found in the areas to the west of the northern segment of the fault where co-seismic surface deformation patterns were observed. Also, the rate of land subsidence was quite fast, at about 1-2cm/month months, for the Yuanlin city and Chinshu fault before the Chi-chi earthquake (Figure 4.7) (Wang et al., 2007).

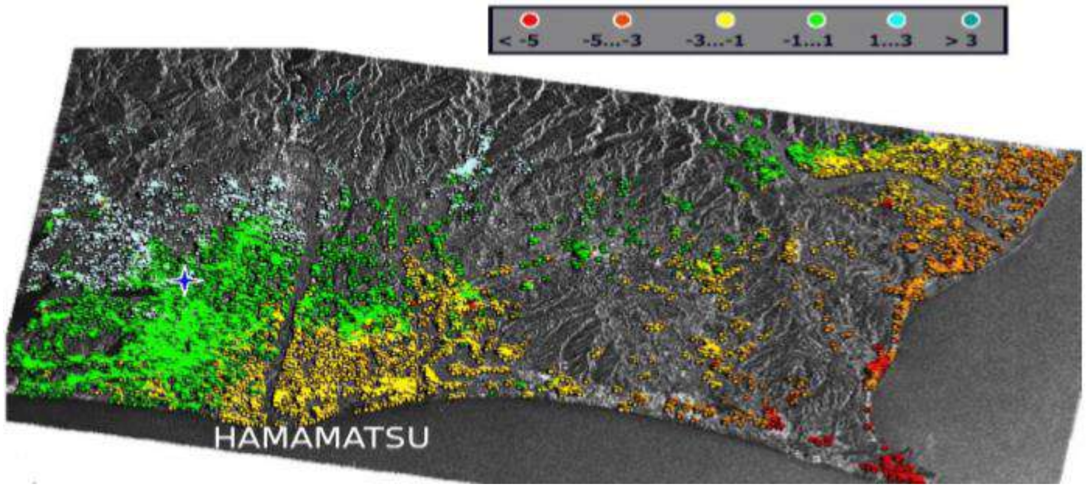

Figure 4.6: Average displacement rate in Tokai region, Japan, 1992–2000 years, vertical deformation, mm/year (Kuzuoka, 2004).

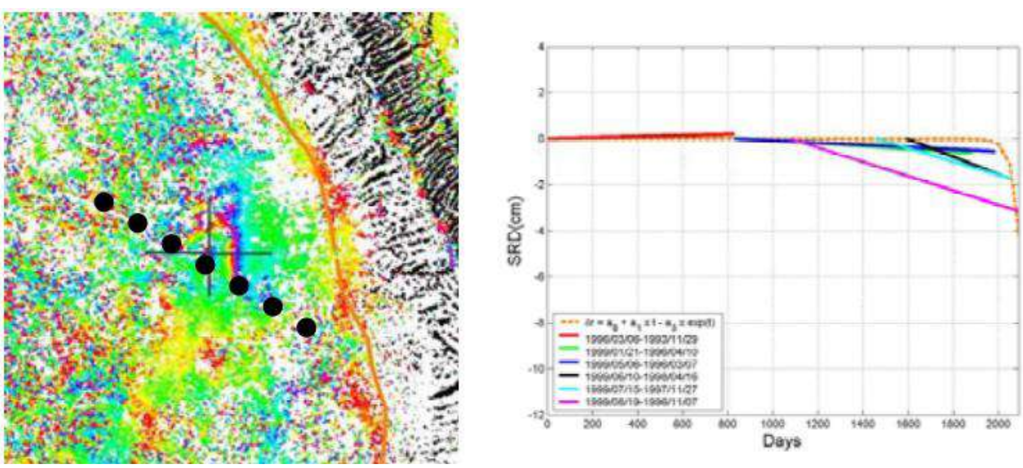

Figure 4.7: (a) Differential interferogram derived from one radar image pair between November 1996 and August 1999. The orange line depicts fault traces. The dark gray line is the observed profiles. (b) The figure shows the slant range displacement profile for the assumed deformation model and the least square fit was used to estimate the time-dependent deformation curve (dot line) (Wang et al., 2007).

4.2.2. Using remote sensing to identify seismic geomorphologic features in Libya

In this study a new method to identify seismic geomorphologic features in Libya was created. To identifying seismic geomorphologic features in Libya, satellite images from Google Earth were used with two different grids on Libya map. Small scale with 200 by 200km for each grid to assist classify and archive image classification and compilation in tandem with latitude-longitude locations. The second grid was tighter (big scale) where each grid represents 20 by 20km to help the classification and compilation of imagery and sites at closer inspection and lower elevation.

4.3. Survey Instruments and Interviews

In some research project, individuals are more relevant to explaining the process under investigation; as discussed below, it is more appropriate to interview key informants—Al-Marj residents including 1963 earthquake survivors and their family members, is a relevant example— than to incorporate this individual's knowledge through a large-scale survey (Cochrane, 1998). The survey is a method research approach that helps to conceptualize geographic context- as-place and to provide new insights into previously understudied geographic regions and associated subjects.

Surveys definitions range from the overly broad to more formal descriptions and explanation of the entire survey research process. Existent definitions include "relatively systematic, standardized approaches to the collection of information . . . through the questioning of systematically identified samples of individuals" (Rossi et al., 1983, p.1), "a method used to gather self-report descriptive information about the attitudes, behaviors, or other characteristics of some population" (Bartlett, 2005, p. 98); and "a method for gathering information from a sample of individuals" (Scheuren, 2004, p. 9). Charles Glock (1988), the famous sociologist and founder of the Survey Research Center at the University of California Berkeley, describes survey research "as being concerned with the study of variation" (Bartlett, 2005, p. 98). This is a useful definition as it highlights the fundamental purpose of the survey and cautions against inappropriate application of the method. The survey is recognized as the most frequently used data collection method in organizational research for assessing and analyzing phenomena which are not directly observable (Schneider et al., 1996).

The advantage of using surveys compared with many other research methods is that they are usually quicker, cheaper, and broader in coverage. With the beginning of the 1930s, the acceptance and use of surveys have increased, and this has been linked to changing societal attitudes, increased emphasis on cost and efficiency, advances in technology, and greater knowledge and understanding of survey error structure (Dillman, 2002; Bartlett, 2005). In his summary of the developments over the past 25 years, Kalton (2000) describes how the use of survey research grew significantly after World War II. By the 1970s, both household and organization surveys were well established as the best method for collecting statistical data for researchers and policymakers on a wide range of topics. In 1975 refereed papers on survey methodology were launched in a variety of journals. The research profession of practitioners involved in conducting surveys continued to grow rapidly as organizational leaders and policymakers understood the value of survey data for making informed decisions. Over the past two decades, the widespread use of computers has furthered the application of surveys with the use of the Internet opening a new stage in the history of this method (Kalton, 2000).

Surveys are a long-standing research tool in the Geographic Sciences, and surveys are still frequently employed although human geographers have turned away from quantitative methods as the discipline’s primary research approach (Johnston et al., 2003). This ranges from region and country-specific surveys aimed at addressing particular questions of interest (Secor & O’Loughlin, 2005; O’loughlin & Ó Tuathail, 2009), national censuses (Pacione, 2005), and Eurobarometer (Dahlman, 2004) to large-N datasets—including the World Values Survey (O’Loughlin, 2004; Schueth & O’Loughlin, 2008).

Previously, quantitative methodologies have been employed in the geographic study. The value of surveys, both small and large, is obvious; the results of surveys—or closely related combinations of population, like censuses and elections —are commonly the foundation for public policy formulations and other kinds of political decisions made in aggregate. Similar to voting choices, responses to survey questions addressing social and political questions are context dependent. For example, Secor and O'Loughlin (2005) found that neighborhoods are important in determining the strength of social and political trust in Moscow and Istanbul. Thrift (2002), in his forward-looking piece on geography discipline, noted that longitudinal large-N surveys were evaluated through a variety of solid methods, including geographically-weighted regression and multi-level modeling.

Of interest here, of course, is with contextual surveys conducted in the city of Al-Marj. As a research method, surveys are not significantly different from structured interviews; respondents were asked to participate in a series of questions generated by the researcher. The structure itself is often substantial for a productive interpretation of public and popular opinion. I suggest that surveys most clearly complies with the evaluation of the effect of Individual beliefs, knowledge, and perception on the understanding and coping with the consequences of earthquakes. The suggestion that surveys be associated with popular views, and they do provide a forum for respondents to share their opinions on a specific set of topics. Building on this, I think surveys as the most effective way to aggregate public opinion—a form of popular opinion into a comprehensible picture.

A combination of Al-Marj residents including 1963 Earthquake survivors and their family members from various socio-economic strata were surveyed: University students, staff, and faculty members, shopkeepers and customers, housewives, unemployed, and government officials. Participants usually responded with interest when asked to fill out a survey. Also, some respondents provided additional notes, personal quotes, and stories to tell their experience and opinion of earthquakes. However, in the time of sampling, in-home interviews for residents some complications were noted. Females were not interested in participating in the surveys. So, the participating residents from outside the university were mostly males. In the University of Al-

Marj sampling was easier as participants were willing to fill out the survey form when solicited. Moreover, given the ‘individual’ nature of the study, it was noted that participants were frequently willing to leave the religious questions unanswered. For many, due to religion is a deeply personal issue, they are hesitant to share their true feelings and opinion on the subject with a stranger.

CHAPTER 5: Creating a Libyan Earthquake Archive:

from Classical Times to the Present

5.1. Introduction

Libya's seismicity has been considered relatively minor (Gutenberg & Richter, 1965), however, several earthquakes of magnitude >5.0 have occurred there (Ambraseys, 1984, 1994; Suleiman et al., 2004). Though its history is relatively less seismically active and damaging than some other sites, nevertheless, a series of relatively recent earthquakes with magnitudes (Richter) up to 7 occurred on April 19, 1935; it has been described as the strongest earthquake in Libya's history, and one of the largest earthquakes in Africa's history (Johnston, 1989; Suleiman & Doser, 1995). The ancient and recent history, of earthquakes in a region located on the Mediterranean boundary of the African Shield, is particularly interesting. The complicated geologic structures between Eurasia and Africa, the corresponding plate movement, and the underlying driving forces, lead to strong variations in seismic hazard throughout the area. Libya, located on the Mediterranean foreland at the north-central margin of the African continent, has experienced considerable tectonic activities, especially along its northern coast (Hassen, 1983). An understanding of the regional seismicity related to this seismo-tectonic setting mostly depends on the data from instrumental records, so many historical earthquakes of the past are rarely known or recorded. Identifying prehistoric and historic earthquake hazards and history is an important component of predicting the causes and effects of future earthquakes and the assessment of risk (i.e. deaths, injury, and economic loss) because past earthquakes suggest the location, magnitude, and size of future earthquakes (Burton et al., 1993).

To better understand earthquake hazards, regional tectonics, and the present-day evolution of Libya's seismicity, this chapter addresses the region's earthquakes from Roman records, to the monitoring of modern national geophysical centers and global seismic data, to create a comprehensive earthquake archive. This earthquake archive can be used to (a) create

Libya's first national earthquake policies for effective mitigation (i.e. planning, policy, engineering, education), (b) a foundation to create structural construction standards, and to (c) assist in the preparation for future hazardous events and risk assessment. These findings are expected to contribute to the greater understanding of the earthquake activity in Libya, and to advance knowledge of regional earthquakes in Libya, across North Africa, and the Mediterranean Basin.

5.2. Geologic Setting of Libya

Libya is located in the Northeast African Tectonic Zone which is bordered by the Gulf of Aqaba and Red Sea to the East. The northeastern portion of the African Continent represents the contact between the African, Arabian, and Eurasian/Anatolian Plates (Figure 5.1). These plates are involved in the geodynamic reconstructions of the south part of the east of Mediterranean (Abou Elenean, 2007). The models of plate tectonic suggest the African plate is moving northward relative to the Eurasian plate at a rate of ∼6 mm/year (Salamon et al., 2003; Reilinger et al., 2006) while the Arabian plate is moving north–northwest toward Eurasia at a rate of about ∼18 mm/year (Mourabit et al., 2014). Due to these movements, crustal spreading is occurring along the axis of the Red Sea and left-lateral slip along the Dead Sea Transform Zone. The different rates of movement between Africa and Arabia (∼12 mm/year) is taken-up by a left-lateral motion along the Dead Sea Transform Fault (McClusky et al., 2003; El-Fiky, 2000; Suleiman & Doser, 1995). Corti et al. (2006) suggested that the Red Sea Rift is transferring compressional stress to Libya and western Egypt, generating significant earthquakes along the southeastern Mediterranean where earthquakes are widely felt and have caused widespread damage (Ambraseys et al., 1995; Mourabit et al., 2014).

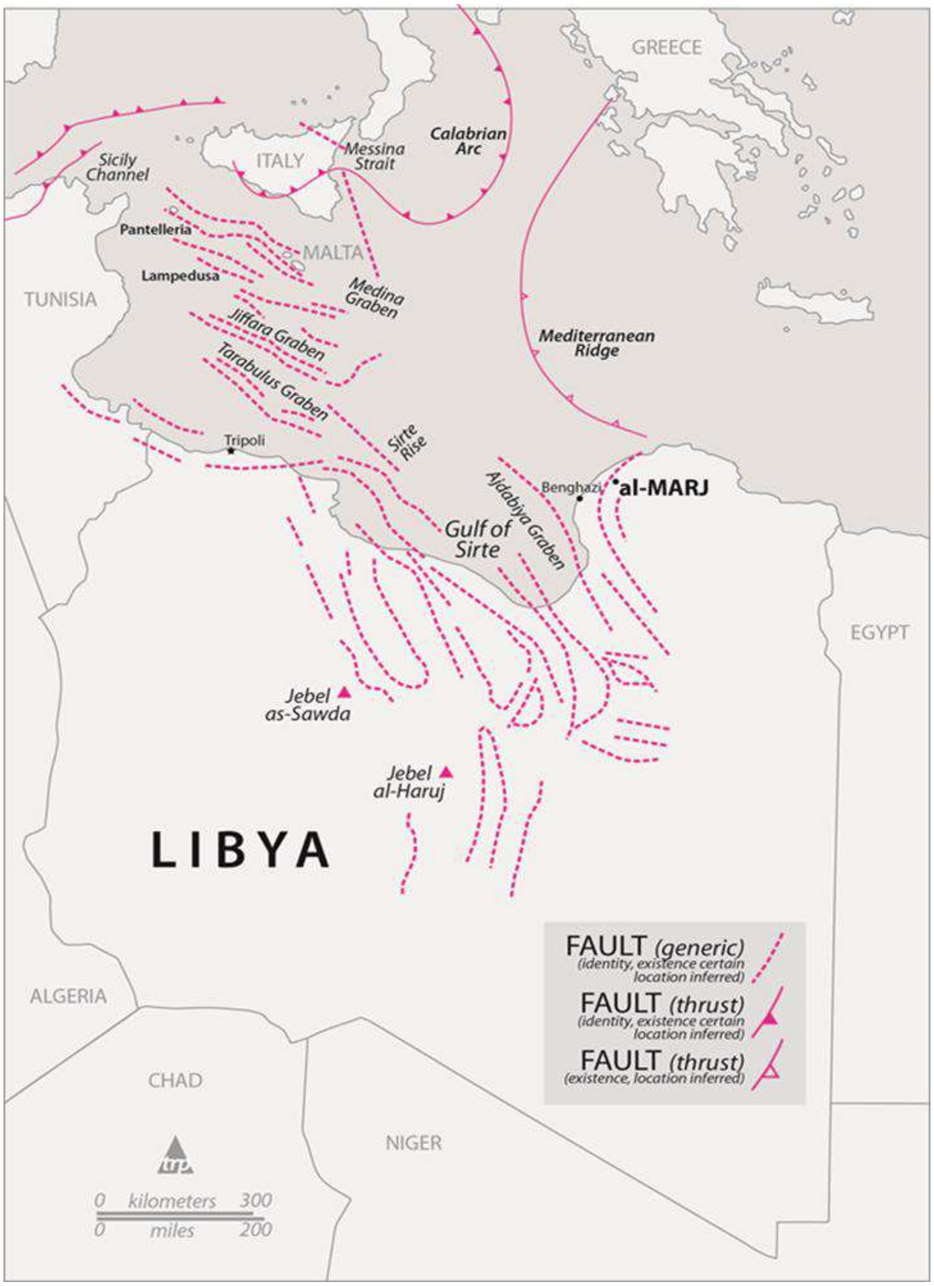

Figure 5.1: Tectonic map of Central Mediterranean Sea and Tripolitania–Sirte Basin, Libya (Capitanio et al., 2011). Cartography by author, 2019.

5.3. Methodology

This archive of Libya's seismic history chronicles past date of event (year), location, and magnitude (when possible). In order to incorporate both quantitative and qualitative methods, this study used multimedia records, documents, and past archives of Libya's earthquake history (i.e. written records, newspapers, film, images). By translating Latin codices, records and texts, and Arabic, French, Italian, and English records, oral histories, newsreels, and news sources, the authors created an archive representing the earliest earthquake activity in Libya from the Classical period (262AD) to our modern times from varied multi-lingual sources.

The collection of historical and ancient seismic events relied upon a combination of historical records, and archaeological data when recorded information was not extant. Seismic records were rare in ancient times, so the archive relies upon archaeological data. Guidoboni (1994) with the collaboration of Comastri and Traina, as well as Ambraseys et al. (1995) published catalogues of earthquakes in which Libya events were included. Dating of early earthquakes was derived from the archaeological chronological evidence provided by dated artifacts of known/estimated age (i.e. ceramics, coins) excavated above and below the ruins -- a conventional technique (Joukowsky, 2002).

For example, in the cities of Sabratha (NW Libya) and Cyrene (NE Libya), the dates of their razing by earthquakes was dated by (a) Greek Christian inscriptions (Guidoboni et al., 1994, Di Vita, 1995) and (b) excavated coins unearthed in the quake-related rubble and ruins (Goodchild, 1966, 1968; Stiros, 2001). Excavation and dating of artifacts related to structural collapse and debris is widely used and has proven itself valuable and quite accurate when records are subsequently discovered that corroborate the dates of the temblors, and the estimated intensity and magnitudes of the events.

In the early 20th century, Sieberg (1932) discussed Libyan historical earthquakes in his comprehensive tome of earthquakes of the region, Erdbebengeographi. Such descriptive catalogues, known for their in-depth classical compilations, are often the only primary works and translations used to identify these early quakes (i.e. Tripolitania 1183). However, in this research, it was the lacunae of these early catalogues that required updating from antiquity to into the 20th Century (Sieberg, 1932; Suleiman et al., 2004).

Dates, information, and narratives from 20th Century earthquakes were collected and revised from varied sources including compilations from Rudolph (1905) in addition to French findings from Critikos (1928), Italian research from Cavasino (1927) and Lipparini (1940), data from U.S National Geophysical Center and Solar-Terrestrial Data Center in Kebeasy's study (1980), Ambraseys' work (1984 - 1995), and United States Geological Survey (USGS) - ANSS Comprehensive Earthquake Catalog (ComCat) Documentation (2019).

These assorted archives provided information about real-time earthquakes through online archives, seismic maps, statistics, and related descriptions. Using this broad method with in-depth translations, and assorted mixed sources assisted in the compilation of these archaeologic, historic, and modern seismic data to create a baseline inventory of past-present seismic activity and present that in form of maps and graphs by using ArcMap program and provide the collected seismic data of this study. The data include the date, latitude and longitude, magnitude, and depth (km) of seismic events upon which the Libyans may add, improve, and supplement this archive. In addition, through this new chronology, cartographic representations can be produced in the hopes of creating a baseline GIS database from which further earthquakes may be added.

5.4. Results

5.4.1. Antiquity – 1900

In this study, seismic events (dates and locations) have been separated into two groups from 262 A.D. to 1900 (Table 5.1, Figure 5.2), and from 1900 to the present (Table 5.2, Figure 5.3) when new technologies emerged that increased accurate event records. The earliest earthquake in Libya has been documented in 262 A.D (Goodchild, 1968; Vita-Finzi, 2010) and was recorded in the Historia Augusta during the consulship of Gallienus and Faustinus. At the time, there were a number of serious earthquakes across the Mediterranean, specifically in Rome, Libya, and Asia Minor (Guidoboni et al., 1994).

In 262 A.D, this early earthquake caused considerable damage across Libya. The shock affected all of the province of Cyrenaica, however, the devastation was focused on the city of Cyrene (or observed and recorded in better detail) where archaeological evidence of the destruction was provided by Roman ruins. The city was razed to such a degree that it was was rebuilt in 267 under the new name Claudiopolis for ‘meliorem fortunam’ or better luck/fortune (Goodchild, 1968) (Figure 5.2). Evidence from the architectural rubble from Cyrene indicated that the angle of column drum fall can indicate the direction of epicenter/focus, while sediment components above and below the remnants can be used to identify the date of the tremor (Goodchild, 1968); architectural ruins are now a conventional means of identifying the time, location, and relative magnitude of severe earthquakes (Joukowsky, 2002).

During the Fourth Century, between 306 and 310AD and again in 365AD the city of Sabratha -- located on the Mediterranean coast about 70 kilometers (40 Miles) west of Tripoli -- was hit by two destructive earthquakes (Pirazzoli et al., 1996). The first earthquake razed many private houses and inflicted a heavy toll on the public buildings of the city. After having been destroyed, the buildings were rebuilt and restored in 340-350AD. The 365AD earthquake shook Sabratha to an even greater degree. This time it was razed to the ground and none of its temples were rebuilt because the new faith, Christianity, forbade it. Also, the forum lost its full colonnade, yet the pavement of the north portico was obviously rebuilt (Di Vita-Evrard, 1999) (Figure 5.2).

Cyrenaica was hit again by an earthquake in 365AD. According to reliable archaeological evidence and documentation, and recalled in literary and epigraphic sources, this earthquake destroyed the public buildings across the city (White, 1967; Goodchild, 1968). Further excavation has unearthed several collapsed structures containing buried skeletons, which confirmed the severe magnitudes of these historic quakes. Such damage, dated by inscriptions and coins, occurred after 364 and before 378AD (Stiros, 2001). A painted Greek Christian inscription was found in the necropolis on Demetria's Tomb in Cyrene that records in visual detail, the death of Demetria and her son in an earthquake in the late of 4th Century (Guidoboni et al., 1994). During this period of increased seismicity, similar destruction, however lesser, was recorded along the northwest coast of Libya dated by numismatic evidence (Stiros, 2001).

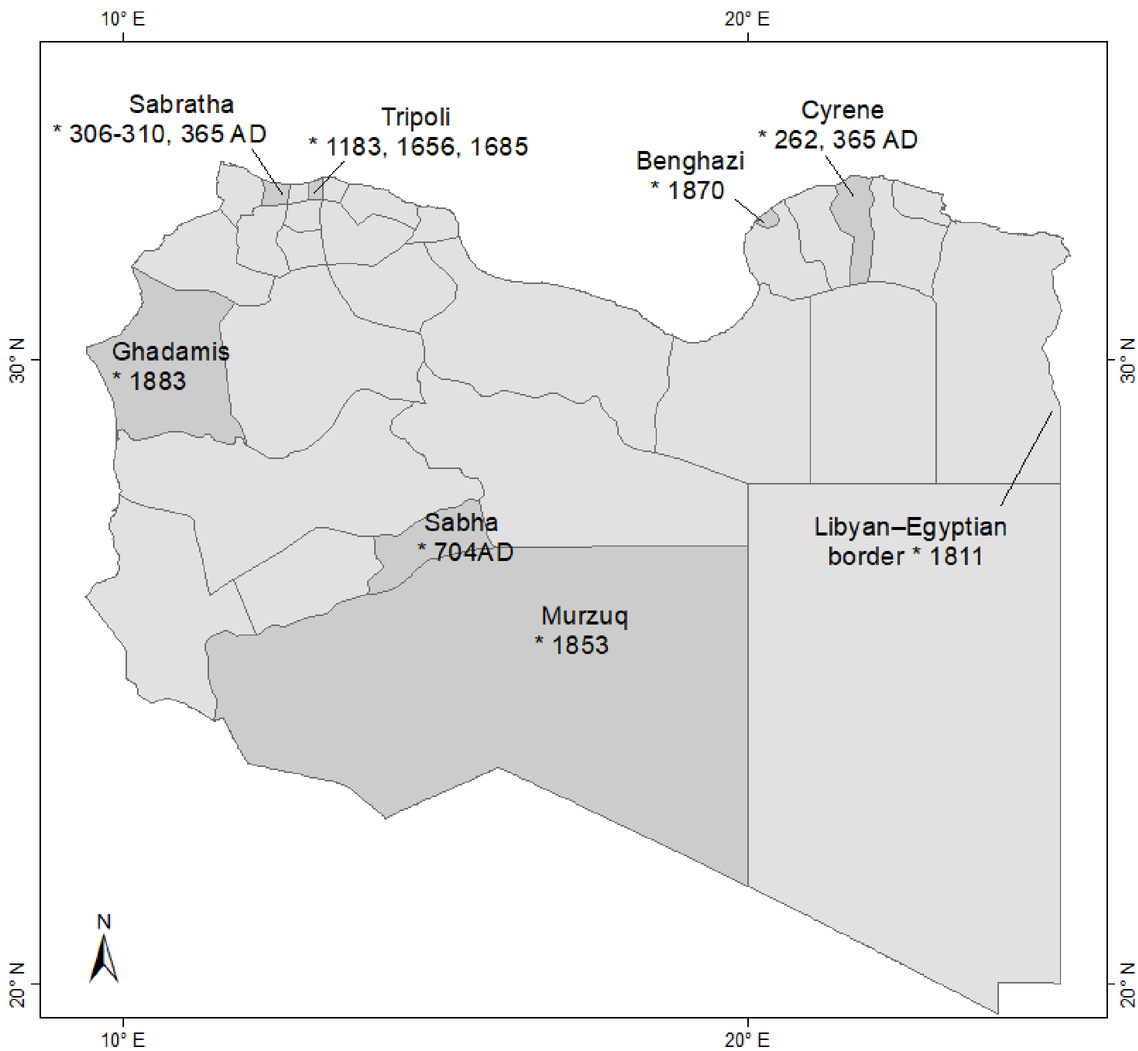

Figure 5.2: The map shows the seismic regions of Libya with event dates from Antiquity to 1900. (Sieberg, 1932; Goodchild, 1968; Bono, 1982; Ambraseys, 1984, 1995; Guidoboni et al., 1994; di Vita-Evrard, 1999). Cartography by author, 2019.

Sieberg (1932) reported that four major earthquakes occurred before the 1930s in Libya. A large shock struck in 704AD that destroyed many towns and villages in the Sabha Territory and the adjacent Fezzan Province. Then in 1183 a great earthquake shook Tripoli nearly destroying the city and killing roughly 20,000 people. With the exception of the earthquakes in

Table 5.1: Historic Earthquakes Affecting Libya, up to 1900.

Date A. D. Year m: d:	Level of Effects	Location Lat °N Long °E	Magnitude (Descriptive)	Location and Remarks
262	Damage	E. Mediterranean	Large	Cyrene and other cities destroyed in Cyrenaica region
306 to 310	Damage	N. Libya	Large	Sabratha
365	Damage	N. Libya		Sabratha
365 7 21	Damage	E. Mediterranean		Cyrenaica
704		S.W. Libya	Large	Towns and villages in Fezzan and Sebha destroyed
1183	Damage	N.W Libya	Large	Tripoli destroyed, 20,000 deaths
1656	Damage	N.W Libya	Large	Tripoli half houses destroyed
1685 5 25	Damage	N.W Libya	Large	Tripoli, >200 buildings collapsed
1803	Felt	N.W Libya	Small	Tripoli
1811	Felt	Libya-Egypt border	Large	Siwa Temple Ammon damaged
1853 8 5 1853 10 11	Felt	S.W Libya	Small	Murzuq
1870 6 24	Felt	N. Libya	Small	Benghazi
1881 6 10	Felt	Libya-Tunisia border	Small	Eastern Tunisia, between Gabes and Meret
1883 8	Damage	W. Libya	Small	Ghadamis

Sources: Sieberg 1932; Goodchild 1968; Bono 1982; Ambraseys 1984, 1995; Guidoboni et al. 1994; di Vita-Evrard 1999.

704 AD and 1183 the first severe earthquake in Tripolitania, reported in early texts, occurred toward the end of 1656. It was strong and destroyed nearly half of the structure in Tripoli. The shaking and related seiche causing the sinking of five pirate vessels in the port (Ambraseys, 1984). On May 25, 1685 a tremor hit Tripoli and caused the collapse of more than 200 buildings. This event was reported in the flysheet contained in an anonymous letter sent to a merchant in Ancona from Tripoli (Bono, 1982).

In 1803, an earthquake of moderate magnitude was recorded to have occurred in Tripoli (Ambraseys et al., 1995). Then in 1811, a tremor occurred near the Egyptian border, in the Libyan desert near Siwa, razing the Temple of Ammon at the Siwa Oasis (Kebeasy, 1980). Many shocks were felt on 5 August, 1853 in Murzuq in the Fezzan Region, and again on 11 October in the same year. On December 22, 1860, on the edge of the Little Desert on the Libyan border with Tunisia, a violent shock was centered in Matmata, 320km (200 miles) west of Tripoli. It knocked people to the ground, however, no structures were damaged or destroyed.

In August 1883, Ghadamis -- which lies about 462 km (287 mi) to the southwest of Tripoli, near the border with Tunisia and Algeria -- was shaken by a temblor which caused great damages, injury, and death. The severe shaking was accompanied by loud explosive booms, which were reportedly heard within 350 km of the town, implying a very large magnitude quake (Ambraseys et al., 1995) (Figure 5.2).

5.4.2. 1900 – Present earthquakes

After 1900, the number of reported earthquakes increased because of better instrumentation and advancements in innovating more sensitive seismographs, seismometers, and timing systems, so that earthquakes could be better located through triangulation (Havskov & Alguacil, 2002). Accompanying this progress was a new interest in earthquake research and the advancement of the nascent field of seismology (Sieberg, 1932; Minami, 1963; Campbell, 1968; Goodchild, 1968; Kebeasy, 1980; Ambraseys, 1984, 1994). Gordon and Engdahl (1963) in their instrumental study of the Libyan 1963 Earthquake, they used the standard C&GS hypocenter program to compute the locations of the main earthquake and the two largest aftershocks to gain an appreciation of possible differences between seismic records of earthquakes contrasted with records of large explosions. Hassen (1983) investigated the seismic activity and its relationship to the geology and tectonics of Libya. Articles and commentaries now appeared in the local press, and in different regional and national publications across Libya. However, such notices were brief and gave few details, with little information that could be used to determine the locations (i.e. epicenters) of the events. However, what could be gleamed from these various sources from 1900-2019 have been compiled and listed (Figures 5.2, 5.3).

An earthquake struck Tripoli on 22 November, 1903 (Rudolph, 1905) but caused little damage. The shocks were stronger inland, focused in the Tarhuna Region. The earthquake was not recorded by the early Italian Seismic Network, yet some of the European stations described the event (Ambraseys, 1984). The Earthquake of 18 May, 1914 was strongly felt and demolished the fort at Gheddahia, and caused some damage to two other nearby forts. This shock was widely recorded by European seismological stations, but an attempt at an instrumental location of the quake did not succeed (Lipparini, 1940).

In 1926, a large earthquake was felt at Cyrenaica and Tripoli striking the eastern part of the Mediterranean Ridge on 26 June (Critikos, 1928). On 30 August, 1926 an earthquake felt by nearly everyone was felt across Benghazi and Derna. The intensity indicates a higher magnitude than was reported on the 26 June 1926 event (Cavasino, 1927).

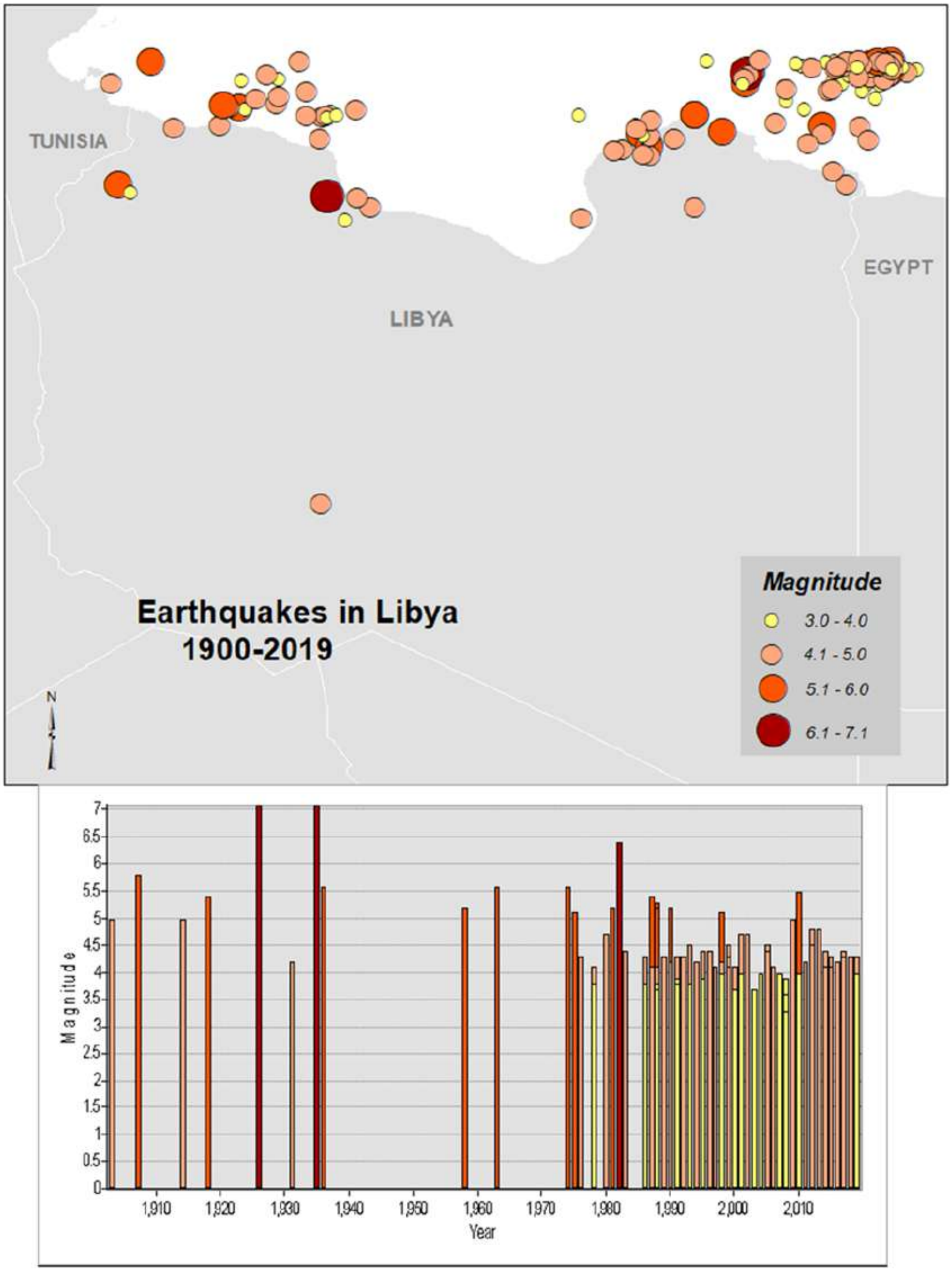

Figure 5.3: Earthquakes affecting Libya between 1900 and 2019 (M ≥4.0). This map and graph represent the distribution of the earthquakes that have occurred in or near Libya (20°-34°N, 10°-25°E) with color-coded events identified chronologically and spatially. Note the recent swarms (low magnitude 3-4) between 1990 and 2019 that are more frequent than previous events. (Campbell, 1968; Ambraseys, 1994; Suleiman et al., 2004; USGS, 2019). Graphic by author, 2019.

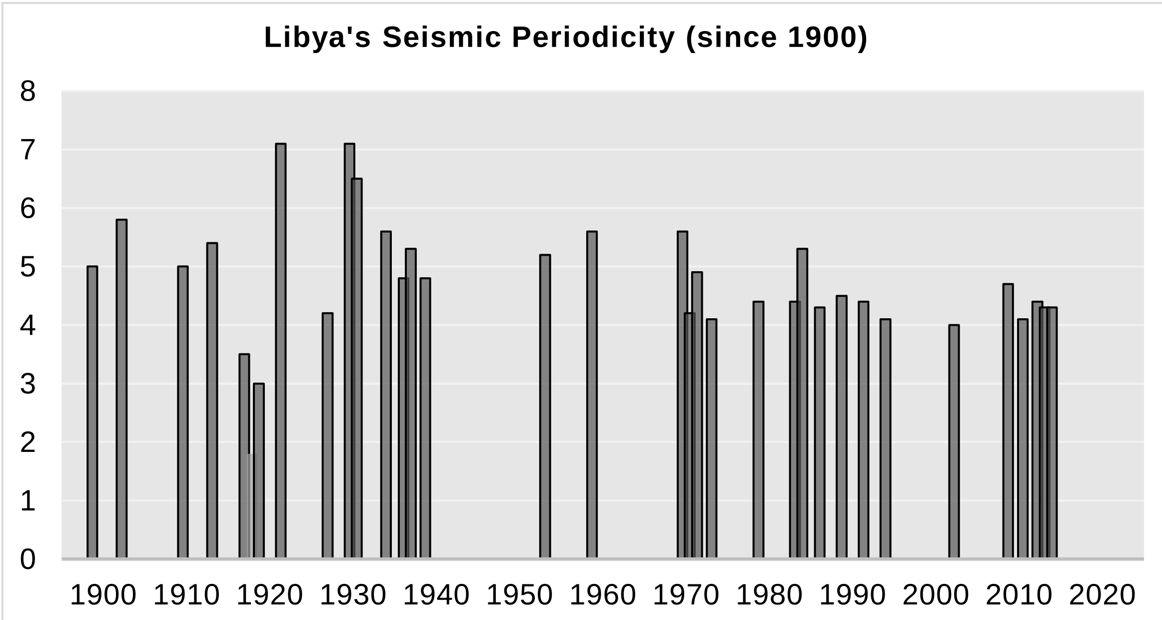

Figure 5.4: Earthquakes affecting Libya from 1903-2017 with magnitudes ranging from 4-8 (MR) (Campbell, 1968; USGS, 2018). Graphic by author, 2019.

Between 1935 and 1939, a series of large earthquakes shook the Hun Graben area, west of the Gulf of Sirte. One of the first quakes to hit during this period occurred on 19 April, 1935 with a magnitude 7.1 (MI). Striking the desert region along the west coast of the Gulf of Sirte between Zlitan, Bani Walid, Bu Nujaym, and Sirte, although not of a severe magnitude, it one of the most violent quakes in Africa's modern history. However, since the epicenter was in the desert the population was sparse and no damage was reported. This earthquake was followed by two large aftershocks of magnitudes 6.0 and 6.5. Several smaller aftershocks followed this shock (Kebeasy, 1980).

On January 23, 1939, an earthquake with a magnitude between 5.6 and 5.9 occurred in the same area. This shock took place in Gheddahia, 100km (62 miles) southern Misratah, and was followed by four tremors (Kebeasy, 1980). These earthquakes continued for three days shaking the coastal cities of Tripoli, al-Khums, Misratah, Buwayrat, and Sirte (Ambraseys et al., 1995). A major earthquake then followed six years later 80km (50 miles) to the southeast of the 1935 mainshock on 4 March, 1941 with a 5.6 magnitude (Kebeasy, 1980).

This seismically active region east of the Hun Graben, extends NNW along the western side of the Gulf of Sirte. Several shocks have been recorded with epicenters on the eastern side of this gulf. The observed seismic activity of the eastern Hun Graben and its extension into the Mediterranean Sea forms the western side of the Gulf of Sirte, and the activity along the east of the gulf boundary suggests that the gulf area is subjected to continual and significant tectonic movement creating raised flanks (Libya mainland) with a depressed central plate (Gulf) (Kebeasy, 1980).

The northeastern coast of Libya in the region of Al-Jabal Al-Akhdar continues to be seismically active. The modern town of Al-Marj -- the Roman outpost city of Barce -- had a population of 13,000 in 1963 when it was razed by an earthquake of 5.6 magnitude at 17:14 (local time) on 21 February. The earthquake is renowned in Libya, not because of its magnitude, but because of the loss of life (Gordon & Engdahl, 1963; Minami, 1965). Many structures collapsed killing 300 and injuring 375 people. Moreover, the whole population was left homeless (Campbell, 1968; Ambraseys, 1994). It was followed by five small aftershocks (Gordon & Engdahl, 1963). The poorly constructed stone, fired clay, and adobe-brick structures found in the city were responsible for injuries, deaths, and property damage. Structures constructed of rubble stone with mud or clay mortar suffered extensive damage (Minami, 1965).

Tripoli continued to be seismically active where in 1974 and 1976 offshore earthquakes with magnitudes of 5.6 and 4.9 occurring across the region (Ambraseys, 1984; Westaway, 1990; Suleiman & Doser, 1995). In addition, a number of tremors of 4 to 4.7 magnitude (Ml) were recorded across northern coastal Libya from 1990 into 2019 (USGS, 2019) (Table 5.2).

Table 5.2: Earthquakes affecting Libya and Libyan Offshore 1900-2019 (M ≥4.0).

Date A. D. Year m: d:	**Time G. M. T. H: m: s:**	**Location Lat °N Long °E**	**Magnitude (Descriptive or Richter)**	**Location and Remarks**
1903 11 22	----	32.80 13.20	5.0	Tripoli
1907 2 2	09: 04: 00	33.0 21.00	5.8	Offshore in North Cyrenaica
1914 5 18	10: 46: 00	31.30 22.00	5.0	Violent earthquake demolished Gheddahia blockhouse
1918 10 14	14: 06: 00	33.0 22.0	5.4	Offshore: 10 km N of Susa
1919 8 3	----	31.5 19.5	----	Offshore: East Gulf of Sirte
1926 6 26	----	Hellenic arc	Small	Cyrenaica and Tripoli
1926 8 30	12: 40: 00	Hellenic arc	7.1	Benghazi and Derna
1931 4 24	15: 21: 00	32.1 19.9	4.2	Offshore: East Gulf of Sirte
1935 4 19	15: 23: 22	31.5 15.2	7.1	In area of Hun Graben
1935 4 20	05: 10: 51	31.0 15.5	6.5	8 tremors recorded in this area in the period April 19-29, 1935
1936 6 13	00: 32: 39	32.7 22.5	5.3-5.9	15 km West of Derna
1939 1 23	02: 22: 46	31.5 16.0	5.6	Gheddahia, aftershocks in cities along Libyan Coast
1940 1 2	----	30.3 22.0	4.8	South of Jabal al Akhdar area
1941 3 4	23: 45: 00	30.7 15.7	5.3-5.9	Hun Graben area
1941 5 3	23: 45: 10	33.3 23.5	----	Offshore: 100 km NE of Derna
1943 7 16	01: 54: 00	33.0 21.5	4.8	Offshore: ~45 km WNW of Susa
1948 5 22	----	33.3 23.5	----	Offshore: 100 km NE of Derna
1957 5 2	02: 00: 00	----	Minor	Felt in Northern Cyrenaica
1958 5 17	05: 25: 33	31.8 11.3	5.2	Jabal Nefusa area, E. Nalut
1963 2 21	17: 14: 31	32.6 20.9	5.6	Barce (Al-Marj) badly damaged
1974 9 4	06: 29: 16	33.05 13.5	5.6	Tripoli
1975 01 01	07: 03: 51	32.4 21.2	4.2	Al-Marj
1976 12 19	21: 21: 53	33.01 13.97	4.9	Tripoli
1978 6 7	07: 21: 21	25.7 15.0	4.1	North of Murzuq
1983 10 17	22: 39: 07	31.2 15.9	4.4	North of Sirte
1988 01 28	19: 12: 17	32.2 21.1	4.4	Al-Marj
1988 01 28	05: 48: 08	32.4 21.1	5.3	Al-Marj
1990 05 18	18: 27: 51	31.7 24.7	4.3	North of Batnan
1993 09 9	00: 32: 40	32.3 20.6	4.5	Al-Marj
1996 10 30	10: 43: 02	32.3 20.5	4.4	North of Benghazi
1999 11 7	14: 43: 35	32.6 21.1	4.1	Al-Marj
2007 9 3	11: 58: 38	31.5 11.5	4.0	North of Nalut
2013 5 11	04: 42: 37	32.7 12.3	4.7	North of Zuwarah
2015 10 3	22: 47: 55	32.2 21.0	4.1	Al-Marj
2017 5 2	09: 43: 12	31.9 24.5	4.4	WNW of Bardiyah
2017 11 11	19: 00: 48	32.75 20.92	4.3	NNE of Al-Marj
2019 2 21	02: 19: 32	32.57 21.62	4.3	Bayda

Sources: Cavasino, 1927; Critikos, 1928; Campbell, 1968; Ambraseys, 1994; Suleiman et al., 2004; and USGS, 2019.

5.5. Discussion and Conclusion

Since the seismic history of Libya extends back at least 1700 years, the periodicity and location of earthquakes is crucial to better understanding the factors that influence its quakes, and those that affect the determination of seismic risk across Libya today. The identification of accurate earthquake locations and epicenters before 1930 is difficult because of the absence of records, whether written, film, or oral. This difficulty should be seen simply as poor reporting in sources lacking regional descriptions rather than in any lack of seismic activity. Also, it is possible that due to scarce seismic records, we are unaware of one or more large historic earthquakes across the region. The recorded number of earthquakes in Libya before the 1980s does not represent the actual number due to the small number of seismological stations in the region, and the limitations of instrument sensitivity. This fact was confirmed in a reconnaissance survey carried out in the Gharyan area in February 1977. A more sensitive and accurate vertical seismograph was used for only six hours, and it recorded three moderate earthquakes; these earthquakes were not reported by any other seismological stations (Kebeasy, 1980).

The Eastern Mediterranean region was affected by major tectonic activity between the middle of the Fourth Century to the middle of the Sixth Century, often termed: *the Early Byzantine Tectonic Paroxysm (EBTP)*. Modern geological studies indicate a clustering of high magnitude earthquakes around the Eastern Mediterranean shores during this time (Pirazzoli et al., 1996).

The 365 A.D event is most likely to be identified with a Hellenic Arc Subduction Zone event of large (M >8) magnitude (Stiros, 2001). Historical and archaeological data support the hypothesis that the Fourth to Sixth Centuries exhibited increased quake periodicity across the Eastern Mediterranean Basin. Although there are no specific statistics for these historic events, widespread damage, injury, and death occurred in 262, 365, 704, 1183, 1656, and 1685 suggesting large magnitudes for these events (>7). Therefore, the data on historical earthquakes are of crucial importance to our understanding of Libya's relatively unknown seismic history.

If a historic record exists of one or more large earthquakes in a region, it is a likely location for similar earthquakes at some time in the future (Kelleher et al., 1973; Allen, 1975; Shimazaki & Nakata, 1980). Throughout our historic epochs, the western edge of the Sirte basin, including the Hun Graben, has been one of the most seismically active regions in Libya. The 1935 Hun Graben Earthquake shook with a 7.1 magnitude and struck north-central Libya. It was largely caused by regional tectonics and the geological history of the North African craton -- the segment most likely to cause severe tremors in the future.

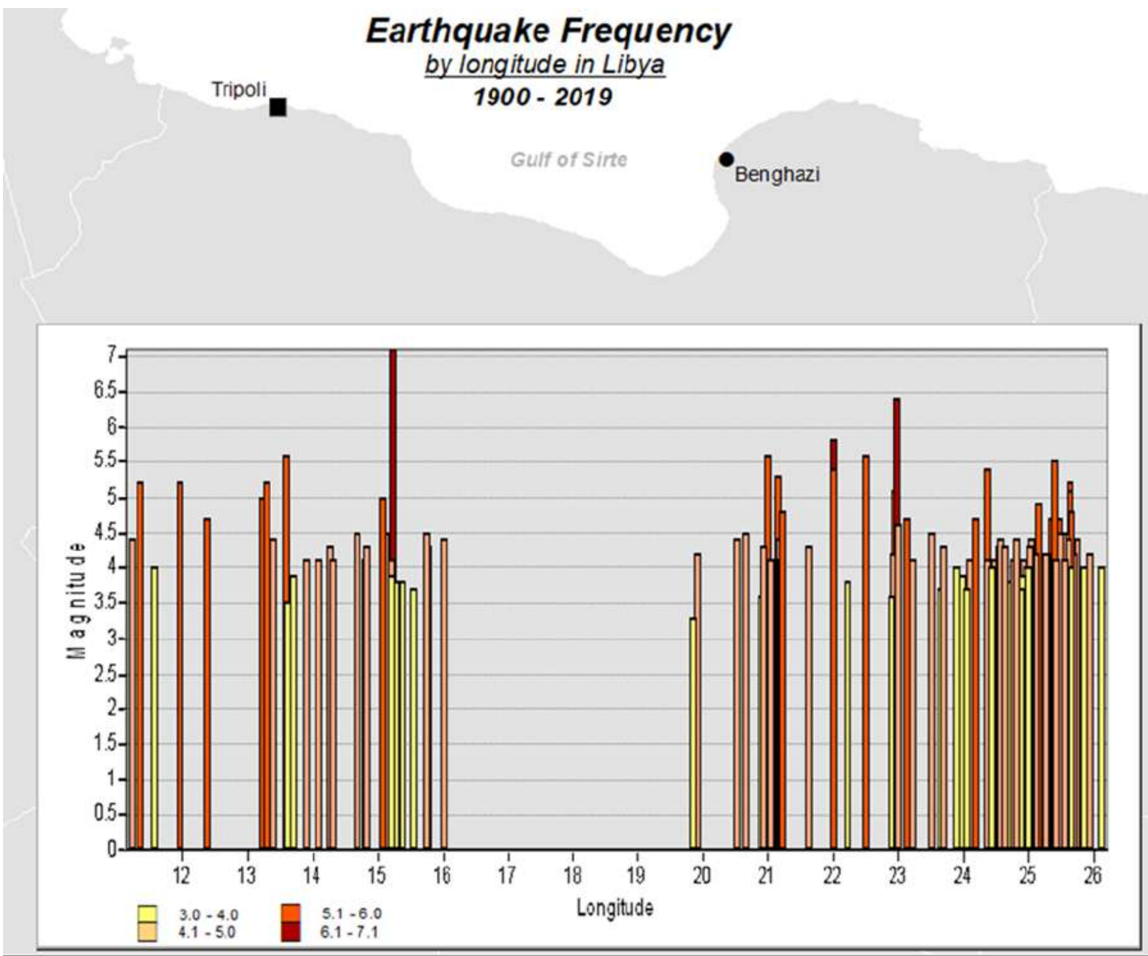

Figure 5.5: Libya's recent earthquake epicenters – when spatially represented – show distinct seismic regions: West (III) and East (II). Libya's central region along the Gulf of Sirte, displays a dramatically decreased frequency in recorded earthquakes since 1900. (Campbell, 1968; Ambraseys, 1994; Suleiman et al., 2004; USGS, 2019). Graphic by author, 2019.

Quake locations from 1900-2019 strongly suggest that most of the seismic activities are clustered in three areas: (a) the north-northwest trending Hun Graben which extends in the Mediterranean in the north, and in the middle of Libya in the south, (2) the Al Jabal Al Akhdar in northeast Libya and extends in the Mediterranean in the north, and (3) the east-western axis from the Tunisian borders to Al Aziziya to Houn. In the area surrounding Hun Graben, most of the seismic events are concentrated along the eastern coast of the NW-SE trending Hun Graben. More recent activity (1939-1972) seems to have extended northeast from the Graben into the Mediterranean Sea (Figure 5.3). If the active fault zone associated with the 1935 and 1941 Earthquakes extends toward the northwest, it may represent a significant risk to the cities of Al-Khums (201,943), Zlitan (109,972), and Misratah (386,120) with 700,000 lives affected (*Libya Population*, 2019) (LP, 2019). These three modern cities represent more than 10% of Libya's population in 2018. Seismic activity seems to be concentrated near Al-Marj, at the western edge of al-Jabal Al-Akhdar as well. After the 1963 earthquake series, tremors then followed in 1975, 1988, 1993, 1999, and 2015. This suggests that the area is still tectonically active. The locations of epicenters in this area corroborate the current understanding as a zone associated with the collisional boundary between Africa and Eurasia. The eastern side of the Sirte Basin Rift System is less active nowadays, with relatively no activity within the basin itself (Figure 5.3).

From the overview provided in this research, it is evident that our knowledge of earthquakes in Libya between the 3rd century AD and 1935 is based on a meager number of archaeologic and historic records. The historic and geographic factors that could account for missing seismic periods have to identified and examined when preparing a feasibility study aiming at collecting new data on past seismic events in Libya. To understand future seismic risk of earthquakes in Libya, it is imperative that we understand Libya's seismic history and hazards all in the hopes of decreasing seismic risk and its grim consequences of injury, death, loss, and damage (Montz et al., 2017).

CHAPTER 6: Framework for Identifying Remotely-sensed Seismogenic Geomorphology

6.1. Introduction

Geomorphology is the science that studies ‘‘the systematic description, analysis, and understanding of landscapes and the processes that change them’’ (Bloom, 1998: 1). A landscape or landform is a three-dimensional characteristic on the Earth's surface shaped by natural or anthropogenic processes. Jensen (2007) explained that the study of geomorphology involves five major processes that constantly work to erode or deposit materials on the Earth’s crust, including running water (fluvial), glacial ice (glacial), groundwater, wind-driven water waves, and wind (eolian).

Tectonic geomorphology is the surface evidence of tectonic deformation and earthquake zone and can be used to identify and refine the location and characteristics of seismic sources. In particular, this is useful in the early stages of earthquake hazard studies in tectonic environments where multidisciplinary data may not be available (Estrada, 2013) - the thrust of this chapter. When seismic activity is often sporadic and/or long-term, the identification of surface features caused by or related to seismicity represents a vital surrogate for the recognition and documentation of earthquake magnitude and frequency, all in the hopes of decreasing seismic risk and its subsequent injuries, damages, and deaths.

6.2. Tectonic and Seismic Geomorphologic Features

6.2.1. Faults

‘‘Earth fractures along which there has been demonstrable slipping of one side past the other are known as faults’’ (Shelton & Shelton, 1966: 94). Faults are classified by the nature of the pressure, and the balance of sheer strength and sheer stress. *Normal faults* (also known as tensional and gravity faults) are associated with the extension of the crust. Compressional faults with a dip of more than 30° and less than 60° are known as *reverse faults*, but they called *thrust* faults when displaying lower dips. In normal and reverse faults, there is a distinct horizontal component to the movement. However, the horizontal dislocation in some faults is dominant and any vertical movement so small as to be incidental. Such faults are known as wrench, transcurrent, strike-slip, or tear faults. *Strike-slip* or *Wrench faults* are described as either right-lateral (dextral) or left-lateral (sinistral) (Twidale, 1971). Some of the most important faults in the world are of this type including the San Andreas Fault of California, the Alpine Fault of New Zealand, and the Great Glen Fault of Scotland. It has been suggested that the faults bordering the East African rifts are of this kind as well (USGS, 2019b).

The San Andreas Fault of California (Figure 6.1) is arguably the best-studied strike-slip fault in the world (Akçiz & Arrowsmith, 2013), running for about 750 miles long (1200 km) through California from north of the Mexican border to Point Arena on the Pacific coast north of San Francisco. The slip rate along with the fault has been documented from 20 to 35 mm/yr (SCEDC, 2013). The San Andreas Fault of California defined by Lawson et al (1908) as "a belt of topographic features along the fault zone" (Twidale, 1971).

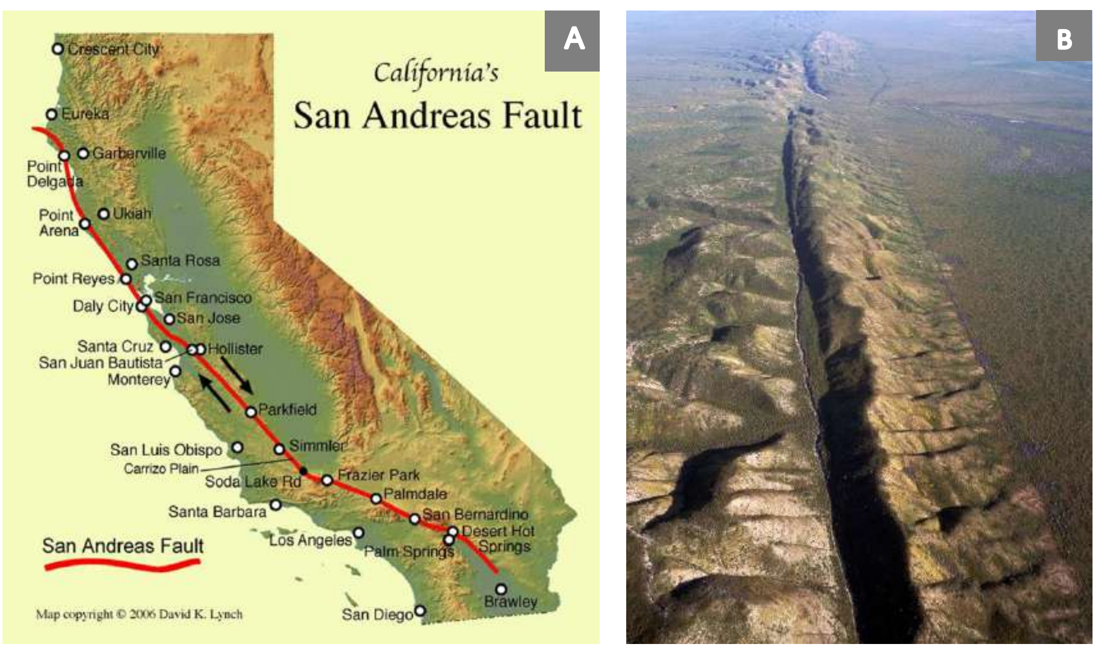

Figure 6.1: A) The red line follows the trace of the San Andreas Fault across California (Lynch, 2006). B) The San Andreas Fault bisects the Carrizo Plain in San Luis Obispo County in California (Vergano, 2014).

For example, specific tectonic forms like fault scarps, minor grabens, offset streams, sag ponds, and shutterridges, as well as structural features such as fault-line valleys and fault saddles, have been identified as surface feature characteristic of earthquake activity. Generally, earthquakes in California rupture along faults showing evidence of prior Quaternary movement (Wesnousky, 1986). The fault is divided into three segments, which have different characteristics and a different earthquake risk degree (SCEDC, 2013). The southern California component of San Andreas fault has been identified as the most likely source of a large future earthquake in California (USGS, 2019c).

The Alpine Fault of New Zealand (Figure 6.2A) is one of the world's major geological features. It is right-lateral wrench fault, which runs for about 370 miles (600 km) up the spine of New Zealand's South Island, and it is the "on-land" boundary of the Pacific and Australian Plates (GNS, 2018). The fault zone is distinguished by a characteristic collection of forms which includes fault scarps and fault-line scarps, fault valleys and corridors, fault-line valleys, faulted terraces and moraines, stream displacements, and shutterridges (Twidale, 1971). The Alpine Fault, like the San Andreas Fault in California, is believed to have had a long history of transcurrent movements (Canora-Catalán et al., 2008), with a total displacement of hundreds of kilometers (Evion, 1963). This fault is a prime example of a transform plate boundary fault which has a simple structure (long, straight trace with a small number of large step-overs), large total offset (about 480 km), and a high slip rate at Hokuri Creek (Berryman et al., 2012).

The Alpine Fault provided one of the earliest well-substantiated occurrences of movement accompanying an earthquake, when the Wairarapa Fault moved at the time of the Wellington earthquake of 1855 (Figure 6.2B) (Bloom, 1998). In the past 900 years, this fault has ruptured four times, each time producing an earthquake of about 8 magnitude. Based on data collected near Lake McKerrow, research published by scientists from GNS Science (2012) documented an 8000 year-long record of 24 Alpine Fault earthquakes (GNS, 2018).

Figure 6.2: A) Satellite image of New Zealand's South Island shows the trace of the Alpine Fault along the straight western edge of the Southern Alps. The aftermath of a heavy blizzard which hit the South Island of New Zealand in July 2003. Elevated regions are draped in snow, clearly delineating the escarpment northwest of the Southern Alps (NASA, 2003). B) The view looking south from Thrust Creek along to the southern tip of the Rimutaka Range. A maximum of 6 meters of uplift occurred along this coast during the 1855 earthquake (Julian, 2014).

The Great Glen Fault of is a major topographical feature and tectonic structure that transects the Scotland Highlands (Figure 6.3), trends NNE–SSW across northern Scotland and separates the Grampian Highlands to the southeast from the Northern Highlands to the northwest. The Fault developed as a left-lateral strike-slip fault during the Caledonian Orogeny (Hutton & McErlean, 1991; Soper et al., 1992; Stewart et al., 2001; Mendum & Noble, 2010), but then it reactivated right-laterally in the Tertiary (Le Breton et al., 2013). Kennedy (1946) gathered evidence pointing strongly to the Great Glen fault zone, which at 1.5 km wide, being of wrench character, with the area to the north moved southwest a distance of 105 km. The dislocation is due to strong north-south pressure during the late Devonian or early Carboniferous times. This Fault is a line of weakness that has been eroded by streams and glaciers. The great fault-line valley forms a major breach in the Highlands of northern Scotland which is still seismically active (Twidale, 1971).

Figure 6.3: The white line follows the trace of the Great Glen Fault in Scotland. Satellite image is from Esri. Cartography by author, 2019.

Young faulting borders the East African Rift occurs in two branches of System; the east branch and the west branch (Figure 6.4) (Chorowicz, 2005). Some faults display Late Pleistocene and Holocene normal displacements, and many of them were active at least in the Middle Pleistocene age. This and current seismicity emphasize the continuous extension within the rift zone whose rates reaching values of 5-10 mm per year. Signs of longitudinal side movements were also found, right-lateral in the junction of the Malawi and Rukwa Rifts (Delvaux et al., 1992) and left-lateral in the Ethiopian Rift (Boccaletti et al., 1998). It is significant that the right-lateral strike-slip movement seems more characteristic for the northwest-trending faults, while the left-lateral movements occur mainly along the northeast-trending faults. A positive correlation has been found between young movements and crustal seismicity. Both follow microplate boundaries, relative motions of which form modern geodynamics of the region. (Skobelev et al., 2004).

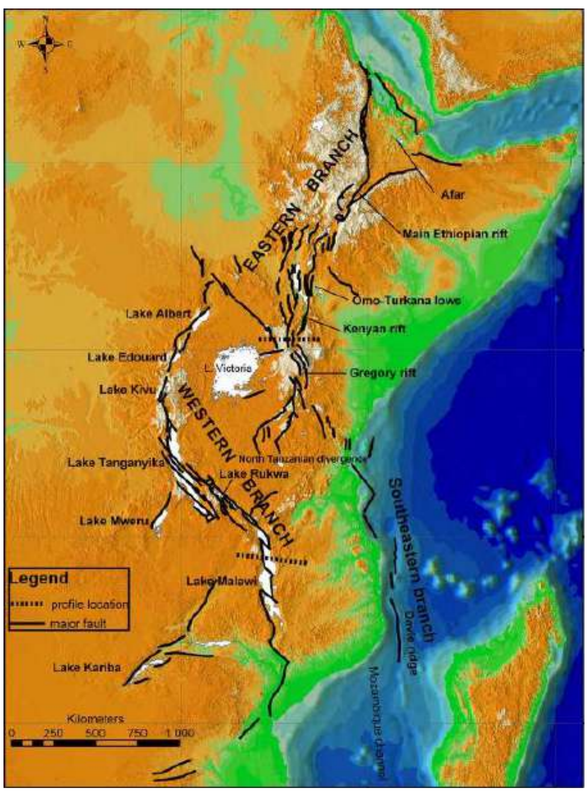

Figure 6.4: The main faults of the eastern and western branches of the East African Rift System (Chorowicz, 2005).

6.2.2. Fault Escarpments

Fault escarpments or scarps are the features on the earth's surface that appear like steps caused by slip or uplift on the fault (USGS, 2019b) and are the most common landforms related to faults. In seismically active regions, several small-scale scarps may be evident and represent the direct result of displacement during earthquakes, often developing into horsts and grabens) (Berberian, 1979; Philip & Meghraoui, 1983; Kelson et al., 2001; Ishiyama et al., 2004; Tsutsumi & Sato, 2009; Bruno et al., 2017). They may be actual fault scarps or minor effects of differential compaction and slumping. Open *fissures* form during some earthquakes, likely because of the consolidation of rigid, porous, or permeable surface materials. However, soil creep and erosion may obliterate such features quickly.

Also closed basins or *sag ponds* may develop at the foot of recent fault scarps. some successful work has been achieved at estimating the age of prehistoric fault scarps (Colman & Watson, 1983; Nash, 1984; Zreda & Noller, 1998). A diversity of other small landforms forms along recent fault scarps. *Pressure ridges* (low elongate mounds) may parallel the surface break if the stress field on the fault is compressional. Minor scarps facing the major scarp across a shallow trench are called *earthquake rents*, *cicatrices*, or *reverse scarplets* (Cotton, 1950; Twidale, 1971; Bloom, 1998). Although their significance is not obvious, these *rents* may record local or shallow buckling of fault blocks adjacent to the main fault surface. Along the San Andreas Fault, Wallace Creek, the vertical component of movement, has been northeast side up, resulting south facing 8- to 9-m-high scarp. This section of the San Andreas Fault ruptured in 1857 during the latest large earthquake with several meters of right-lateral offset (Sieh, 1978; Liu-Zeng et al., 2006). In 1959, a largest earthquake of 7.5 M was ever recorded within the Rocky Mountain Intermountain Seismic Belt where an earthquake near Hebgen Lake, Montana produced surface ruptures 34 km long with vertical offsets produced fault scarps ranging up to 22 feet (6.7 m) high and producing a total of 18-22 miles (29-35 km) of scarps (Figure 6.5A) (Zreda & Noller, 1998). In Utah and Wyoming, extensional reactivation of thrust faults north of

Figure 6.5: A) Hebgen Lake earthquake scarp in 1959. Photo by Losco (2012). B) A view along of the Big Burn trench toward the fold scarp in Bear River Fault Zone, Utah. The dashed white line marks the base of the scarp (Hecker et al., 2019). C) Fault scarp close to epicenter of the 2019 Searles Valley earthquake, California. Photo by Cochran (USGS, 2019c).

the Uinta Mountains is accompanied by Quaternary surface faulting, tilting, and monoclinal folding (Bruno et al., 2017).

The 40 km in length Bear River Fault zone consists of down to the west, right-stepping, *en echelon* scarps, each about 3.0 to 3.5 km long. The scarps record two Holocene surface ruptures with net vertical tectonic displacements ranging from <1 to >5 meters per event (West, 1993) (Figure 6.5B). Figure 6.5C shows a fault scarp near the epicenter of the 2019 Searles Valley earthquake, California. In this location, the fault has a main strand where much of the slip occurred and distributed fractures (USGS, 2019c).

6.2.3. Offset stream channels

During small but frequent movements along wrench faults, some streams which flow across the fault zone have maintained their courses. They show prominent bends, usually including two right-angle turns, called *offset* or *jogged streams* (Twidale, 1971). Spectacular examples of offset streams described from California in association with the San Andreas, Garlock, and Big Pine Faults (Hill & Dibblee Jr, 1953), south coast region between Cholame and Camp Dix (Wallace, 1968; Lienkaemper, 2001), and Van Matre Ranch site, Carrizo Plain fault (Noriega et al., 2006). The main channel at Wallace Creek, Carrizo Plain Fault (Figure 6.6) is offset about 130 m and was incised approximately 3,700 years ago (Sieh & Jahns, 1984). This fault experienced the largest offsets during the large earthquake in 1857 (Grant & Sieh, 1994). Liu-Zeng et al. (2006) used stream channels as piercing lines to present evidence of six sequential offsets at a site in the Carrizo Plain across the San Andreas Fault. Arrowsmith and Zielke (2009) discussed that the offset channels along the south-central San Andreas Fault have developed by the interaction of repeated slip along the fault zone (over at least the Holocene). At Van Matre Ranch along the San Andreas Fault on California’s Carrizo Plain, Salisbury and his colleagues (2018) investigated the origins of topographic depressions which previously explained as beheaded channels representing small offsets, and that to better understand the relation between geomorphology and fault slip. Examples also studied in New Zealand (Norris & Cooper, 2001). Raub et al. (1987) discussed geomorphic evidence for a recurrent dextral slip of 3.5-4.0 m on the Mohaka Fault, New Zealand during the recent two, prehistoric earthquakes. Berryman and others (1992) measured 6m and 12m offsets along stream channels at one location along the Alpine fault, New Zealand (Sieh, 1996). In each case, the direction changes of the stream as it enters the fault zone reflects the sense of movement along the fault.

Figure 6.6: Aerial photograph of offset stream channels view northeast at Wallace Creek along the San Andreas Fault, Carrizo, California. Main channel is offset about 130 m and was incised around 3,700 years ago. Channel farther to the left on the near side of the fault was displaced about 250 m and was incised around 10,000 years ago. These offsets and ages indicate a long term slip rate of about 35 mm/yr along the San Andreas fault (Sieh & Jahns, 1984). Photo by (Rymer, 2013).

6.2.4. Landslides

Many mountainous regions that are vulnerable to landslides have experienced at least moderate rates of earthquake events in recorded times. The occurrence of earthquakes in steep landslide-prone areas greatly increases the probability that mass-wasting will take place, and that due to the ground shaking alone or shaking-caused dilation of soil materials, which fasts rapid infiltration of water. Large earthquakes that induced rock soil avalanches, avalanches, and underwater landslides can be very destructive. One of the most spectacular examples occurred during the 1970 Ancash Earthquake in Peru when a single rock avalanche killed more than 18,000 people (USGS, 2019a). A similar, but less spectacular failure is the 1964 Great Alaska Earthquake which caused widespread subsidence, mudlfows, and other ground failures (Figure 6.7). The destructive mass-wasting which accompanied this earthquake indicated that seismically triggered landslides are one of the greatest geologic hazards in Anchorage (Jibson & Michael, 2009).

Figure 6.7: The collapse of Fourth Avenue near C Street in Anchorage, Alaska due to a landslide caused by the 1964 Great Alaska Earthquake. Before the tremor, the sidewalk on the left, which is in the graben, was at the street level on the right. The graben came down11 feet in response to 14 feet of horizontal movement. Photo from the Earth Science Photographs from the U.S. Geological Survey Library (McGregor & Abston, 1995).

Landslide in the 1959 Hebgen Lake, Montana, earthquake carried about 50 million cubic yards of mud, rock, debris down the south side of the canyon and a half path up the north side, partially burying the Rock Creek Campground on the floor of the valley. The debris flow also blocked up the Madison River creating Earthquake Lake by water empounded behind (USGS, 2019a). Some areas of the United States, such as the Puget Sound region in Washington and California, have experienced slides, lateral spreading, and other types of ground failure because of moderate to large earthquakes. As a result of ground shaking also widespread rockfalls are caused by the loosening of rocks (Highland, 2004). The size of the area affected by quake-induced landslides depends on the earthquake magnitude, its focal depth, duration of ground shaking, the amplitude, frequency composition, and the topography and geologic conditions near the causative fault (USGS, 2019b).

Most earthquakes result from movements along fault zones which are unstable. Understanding the strength and slip behavior of faults is crucial in earthquake physics and seismic hazard assessment (Scholz, 2000; Moore & Rymer, 2007; Collettini et al., 2009; Niemeijer et al., 2010). Active faults are sources of strong earthquakes; 90% of historic earthquakes have occurred on active fault zones (V. G. Trifonov & Machette, 1993), and some disasters like volcanism, mass-wasting, and the ground deformation that often accompanied the earthquakes can be caused by the slow motion of faulting with resulting features of their structural peculiarities. Active faults can produce vast datasets as well to help us better understand geodynamics of the tectonic processes (Trifonov, 2004; Ishiyama et at., 2004; Liu-Zeng et al., 2006).

Earthquake models support the possibility of quantitative prediction of strong motion from geological observation of the causative fault behavior and may procedure the earthquake hazard estimation (Aki, 1984; Liu-Zeng et al., 2006; Boore & Atkinson, 2008; Bindi et al., 2011). Many models have been proposed to describe earthquake recurrence. Some models predicted highly regular (episodic) sequences (e.g., Schwartz & Coppersmith, 1984; Sieh, 1981, 1996;

Stuart, 1986; Tse & Rice, 1986; Ward & Saskia, 1993; Rice, 1993; James R Rice & Ben-zion, 1996; Lapusta et al., 2000), While others predicted highly irregular behavior (e.g., Bak & Tang, 1989; Carlson & Langer, 1989; Ito & Matsuzaki, 1990; Huang et al., 1992; Shaw, 1995 ; Ben-Zion, 1996; Cochard & Madariaga, 1996; Ward, 1997; Shaw & Rice, 2000; Lyakhovsky et al., 2001). Overall, seismic geomorphology represents the key to understanding seismic frequency and magnitude especially in regions where few faults have been identified since these features can indicate areas of past or present seismicity even though fault location and/or quake frequency has yet to be determined.

6.3. Tectonic/Seismic Geomorphology of Libya

The major regional structures of Libya (Figure 6.8) are represented by (a) basins and (b) uplifts; the Ghadamis, Sirte, Murzuq (Murzuk), and Al Kufrah Basins, and the Haruj and Cyrenaican Uplifts. Several large basalt flows and flood basalts of Cenozoic age also exist representing some of the most visible North African landform features from space (Figure 6.9). Roughly one third of Libya is covered by sand, gravel and rubble actively moving and blanketing the surface from eolian, fluvial, and downslope movement. Over time, various parts of the country have been tilted, faulted, warped into arches or basins, or covered by outpourings of lava. Two groups of faults dominate the mid-section of Libya. The northern fault group influences the shape of the Gulf of Sirte. Near the intersection of the two fault groups is also the location of Libya's extensive flood basalt fields. It is clear to note that these two fault trends are approximately parallel with the great rift system in the Gulf of Suez and East African regions (Conant, 1967). Recent deformation and fault zones in Libya are a part of the active faults of North Africa which are concentrated mainly on the northwestern side of the continent that belongs to the Alpine–Himalayan belt, and especially in the Atlas Orogenic System (Skobelev et al., 2004).

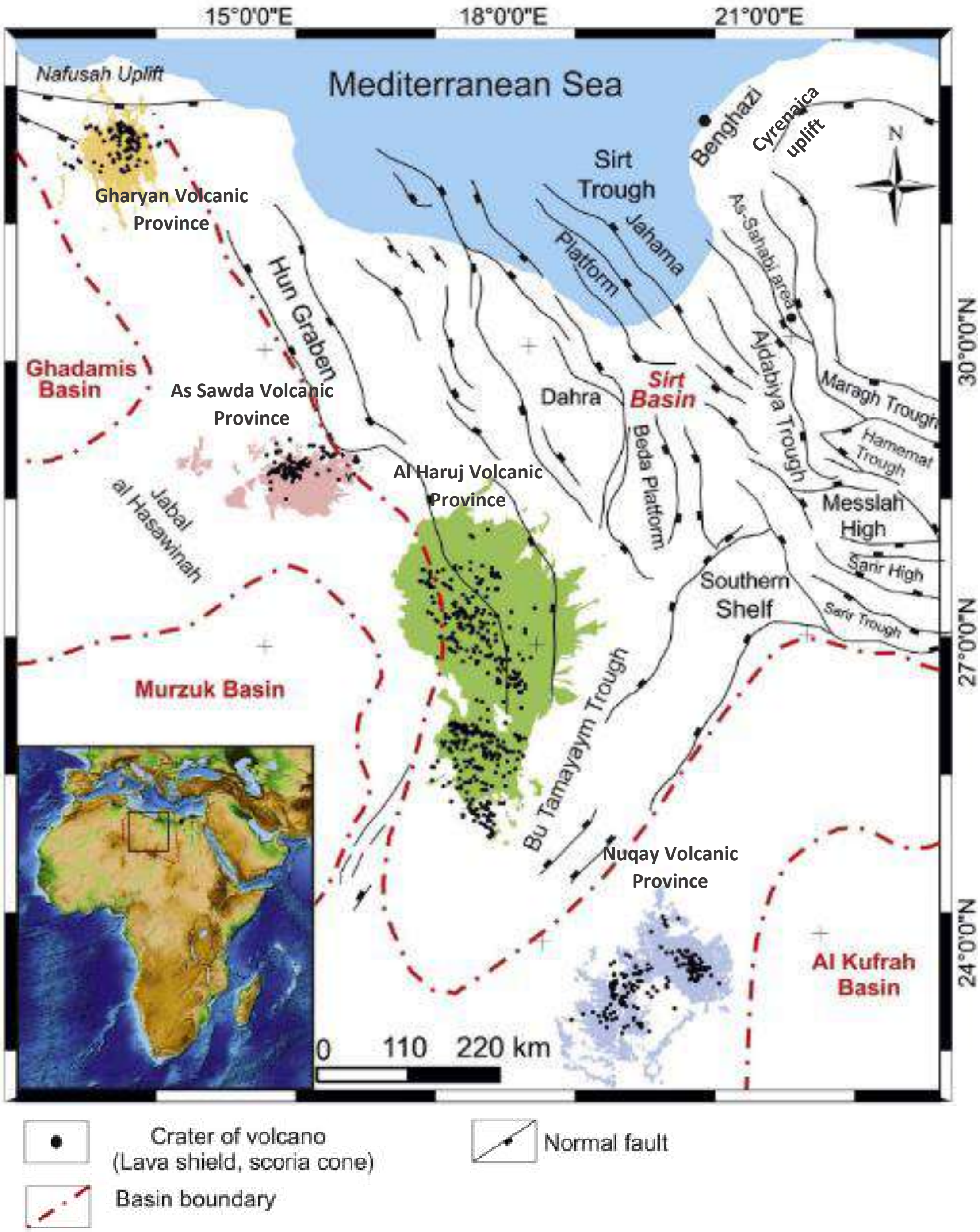

Figure 6.8: Simplified tectonic map of Libya modified after Elshaafi and Gudmundsson, 2018.

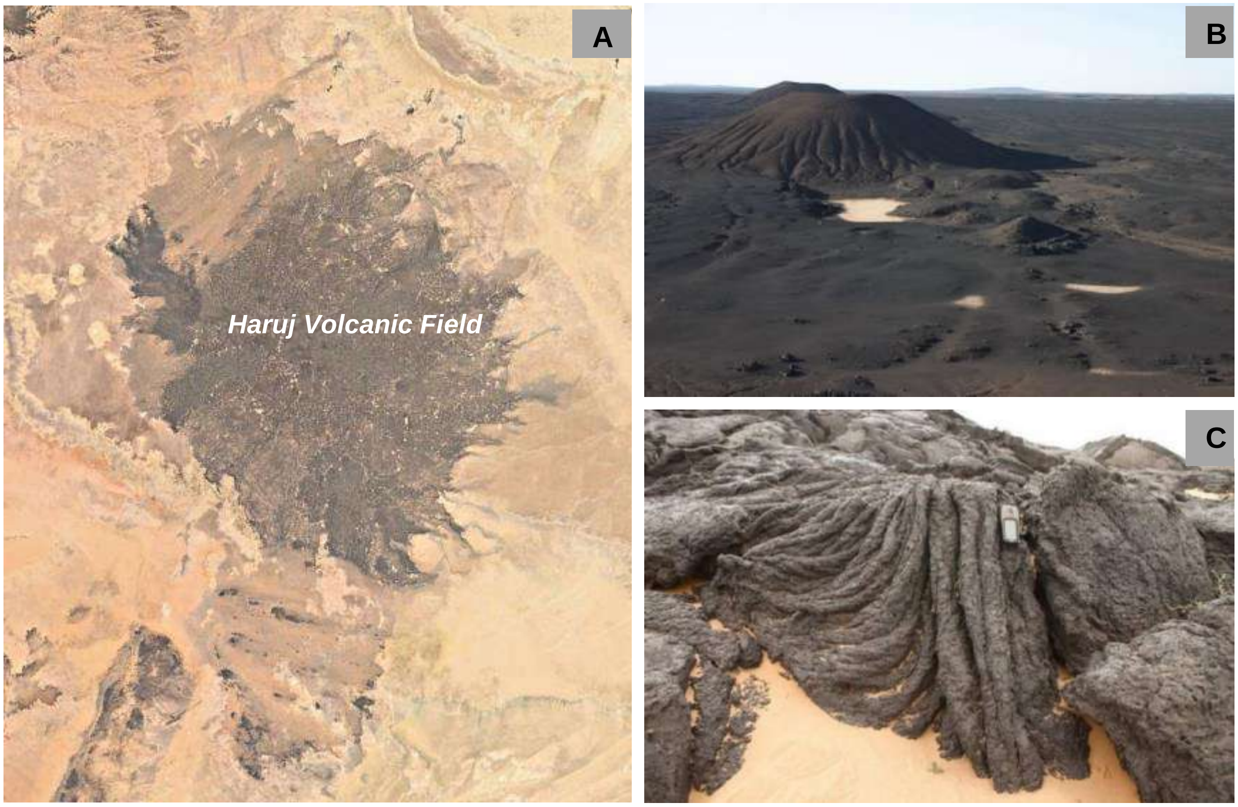

Figure 6.9 : (A) Satellite imagery of Haruj as seen from space (Google Earth, 2019). (B) Volcanoes in the central Al-Haruj. (C) Lava ropes are thousands of years old in maximum in northern Al-Haruj. Photos from Norbert Brügge (2015).

Campbell (1968) explained that there is a close correlation and can be established between the seismic activities and existing tectonic and structure in Libya. Hun Graben is a prominent Rift Valley which extends north from Hun in central Libya to Qaddahia in the northwest; the faults trend NNW-SSE to NW-SE. The boundary faults of Hun Graben are marked by scarps and substantial fault displacement, giving it visible extents, and often recognizable at the surface (Abdunaser, 2015). Throughout historic times, the Hun Graben has been one of the most seismically active regions in the country (Suleiman & Doser, 1995); a series of strike-slip earthquakes occurred along the eastern boundary graben fault in 1935 (Abdunaser & McCaffrey, 2015).

The recorded primary tremor (and aftershocks) of the 1963 Earthquake of Al-Marj, strongly suggested that the earthquake resulted from fault movement (Campbell, 1968) and lent support to its active status in NW Libya. The distinctive escarpments of NW Libya are believed to be fault-line scarps modified by marine erosion (L. C Conant & Goudarzi, 1967).

6.3.1. Identifying Seismic Geomorphologic features in Libya

During the last few years, the invention and the fast expansion of International Computer Networks have provided an impetus to information dissemination and management, and with this integration, remote sensing has become real time and interactive. With the appearance of operational remote sensing becomes possible to efficiently accurately map earthquake induced ground changes and reactivated landslides. Also, it is significant to notice that remote sensing gives unbiased recording of the events (Saraf, 2000).

In this study, satellite images from Google Earth were used to identify seismogenic geomorphology in Libya. The satellite images in Google were created from the imagery provider called DigitalGlobe and mosaiced in Google Earth. DigitalGlobe is one of the largest private satellite data imagery providers in the world. They have a wide collection of extensive high resolution satellite sensors in their orbiting instrumentation which includes (a) QuickBird which has 0.65m spatial resolution, (b) GeoEye-1 has 41-centimeters black and white, and color 1.64-meter multi-spectral, (c) WorldView-1 with 50-centimeters black and white, (d) WorldView-2 with 46-centimeters black and white, and color 1.84-meter multi-spectral, and (e) WorldView 4 - 3 with 31-centimeters black and white, and color 1.24-meter multi-spectral spatial resolution (DAR, 2016).

The Google Earth imagery provides accurate and mission-critical information about changing earth features. Google Earth supports a wide variety of uses, including mapping and analysis, mission-planning, environmental monitoring, oil and gas exploration, and infrastructure management. It is through this vast image archive that we are able to understand our changing planet in order to save lives, resources, and time. In the case of this research, Google Earth represents an ideal platform for the surface identification, location, and analysis of surface geomorphology related to seismogenic features.

Two different grids were used on a Libya map: broad grid where each grid represents 200 by 200km (small scale) (Figure 6.10) to help classify and archive image classification and compilation in tandem with latitude-longitude locations; and tighter grid where each grid represents 20 by 20km (larger scale) (Figure 6.11) to facilitate the classification and compilation of imagery and sites at closer inspection and lower elevation (nadir).

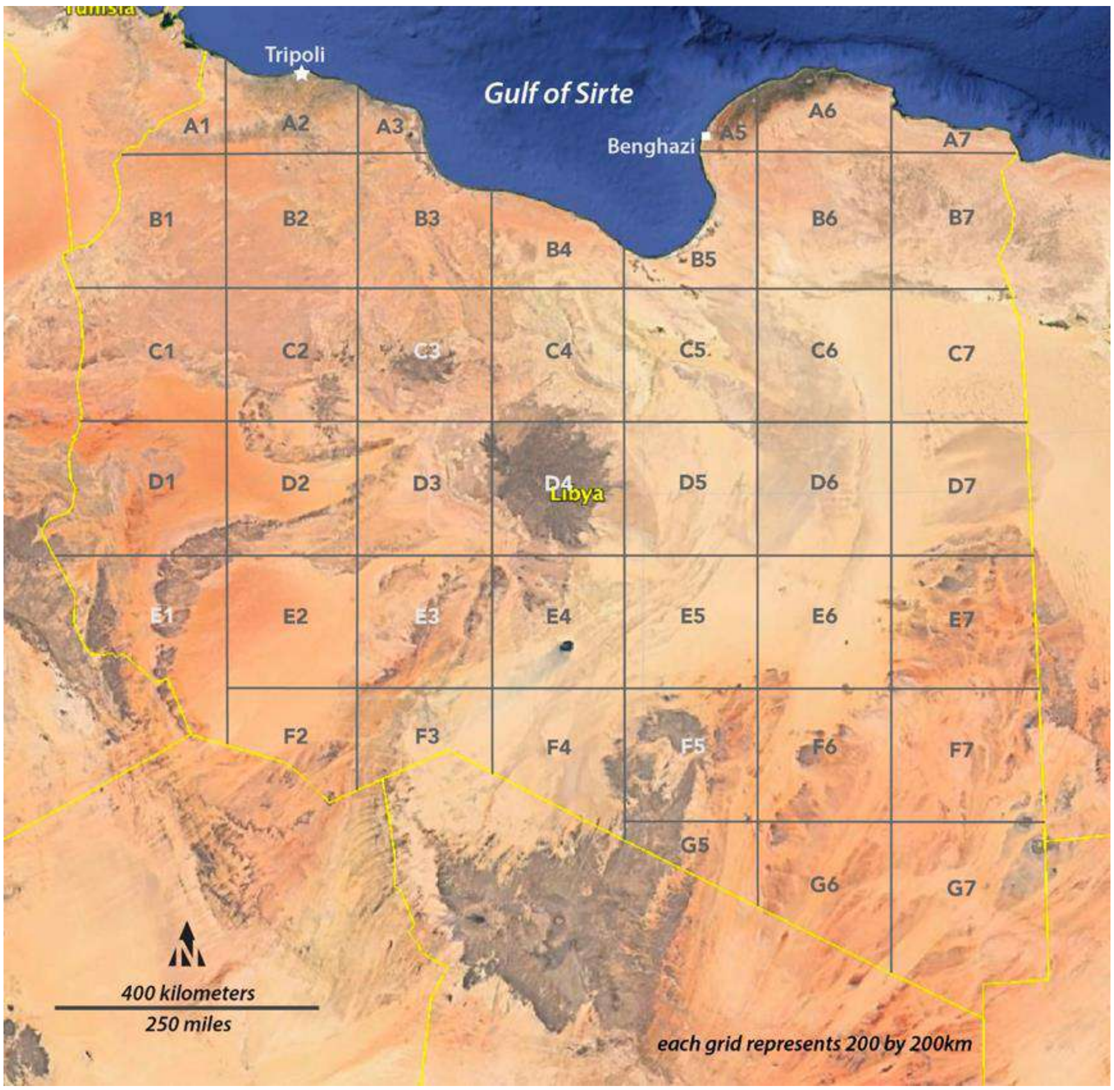

Figure 6.10: Image shows an overlain grid on a satellite image where each grid represents 200 by 200km (small scale). This grid is used to help classify and archive image classification and compilation in tandem with latitude-longitude locations (Google Earth, December 13, 2015). Cartography by author, 2019.

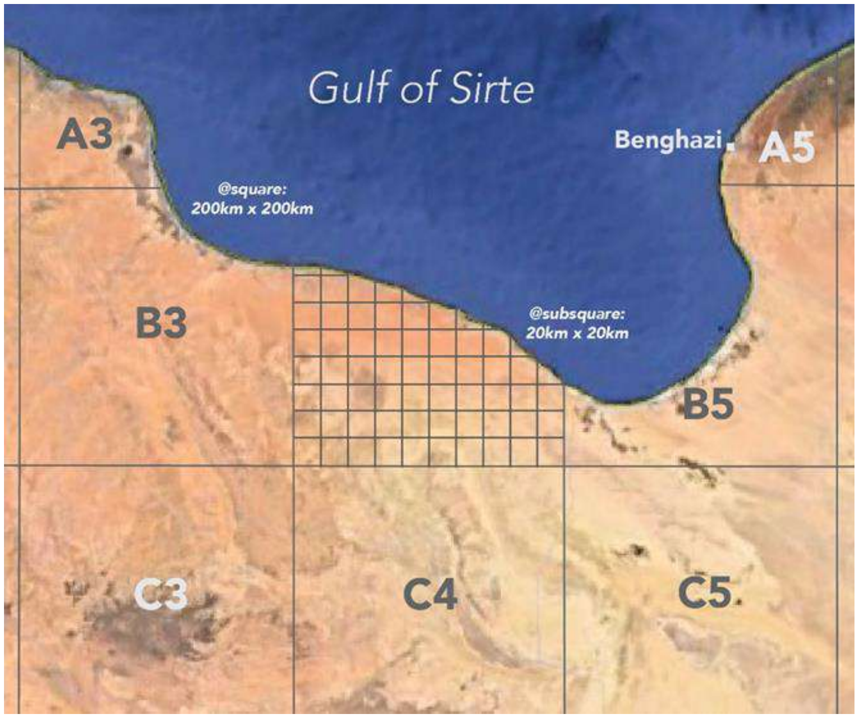

Figure 6.11: Tighter grid overlain on a satellite image representing 20 by 20km (big scale) to facilitate the classification and compilation of imagery and sites at closer inspection and lower elevation (Google Earth, December 13, 2015). Cartography by author, 2019.

It is through the remotely-sensing images some seismogenic surface features were identified in different locations in the country. In eastern and northeastern Sirte, large graben feature, faultline scarps, displacement of offset wadi channels and en-echelon faulting were located (Figure 6.12, 6.13). In Al Jabal Al Akhdar (northeast Libya), offset wadi channels and faultline scarps in Al-Shuqluf, Al-Khirbet, and Amira Valleys between Al Hamamah and Susah were located (Figure 6.14). In the Haruj Volcanic field, several geomorphic features were found. In the southwest of the field, large strike-slip fault, small flanking en-echelon, and faults faultline scarps were identified (Figure 6.15). North of the field, graben complex, offset wadi channels, distinctive en-echelon faulting, and faultline scarps developed (Figure 6.16, 6.17). Offset stream channels and wadis indicated the surface presence of faulting that is actively shifting wadi channel alignment – a key indicator in identifying seismogenic geomorphology. In northeast Al Jabal Al Gharbi (western Libya), faulting, en-echelon faulting, and offset wadi channels were located identified (Figure 6.18). Using remotely-sensed images is important in examining surface features at various scales in various elevations.

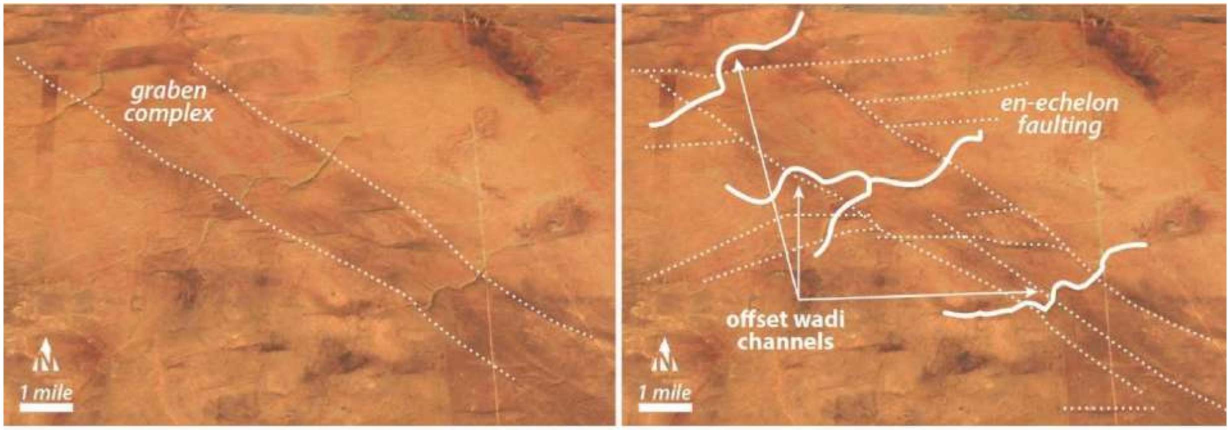

Figure 6.12: Matched image pair showing (a) large graben feature trending SE-NW, (b) offset wadi channels indicative of active fault displacement, and (c) en-echelon faulting located in 30°13'N, 18°28'E, northeastern Sirte, Libya (Google Earth, December 25, 2016). Cartography by author, 2019.

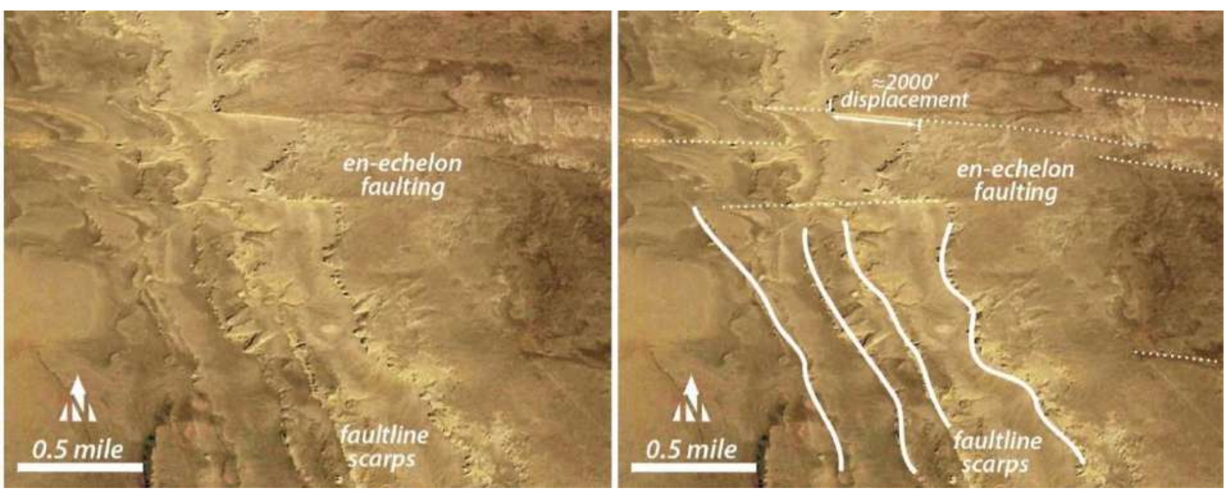

Figure 6.13: Matched image pair displaying (a) faultline scarps and (b) displacement of en-echelon faulting located 29°44'N,18°04'E eastern Sirte (Google Earth, December 13, 2015). Cartography by author, 2019.

Figure 6.14: Matched image pair showing (a) offset wadi channels and (b) faultline scarps in Al-Shuqluf, Al-Khirbet, and Amira Valleys between Al Hamamah and Susah (32°54'N, 21°45'E). Offset stream channels and wadis indicate the surface presence of faulting that is actively shifting wadi channel alignment – a key indicator in identifying seismogenic geomorphology (Google Earth, March 9, 2019). Cartography by author, 2019.

Figure 6.15: Matched image pair showing (a) large strike-slip fault, (b) smaller flanking en-echelon faults (possible transform faulting), and (c) faultline scarps southwest the Haruj Volcanic Field (26°26'N, 16°51'E) (Google Earth, November 5, 2012). Cartography by author, 2019.

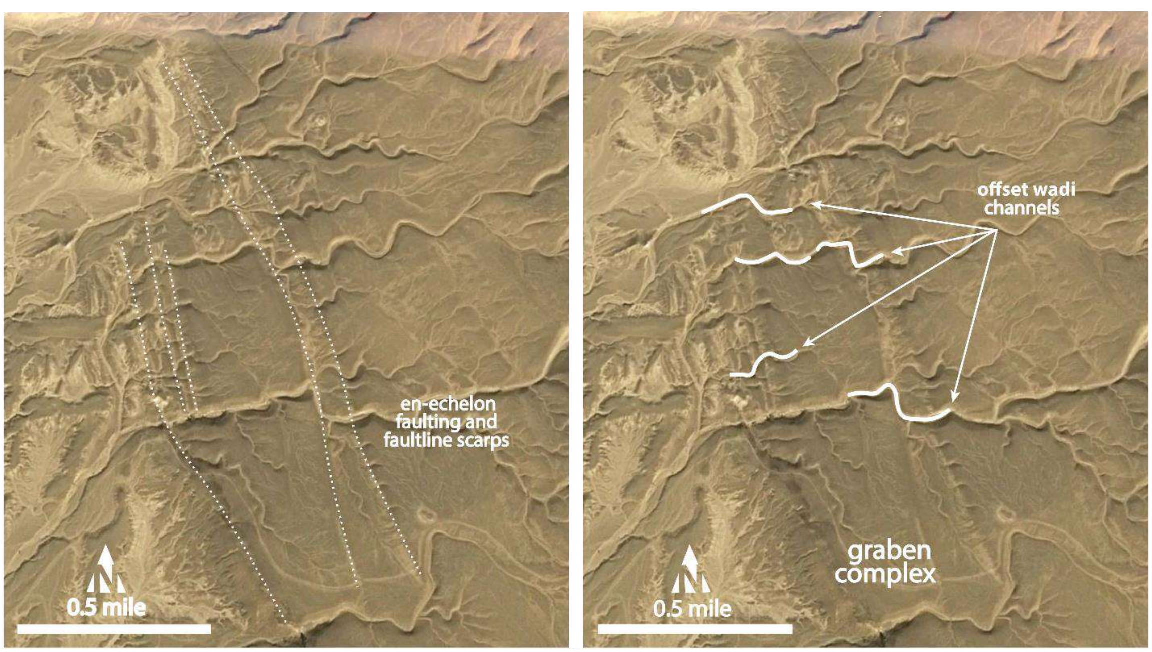

Figure 6.16: Matched image pair displaying a (a) graben complex, (b) offset wadi channels, (c) clear en-echelon faulting, and (d) faultline scarps developed north of the Haruj Volcanic Field (28°58'N, 17°48'E) (Google Earth, September 3, 2012). Cartography by author, 2019.

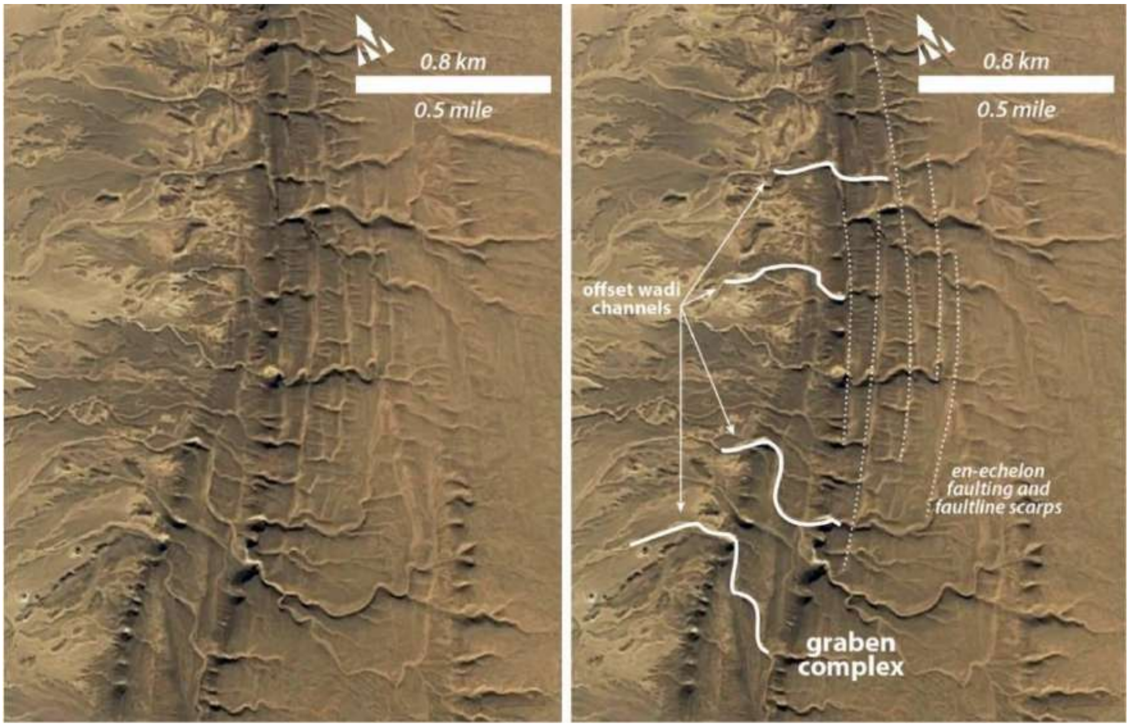

Figure 6.17: Matched image pair showing (a) graben complex, (b) offset wadi channels, (c) distinctive en-echelon faulting, and (d) faultline scarps developed north of the Haruj Volcanic Field (28°56'N, 17°49'E) (Google Earth, September 3, 2012). Cartography by author, 2019.

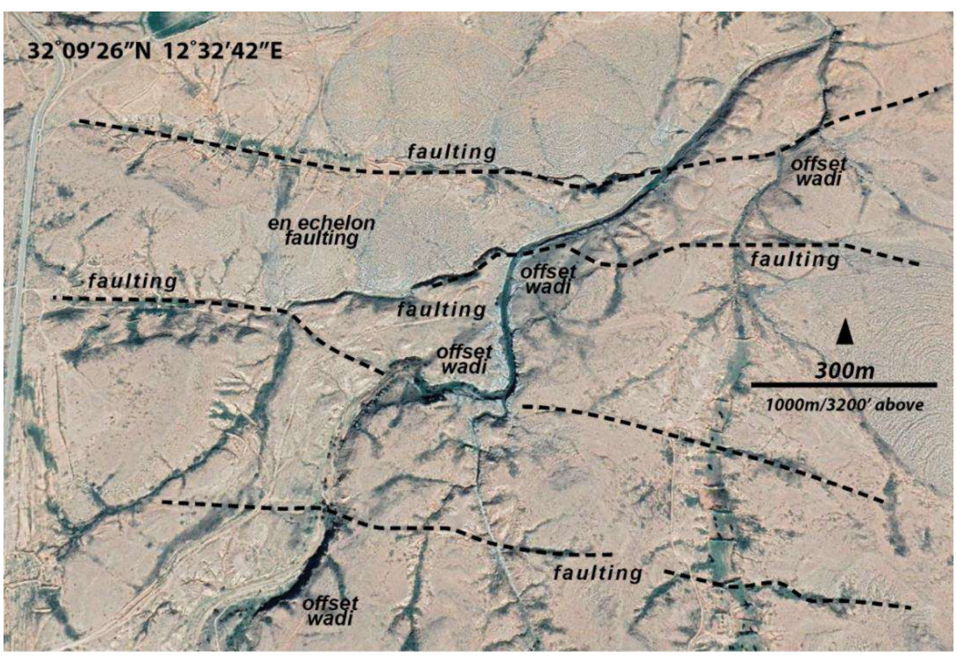

Figure 6.18: Matched image displaying (a) faulting, (b) offset wadi channels, (c) en-echelon faulting, located 32°09' N 12°32' E northeast Al Jabal Al Gharbi western Libya (Google Earth, January 26, 2019). Cartography by author, 2019.

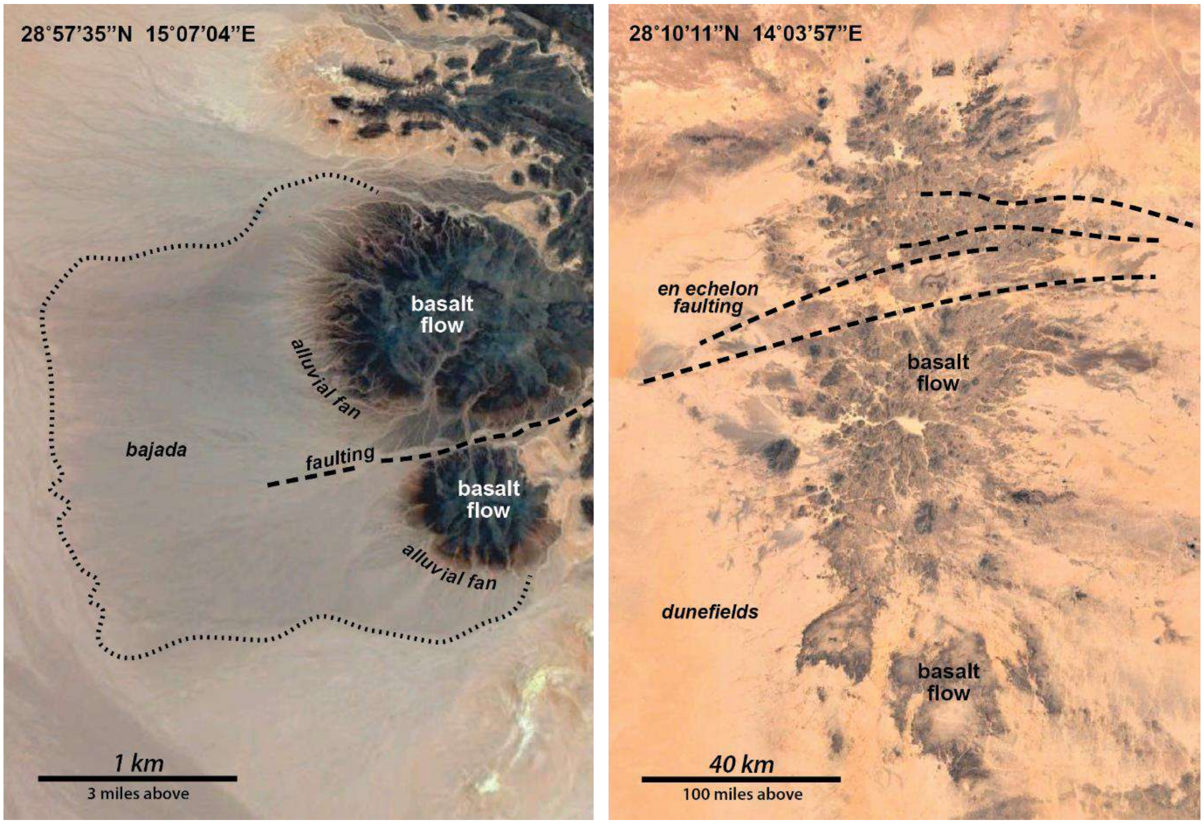

Figure 6.19 : These two images illustrate seismogenic surface features in west the Haruj Volcanic Field from various elevations (3 miles vs 100 miles) and at various surface scales (1km vs 40km). These images illustrate the importance of examining surface features at various scales using remotely-sensed imagery (Google Earth, December 8, 2016). Cartography by author, 2019.

Such geomorphic features in arid landscapes can be identified and classified through multi-scalar techniques and represent the FIRST crucial procedure in identifying potentially hazards seismogenic features. It is through the remotely-sensing images that these surface features may be identified first, then ground-truthed for further study, hazard assessment, and risk management. In a country as vast as Libya, using ground observations to identify and assess seismic features would be too costly and time-consuming. Therefore, using remote-sensed imagery to locate and classify similar features is less costly and ultimately cost-effective and efficient. An efficient plan to first use remote imagery to locate these features, and then undertake ground observation and feature assessment would be an ideal plan to locate, classify, assess, and archive all potentially hazardous seismogenic features (and other related geomorphology) across Libya.

CHAPTER 7: Seismic Risk Perception in Al-Marj, Libya:

a case study after the 1963 Earthquake

7.1. Introduction

Because of its unpredictable nature injury, death, and damages from earthquake, human life and property are often more vulnerable to this natural disaster (Azim & Islam, 2016). In fact, a natural hazard becomes a disaster when it causes deaths, injury, and material losses (Montz et al., 2017). This new perspective confirms that disasters do not occur, but are caused (Oliver-smith, 1999). It takes a long time to recover from a disaster and regain normalcy. In terms of the natural hazard response, two major approaches have been recognized and addressed (Degg & Homan, 2005). First, the ***top-down*** approach focuses on improved hazard and disaster response (e.g. through public awareness and hazard training programs) and hazard planning and regulation (e.g. through land-use planning, and the design and implementation of building codes). Second, the ***bottom-up*** approach puts greater emphasis on the necessity to understand the social, political and economic processes that create societal vulnerability to hazard (Pelling, 2003). The *bottom-up* approach, or the community-based approach, was first coined by Andrew Maskrey (1989) through his influential book, *Disaster Mitigation: a community based approach*. Across Turkey, citizens demanded action by their governments when contractors had not followed building codes and had used low-quality materials; these poor construction standards exacerbated the damage following the 1999 Izmit earthquake (Degg & Homan, 2005). In the U.S. south Florida, when it became clear that poor construction methods were responsible for much of the avoidable damage caused by Hurricane Andrew in 1992 (Wisner & Luce, 1993) similar outrage developed. Maskrey objected to the *top-down* perspective that many people are living in vulnerable situations due to lack of knowledge or understanding about hazard exposure or due to immediate economic prospects. Living in an area susceptible to serious earthquake exposure, in poorly constructed structures, for instance, may well be perceived to pose less of a direct threat to well-being than everyday concerns such as having no way of earning a living and having little to eat (Maskrey, 1989). People are unlikely to adapt or change their behavior or habits to reduce vulnerability to natural hazards if this increases their vulnerability to other major concerns. In these situations, the *top-down* approach seems to be less effective in reducing community vulnerability. Therefore, it is argued that the first step for reducing vulnerability should come from within the community. People should be aware of, and concerned about their own safety (Degg & Homan, 2005). Research has repeatedly confirmed that people are most likely to take protective action if they believe that they are at risk (Fitzpatrick & Mileti, 1991; Gladwin et al., 2001; Tierney et al., 2001; Zhang et al., 2004; Lindell & Perry, 2004).

Under the Roman occupation of North Africa, the 262AD and 365AD earthquakes razed the region of Cyrenaica in northeastern Libya. However, since 1900 the coastal zone of northeastern Libya near Al Jabal Al Akhdar continues to be a seismically active, although most earthquakes produced moderate magnitudes, generally ≥4.5 (Ml). A major event was recorded in Al-Marj where the city was destroyed by an such an earthquake (5.6R) on 21 February, 1963 (USGS, 2018). This study focuses on perceptions of earthquake recurrence, construction standard policies, and the level of preparedness of the survivors of Al-Marj tremor. Here the belief, attitudes, knowledge, perception, and actions of the individuals were considered to play a vital role in understanding and coping with the consequences of quake.

7.2. Study site

The modern city of Al-Marj, (30°N, 20°W) in northeastern Libya, at the western end of the Jebel al-Akhdar Mountain (Figure 7.1), is the ancient Greco-Roman Cyrenaican town of Barce established c.550 B.C. (Goodchild, 1968) in the eastern coastal province of Libya. It was a part of the Greco-Roman province of Crete and Cyrenaica. The area came to be known as Barqa during the Islamic period (Huesken, 2012). The present town grew around a Turkish fort built in 1842 (now restored). Cyrenaica was also the name of the administrative division from 1927 during the Italian occupation of Libya when the Italians developed the town as an administrative center, market nexus, and hill resort from 1913–1941 (Luebering, 2014). The name, Cyrenaica was used in the Kingdom of Libya until 1963 (Huesken, 2012).

Al-Marj is situated on an alluvial plain which has provided fertile soil for agriculture for centuries, which lead to its early settlement during Greek times (Campbell, 1968). The flat plain is located at the top of the first escarpment of Al Jebel al-Akhdar, which runs longitudinally descending toward the sea to the north, rising 200 to 400 meters above sea level. Directly behind this plain is the terrace of the second escarpment rising 400 to 875 meters above sea level also facing north, running in parallel with the first escarpment. Sited on the plain between the first and second escarpment is the city of Al-Marj. These two escarpments trend to the northeast created a 'grand staircase' lifted tectonically from the adjacent mountainous range of Al-Jebel al-Akhdar (UPA, 2008).

Al-Marj was destroyed in 1963, then rebuilt on rock substrates 3 miles (5 km) from the old city (Luebering, 2014). The new city is 90 km (56 miles) northeast of Benghazi and is the administrative seat of the Marj District. Al-Marj and Darnah are the major service and commercial centers and centers of major agricultural activities including fisheries (UPA, 2008). It has been postulated that these escarpments are uplifted fault-plains, however recession has taken place since the scarps were formed, and the these controlling faults now exist north of the present-day escarpments (Campbell, 1968). Erosion has deteriorated the fault-bound cliffs leaving a rounded and cracked escarpment face and plain(UPA, 2008). Figure 7.2 illustrates the coast of northeastern Libya in Al-Jabal Al-Akhdar areas which continues to be a seismically active.

Figure 7.1: Location map of the study area. Cartography by author, 2019.

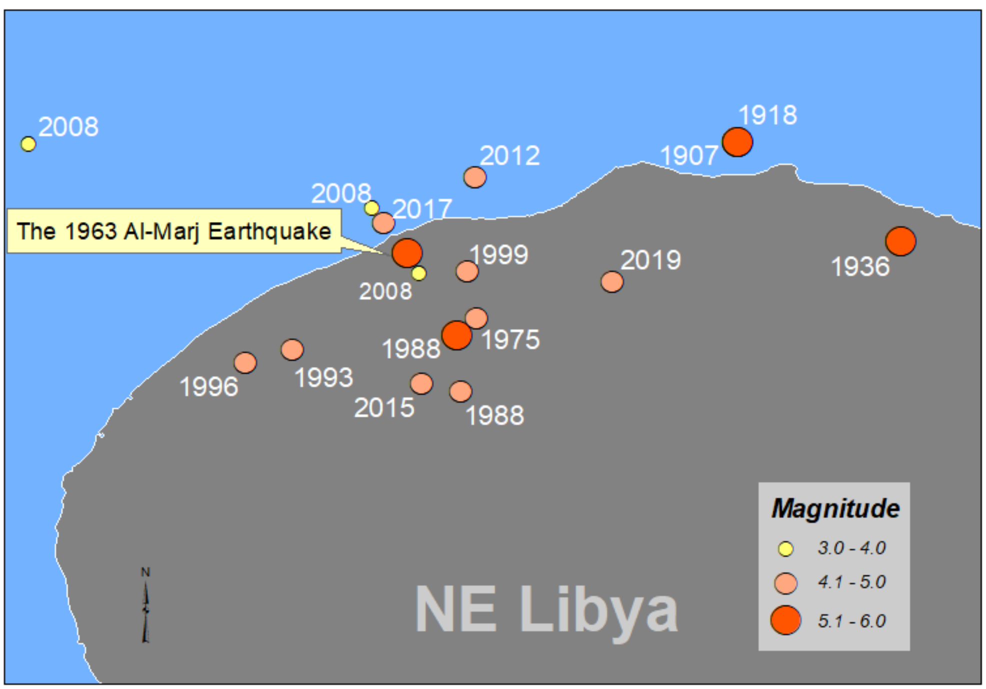

Figure 7.2: Distribution of the earthquakes that occurred in NE Libya (1900-2019). Data from USGS, 2019. Cartography by author, 2019.

7.3. The 1963 earthquake

On 21 February 1963, at 17:14 (local time), during the 27th night of Ramadan, an earthquake shook the region when the Muslim inhabitants of the town gathered in their houses to take their evening meal after the sundown. The shock was centered 13 km northwest of Al-Marj. The epicenter was located at 32.6°N and 20.9°E, while the focus of the earthquake was approximately 33km below the ground surface. The tremor hit with a Richter magnitude of 5.6, and a maximum intensity of IX on the modified Mercalli intensity scale (Minami, 1965). The earthquake leveled most structures, killing 300 and injuring 375 people; the whole population of 13,000 residents was left homeless (Campbell, 1968). Five aftershocks followed the first shock with magnitudes greater than 4 which continued throughout the day (Gordon & Engdahl, 1963) (Table 7.1).

Table 7.1: Basic data for the aftershocks.

Date	Origin Time	Location Lat.(°N) Long.(°E)	Depth (km)	Magnitude	Stations Reporting P-Readings
February 21	17: 24: 36	32.6° 21.1°	33	4.0	7
February 21	18: 33: 00	32.9° 21.0°	30	4.6	35
February 21	18: 36: 19	32.6° 21.0°	30	4.0	9
February 21	20: 26: 40	32.6° 21.0°	33	4.8-4.4	70
February 22	02: 47: 15	32.9° 21.1°	33	4.3	23

Sources: Gordon & Engdahl, 1963; and Minami, 1965.

The next morning, two more quakes struck as rescue work was in full swing. The Libyan Air Force sent eleven air transports loaded with relief supplies from its base near Tripoli. American and British military forces, and Libyan soldiers and police provided food and tents to survivors while rescue workers dug through the ruins for others trapped, injured, or killed (Grandy, 1963). Libyan officials rushed from Tripoli to supervise rescue operations. An emergency was declared throughout the country by the Libyan government. After an appeal for help from local Libyan authorities, British troops were in charge of rescue operations. British assistance was flown from the Benghazi area and nearby Cyprus. A British-American control center was set-up in Al-Marj. In addition, U.S. planes sent medical personnel and relief supplies from the US' Wheelus AFB close to Tripoli, 300 miles west of the quake area. The first planes transferred a full field hospital with two surgeons, three other doctors, medics, and a medical group able to parachute into the earthquake area. British troops hurried to the scene with support from the station at Benghazi ("Earthquake in Libya Leave Hundreds Dead and Injured," 1963).

The poorly constructed stone and clay structures found in the city were responsible for injuries, human lives, and property (Figure 7.3). The structures comprised of rubble stone embedded in mud and/or clay suffered extensive damage (Figure 7.4). Also, construction that used sandstone or limestone mortared with lime, cement, or cement mortar but without reinforcement (e.g. steel bars) was susceptible to ground movement and presented a serious danger to residents in these buildings. Construction that implemented hollow concrete blocks for one-floor dwelling houses suffered moderate damage, although they were not reinforced. Buildings with reinforced concrete frames (foundations, columns girders, slabs) escaped serious structural damage, although their walls were badly cracked. It was only concrete structures with reinforced steel integration that survived the disaster, and they were uncommon. For example, the elevated water tank of reinforced concrete and the adjacent five-story storage silo near the railway station withstood the shock forces with no damage (Minami, 1965) (Figure 7.5).

Figure 7.3: The heap of rubble stones in the popular housing area. In the center is the remainder of the fallen roof consisting of wooden rafters. Among the ruins, a building with girders and reinforced concrete columns remain standing though damaged (Minami, 1965).

Figure 7.4: An example of damage to a rubble stone and mud house. Photo from Sulfium Forum, 2010.

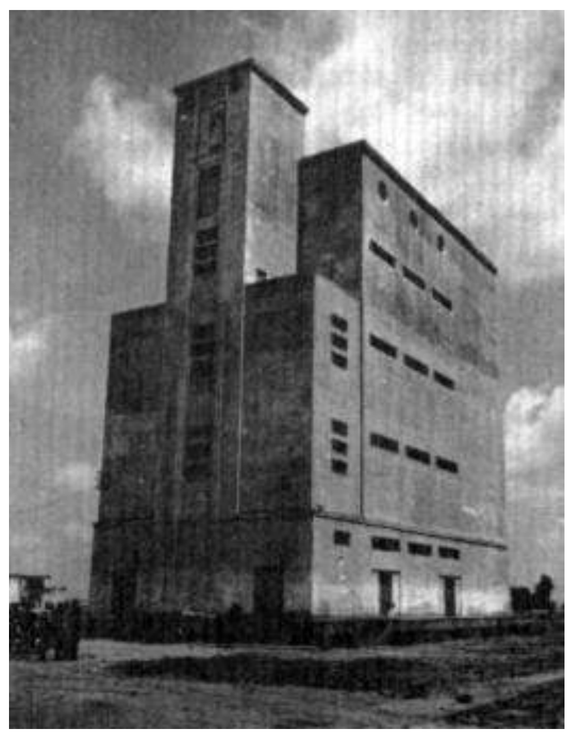

Figure 7.5: The five-story silo building of reinforced concrete construction. The structures with reinforced concrete walls withstood the earthquake forces (Minami, 1965).

7.4. Perception, risk, and culture

Perception is a process by which people interpret and organize their sensory impressions in order to give meaning to their environment . . . An individuals' behavior is based on their perception of what reality is not on reality itself (Buffett in Robbins & Judge, 2013). Risk perception is the reaction of an individual or a social unit toward a natural disaster occurring, and this response is a result of their culturally-related perceptions formed from experiences, training, and/or education (Jung, 1959). Humans perceive and act on risk in two essential ways. Risk as feelings refers to individuals' intuitive and instinctive reactions to danger. Risk as analysis brings logic, reason, and scientific consideration to bear on risk management (Paul Slovic & Peters, 2006). Plato divided the mind into four realms – metaphysics, opinion, knowledge, and the sensation – and suggested that ***perception*** existed within the opinion realm between the worlds of knowledge and sense. This idea that what we perceive emerges through a filter of sensing, understanding, realizing and utilizing was established 2,500 years ago, and it is still widely accepted. The *mind's eye and filtering* between observing and understanding has been in discussion for years, however, it started with the work of analysts such as Freud, Jung, and the Gestalt group that the modern notions of perceptions of danger, risk and safety began to be established. Freud in 1916-1917 designed a "mental topography" to characterize the complicated interaction of the psyche and reality as part of the "perception-consciousness system", trying to explain how people take in impressions and order them according to their relationships to impulse and instinct (Freud, 1963).

Freud (1963) believed that the senses receive impressions, then organizing them according to their relationships to impulse and instinct, emphasizing that what we see is only the beginning; it will later be modified, classified and stored in realms that are immediately conscious. Jung (1959) suggested that people first sense, classify, emplace and then judge on the basis of knowledge, experience, and context, and that added a new dimension to the concept.

Much of modern research in cognitive psychology operates with a model of man that is not passive but an *active recorder*, seeking and constructing an internal representation of the environment that will enable him to achieve his developing needs, and to overcome and cope with the pervasive problem of adapting to the environment. As Bartlett (1932) explained, man is involved in a continual “effort after meaning” (Lee, 1981). The familiarity with repeated events has also been found to dramatically decrease the risk that is associated with some events, while some cultural appearances have been found to increase or decrease the risk relative perception. White (1945) determined that floodplain inhabitants who have the greatest experience with the previous flooding underestimated the perceived risk of future floods. However, urban and rural flood-plain residents display differences in the perception of flood hazard (Kates, 1962). In prior studies of urban (Kates, 1962) and agricultural (Burton, 1962) landscapes, flood-plain residents indicated a greater sensitivity into floods terms of awareness for agricultural land users, while the frequency of hazard was the same for both agricultural land and urban users (Burton & Kates, 1964).

Attributing natural disasters to external forces beyond any human control has a great effect on how communities manage, modify, mitigate, cope and/or participate in decision-making. Lee (1981) discussed that communities which accept some level of blame for natural hazard effects were more likely to be active in community decision-making and mitigation, which reduces risk. The realization that an individual’s or community’s influence can modify risk is a crucial method to effective mitigation and/or preparation for the next disaster (Slovic et al., 1977; Slovic & Weber, 2002). Different demographic factors are believed to have an effect on the positions and perceptions of individuals with regard to certain types of stressful events (Soffer et al., 2011). Gender connected to the knowledge of the causes of earthquakes, the ability to cope with severe risks, and emergency preparation (Taylor, 2005; Eisenman et al., 2006; Paradise, 2008). Armaş (2006) pointed out that the education level is closely associated with the extent to which people are aware of the seismic danger.

7.5. Methodology

The administration of survey instruments was used to assess the perceptions of seismic hazard and risk of survivors and residents of Al-Marj now 55 years after the devastating earthquake in 1963. It was designed and written in Arabic during Fall 2018 for targeting of university students, faculty, and staff, and in-home interviews for residents.

Stratified sampling techniques were applied to assess a representative sample of responses according to the respondent demographics. This kind of sampling (stratification) increases the reliability of estimates and is much utilized in opinion surveys (Kothari, 2004). For obtaining specific information and secure data appropriate for the analysis, the survey included a variety of indicators which included 37 questions divided into three sections: demographic information, earthquake historical knowledge, and seismic risk perception (Table 7.2). The Indicators included six demographic questions of sex, age, current address, years living in the place, education level, income, 14 questions designed to assess general quake historical knowledge such as 'How many times have you felt an earthquake?; When did you last feel an earthquake?'. Finally, 17 Likert-scale questions (1–5) were designed to elicit a general view of risk perception using a range of answers *(1= strongly disagree, disagree, no opinion, agree, 5= strongly agree) (*Figure 7.6) (Paradise, 2005)*.*

Using open-ended questions with discrete categories, the data allowed comparisons of subcategories or cross tabulation with other variable categories (Haring et al., 1992) which were used to analyze data in addition to descriptive statistics. Also, to answer some other questions, the respondents used Likert-scale techniques that correspond to a range of responses from strong agreement to strong disagreement (Kothari, 2004). These scaled responses allowed the researcher to quantify the answers that enabled inferential and descriptive statistical analysis. In the study, this technique proved simple and effective in correlating and explaining significant relationships.

Table 7.2: Survey instrument sections.

Sections	Example Questions	Obtained information
Demographic information	-What is your age and gender? -What is your education attained level? -What is your annual income? -How many years have you lived in the area?	The demographic information provides indicators on the targeted social unit.
Earthquake historical knowledge	-How many times have you felt an earthquake? -When do you believe was the last large earthquake? -What did you do first during the last earthquake?	Historical seismic information will clarify if residents are aware of the seismic activity in their region.
Seismic risk perception	-How much do you personally know about earthquakes? -Where do you get your information about earthquakes? -Do you prepare for another earthquake? -Why do earthquakes happen? -What did you first do when an earthquake happened? -What part of the building is safer during an earthquake? -When do you believe the next earthquake will occur?	Risk perception information provides how the residents react with earthquakes and how their response is related to their experiences, training, and education.

My local government is prepared for earthquake

strongly disagree ***disagree*** ***no opinion*** ***agree*** ***strongly agree***

When will there be an earthquake in/around your village/town/city?

Days ***Months*** ***Years*** ***God Knows***

Figure 7.6: An example of the Likert-style question used in the survey.

The survey was administered during the Spring 2019 and continued for four months. The questionnaires were administered across Al-Marj and carried out at the University of Al-Marj and completed by the students of the university, the residents of the university community, and the surrounding area. The survey was conducted face-to-face, during class time for the university students, and in-home interviews for residents 20-70 years old. The two-member survey team consisted of two local lecturers of Geosciences and Engineering targeted earthquake survivors and their family members. A combination of Al-Marj residents including 1963 earthquake survivors from various socio-economic strata were surveyed: University students, staff, and faculty, shopkeepers and customers, housewives, unemployed, and government officials.

More than 364 survey interviews were completed (n=368), 27 earthquake survivors were surveyed and interviewed and the remaining 337 were residents with memories from oral histories of the quake. Four incomplete surveys were rejected. Overall, the respondents of Al-Marj were friendly and more than willing to discuss the past earthquake and what may occur again. Additional notes, personal quotes, and anecdotes were written on many of the anonymous surveys by respondents often delighted to recount their experience, stories, and/or opinion of earthquakes. The survey data were then collected, compiled, and organized in spreadsheet formats and analyzed using Excel software.

7.6. Results

The aim of the study was to compare how respondents understood, perceived, and viewed seismic danger in Al-Marj using demographic, educational, economic, hazard, and vulnerability factors. Some of the results from the 364 successful surveys and interviews were predictable and some were revealing (Table 7.3). The most notable results were found in the differences in perceptions between age, education, technology, and gender categories, in addition to the general lack of belief in the use of seismic predicting. This was revealed in the correlations between demographics and Likert-style responses. Especially interesting and statistically significant were the relationships of age and education level to the scaled responses.

Most respondents (88%) felt earthquakes, some (12%) have not felt one. Of those who experienced earthquakes; 51% stated that they were felt in the last 12 months, while 35% in the last 1-10 years. 45% did nothing during last earthquake, while 30% prayed, 13% screamed, and just 8% sought a cover (Figure7.7). 78% did not want to predict whether if their city will have another earthquake, and they responded by ''I do not know'' and 22% responded ''yes''; 96% responded ''God knows'' for when the next earthquake will occur. Most participants refused to make a simple prediction even though they responded that their region was seismically active; moreover, their education level did not make any difference. In general, gender played a minor role in most of the correlations: 49% of the women and 42% of the men interviewed stated that they did not know the cause of earthquakes, 22% of the women and 22% of the men stated that Allah tests the believers. 22% of the women and 25% of the men stated earthquakes happen because of the slip of tectonic plates.

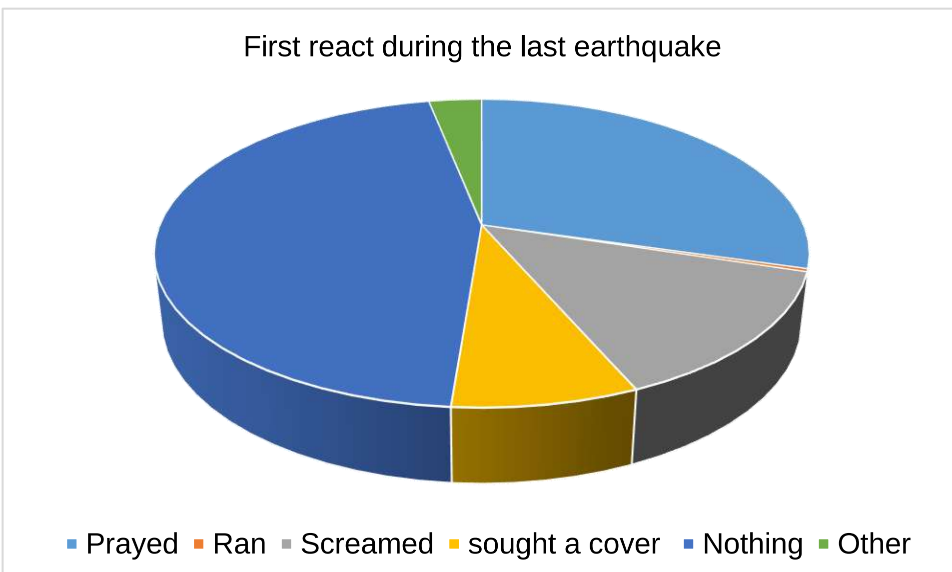

Figure 7.7: Most respondents did nothing while others chose to pray as first reaction when they felt earthquake. Only 8% sought cover.

Table 7.3: Summary of descriptive statistics representing the overall responses to the demographic information and earthquake historical knowledge.

Sex	M: 51%	F: 49%			
What is your age?	<20 years: 27%	21-30 years: 48%	31-40 years: 9%	41-50 years: 8%	51-70 years: 7%
Where are you living?	New Al-Marj: 71%	Old Al-Marj: 6%	Farm: 23%		
How many years have you lived in the area?	1-5 years: 12%	6-10 years: 5%	11-15 years: 12%	16-20 years: 24%	> years: 47%
Education attained?	Elementary: 1%	Middle-High: 15%	College: 81%	Master's: 12%	
Monthly Income?	$<50: 41%	$50 - 125: 24%	$125 - 250: 24%	$250<: 11%	
Have you ever felt an earthquake?	Yes: 88%	No:12%			
How many times have you felt a quake?	1: 19%	2: 29%	3: 20%	>4: 20%	
When did you last feel an earthquake?	1-12 Month: 51%	1-10 years: 35%	11-20 years: 2%	>20 years: 1%	
What did you do first during the last earthquake?	Prayed: 26%	Screamed: 12%	Sought Cover: 7%	nothing: 40%	Other: 3%
Another quake soon?	Yes: 19%	No: 1%	I don't know:69%		
When is the next quake?	Days: 1%	Months: 2%	years: 2%	God Knows: 96%	
Why do earthquakes happen?	I don't know: 46%	Allah punishes the sinful: 6%	Allah tests the believers: 23%	Tectonic plate slip: 24%	
What is your house's building type?	Clay: 4%	Adobe brick: 20%	Concrete: 31%	Reinforced concrete: 45%	
Who owns your house?	I:13%	My Family	Landlord:2%	Government: 3%	Other
How much do you Know about quakes?	Nothing: 25%	Little: 46%	Some: 24%	Much: 5%	
Where do you get your information about earthquakes?	TV: 30%	Internet: 38%	Religious books: 1%	Science Papers: 8%	Radio: 8%

Relating to the relationship between education level and the cause of earthquakes, 46% said ‘’I don’t know”, but higher-educated respondents tended to attribute earthquakes to the slip of tectonic plates alongside each other, and less-educated respondents tended to attribute earthquakes to divine testing and punishment (Figure 7.8).

Interestingly, for most of the participants, the Internet and TV were the primary source information regarding earthquakes. Nevertheless, age played a major role in choosing the source of this information: 15-30 years old depended more on the Internet and TV came second, while 31-50 years old depended more on TV followed by the Internet. 51-70 years-old stated that TV had the highest percentage (52%) followed by radio (30%) (Figure 7.9). Although 59% of the respondents considered earthquakes represent a serious threat to their community, 49% were frightened from earthquakes; some (40%) believed that their house is resistant to earthquakes. There was a correlation between the opinions on structural safety and building type. Of those who strongly agreed that their house was safe from earthquakes, 41% their houses were built from reinforced concrete, and 30% from concrete. Of those who agreed, 57% lived in structures of reinforced concrete, and 25% in concrete (Figure 7.10).

As regard to earthquake preparedness, this question included five options: strongly disagree, disagree, no opinion, agree, strongly agree. 25% respondents had no opinion. It was found that 53% of the respondents agreed that they were not at all prepared for earthquakes, while 22% were prepared. Concerning the relationship between age and earthquake preparedness, it was found that most of the respondents were not prepared, but younger respondents were relatively more prepared than older respondents (Figure 7.11). Higher-educated respondents were found to be less prepared than lower educated. About how their house was safe to earthquake forces and earthquake preparedness, it was found that of those who strongly disagreed or disagreed, their houses were believed to be resistant to earthquake forces. 75% did not prepare for another earthquake, and 25% did prepare. In terms of the responsibility to actively engage in earthquake preparedness, 44% respondents

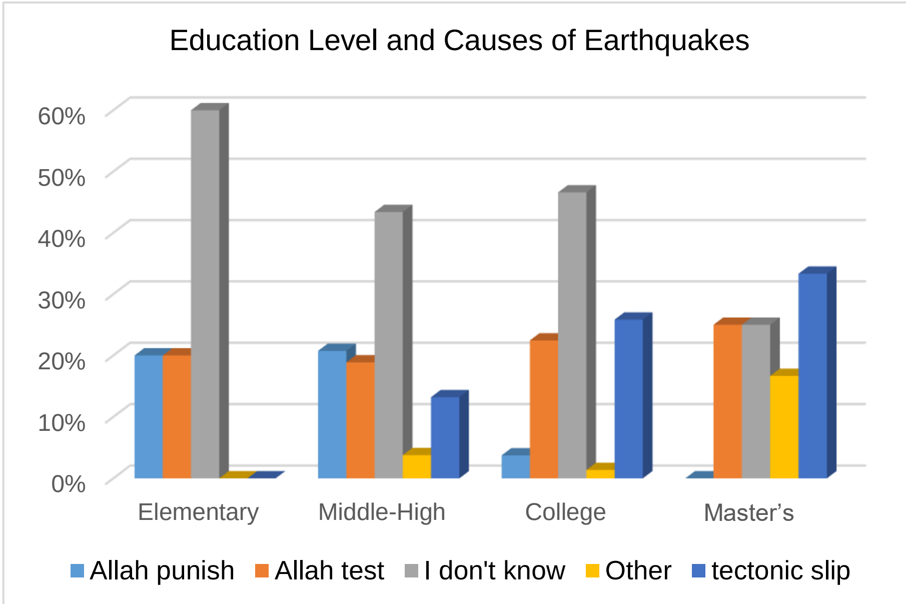

Figure 7.8: The relationship between education level and the cause of the earthquakes showed, 46% said ''I don't know, less-educated respondents tended to attribute earthquakes to divine testing and punishment, but higher-educated respondents tended to attribute earthquakes to the slip of tectonic plates alongside each other.

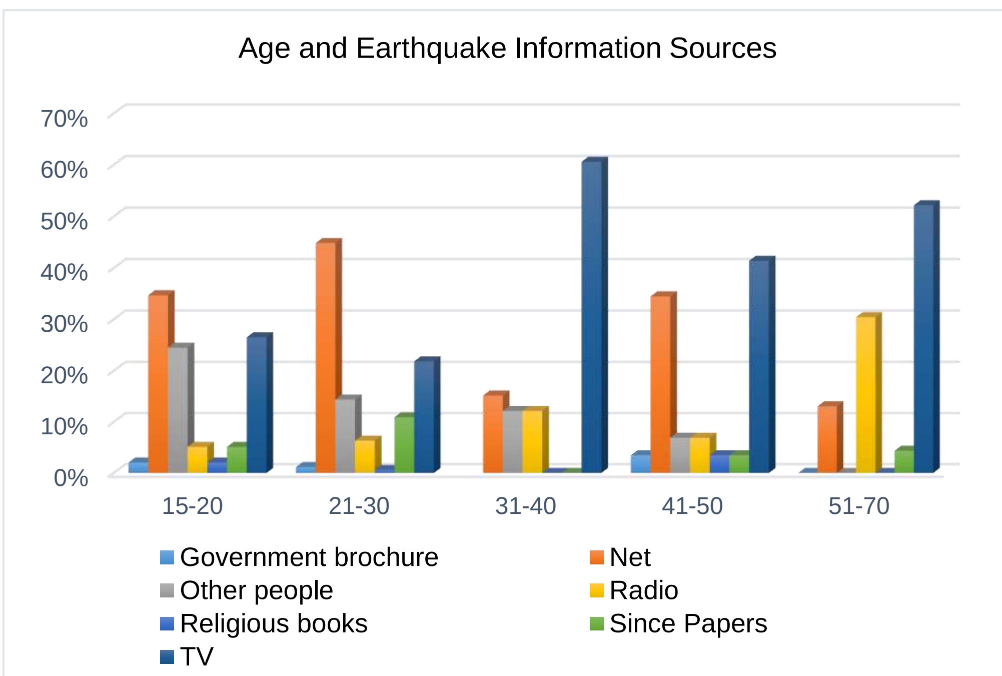

Figure 7.9: Earthquake information sources were varied between age categories. The categories 15-20 years old and 21-30 years old relied more on the Internet and TV came second, the categories 31-40 years old and 41-50 years old depended more on TV followed by the Internet, with the category 51-70 years old TV had the highest percentage followed by radio.

believed that citizens had a responsibility to actively engage in earthquake preparedness, and 57% of them think preparedness to reduce earthquake damages was not just the government's duty. However, 33% respondents believed citizens did not have a responsibility in earthquake preparedness, and 43% of them saw this was just government's duty.

With regards to seismic risk and technology, four measures were found to have high priorities to the respondents: (1) choosing a site for residential development which was less vulnerable to earthquake will definitely minimize the risk related to earthquake (71% lived in New Al-Marj, and 77% indicated that Old Al-Marj was more dangerous to live); (2) constructing houses with steel rod reinforcement, cement, and concrete will reduce the damage (31% concrete and 45% re-concrete); (3) educating people will have an important role in reducing the earthquake damages; and (4) engaging in earthquake preparedness was the responsibility of the residents (44%) beside the government's duty. This indicates that the respondents positively believed that taking preventive or preparatory measures will lead to decreased consequences. Ignoring risk altogether was attributed to two responses in the survey: (1): ‘Will there be an earthquake in your city’ was answered ‘’I do not know’’ (69%) and/or 96% of the respondents stated that ‘’God knows’’ when the next earthquake will.

7.7. Discussion and Conclusion

An individual’s or community’s response to hazards is related both to the perception of the phenomena and to awareness of the opportunities to make adjustments. Rarely are people unaware of the existence of potential hazards in their environment, but their perception and cause may vary markedly from the estimates of professionals and experts (Burton et al., 1993). In terms of overall risk perception, it has been observed and researched that people hold various perceptions about earthquakes. In this study, it was found that the individuals believed that an earthquake was a serious threat to their city, however, they knew nothing or little about earthquakes (71%). So, they were ill-equipped with the necessary

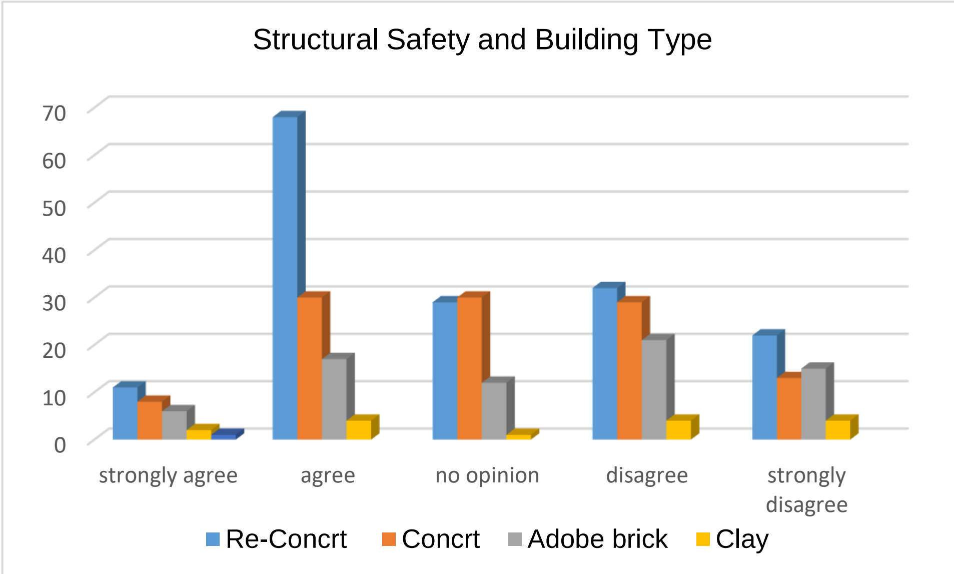

Figure 7.10: The correlation between the opinions on structural safety and building type showed that participants agreed that constructing houses with reinforced iron, cement mortar, and concrete will keep their house safe and reduce the damage.

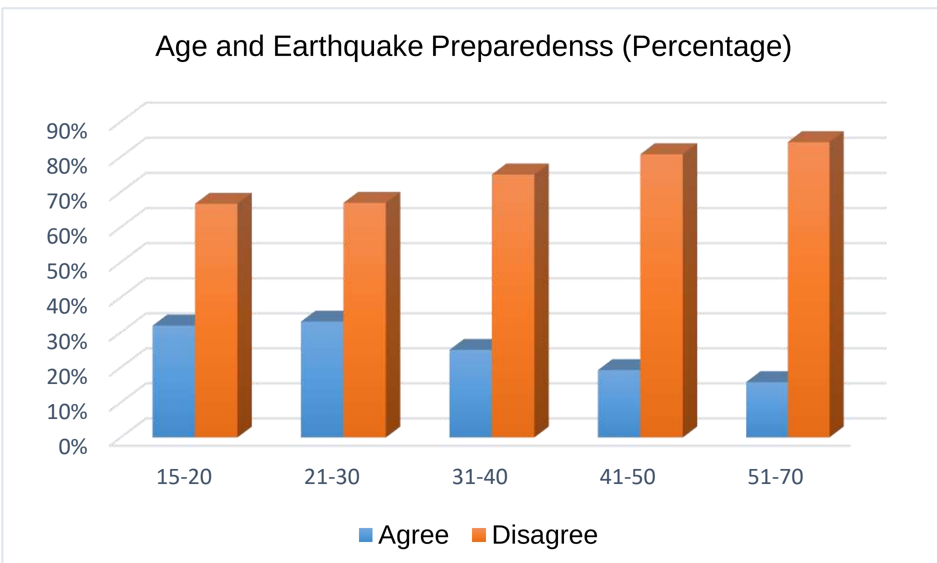

Figure 7.11: Younger participants are observed to be relatively more prepared than older participants.

information about earthquake causes, safety, and damage prevention. They only understood the basics observable information about the tremors they had experienced. However, they were not informed about the causes, influences, or the significance of seismic activity and its consequences. Almost all the participants in this survey had accessed information about earthquakes from various popular media sources (91%), and never from a scientific or more fact-based resource. During the Al-Marj Earthquake overwhelmingly they only prayed, screamed or ‘did nothing’ (78%). In his study of the floodplain communities of Bangladesh, Haque (1987) found similar responses; the respondents prayed to Allah as their first solution to everyday, and catastrophic suffering, and to those imminent hazards. For the causes attributed to earthquakes most responded "I do not know, Allah punishes, or Allah tests the believers" (75%), but some with higher education tended to attribute earthquakes to the slip of tectonic plates alongside each other. Thus, it goes against the findings of Demirkaya (2008) in Turkey, who studied the perceptions of survivors of 1971 Burdur Earthquake in Yazıköy and Yarıköy. Most of his responses believed supernatural powers were the reason for earthquakes beyond or different than the omnipotence of Allah-God.

In addition, Libyan participants were frightened of recent earthquakes, and their neighborhood was believed to be unsafe from earthquakes (60%). Although, younger respondents were relatively more prepared than older respondents, most of them were not prepared for future earthquakes (78%), indicating a widespread apathy among the participants. This reluctance can be referred to the lower level of risk perception. In their memorable past, Al-Marj city experienced a deadly earthquake in 1963 (Minami, 1965), and although the respondents responded that their region was seismically active, they did not consider any form of preparation to be important. It was also observed that such a negative relationship between risk perception and preparedness was supported by prior research by Paradise (2006), and Azim and Islam (2016). Lower levels of risk perception may be due to two main reasons. First, it may be related to a lack of knowledge and/or shared information about previous earthquakes in Libya. Second, their view of earthquakes as events sent from Allah as acts of retribution for weak followers may also be widespread.

Researchers at the European Centre for Cultural Heritage (1993) have identified a possible correlation between earthquake frequency and building practices; in cases where events are infrequent, a ‘seismic culture of repairs’ may develop where people are responsive to disaster reduction information in the immediate aftermath of an event, but then tend to revert back to pre-disaster poorer building techniques and unprepared lifestyles (Homan, 2004).

It was found that most of the survey respondents refrained from answering the questions related to risk perception and refused to make simple predictions. A high percentage (69%) of them did not want to predict whether their city will experience another earthquake. Instead, they commented ‘‘I do not know’’ or ‘‘God knows’’. These common replies were shared equally by men and women, young and old, educated and uneducated, rich and poor. In his study of Agadir, Morocco, Paradise (2005), and Azim and Islam (2016) in their study in Jeddah, Saudi Arabia they found similar responses. So, from these findings in Al-Marj, the major influence of Islam to perception and behavior is understood.

However, an understanding and appreciation for better seismic monitoring indicates that the respondents strongly believed that taking preventive measures regarding seismic risk will lead to lower risks and decreased consequences. Even though it was found that the respondents did not take precautions against possible damage related to future tremors, the participants thought that the damage from earthquakes can be minimized by taking precautions and preparing. They explained that choosing a site for residential development which was less vulnerable to ground-shaking would definitely minimize the risk related to earthquake. Also, constructing houses with reinforced iron, cement mortar, and concrete will reduce the damage.

It was also found that educating people may be an underestimated and under-utilized role in reducing related damages while earthquake preparedness may be as much as a citizen’s responsibility and duty as that of the government. This indicates that individuals do believe that taking preventive or preparatory measures will lead to lower seismic risk and consequences.

Since cultural values tend to change slowly, education may play a vital role in instilling modern values and attitudes that will ultimately lower risk and decrease injury, death, and damages.

It has been said that progress requires the need to address different types of vulnerability. Zaman highlighted five vulnerability types: *physical, social, economic, educational,* and *environmental vulnerability* (1999). A community's effective mitigation against seismic risk necessitates consideration of all these factors. As such, interdisciplinary research and action become the fundamental prerequisite in the reduction of these vulnerabilities necessitating geologists, architects, politicians, engineers, community leaders, social scientists, and public policy makers to work together to produce sustainable disaster management strategies in a seismically active region like northeast Libya. When natural hazards in Libya like earthquake recurrence are better understood, then the potential consequences of injury, damages, and deaths may be assessed, and an overall plan to decrease risk can be created and implemented.

CHAPTER 8: Conclusion

In this concluding chapter, the main findings of the dissertation are summarized through a recapitulation of the chapters, reflecting on the work on the seismicity of Libya in order to better understand earthquake hazards, related geomorphic features, and the current evolution of Libyan perceptions of seismic risk. The dissertation was arranged to manifest its objectives by preceding it with an introduction. Particular attention was paid in the second chapter to detect the physical and human landscapes of the study site. Prior studies of natural hazard risk and vulnerability, remote sensing of natural disasters, and risk perception was presented in the third chapter. The three different methods were detected Chapter 4. The primary contributions of the dissertation came in three essential chapters summarized below.

8.1. Creating an earthquake archive in Libya from classical times to the present

Chapter 5 developed a baseline of past and current seismic inventory in Libya, which represented an assessment of Libya seismic hazard by translating, analyzing, and compiling historical sources and archaeological data of Libya's seismic history. This approach used records, documents, and past archives of Libya's earthquake history (i.e. written records, newspapers, film, images). When the seismic recorded information of ancient times was not extant, the archive relies upon archaeological data. The historical Libyan earthquake record is far from complete, so it rarely specifies data of interest to geographers and seismologists: which event location, magnitude, depth, rupture length, and damage size etc.

The results from this study show that Libya has experienced earthquakes in varying degrees since ancient times. The earliest references to earthquakes have been found in historic records and archaeological data since 262AD. and 365 AD. Through the spatial and temporal distribution of earthquakes from 1900-2019 strongly suggest Libya can be divided into three seismologically active regions: (1) the north-northwest trending Hun Graben which extends in the Mediterranean in the north, and in the middle of Libya in the south, (2) Al Jabal

Al Akhdar in northeast Libya and extends in the Mediterranean in the north, and (3) the east-western axis from the Tunisian borders to Al Aziziya to Houn. These specific findings contribute to discussions of the need for further research that seeks to understand the earthquake activity in Libya. The historic and geographic factors that could account for missing seismic periods have to identify and examined when preparing a feasibility study aiming at collecting new data on past seismic events in Libya. Since The historical and more ancient seismic event is a crucial key to the seismic future., it is imperative that we understand Libya's seismic history and hazards all in the hopes of decreasing seismic risk and its grim consequences of injury, death, loss, and damage.

8.2. Identifying Seismogenic geomorphologic features in Libya

In Chapter 6, a new method to identify seismic geomorphologic features in Libya was created. To identifying seismic geomorphologic features in Libya, satellite images from Google Earth were used with two different grids on Libya map. Small scale with 200 by 200km for each grid to assist classify and archive image classification and compilation in tandem with latitude-longitude locations. The second grid was tighter (big scale) where each grid represents 20 by 20km to help the classification and compilation of imagery and sites at closer inspection and lower elevation.

It is through the remotely-sensing images some seismogenic surface features were identified in different locations in the country. In eastern and northeastern Sirte, large graben feature, faultline scarps, displacement of offset wadi channels and en-echelon faulting were located. In the Haruj Volcanic field, several geomorphic features were found. In the southwest of the field, large strike-slip fault, small flanking en-echelon, and faults faultline scarps were identified. North of the field, graben complex, offset wadi channels, distinctive en-echelon faulting, and faultline scarps developed. In Al Jabal Al Akhdar (northeast Libya), offset wadi channels and faultline scarps in Al-Shuqluf, Al-Khirbet, and Amira Valleys between Al Hamamah and Susah were located. Offset stream channels and wadis indicated the surface presence of faulting that is actively shifting wadi channel alignment – a key indicator in identifying seismogenic geomorphology. In northeast Al Jabal Al Gharbi (western Libya), faulting, en-echelon faulting, and offset wadi channels were located identified. Using remotely-sensed images is important in examining surface features at various scales in various elevations.

8.3. Seismic risk perception in Al-Marj, Libya

Chapter 7 assessed the perceptions of seismic hazard and risk of earthquake survivors and residents in Al-Marj, Libya – a city razed in the 1963 tremor. More than 364 survey were designed and conducted in Arabic and included demographic, educational, economic, hazard, and vulnerability questions in addition to Likert-scaled responses.

In Chapter 7, several notable trends were found in an analysis of the results of the survey. The correlations between demographics and Likert-style responses revealed the differences in perceptions between age, education, technology, and gender categories, in addition to the general lack of belief in the use of seismic predicting. Most participants refused to make a simple prediction even though they responded that their region was seismically active, and they believed their neighborhoods were unsafe. Especially interesting and statistically considerable were the relationships of age and education level to the scaled responses. Most respondents were not prepared, however, they also attributed earthquakes to tectonic slipping and not divine retribution or retaliation, the respondents positively believe that taking preventive or preparatory measures will lead to decreased consequences. The respondents positively believe that choosing a less vulnerable residence site will lead to lower risks and decreased consequences. Also, the type of constructing houses will affect the damage size. Educating people will have an important role in reducing the earthquake damages.

8.4. Recommendation and Implication

- More seismic studies and analysis should be conducted for the country.
- Develop proper building code standards in the different regions of the country.
- More studies should be conducted to identify and examine when surface fault ruptures and event displacements have occurred.
- More geomorphic analysis to enable interpretation to identify and assess accumulated slip and displacement on each of fault.
- Identify, examine, and assess the mechanisms influencing single-event displacements.
- Investigate spatial and temporal changes in the position and rate of fault strain and the interdependence of the displacement rates between modern, historic, and ancient earthquakes across Libya.
- Earthquakes and disaster preparedness follow up should be done regularly by an agent such as Red Cross which is well versed in disaster preparedness.
- Earthquake safety and drill exercise should be introduced in the schools and community level.
- Awareness programs should be launched through printing and electronic media in order to spread it to all community.

CHAPTER 9: Bibliography

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CHAPTER 10: Appendices

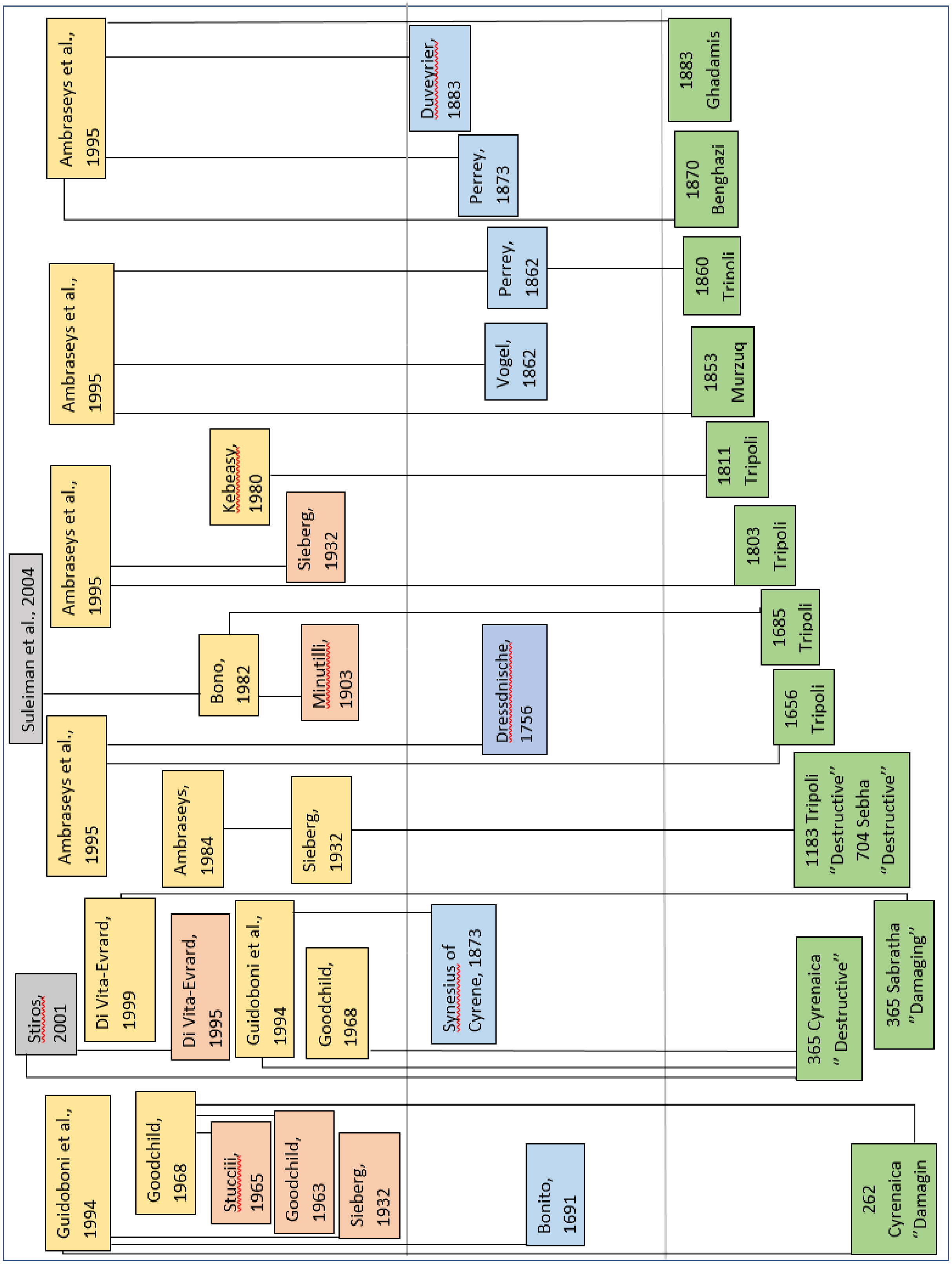
A: Seismic Record and Bibliographic Diagram

B: Survey Instrument Summary

C: Survey Data Compilation

D: Photograph Archive Al-Marj, Libya

A: Seismic Record and Bibliographic Diagram



B: Survey Instrument Summar

Question	strongly disagree	disagree	no opinion	agree	strongly agree
My local government is prepared for earthquake:	51%	22%	21%	4%	2%
My house is safe from earthquakes (resistant to earthquakes):	15%	24%	20%	33%	7%
My neighborhood is safe from earthquakes:	25%	35%	20%	13%	7%
I am frightened of recent earthquakes:	15%	13%	22%	30%	19%
I am prepared for another earthquake:	26%	27%	25%	14%	8%
Earthquake is a serious threat to my village/town/city:	14%	11%	15%	36%	23%
Laws safety govern quake exist in schools, hospitals, emergency buildings:	41%	22%	20%	9%	7%
City management is prepared for earthquakes:	38%	27%	22%	8%	5%
Educating people have an important role in reducing the earthquake damages:	6%	7%	13%	37%	37%
Preventive measures such as strengthening the old buildings have an important role in reducing the earthquake damages:	7%	18%	14%	37%	23%
Building codes and laws exist and are implemented:	28%	23%	23%	15%	10%
Citizens have a responsibility to actively engage in earthquake preparedness:	16%	17%	23%	34%	10%
Preparedness to reduce earthquake damages is just government's duty:	18%	30%	14%	23%	14%
After the 1963 earthquakes, buildings were built better in Al Marj:	14%	10%	23%	41%	11%
Taking earthquake preventive measures is against divine fate:	26%	15%	40%	12%	7%
Earthquake safety is not in my community's priorities:	26%	27%	13%	21%	12%
Earthquake safety is not in government's priorities:	28%	17%	18%	21%	15%

C: Survey Data Compilation

Q	Addrs	Y-Live	Age	Sex	Edu	Income	Felt EQ.	# EQ. felt	When last EQ.
1	Farm	>21	41-50	F	Mstr	125 - 250	Yes	2	1-10Y
2	N-Marj	>21	21-30	M	Mstr	250<	Yes	3	1-10Y
3	N-Marj	11-15	31-40	F	Colg	50>	Yes	4mor	1-10Y
4	N-Marj	11-15	15-20	F	M-H	50>	Yes	1	1-12M
5	N-Marj	11-15	15-20	F	M-H	50>	Yes	1	1-12M
6	N-Marj	1-5	15-20	F	M-H	50>	Yes	1	1-12M
7	N-Marj	>21	21-30	F	Colg	50>	Yes	4mor	1-12M
8	N-Marj	11>15	21-30	F	M-H	50-125	Yes	1	1-12M
9	N-Marj	11-15	15-20	F	M-H	50>	Yes	1	1-12M
10	N-Marj	16-20	15-20	F	M-H	50>	Yes	3	11-20Y
11	N-Marj	>21	21-30	F	Colg	50>	Yes	1	1-12M
12	N-Marj	1-5	41-50	M	Elm	50 - 125	Yes	1	1-12M
13	N-Marj	>21	51-60	M	Colg	125 - 250	Yes	4mor	1-10Y
14	N-Marj	11-15	31-40	F	M-H	50>	Yes	1	1-12M
15	N-Marj	11-15	15-20	F	M-H	50>	Yes	1	1-12M
16	N-Marj	11-15	21-30	F	M-H	50>	Yes	1	1-12M
17	N-Marj	21mor	51-60	F	Mstr	125 - 250	Yes	4mor	1-10Y
18	N-Marj	11-15	21-30	F	M-H	50>	Yes	2	1-12M
19	N-Marj	11-15	21-30	M	M-H	50 - 125	Yes	1	1-12M
20	N-Marj	>21	21-30	M	Colg	125 - 250	Yes	4mor	1-10Y
21	N-Marj	>21	51-60	M	M-H	125 - 250	Yes	4mor	1-10Y
22	N-Marj	>21	41-50	M	Colg	125 - 250	Yes	4mor	1-10Y
23	Farm	>21	51-60	M	Colg	125 - 250	Yes	4mor	1-10Y
24	N-Marj	16-20	41-50	F	Colg	50 - 125	Yes	3	1-10Y
25	Farm	>21	>61	M	M-H	50 - 125	Yes	1	1-12M
26	N-Marj	>21	41-50	F	M-H	125 - 250	Yes	4mor	1-10Y
27	N-Marj	>21	51-60	M	Colg	125 - 250	Yes	1	1-10Y
28	N-Marj	>21	51-60	M	Colg	125 - 250	Yes	4mor	1-10Y
29	N-Marj	>21	51-60	M	Colg	125 - 250	Yes	4mor	1-10Y
30	N-Marj	>21	51-60	M	M-H	125 - 250	Yes	3	1-12M
31	N-Marj	>21	51-60	M	M-H	250<	Yes	4mor	1-12M
32	N-Marj	>21	>61	M	Colg	50 - 125	Yes	4mor	1-12M
33	N-Marj	>21	>61	M	M-H	50 - 125	Yes	4mor	20mor
34	N-Marj	>21	>61	M	Colg	250<	Yes	4mor	1-12M
35	N-Marj	>21	41-50	F	Colg	125 - 250	Yes	3	1-12M
36	N-Marj	16-20	15-20	F	M-H	50>	Yes	2	1-12M

Q	**What Did**	**Will EQ.**	**When next EQ.**	**Why EQ. happen**	**Dange rous in**	**Safer place**	**Aware E. S.**
1	Run	I don't know	God know	tectonic slip	O-Marj	Cornr	No
2	Nothing	I don't know	God know	Allah test	O-Marj	Cornr	No
3	Pray	I don't know	God know	I don't know	O-Marj	Cornr	No
4	Cover	I don't know	God know	I don't know	O-Marj	Cornr	No
5	Cover	I don't know	God know	I don't know	O-Marj	Cornr	No
6	Scream	I don't know	God know	I don't know	O-Marj	Cornr	No
7	Scream	I don't know	God know	Allah test	O-Marj	1st Flr	No
8	Cover	I don't know	God know	I don't know	O-Marj	Cornr	No
9	Scream	I don't know	God know	I don't know	O-Marj	Cornr	No
10	Scream	I don't know	God know	I don't know	O-Marj	Cornr	No
11	Scream	I don't know	God know	Allah test	O-Marj	1st Flr	No
12	Nothing	I don't know	God know	I don't know	O-Marj	Cornr	No
13	Pray	I don't know	God know	I don't know	O-Marj	Cornr	No
14	Cover	I don't know	God know	I don't know	O-Marj	Cornr	No
15	Cover	I don't know	God know	I don't know	O-Marj	Cornr	No
16	Cover	I don't know	God know	I don't know	O-Marj	Cornr	No
17	Pray	I don't know	God know	Allah test	O-Marj	Cornr	No
18	Nothing	I don't know	God know	I don't know	O-Marj	Cornr	No
19	Cover	I don't know	God know	I don't know	O-Marj	Cornr	No
20	Pray	I don't know	God know	I don't know	O-Marj	Cornr	No
21	Pray	I don't know	God know	I don't know	O-Marj	Cornr	No
22	Pray	I don't know	God know	I don't know	O-Marj	Cornr	No
23	Pray	I don't know	God know	Allah test	O-Marj	Cornr	No
24	Cover	I don't know	God know	Allah test	O-Marj	Cornr	No
25	Pray	I don't know	God know	I don't know	O-Marj	Cornr	No
26	Pray	I don't know	God know	I don't know	O-Marj	Cornr	No
27	Pray	I don't know	God know	I don't know	O-Marj	Cornr	No
28	Pray	I don't know	God know	I don't know	O-Marj	Cornr	No
29	Pray	I don't know	God know	I don't know	O-Marj	Cornr	No
30	Nothing	I don't know	God know	tectonic slip	Farm	Cornr	No
31	Pray	I don't know	God know	tectonic slip	N-Marj	Cornr	No
32	Other	Yes	God know	tectonic slip	O-Marj	Cornr	No
33	Pray	I don't know	God know	tectonic slip	O-Marj	1st Flr	No
34	Nothing	Yes	God know	tectonic slip	O-Marj	Cornr	No
35	Pray	I don't know	God know	Allah punish	O-Marj	U-table	No
36	Nothing	I don't know	God know	tectonic slip	O-Marj	U-table	No

Q	**Building Type**	**Own House**	**know EQ.**	**Get information**	**Gov. is prepared**	**House is Safe**
1	Adobe brick	I	Little	Other	no opinion	agree
2	Re-Concrete	Family	Little	Net	strongly disagree	agree
3	Re-Concrete	Other	Much	TV	disagree	agree
4	Re-Concrete	Other	Much	Religious/B	disagree	agree
5	Re-Concrete	Other	Much	Since Paper	disagree	agree
6	Re-Concrete	Family	Some	Net	disagree	agree
7	Adobe brick	Family	Some	people	strongly disagree	agree
8	Re-Concrete	Family	Little	TV	disagree	agree
9	Adobe brick	Family	Little	TV	disagree	agree
10	Re-Concrete	Family	Little	TV	disagree	agree
11	Re-Concrete	Family	Some	TV	disagree	agree
12	Re-Concrete	Family	Little	TV	disagree	agree
13	Re-Concrete	Family	Some	TV	disagree	agree
14	Re-Concrete	Family	Little	TV	disagree	agree
15	Re-Concrete	Family	Little	TV	disagree	agree
16	Re-Concrete	Family	Nothing	TV	disagree	agree
17	Adobe brick	Family	Little	TV	disagree	agree
18	Re-Concrete	Family	Some	Radio	disagree	agree
19	Re-Concrete	I	Little	Net	disagree	strongly agree
20	Re-Concrete	Family	Some	TV	disagree	agree
21	Re-Concrete	Family	Little	TV	no opinion	agree
22	Re-Concrete	I	Little	TV	no opinion	agree
23	Re-Concrete	I	Some	TV	no opinion	agree
24	Re-Concrete	Family	Little	TV	strongly disagree	no opinion
25	Adobe brick	I	Little	Other	strongly disagree	disagree
26	Re-Concrete	Family	Little	TV	no opinion	agree
27	Re-Concrete	Family	Little	TV	no opinion	agree
28	Re-Concrete	Family	Little	TV	no opinion	agree
29	Re-Concrete	Family	Some	Radio	no opinion	agree
30	Re-Concrete	Family	Little	TV	disagree	strongly disagree
31	Re-Concrete	I	Little	Since Paper	strongly disagree	no opinion
32	Re-Concrete	Family	Little	Other	strongly disagree	disagree
33	Re-Concrete	I	Little	Radio	no opinion	strongly disagree
34	Re-Concrete	I	Much	Other	strongly disagree	agree
35	Concrete	Family	Little	Net	strongly disagree	no opinion
36	Re-Concrete	Family	Little	Net	strongly disagree	disagree

Q	**Neighborhood Safe**	**Frightened**	**I am prepared**	**EQ. threat**
1	strongly disagree	strongly disagree	strongly agree	strongly disagree
2	strongly disagree	agree	disagree	agree
3	disagree	agree	disagree	disagree
4	disagree	agree	disagree	disagree
5	disagree	agree	disagree	disagree
6	disagree	agree	disagree	disagree
7	strongly agree	disagree	no opinion	no opinion
8	disagree	agree	disagree	disagree
9	disagree	agree	disagree	disagree
10	disagree	agree	disagree	disagree
11	disagree	agree	disagree	disagree
12	disagree	agree	disagree	disagree
13	disagree	agree	disagree	disagree
14	disagree	agree	disagree	disagree
15	disagree	agree	disagree	disagree
16	disagree	agree	disagree	disagree
17	disagree	agree	disagree	strongly disagree
18	disagree	agree	disagree	disagree
19	strongly disagree	no opinion	disagree	strongly disagree
20	disagree	agree	strongly disagree	strongly agree
21	disagree	strongly disagree	disagree	agree
22	disagree	strongly disagree	disagree	agree
23	disagree	strongly disagree	disagree	agree
24	disagree	no opinion	strongly disagree	strongly agree
25	disagree	strongly agree	strongly disagree	strongly agree
26	disagree	strongly disagree	disagree	agree
27	disagree	strongly disagree	disagree	agree
28	disagree	strongly disagree	disagree	agree
29	disagree	strongly disagree	disagree	agree
30	strongly disagree	strongly disagree	agree	agree
31	disagree	disagree	agree	agree
32	strongly disagree	agree	strongly disagree	agree
33	strongly disagree	agree	no opinion	agree
34	disagree	strongly disagree	disagree	agree
35	disagree	agree	strongly disagree	agree
36	strongly disagree	disagree	agree	agree

Q	**Laws safety exist**	**City is prepared**	**Education Role**	**Preventive measures Role**
1	strongly disagree	no opinion	strongly agree	strongly agree
2	strongly disagree	strongly disagree	strongly agree	agree
3	strongly disagree	strongly disagree	strongly agree	disagree
4	strongly disagree	strongly disagree	strongly agree	disagree
5	strongly disagree	strongly disagree	strongly agree	disagree
6	strongly disagree	strongly disagree	strongly agree	disagree
7	strongly disagree	strongly disagree	agree	agree
8	strongly disagree	strongly disagree	strongly agree	disagree
9	strongly disagree	strongly disagree	strongly agree	disagree
10	strongly disagree	strongly disagree	strongly agree	disagree
11	strongly disagree	strongly disagree	strongly agree	disagree
12	strongly disagree	strongly disagree	strongly agree	disagree
13	strongly disagree	strongly disagree	strongly agree	disagree
14	strongly disagree	strongly disagree	strongly agree	disagree
15	strongly disagree	strongly disagree	strongly agree	disagree
16	strongly disagree	strongly disagree	strongly agree	disagree
17	strongly disagree	strongly disagree	strongly agree	disagree
18	strongly disagree	strongly disagree	strongly agree	disagree
19	disagree	disagree	strongly agree	disagree
20	disagree	strongly disagree	strongly agree	agree
21	strongly disagree	disagree	strongly agree	agree
22	strongly disagree	disagree	strongly agree	agree
23	strongly disagree	disagree	strongly agree	strongly agree
24	strongly disagree	strongly disagree	agree	agree
25	strongly disagree	disagree	strongly agree	agree
26	strongly disagree	disagree	strongly agree	agree
27	strongly disagree	disagree	strongly agree	agree
28	strongly disagree	disagree	strongly agree	agree
29	strongly disagree	disagree	strongly agree	agree
30	strongly disagree	strongly disagree	agree	strongly agree
31	disagree	disagree	agree	agree
32	strongly disagree	strongly disagree	strongly agree	agree
33	no opinion	no opinion	agree	agree
34	strongly disagree	strongly disagree	strongly agree	agree
35	disagree	strongly disagree	strongly agree	agree
36	strongly disagree	disagree	strongly agree	no opinion

Q	**Building Codes exist**	**Citizens have a responsibility**	**Preparedness Gov. duty**	**Buildings built better**
1	strongly agree	strongly disagree	agree	strongly agree
2	strongly disagree	agree	disagree	agree
3	disagree	disagree	agree	agree
4	disagree	disagree	agree	agree
5	disagree	disagree	agree	agree
6	disagree	disagree	agree	agree
7	disagree	strongly agree	disagree	no opinion
8	disagree	disagree	agree	agree
9	disagree	disagree	agree	agree
10	disagree	disagree	agree	agree
11	disagree	disagree	agree	agree
12	disagree	disagree	agree	agree
13	disagree	disagree	agree	agree
14	disagree	disagree	agree	agree
15	disagree	disagree	agree	agree
16	disagree	disagree	agree	agree
17	disagree	disagree	agree	agree
18	disagree	disagree	agree	agree
19	no opinion	no opinion	strongly disagree	no opinion
20	disagree	agree	strongly agree	agree
21	agree	agree	strongly agree	agree
22	agree	agree	strongly agree	agree
23	no opinion	no opinion	agree	no opinion
24	no opinion	no opinion	agree	no opinion
25	agree	disagree	strongly agree	agree
26	agree	agree	strongly agree	agree
27	agree	agree	strongly agree	agree
28	agree	agree	strongly agree	agree
29	agree	agree	strongly agree	agree
30	strongly agree	agree	strongly disagree	strongly agree
31	disagree	agree	strongly disagree	agree
32	no opinion	strongly agree	no opinion	strongly agree
33	agree	agree	strongly agree	strongly agree
34	strongly disagree	agree	strongly disagree	strongly agree
35	no opinion	agree	disagree	agree
36	strongly disagree	strongly disagree	strongly agree	strongly agree

Q	**Preparedness against faith**	**EQ. safety not Com. priorities**	**EQ. safety not Gov. Priorities**
1	disagree	strongly disagree	disagree
2	strongly disagree	agree	agree
3	no opinion	disagree	no opinion
4	no opinion	disagree	no opinion
5	no opinion	disagree	no opinion
6	no opinion	disagree	no opinion
7	no opinion	agree	disagree
8	no opinion	disagree	no opinion
9	no opinion	disagree	no opinion
10	no opinion	disagree	no opinion
11	no opinion	disagree	no opinion
12	no opinion	disagree	no opinion
13	no opinion	disagree	no opinion
14	no opinion	disagree	no opinion
15	no opinion	disagree	no opinion
16	no opinion	disagree	no opinion
17	no opinion	disagree	no opinion
18	no opinion	disagree	no opinion
19	disagree	disagree	agree
20	no opinion	disagree	strongly disagree
21	no opinion	disagree	strongly disagree
22	no opinion	disagree	strongly disagree
23	agree	strongly disagree	agree
24	disagree	strongly disagree	agree
25	no opinion	disagree	agree
26	no opinion	disagree	strongly disagree
27	no opinion	disagree	strongly disagree
28	no opinion	disagree	strongly disagree
29	no opinion	disagree	strongly disagree
30	strongly disagree	strongly disagree	strongly disagree
31	disagree	disagree	disagree
32	strongly disagree	disagree	strongly disagree
33	no opinion	disagree	disagree
34	strongly agree	disagree	strongly disagree
35	strongly disagree	strongly agree	strongly agree
36	strongly disagree	strongly agree	strongly agree

Q	Addres	Y-Live	Age	Sex	Edu	Income	Felt EQ.	# EQ. felt	When last EQ.
37	N-Marj	16-20	21-30	F	Colg	50>	Yes	2	1-12M
38	N-Marj	>21	51-60	M	M-H	250<	Yes	4mor	1-12M
39	N-Marj	>21	21-30	M	M-H	50 - 125	Yes	1	1-12M
40	N-Marj	>21	41-50	M	Colg	250<	Yes	2	20mor
41	N-Marj	>21	41-50	M	M-H	250<	Yes	2	1-12M
42	N-Marj	16-20	41-50	M	M-H	125 - 250	Yes	2	1-12M
43	N-Marj	>21	61mor	M	M-H	50 - 125	Yes	4mor	1-12M
44	N-Marj	11-15	41-50	M	M-H	125 - 250	Yes	4mor	1-12M
45	N-Marj	>21	41-50	M	Mstr	250<	Yes	2	1-12M
46	N-Marj	>21	61mor	M	Colg	50 - 125	Yes	3	1-10Y
47	N-Marj	>21	61mor	M	Colg	50 - 125	Yes	3	1-10Y
48	N-Marj	16-20	61mor	M	Colg	250<	Yes	4mor	1-12M
49	N-Marj	11-15	31-40	F	Colg	50 - 125	No	0	0
50	Farm	>21	31-40	M	M-H	125 - 250	No	0	0
51	N-Marj	11-15	31-40	F	Colg	125 - 250	No	0	0
52	N-Marj	6-10	31-40	F	Mstr	250<	Yes	3	1-10Y
53	N-Marj	>21	31-40	M	Colg	125 - 250	Yes	3	1-10Y
54	N-Marj	11-15	31-40	F	Colg	125 - 250	No	0	0
55	Farm	>21	31-40	M	Colg	125 - 250	Yes	2	1-10Y
56	N-Marj	>21	31-40	M	Colg	125 - 250	No	0	0
57	N-Marj	16-20	31-40	M	Colg	50 - 125	No	0	0
58	N-Marj	11-15	31-40	M	Colg	125 - 250	No	0	0
59	N-Marj	16-20	21-30	F	Colg	50>	No	0	0
60	O-Marj	1-5	21-30	M	Colg	50 - 125	Yes	2	1-10Y
61	Farm	16to20	41-50	M	M-H	50 - 125	No	0	0
62	N-Marj	>21	31-40	F	Colg	125 - 250	Yes	3	1-10Y
63	O-Marj	1-5	21-30	M	Colg	50 - 125	Yes	2	1-10Y
64	N-Marj	>21	31-40	M	Colg	125 - 250	Yes	3	1-10Y
65	N-Marj	6-10	21-30	M	Colg	125 - 250	No	0	0
66	N-Marj	16-20	31-40	F	Colg	125 - 250	Yes	0	0
67	N-Marj	>21	21-30	M	Colg	50>	No	0	0
68	Farm	6-10	21-30	F	Colg	125 - 250	No	0	0
69	Farm	11-15	31-40	M	Colg	125 - 250	No	0	0
70	N-Marj	16-20	31-40	F	Colg	50>	Yes	2	1-10Y
71	N-Marj	6-10	21-30	F	Colg	50 - 125	No	0	0
72	N-Marj	1-5	21-30	F	Colg	50>	No	0	0
73	Farm	21mor	31-40	M	M-H	50 - 125	No	0	0

Q	**What Did**	**Will EQ.**	**When next EQ.**	**Why EQ. happen**	**Dange rous in**	**Safer place**	**Aware E. S.**
37	Nothing	I don't know	God know	I don't know	O-Marj	Halway	No
38	Other	I don't know	God know	Allah punish	O-Marj	U-table	No
39	Nothing	I don't know	God know	Allah punish	O-Marj	Othr	No
40	Other	I don't know	God know	tectonic slip	N-Marj	Cornr	No
41	Nothing	I don't know	God know	tectonic slip	O-Marj	Othr	No
42	Pray	Yes	God know	I don't know	O-Marj	1st Flr	No
43	Cover	Yes	God know	tectonic slip	O-Marj	1nd Flr	No
44	Cover	Yes	God know	I don't know	O-Marj	Cornr	No
45	Pray	I don't know	God know	tectonic slip	O-Marj	Cornr	No
46	Cover	I don't know	God know	Other	O-Marj	1st Flr	No
47	Cover	I don't know	God know	Other	N-Marj	Cornr	No
48	Pray	I don't know	God know	Allah test	O-Marj	Cornr	No
49	0	0	God know	Allah test	O-Marj	Halway	No
50	0	0	God know	Allah test	O-Marj	Halway	No
51	0	0	God know	Allah test	O-Marj	1st Flr	No
52	Nothing	I don't know	God know	Other	O-Marj	Halway	No
53	Nothing	I don't know	God know	I don't know	O-Marj	Halway	No
54	0	0	God know	I don't know	O-Marj	Halway	No
55	Nothing	I don't know	God know	I don't know	O-Marj	Halway	No
56	0	0	God know	I don't know	O-Marj	Halway	No
57	0	0	God know	I don't know	O-Marj	1st Flr	No
58	0	0	God know	I don't know	O-Marj	Halway	No
59	0	0	God know	I don't know	O-Marj	Halway	No
60	Nothing	I don't know	God know	I don't know	O-Marj	Halway	No
61	0	0	God know	Allah punish	O-Marj	1st Flr	No
62	Nothing	I don't know	God know	I don't know	O-Marj	Othr	No
63	Nothing	I don't know	God know	Allah test	O-Marj	Halway	No
64	Nothing	I don't know	God know	Other	O-Marj	Halway	No
65	0	0	God know	tectonic slip	O-Marj	1st Flr	No
66	Nothing	I don't know	God know	tectonic slip	O-Marj	Cornr	No
67	0	0	God know	Allah test	O-Marj	Halway	No
68	0	0	God know	tectonic slip	O-Marj	Othr	No
69	0	0	God know	tectonic slip	O-Marj	Halway	No
70	Nothing	I don't know	God know	I don't know	O-Marj	Cornr	No
71	0	0	God know	Allah test	O-Marj	Halway	No
72	0	0	God know	tectonic slip	O-Marj	Halway	No
73	0	0	God know	Allah punish	O-Marj	Halway	No

Q	Building Type	Own House	know EQ.	Get information	Gov. is prepared	House is Safe
37	Re-Concrete	Family	Little	Net	strongly disagree	disagree
38	Concrete	I	Little	Net	strongly disagree	disagree
39	Concrete	Family	Some	Net	strongly disagree	no opinion
40	Concrete	Family	Some	Gov. brochure	strongly disagree	no opinion
41	Re-Concrete	I	Little	Net	strongly disagree	disagree
42	Re-Concrete	I	Nothing	TV	strongly disagree	disagree
43	Re-Concrete	I	Little	TV	no opinion	no opinion
44	Concrete	Family	Nothing	TV	strongly disagree	no opinion
45	Concrete	I	Some	TV	no opinion	strongly disagree
46	Re-Concrete	I	Little	Other	strongly disagree	strongly agree
47	Re-Concrete	I	Some	TV	strongly disagree	agree
48	Re-Concrete	I	Some	Radio	strongly disagree	agree
49	Concrete	Family	Some	TV	no opinion	no opinion
50	Concrete	Gov.	Some	TV	strongly disagree	no opinion
51	Re-Concrete	Family	Little	Radio	strongly disagree	agree
52	Concrete	Family	Much	Net	strongly disagree	disagree
53	Concrete	Family	Little	TV	disagree	disagree
54	Concrete	Family	Little	Radio	no opinion	no opinion
55	Concrete	Family	Little	TV	no opinion	no opinion
56	Concrete	Family	Little	TV	disagree	disagree
57	Re-Concrete	Family	Little	TV	strongly disagree	disagree
58	Concrete	Family	Nothing	Other	strongly disagree	no opinion
59	Other	Family	Little	TV	disagree	disagree
60	Adobe brick	Gov.	Some	TV	disagree	disagree
61	Concrete	Family	Little	TV	disagree	disagree
62	Concrete	Family	Little	TV	strongly disagree	no opinion
63	Adobe brick	Landlord	Some	TV	strongly disagree	strongly disagree
64	Concrete	Family	Little	TV	strongly disagree	no opinion
65	Concrete	Family	Some	Net	strongly disagree	no opinion
66	Concrete	Family	Some	TV	strongly disagree	no opinion
67	Concrete	Family	Little	Net	strongly disagree	no opinion
68	Concrete	Family	Little	TV	strongly disagree	agree
69	Concrete	Family	Little	TV	strongly disagree	agree
70	Re-Concrete	Family	Some	TV	strongly disagree	no opinion
71	Re-Concrete	Family	Some	Net	strongly disagree	no opinion
72	Concrete	Family	Some	Net	strongly disagree	no opinion
73	Concrete	Family	Little	TV	strongly disagree	Agree

Q	Neighborhood Safe	Frightened	I am prepared	EQ. threat
37	strongly disagree	agree	disagree	agree
38	strongly disagree	disagree	disagree	agree
39	strongly disagree	agree	strongly disagree	agree
40	agree	no opinion	disagree	agree
41	strongly disagree	agree	strongly disagree	agree
42	strongly disagree		strongly disagree	agree
43	no opinion	no opinion	no opinion	no opinion
44	no opinion	strongly agree	strongly disagree	no opinion
45	disagree	disagree	strongly disagree	agree
46	strongly agree	no opinion	disagree	strongly disagree
47	strongly disagree	strongly disagree	agree	strongly agree
48	agree	no opinion	no opinion	strongly disagree
49	no opinion	agree	disagree	agree
50	no opinion	no opinion	no opinion	strongly agree
51	disagree	disagree	agree	strongly agree
52	disagree	no opinion	disagree	strongly agree
53	no opinion	no opinion	no opinion	agree
54	agree	agree	agree	agree
55	no opinion	no opinion	disagree	agree
56	no opinion	agree	agree	no opinion
57	disagree	no opinion	disagree	agree
58	no opinion	no opinion	disagree	disagree
59	disagree	agree	disagree	strongly agree
60	disagree		disagree	agree
61	disagree	no opinion	disagree	agree
62	no opinion	agree	disagree	strongly agree
63	strongly disagree	strongly disagree	strongly disagree	strongly agree
64	disagree	no opinion	disagree	strongly agree
65	disagree	no opinion	no opinion	strongly agree
66	no opinion	agree	disagree	strongly agree
67	disagree	no opinion	no opinion	strongly agree
68	no opinion	no opinion	no opinion	strongly agree
69	no opinion	no opinion	no opinion	strongly agree
70	disagree	agree	disagree	strongly agree
71	disagree	agree	disagree	strongly agree
72	strongly disagree	strongly disagree	agree	strongly agree
73	strongly disagree	agree	no opinion	agree

Q	**Laws safety exist**	**City is prepared**	**Education Role**	**Preventive measures Role**
37	strongly disagree	strongly disagree	strongly agree	strongly agree
38	no opinion	disagree	agree	no opinion
39	strongly disagree	disagree	agree	agree
40	no opinion	no opinion	no opinion	strongly agree
41	strongly disagree	strongly disagree	agree	agree
42	strongly disagree	strongly disagree	agree	agree
43	no opinion	no opinion	no opinion	no opinion
44	disagree	no opinion	no opinion	disagree
45	strongly disagree	strongly disagree	strongly agree	strongly agree
46	no opinion	no opinion	agree	strongly agree
47	strongly disagree	strongly disagree	no opinion	agree
48	strongly disagree	disagree	strongly agree	strongly agree
49	disagree	no opinion	agree	disagree
50	strongly disagree	disagree	agree	agree
51	strongly disagree	strongly disagree	agree	agree
52	strongly disagree	strongly disagree	agree	agree
53	disagree	agree	agree	disagree
54	strongly disagree	strongly disagree	agree	disagree
55	disagree	disagree	agree	disagree
56	disagree	disagree	agree	disagree
57	disagree	disagree	agree	agree
58	disagree	agree	agree	disagree
59	strongly disagree	strongly disagree	agree	agree
60	strongly disagree	strongly disagree	agree	disagree
61	disagree	strongly disagree	agree	disagree
62	no opinion	strongly disagree	strongly agree	strongly agree
63	strongly disagree	strongly disagree	strongly agree	agree
64	strongly disagree	strongly disagree	agree	agree
65	strongly disagree	strongly disagree	agree	agree
66	strongly disagree	strongly disagree	agree	agree
67	strongly disagree	strongly disagree	agree	agree
68	strongly disagree	strongly disagree	agree	strongly disagree
69	strongly disagree	strongly agree	strongly agree	strongly agree
70	strongly disagree	strongly disagree	agree	agree
71	strongly disagree	strongly disagree	agree	agree
72	strongly disagree	strongly disagree	agree	agree
73	strongly disagree	strongly disagree	agree	agree

Q	**Building Codes exist**	**Citizens have a responsibility**	**Preparedness Gov. duty**	**Buildings built better**
37	strongly disagree	strongly disagree	disagree	strongly agree
38	no opinion	agree	disagree	agree
39	no opinion	agree	disagree	agree
40	no opinion	no opinion	strongly agree	strongly agree
41	no opinion	strongly agree	agree	strongly agree
42	strongly disagree	strongly disagree	agree	agree
43	no opinion	no opinion	no opinion	no opinion
44	no opinion	strongly disagree	strongly disagree	agree
45	strongly agree	agree	strongly disagree	agree
46	no opinion	strongly agree	strongly disagree	strongly agree
47	strongly disagree	no opinion	strongly disagree	agree
48	no opinion	agree	strongly disagree	strongly agree
49	no opinion	agree	no opinion	no opinion
50	strongly disagree	agree	disagree	strongly agree
51	strongly disagree	agree	disagree	agree
52	strongly disagree	agree	disagree	agree
53	strongly disagree	agree	disagree	agree
54	disagree	agree	disagree	no opinion
55	disagree	disagree	disagree	agree
56	disagree	agree	disagree	no opinion
57	disagree	agree	disagree	agree
58	disagree	agree	disagree	agree
59	strongly disagree	agree	no opinion	no opinion
60	strongly disagree	no opinion	agree	no opinion
61	strongly disagree	agree	disagree	no opinion
62	strongly disagree	agree	disagree	agree
63	strongly disagree	agree	disagree	agree
64	strongly disagree	agree	disagree	agree
65	strongly disagree	agree	disagree	agree
66	strongly disagree	agree	disagree	agree
67	strongly disagree	agree	disagree	agree
68	strongly disagree	agree	disagree	no opinion
69	strongly disagree	strongly agree	disagree	no opinion
70	agree	disagree	agree	no opinion
71	disagree	disagree	disagree	agree
72	strongly disagree	strongly disagree	agree	agree
73	strongly disagree	strongly disagree	agree	agree

Q	**Preparedness against faith**	**EQ. safety not Com. priorities**	**EQ. safety not Gov. Priorities**
37	strongly disagree	agree	disagree
38	strongly disagree	strongly agree	strongly agree
39	strongly disagree	agree	strongly agree
40	strongly agree	strongly disagree	strongly disagree
41	strongly disagree	disagree	strongly disagree
42	strongly disagree	strongly disagree	strongly disagree
43	no opinion	no opinion	no opinion
44	no opinion	strongly agree	strongly agree
45	disagree	agree	agree
46	strongly agree	strongly disagree	no opinion
47	no opinion	strongly disagree	strongly disagree
48	agree	agree	agree
49	no opinion	no opinion	no opinion
50	no opinion	strongly agree	strongly agree
51	no opinion	agree	agree
52	no opinion	agree	strongly agree
53	no opinion	agree	agree
54	no opinion	strongly agree	agree
55	no opinion	no opinion	agree
56	no opinion	no opinion	no opinion
57	disagree	agree	agree
58	no opinion	strongly agree	strongly agree
59	no opinion	agree	agree
60	no opinion	no opinion	no opinion
61	no opinion	no opinion	no opinion
62	disagree	agree	agree
63	no opinion	agree	strongly agree
64	no opinion	agree	agree
65	no opinion	agree	strongly agree
66	no opinion	strongly agree	agree
67	no opinion	agree	agree
68	no opinion	agree	agree
69	no opinion	strongly agree	strongly agree
70	no opinion	agree	agree
71	no opinion	strongly agree	strongly agree
72	no opinion	agree	strongly agree
73	no opinion	strongly agree	strongly agree

Q	**Addrs**	**Y-Live**	**Age**	**Sex**	**Edu**	**Income**	**Felt EQ.**	**# EQ. felt**	**When last EQ.**
74	N-Marj	16-20	41-50	M	M-H	125 - 250	Yes	2	1-10Y
75	O-Marj	6-10	15-20	F	M-H	50>	No	2	1-10Y
76	N-Marj	>21	51-60	M	Colg	125 - 250	Yes	2	1-10Y
77	N-Marj	>21	51-60	M	M-H	125 - 250	Yes	3	1-10Y
78	N-Marj	16-20	21-30	F	Colg	125 - 250	No	0	0
79	Farm	16-20	31-40	M	M-H	125 - 250	No	0	0
80	N-Marj	>21	41-50	M	Colg	125 - 250	Yes	2	1-10Y
81	N-Marj	16-20	31-40	F	Colg	125 - 250	No	0	0
82	N-Marj	>21	41-50	M	Mstr	250<	Yes	3	1-10Y
83	O-Marj	6t-10	21-30	F	Colg	125 - 250	Yes	3	1-10Y
84	Farm	16-20	51-60	M	M-H	50 - 125	No	0	0
85	N-Marj	6-10	41-50	M	Colg	125 - 250	No	0	0
86	N-Marj	6-10	41-50	F	M-H	50 - 125	No	0	0
87	N-Marj	>21	>61	M	M-H	125 - 250	Yes	3	1-10Y
88	O-Marj	11-15	41-50	M	Elm	50 - 125	Yes	4mor	1-10Y
89	Farm	11-15	21-30	M	M-H	50 - 125	No	0	0
90	N-Marj	16-20	51-60	M	M-H	125 - 250	Yes	1	1-10Y
91	N-Marj	21mor	31-40	F	Colg	125 - 250	No	0	0
92	Farm	11to15	41-50	F	Colg	125 - 250	No	0	0
93	O-Marj	6to10	41-50	M	Elm	50 - 125	Yes	3	1-10Y
94	N-Marj	21mor	>61	M	M-H	125 - 250	Yes	4mor	1-10Y
95	Farm	11-15	15-20	F	M-H	50 - 125	No	0	0
96	N-Marj	>21	41-50	M	Colg	125 - 250	Yes	3	1-10Y
97	N-Marj	>21	21-30	F	M-H	50>	Yes	4mor	1-12M
98	N-Marj	16-20	15-20	F	Colg	50>	Yes	4mor	1-10Y
99	N-Marj	>21	21-30	M	Colg	50>	Yes	4mor	1-10Y
100	O-Marj	11-15	15-20	M	M-H	50>	Yes	1	1-10Y
101	N-Marj	>21	21-30	M	Colg	50>	Yes	4mor	1-12M
102	N-Marj	>21	21-30	M	Colg	50>	Yes	4mor	1-12M
103	N-Marj	>21	21-30	F	Colg	50 - 125	Yes	3	1-10Y
104	Farm	1-5	21-30	M	Colg	125 - 250	Yes	1	1-10Y
105	Farm	>21	15-20	F	Colg	125 - 250	Yes	4mor	1-10Y
106	O-Marj	>21	41-50	M	Colg	50 - 125	Yes	3	11-20Y
107	N-Marj	>21	41-50	F	Colg	50 - 125	Yes	4mor	1-12M
108	N-Marj	>21	21-30	F	M-H	50 - 125	Yes	4mor	1-12M
109	N-Marj	16-20	15-20	F	Colg	50 - 125	Yes	3	1-10Y
110	N-Marj	16-20	15-20	F	Colg	50>	Yes	2	1-12M

Q	**What Did**	**Will EQ.**	**When next EQ.**	**Why EQ. happen**	**Dangerous in**	**Safer place**	**Aware E. S.**
74	Nothing	I don't know	God know	Other	O-Marj	1st Flr	No
75	Scream	I don't know	God know	Allah test	O-Marj	Halway	No
76	Nothing	I don't know	God know	tectonic slip	O-Marj	Halway	No
77	Other	I don't know	God know	Other	O-Marj	1st Flr	No
78	0	0	God know	tectonic slip	O-Marj	1st Flr	No
79	0	0	God know	Allah test	O-Marj	1st Flr	No
80	Nothing	I don't know	God know	tectonic slip	O-Marj	1st Flr	No
81	0		God know	tectonic slip	O-Marj	1st Flr	No
82	Nothing	I don't know	God know	tectonic slip	O-Marj	Cornr	No
83	Scream	I don't know	God know	Allah test	O-Marj	U-table	No
84	0	0	God know	Allah punish	O-Marj	Halway	No
85	0	0	God know	tectonic slip	O-Marj	Halway	No
86	0	0	God know	I don't know	Farm	Othr	No
87	Nothing	I don't know	God know	Allah test	O-Marj	1st Flr	No
88	Nothing	I don't know	God know	Allah test	O-Marj	Cornr	No
89	0		God know	Allah punish	O-Marj	Othr	No
90	Nothing	I don't know	God know	Allah test	O-Marj	1st Flr	No
91	0	0	God know	I don't know	O-Marj	Halway	No
92	0	0	God know	tectonic slip	O-Marj	U-table	No
93	Nothing	I don't know	God know	I don't know	O-Marj	Cornr	No
94	Nothing	I don't know	God know	I don't know	O-Marj	Halway	No
95	0	0	God know	I don't know	O-Marj	Halway	No
96	Nothing	I don't know	God know	I don't know	O-Marj	U-table	No
97	Other	Yes	God know	Allah punish	O-Marj	U-table	Yes
98	Pray	I don't know	God know	Allah test	O-Marj	Cornr	Yes
99	Pray	Yes	God know	tectonic slip	O-Marj	Halway	No
100	Nothing	I don't know	Years	Allah test	O-Marj	Halway	Yes
101	Nothing	Yes	God know	tectonic slip	O-Marj	Cornr	No
102	Other	Yes	God know	tectonic slip	O-Marj	Halway	No
103	Pray	I don't know	God know	Allah test	O-Marj	Cornr	Yes
104	Nothing	I don't know	God know	Allah test	O-Marj	Cornr	No
105	Nothing	I don't know	God know	Allah punish	N-Marj	Cornr	No
106	Cover	I don't know	God know	I don't know	O-Marj	1st Flr	No
107	Pray	I don't know	God know	I don't know	O-Marj	Cornr	No
108	Scream	No	God know	Allah punish	O-Marj	Cornr	No
109	Scream	Yes	God know	tectonic slip	O-Marj		Yes
110	Nothing	I don't know	God know	Allah test	O-Marj	1st Flr	No

Q	Building Type	Own House	know EQ.	Get info	Gov. is prepared	House is Safe
74	Other	Family	Some	TV	strongly disagree	strongly disagree
75	Adobe brick	Family	Little	TV	strongly disagree	strongly disagree
76	Concrete	Family	Little	TV	strongly disagree	no opinion
77	Re-Concrete	I	Little	Radio	strongly disagree	no opinion
78	Re-Concrete	Family	Some	Radio	strongly disagree	no opinion
79	Re-Concrete	Family	Nothing	people	no opinion	agree
80	Re-Concrete	Family	Nothing	Net	strongly disagree	agree
81		Family	Little	people	strongly disagree	no opinion
82	Re-Concrete	I	Some	Net	strongly disagree	no opinion
83	Adobe brick	Gov.	Some	Radio	disagree	strongly disagree
84	Concrete	Family	Nothing	Radio	strongly disagree	agree
85	Re-Concrete	Family	Little	Radio	disagree	no opinion
86	Concrete	Family	Nothing	people	no opinion	agree
87	Re-Concrete	I	Little	Radio	disagree	agree
88	Clay	Gov.	Nothing	people	strongly disagree	strongly disagree
89	Re-Concrete	Family	Nothing	people	disagree	agree
90	Re-Concrete	I	Little	Radio	strongly disagree	no opinion
91	Re-Concrete	Family	Some	Radio	strongly disagree	agree
92	Re-Concrete	Family	Some	Net	strongly disagree	agree
93	Clay	Landlord	Nothing	Radio	no opinion	strongly disagree
94	Re-Concrete	I	Some	TV	strongly disagree	agree
95	Concrete	Gov.	Nothing	TV	strongly disagree	no opinion
96	Re-Concrete	Family	Little	Net	strongly disagree	agree
97	Concrete	Family	Some	Net	strongly disagree	strongly disagree
98	Concrete	Family	Some	Since Paper	strongly disagree	no opinion
99	Re-Concrete	I	Much	TV	strongly disagree	disagree
100	Clay	Landlord	Some	TV	disagree	disagree
101	Re-Concrete	Family	Much	Since Paper	strongly disagree	disagree
102	Re-Concrete	I	Much	Since Paper	strongly disagree	disagree
103	Concrete	Family	Some	Net	agree	strongly disagree
104	Re-Concrete	Family	Little	TV	no opinion	disagree
105	Re-Concrete	Family	Little	TV	disagree	strongly disagree
106	Concrete	Family	Some	Since Paper	disagree	strongly disagree
107	Concrete	Family	Little	Religious/B	no opinion	disagree
108	Concrete	Family	Little	Since Paper	disagree	disagree
109	Concrete	Family	Little	people	strongly disagree	strongly disagree
110	Re-Concrete	Family	Nothing	Net	no opinion	agree

Q	Neighborhood Safe	Frightened	I am prepared	EQ. threat
74	strongly disagree	agree	strongly disagree	strongly agree
75	strongly disagree	strongly agree	strongly disagree	strongly agree
76	disagree	no opinion	no opinion	strongly agree
77	disagree	agree	disagree	strongly agree
78	disagree	agree	no opinion	strongly agree
79	no opinion	no opinion	no opinion	strongly agree
80	no opinion	agree	no opinion	strongly agree
81	no opinion	agree	no opinion	strongly agree
82	disagree	no opinion	no opinion	strongly agree
83	strongly disagree	strongly agree	strongly agree	strongly disagree
84	no opinion	no opinion	no opinion	agree
85	strongly disagree	no opinion	no opinion	strongly disagree
86	no opinion	agree	no opinion	agree
87	disagree	no opinion	no opinion	strongly agree
88	strongly disagree	strongly agree	strongly agree	strongly agree
89	agree	no opinion	no opinion	strongly agree
90	no opinion	no opinion		agree
91	disagree	no opinion	no opinion	agree
92	agree	no opinion	strongly agree	strongly disagree
93	strongly disagree	strongly agree	agree	strongly disagree
94	disagree	agree	disagree	strongly agree
95	strongly disagree	strongly agree	strongly disagree	strongly agree
96	strongly disagree	agree	disagree	agree
97	strongly disagree	no opinion	strongly disagree	agree
98	no opinion	disagree	disagree	agree
99	disagree	disagree	disagree	disagree
100	no opinion	no opinion	agree	strongly disagree
101	disagree	disagree	no opinion	disagree
102	disagree	disagree	disagree	disagree
103	strongly disagree	agree	disagree	agree
104	no opinion	agree	no opinion	strongly agree
105	disagree	agree	strongly disagree	disagree
106	disagree	strongly agree	disagree	agree
107	strongly agree	agree	disagree	agree
108	strongly disagree	agree	strongly disagree	agree
109	disagree	strongly agree	agree	agree
110	agree	agree	agree	strongly agree

Q	**Laws safety exist**	**City is prepared**	**Education Role**	**Preventive measures Role**
74	strongly disagree	strongly disagree	agree	agree
75	strongly disagree	strongly disagree	strongly agree	strongly agree
76	strongly disagree	strongly disagree	agree	agree
77	disagree	disagree	agree	agree
78	no opinion	disagree	agree	agree
79	disagree	disagree	agree	agree
80	strongly disagree	strongly disagree	agree	agree
81	strongly disagree	strongly disagree	agree	agree
82	strongly disagree	strongly disagree	strongly agree	disagree
83	strongly agree	agree	disagree	agree
84	disagree	disagree	agree	agree
85	strongly agree	strongly agree	disagree	disagree
86	no opinion	no opinion	agree	agree
87	strongly disagree	disagree	agree	agree
88	strongly disagree	strongly disagree	strongly agree	strongly agree
89	disagree	disagree	agree	disagree
90	disagree	strongly disagree	agree	agree
91	disagree	disagree	agree	agree
92	strongly agree	strongly agree	strongly agree	no opinion
93	no opinion	agree	strongly agree	strongly disagree
94	disagree	strongly disagree	strongly agree	agree
95	agree	strongly disagree	strongly agree	agree
96	strongly disagree	strongly disagree	strongly agree	strongly agree
97	strongly disagree	strongly disagree	agree	agree
98	strongly disagree	strongly disagree	agree	agree
99	disagree	disagree	no opinion	disagree
100	strongly disagree	disagree	strongly agree	disagree
101	disagree	disagree	strongly agree	disagree
102	disagree	disagree	strongly agree	disagree
103	agree	agree	strongly agree	strongly agree
104	no opinion	no opinion	agree	agree
105	strongly disagree	disagree	disagree	disagree
106	disagree	disagree	strongly agree	strongly agree
107	agree	disagree	agree	agree
108	strongly disagree	disagree	strongly agree	agree
109	agree	agree	agree	strongly agree
110	no opinion	no opinion	strongly agree	agree

Q	**Building Codes exist**	**Citizens have a responsibility**	**Preparedness Gov. duty**	**Buildings built better**
74	strongly disagree	agree	strongly disagree	agree
75	strongly disagree	strongly agree	strongly disagree	agree
76	strongly disagree	agree	disagree	agree
77	disagree	agree	disagree	agree
78	disagree	disagree	no opinion	agree
79	disagree	agree	disagree	agree
80	strongly disagree	agree	disagree	agree
81	strongly disagree	agree	disagree	agree
82		agree	disagree	agree
83	strongly agree	no opinion	disagree	agree
84	disagree	disagree	agree	no opinion
85	strongly agree	agree	agree	agree
86	no opinion	agree	disagree	agree
87	disagree	agree	disagree	agree
88	strongly disagree	strongly agree	strongly agree	agree
89	disagree	agree	agree	agree
90		agree	agree	agree
91	disagree	agree	strongly agree	agree
92	agree	strongly agree	agree	no opinion
93	strongly disagree	agree	strongly agree	no opinion
94	disagree	agree	strongly agree	agree
95	strongly disagree	agree	strongly agree	agree
96	disagree	strongly agree	disagree	agree
97	strongly disagree	agree	strongly disagree	strongly disagree
98	strongly disagree	strongly disagree	strongly agree	strongly agree
99	strongly agree	no opinion	strongly agree	strongly agree
100	strongly disagree	strongly disagree	strongly disagree	strongly disagree
101	strongly agree	strongly agree	strongly agree	disagree
102	strongly agree	strongly agree	strongly agree	disagree
103	disagree	strongly agree	agree	agree
104	no opinion	agree	disagree	agree
105	disagree	agree	agree	strongly disagree
106	disagree	no opinion	agree	agree
107	strongly disagree	agree	agree	agree
108	disagree	disagree	agree	agree
109	disagree	no opinion	strongly agree	disagree
110	agree	agree	strongly agree	disagree

Q	**Preparedness against faith**	**EQ. safety not Com. priorities**	**EQ. safety not Gov. Priorities**
74	no opinion	agree	agree
75	no opinion	agree	agree
76	no opinion	agree	agree
77	no opinion	agree	agree
78	no opinion	agree	strongly agree
79	no opinion	agree	agree
80	no opinion	agree	agree
81	no opinion	strongly agree	strongly agree
82	no opinion	agree	strongly agree
83	no opinion	agree	strongly agree
84	agree	agree	agree
85	no opinion	agree	agree
86	no opinion	agree	agree
87	no opinion	agree	agree
88	no opinion	strongly agree	strongly agree
89	no opinion	strongly agree	strongly agree
90	no opinion	agree	strongly agree
91	no opinion	agree	strongly agree
92	no opinion	strongly agree	strongly agree
93	agree	agree	strongly agree
94	no opinion	agree	strongly agree
95	disagree	agree	strongly agree
96	no opinion	disagree	agree
97	strongly disagree	strongly disagree	strongly disagree
98	strongly disagree	agree	disagree
99	disagree	strongly agree	disagree
100	disagree	strongly disagree	disagree
101	disagree	strongly agree	disagree
102	disagree	strongly agree	disagree
103	disagree	disagree	disagree
104	strongly disagree	disagree	disagree
105	agree	disagree	disagree
106	strongly disagree	disagree	disagree
107	strongly disagree	strongly disagree	disagree
108	agree	disagree	disagree
109	strongly disagree	strongly disagree	disagree
110	agree	agree	no opinion

Q	**Addrs**	**Y-Live**	**Age**	**Sex**	**Edu**	**Income**	**Felt EQ.**	**# EQ. felt**	**When last EQ.**
111	Farm	1-5	15-20	F	Colg	50>	Yes	4mor	1-12M
112	Farm	>21	15-20	F	Colg	50 - 125	Yes	3	1-10Y
113	N-Marj	>21	15-20	F	Colg	50>	Yes	2	1-12M
114	N-Marj	1-5	15-20	F	Colg	50>	Yes	2	1-12M
115	N-Marj	1-5	15-20	F	Colg	50>	Yes	2	1-12M
116	N-Marj	16-20	15-20	F	Colg	50>	Yes	1	1-12M
117	O-Marj	16-20	21-30	F	Colg	250<	Yes	3	1-12M
118	O-Marj	>21	15-20	F	Colg	50>	Yes	4mor	1-10Y
119	N-Marj	16-20	15-20	F	Colg	50 - 125	Yes	2	1-12M
120	N-Marj	>21	21-30	M	Colg	50>	Yes	4mor	1-12M
121	O-Marj	16-20	21-30	F	Colg	50 - 125	No	0	0
122	N-Marj	16-20	21-30	M	Colg	125 - 250	Yes	1	1-10Y
123	Farm	1-5	15-20	F	Colg	50>	Yes	2	1-10Y
124	N-Marj	>21	21-30	M	Colg	125 - 250	No	0	0
125	Farm	>21	21-30	F	Colg	50>	Yes	3	1-12M
126	N-Marj	>21	21-30	M	Colg	50>	Yes	2	1-12M
127	N-Marj	>21	15-20	F	Colg	125 - 250	Yes	3	1-12M
128	N-Marj	>21	21-30	F	Colg	50>	Yes	2	1-12M
129	N-Marj	16-20	15-20	F	Colg	50>	Yes	4mor	1-10Y
130	N-Marj	16-20	15-20	F	Colg	50>	Yes	2	1-12M
131	N-Marj	>21	51-60	F	Colg	50>	Yes	4mor	1-12M
132	N-Marj	16-20	15-20	M	Colg	125 - 250	Yes	2	1-12M
133	N-Marj	16-20	15-20	M	Colg	50 - 125	No	0	0
134	N-Marj	16-20	21-30	M	Colg	50 - 125	No	0	0
135	N-Marj	11-15	15-20	F	Colg	50>	No	0	0
136	N-Marj	1to5	15-20	F	Colg	50 - 125	No	0	0
137	N-Marj	>21	15-20	M	Colg	250<	Yes	1	1-12M
138	N-Marj	16-20	15-20	F	Colg	50>	Yes	4mor	1-10Y
139	Farm	16-20	61mor	F	Colg	50>	Yes	2	1-12M
140	N-Marj	16-20	15-20	M	Colg	50 - 125	Yes	1	1-12M
141	Farm	1-5	15-20	M	Colg	50 - 125	Yes	2	1-10Y
142	N-Marj	16-20	15-20	M	Colg	50 - 125	Yes	2	1-10Y
143	N-Marj	16-20	15-20	M	Colg	50 - 125	Yes	2	1-12M
144	N-Marj	16-20	15-20	F	Colg	50>	Yes	1	1-12M
145	N-Marj	16-20	21-30	M	Colg	50 - 125	Yes	2	1-12M
146	N-Marj	>21	21-30	M	Colg	125 - 250	Yes	3	1-12M

Q	**What Did**	**Will EQ.**	**When next EQ.**	**Why EQ. happen**	**Dange rous in**	**Safer place**	**Aware E. S.**
111	Pray	I don't know	God know	I don't know	Farm	Cornr	No
112	Cover	I don't know	God know	I don't know	O-Marj	Cornr	No
113	Scream	I don't know	God know	I don't know	O-Marj	Halway	No
114	Scream	I don't know	God know	I don't know	O-Marj	Halway	No
115	Nothing	I don't know	God know	tectonic slip	N-Marj	Othr	No
116	Pray	I don't know	God know	tectonic slip	N-Marj	Othr	No
117	Scream	I don't know	God know	I don't know	O-Marj	Othr	No
118	Scream	I don't know	God know	tectonic slip	O-Marj	Cornr	No
119	Nothing	I don't know	God know	Allah test	Farm	Cornr	No
120	Nothing	Yes	God know	tectonic slip	O-Marj	Cornr	No
121	0	0	Months	I don't know	O-Marj	Cornr	No
122	Nothing	I don't know	God know	I don't know	O-Marj	Othr	No
123	Nothing	I don't know	God know	I don't know	O-Marj	Cornr	No
124	0	0	God know	tectonic slip	O-Marj	Halway	No
125	Nothing	Yes	God know	I don't know	Farm	Othr	No
126	Scream	I don't know	God know	I don't know	O-Marj	Cornr	No
127	Scream	I don't know	God know	I don't know	O-Marj	Cornr	No
128	Nothing	Yes	God know	Allah test	O-Marj	Othr	No
129	Nothing	I don't know	God know	I don't know	O-Marj	1st Flr	No
130	Nothing	I don't know	God know	I don't know	O-Marj	Cornr	No
131	Nothing	Yes	God know	I don't know	O-Marj	Cornr	No
132	Pray	I don't know	God know	tectonic slip	O-Marj	Cornr	No
133	0	0	God know	I don't know	O-Marj	U-table	No
134	0	0	God know	I don't know	O-Marj	Halway	No
135	0	0	God know	Allah test	O-Marj	Cornr	No
136	0	0	God know	I don't know	O-Marj	Othr	No
137	Nothing	I don't know	God know	tectonic slip	O-Marj	1st Flr	No
138	Nothing	I don't know	God know	tectonic slip	O-Marj	Othr	No
139	Nothing	I don't know	God know	I don't know	Farm	Cornr	No
140	Pray	Yes	God know	tectonic slip	O-Marj	Cornr	No
141	Nothing	I don't know	God know	I don't know	O-Marj	U-table	Yes
142	Cover	I don't know	God know	Allah test	O-Marj	Cornr	No
143	Pray	Yes	Years	I don't know	N-Marj	Halway	No
144	Nothing	I don't know	God know	I don't know	O-Marj	Othr	No
145	Pray	Yes	Months	I don't know	N-Marj	1st Flr	No
146	Nothing	I don't know	God know	tectonic slip	O-Marj	Halway	No

Q	**Building Type**	**Own House**	**know EQ.**	**Get information**	**Gov. is prepared**	**House is Safe**
111	Clay	Family	Nothing	Net	no opinion	disagree
112	Adobe brick	Family	Much	Net	strongly disagree	disagree
113	Re-Concrete	Family	Nothing	TV	strongly disagree	no opinion
114	Re-Concrete	Family	Nothing	Radio	strongly disagree	disagree
115	Re-Concrete	Family	Some	TV	disagree	disagree
116	Re-Concrete	Family	Some	TV	disagree	agree
117	Re-Concrete	Family	Much	Since Papers	strongly agree	disagree
118	Adobe brick	Family	Little	Net	strongly disagree	no opinion
119	Adobe brick	Family	Little	TV	strongly disagree	strongly disagree
120	Re-Concrete	I	Much	Since Paper	strongly disagree	disagree
121	Concrete	Family	Nothing	TV	strongly disagree	strongly disagree
122	Concrete	Family	Little	Gov. brochure	strongly disagree	disagree
123	Re-Concrete	Family	Little	Net	no opinion	no opinion
124	Re-Concrete	I	Some	Net	no opinion	no opinion
125	Adobe brick	Family	Nothing	people	strongly disagree	disagree
126	Re-Concrete	Family	Nothing	Net	disagree	disagree
127	Re-Concrete	Family	Little	Net	strongly disagree	disagree
128	Concrete	Family	Little	people	strongly disagree	disagree
129	Concrete	Family	Little	people	strongly disagree	agree
130	Adobe brick	Family	Some	TV	strongly disagree	agree
131	Concrete	Family	Little	Net	strongly disagree	strongly disagree
132	Re-Concrete	Family	Nothing	Net	strongly disagree	strongly disagree
133	Re-Concrete	Family	Little	TV	strongly disagree	disagree
134	Re-Concrete	I	Some	Since Paper	strongly agree	disagree
135	Re-Concrete	Family	Little	Net	strongly disagree	strongly disagree
136	Re-Concrete	Family	Nothing	people	agree	agree
137	Re-Concrete	Family	Nothing	TV	strongly disagree	strongly disagree
138	Re-Concrete	I	Nothing	people	no opinion	no opinion
139	Re-Concrete	Family	Little	Net	no opinion	no opinion
140	Re-Concrete	Family	Nothing	Net	agree	agree
141	Adobe brick	Family	Nothing	people	strongly disagree	strongly disagree
142	Concrete	Family	Nothing	people	strongly disagree	no opinion
143	Adobe brick	Family	Nothing	Net	strongly disagree	disagree
144	Re-Concrete	Family	Nothing	Net	no opinion	strongly disagree
145	Concrete	Landlord	Nothing	TV	disagree	disagree
146	Concrete	Family	Little	Net	strongly disagree	disagree

Q	**Neighborhood Safe**	**Frightened**	**I am prepared**	**EQ. threat**
111	no opinion	strongly agree	strongly disagree	disagree
112	disagree	strongly agree	agree	strongly agree
113	agree	agree	no opinion	disagree
114	disagree	disagree	disagree	disagree
115	agree	strongly agree	no opinion	no opinion
116	no opinion	disagree	no opinion	agree
117	strongly disagree	agree	agree	agree
118	no opinion	agree	disagree	agree
119	strongly disagree	strongly disagree	strongly disagree	no opinion
120	disagree	disagree		disagree
121	no opinion	agree	strongly disagree	agree
122	strongly disagree	agree	strongly disagree	no opinion
123	no opinion	no opinion	no opinion	no opinion
124	no opinion	no opinion	no opinion	no opinion
125	strongly disagree	strongly disagree	strongly disagree	strongly disagree
126	agree	disagree	strongly disagree	agree
127	strongly agree	agree	strongly agree	no opinion
128	disagree	no opinion	no opinion	agree
129	agree	strongly disagree	no opinion	agree
130	strongly agree	strongly agree	strongly disagree	agree
131	strongly disagree	no opinion	strongly disagree	agree
132	strongly disagree	strongly disagree	strongly disagree	strongly agree
133	disagree	no opinion	disagree	strongly disagree
134	disagree	agree	disagree	strongly agree
135	strongly disagree	no opinion	strongly disagree	agree
136	no opinion	agree	disagree	agree
137	strongly agree	no opinion	no opinion	agree
138	no opinion	no opinion	strongly agree	no opinion
139	no opinion	no opinion	no opinion	no opinion
140	agree	no opinion	strongly disagree	no opinion
141	strongly disagree	no opinion	no opinion	no opinion
142	disagree	no opinion	disagree	no opinion
143	no opinion	strongly disagree	no opinion	disagree
144	strongly disagree	agree	no opinion	strongly disagree
145	strongly disagree	strongly disagree	strongly agree	strongly disagree
146	disagree	strongly disagree	strongly agree	strongly disagree

Q	**Laws safety exist**	**City is prepared**	**Education Role**	**Preventive measures Role**
111	no opinion	disagree	no opinion	disagree
112	strongly disagree	strongly disagree	strongly disagree	strongly agree
113	disagree	strongly disagree	strongly disagree	disagree
114	disagree	no opinion	strongly disagree	disagree
115	disagree	no opinion	agree	no opinion
116	agree	strongly disagree	disagree	agree
117	strongly agree	strongly disagree	agree	agree
118	strongly disagree	strongly agree	no opinion	disagree
119	strongly agree	strongly disagree	strongly agree	strongly disagree
120	disagree	disagree	no opinion	disagree
121	strongly disagree	strongly disagree	agree	agree
122	strongly disagree	disagree	agree	agree
123	no opinion	no opinion	no opinion	no opinion
124	no opinion	no opinion	no opinion	no opinion
125	no opinion	disagree	no opinion	no opinion
126	strongly disagree	strongly disagree	agree	agree
127	no opinion	agree	agree	no opinion
128	strongly disagree	strongly disagree	strongly agree	strongly agree
129	strongly disagree	no opinion	strongly agree	strongly agree
130	strongly disagree	strongly disagree	strongly agree	strongly agree
131	strongly agree	strongly disagree	strongly disagree	strongly disagree
132	strongly disagree	no opinion	no opinion	strongly disagree
133	no opinion	strongly disagree	agree	strongly agree
134	no opinion	agree	strongly agree	strongly agree
135	strongly disagree	strongly disagree	agree	agree
136	disagree	disagree	strongly disagree	disagree
137	agree		agree	strongly disagree
138	strongly agree	no opinion	strongly agree	strongly agree
139	no opinion	no opinion	no opinion	no opinion
140	strongly agree	strongly agree	no opinion	no opinion
141	no opinion	no opinion	no opinion	no opinion
142	strongly disagree	no opinion	strongly disagree	no opinion
143	disagree	disagree	disagree	no opinion
144	strongly disagree	no opinion	no opinion	no opinion
145	disagree	disagree	strongly disagree	strongly disagree
146	strongly agree	strongly disagree	no opinion	strongly agree

Q	**Building Codes exist**	**Citizens have a responsibility**	**Preparedness Gov. duty**	**Buildings built better**
111	strongly disagree	no opinion	disagree	strongly disagree
112	strongly disagree	strongly agree	strongly agree	strongly disagree
113	disagree	strongly disagree	disagree	disagree
114	strongly disagree	strongly disagree	strongly disagree	disagree
115	no opinion	agree	strongly agree	agree
116	disagree	agree	disagree	no opinion
117	strongly agree	disagree	agree	disagree
118	agree	no opinion	strongly agree	no opinion
119	strongly agree	strongly agree	strongly agree	strongly disagree
120	strongly agree	no opinion	strongly agree	strongly agree
121	strongly disagree	agree	strongly disagree	strongly disagree
122	strongly disagree	strongly disagree	strongly disagree	agree
123	no opinion	no opinion	no opinion	no opinion
124	no opinion	no opinion	no opinion	no opinion
125	no opinion	no opinion	no opinion	no opinion
126	disagree	agree	agree	strongly agree
127	no opinion	no opinion	no opinion	no opinion
128	strongly disagree	agree	strongly disagree	no opinion
129	strongly disagree	no opinion	no opinion	no opinion
130	no opinion	disagree	agree	no opinion
131	strongly disagree	strongly disagree	strongly disagree	strongly disagree
132	strongly disagree	agree	strongly agree	strongly agree
133	disagree	disagree	disagree	no opinion
134	no opinion	agree	strongly agree	strongly disagree
135	strongly disagree	no opinion	agree	strongly disagree
136	disagree	no opinion	agree	disagree
137	strongly disagree	agree	agree	agree
138	strongly agree	strongly agree	strongly agree	agree
139	no opinion	no opinion	no opinion	no opinion
140	strongly disagree	no opinion	strongly agree	agree
141	no opinion	no opinion	no opinion	no opinion
142	strongly disagree	no opinion	disagree	strongly disagree
143	strongly disagree	disagree	disagree	strongly disagree
144	strongly disagree	no opinion	disagree	no opinion
145	strongly disagree	disagree	disagree	disagree
146	strongly agree	strongly disagree	strongly disagree	strongly agree

Q	**Preparedness against faith**	**EQ. safety not Com. priorities**	**EQ. safety not Gov. Priorities**
111	no opinion	agree	strongly agree
112	strongly agree	strongly disagree	strongly disagree
113	disagree	strongly disagree	strongly disagree
114	strongly disagree	disagree	strongly disagree
115	disagree	agree	strongly agree
116	disagree	agree	strongly agree
117	no opinion	disagree	no opinion
118	disagree	disagree	no opinion
119	strongly agree	strongly agree	strongly disagree
120	disagree	strongly agree	disagree
121	strongly disagree	strongly disagree	agree
122	strongly disagree	strongly disagree	strongly disagree
123	no opinion	no opinion	no opinion
124	no opinion	no opinion	no opinion
125	strongly agree	no opinion	agree
126	agree	strongly agree	no opinion
127	no opinion	no opinion	no opinion
128	no opinion	no opinion	no opinion
129	strongly agree	strongly disagree	strongly disagree
130	strongly disagree	strongly agree	
131	strongly disagree	strongly disagree	strongly disagree
132	strongly disagree	strongly disagree	strongly disagree
133	agree	disagree	strongly disagree
134	strongly disagree	strongly disagree	strongly disagree
135	no opinion	no opinion	strongly disagree
136	no opinion	disagree	disagree
137	agree	strongly disagree	strongly disagree
138	no opinion	no opinion	no opinion
139	no opinion	no opinion	no opinion
140	no opinion	strongly agree	strongly disagree
141	disagree	disagree	no opinion
142	disagree	strongly disagree	strongly disagree
143	disagree	strongly disagree	disagree
144	no opinion	disagree	disagree
145	agree	strongly agree	no opinion
146	strongly disagree	strongly disagree	strongly disagree

Q	**Addrs**	**Y-Live**	**Age**	**Sex**	**Edu**	**Income**	**Felt EQ.**	**# EQ. felt**	**When last EQ.**
147	N-Marj	>21	31-40	M	Colg	125 - 250	Yes	4mor	1-10Y
148	N-Marj	>21	21-30	M	Colg	50 - 125	Yes	2	1-12M
149	N-Marj	>21	21-30	M	Colg	50 - 125	Yes	2	1-12M
150	N-Marj	>21	31-40	M	Colg	125 - 250	Yes	2	1-12M
151	N-Marj	>21	21-30	M	Colg	250<	Yes	4mor	1-12M
152	Farm	>21	21-30	F	Colg	50>	Yes	1	1-12M
153	Farm	>21	21-30	F	Colg	50>	Yes	1	1-12M
154	N-Marj	11-15	21-30	M	Colg	50>	Yes	1	1-12M
155	N-Marj	16-20	41-50	M	Colg	250<	Yes	2	1-12M
156	N-Marj	16-20	21-30	M	Colg	125 - 250	Yes	3	1-10Y
157	N-Marj	1-5	21-30	F	Colg	50>	Yes	1	1-12M
158	N-Marj	>21	21-30	M	Colg	250<	No	0	0
159	N-Marj	>21	21-30	M	Colg	50>	Yes	2	1-12M
160	N-Marj	>21	21-30	M	Colg	250<	Yes	2	1-12M
161	Farm	>21	21-30	M	Colg	250<	Yes	2	1-12M
162	N-Marj	11-15	21-30	M	Colg	50>	Yes	2	1-12M
163	N-Marj	6-10	21-30	M	Colg	250<	Yes	1	1-12M
164	N-Marj	>21	21-30	M	Colg	125 - 250	Yes	3	1-10Y
165	N-Marj	11-15	21-30	M	Colg	125 - 250	Yes	3	1-12M
166	Farm	11-15	21-30	M	Colg	50 - 125	Yes	4mor	1-12M
167	Farm	16-20	21-30	M	M-H	50 - 125	Yes	4mor	1-12M
168	N-Marj	1-5	15-20	M	Colg	50 - 125	Yes	2	1-10Y
169	N-Marj	1-5	21-30	M	Colg	50>	Yes	1	1-12M
170	N-Marj	11-15	21-30	M	Colg	50 - 125	Yes	3	1-12M
171	N-Marj	6-10	21-30	M	Colg	250<	Yes	1	1-12M
172	N-Marj	16-20	21-30	M	Colg	50 - 125	Yes	3	1-12M
173	N-Marj	11-15	21-30	M	Colg	50 - 125	Yes	3	1-12M
174	N-Marj	1-5	21-30	M	Colg	125 - 250	Yes	3	1-12M
175	N-Marj	16-20	15-20	M	Colg	50 - 125	Yes	2	1-12M
176	N-Marj	>21	31-40	F	Mstr	250<	Yes	4mor	1-10Y
177	Farm	16-20	41-50	M	Colg	50>	No	2	1-10Y
178	N-Marj	>21	21-30	F	Colg	50>	Yes	3	1-12M
179	N-Marj	>21	21-30	F	Colg	50>	Yes	2	1-12M
180	N-Marj	16-20	21-30	F	Colg	50>	Yes	4mor	1-12M
181	Farm	>21	21-30	F	Colg	50>	Yes	1	1-10Y
182	N-Marj	15	21-30	F	Colg	50>	Yes	2	1-10Y
183	N-Marj	1-5	21-30	F	Colg	50>	Yes	2	1-12M

Q	**What Did**	**Will EQ.**	**When next EQ.**	**Why EQ. happen**	**Dange rous in**	**Safer place**	**Aware E. S.**
147	Pray	I don't know	God know	tectonic slip	O-Marj	U-table	No
148	Nothing	Yes	God know	I don't know	O-Marj	U-table	Yes
149	Nothing	I don't know	God know	Allah test	O-Marj	U-table	Yes
150	Pray	Yes	Months	tectonic slip	O-Marj	U-table	No
151	Pray	Yes	God know	tectonic slip	O-Marj	Cornr	Yes
152	Scream	I don't know	God know	I don't know	Farm	Cornr	Yes
153	Nothing	I don't know	God know	I don't know	Farm	Cornr	Yes
154	Nothing	I don't know	God know	Allah test	O-Marj	Cornr	No
155	Nothing	I don't know	God know	tectonic slip	O-Marj	U-table	No
156	Nothing	I don't know	God know	Allah punish	O-Marj	U-table	No
157	Pray	I don't know	God know	I don't know	N-Marj	1st Flr	No
158	0	0	God know	Allah test	N-Marj	Othr	Yes
159	Pray	I don't know	Days	I don't know	N-Marj	1st Flr	Yes
160	Pray	I don't know	God know	I don't know	N-Marj	1st Flr	No
161	Cover	Yes	God know	tectonic slip	O-Marj	Cornr	No
162	Pray	Yes	God know	I don't know	N-Marj	1st Flr	No
163	Nothing	I don't know	God know	Allah test	O-Marj	Cornr	No
164	Nothing	I don't know	God know	tectonic slip	O-Marj	Halway	No
165	Nothing	Yes	God know	Allah punish	O-Marj	Cornr	No
166	Nothing	Yes	God know	Allah test	Farm	Cornr	No
167	Nothing	Yes	God know	Allah test	Farm	Cornr	No
168	Pray	Yes	Days	tectonic slip	O-Marj	1st Flr	Yes
169	Nothing	I don't know	God know	I don't know	O-Marj	1st Flr	No
170	Pray	I don't know	God know	I don't know	N-Marj	1st Flr	No
171	Nothing	Yes	God know	Allah test	O-Marj	Halway	Yes
172	Cover	Yes	God know	Allah test	O-Marj	Halway	No
173	Nothing	Yes	God know	Allah test	O-Marj	Cornr	No
174	Nothing	I don't know	Months	I don't know	N-Marj	1st Flr	No
175	Pray	I don't know	God know	tectonic slip	O-Marj	Othr	Yes
176	Pray	I don't know	God know	Other	O-Marj	Cornr	No
177	Other	I don't know	God know	I don't know	O-Marj	1st Flr	No
178	Nothing	I don't know	God know	Allah test	Farm	Cornr	No
179	Scream	I don't know	God know	I don't know	N-Marj	1st Flr	No
180	Scream	I don't know	God know	I don't know	Farm	U-table	No
181	Scream	I don't know	God know	I don't know	N-Marj	Cornr	No
182	Pray	I don't know	God know	I don't know	O-Marj	Cornr	Yes
183	Pray	Yes	God know	tectonic slip	O-Marj	Cornr	No

Q	Building Type	Own House	know EQ.	Get information	Gov. is prepared	House is Safe
147	Re-Concrete	Family	Little	TV	no opinion	agree
148	Adobe brick	Family	Some	Net	no opinion	no opinion
149	Concrete	Family	Nothing	Net	no opinion	agree
150	Re-Concrete	I	Some	Other people	strongly disagree	no opinion
151	Re-Concrete	Family	Little	Since Papers	disagree	strongly disagree
152	Adobe brick	Family	Little	Other people	strongly disagree	agree
153	Adobe brick	Family	Little	TV	strongly disagree	agree
154	Re-Concrete	Family	Nothing	Other people	disagree	strongly agree
155	Re-Concrete	Family	Much	TV	strongly disagree	strongly agree
156	Re-Concrete	Family	Some	TV	no opinion	no opinion
157	Adobe brick	Family	Some	Other people	no opinion	strongly disagree
158	Re-Concrete	Family	Little	Net	disagree	strongly disagree
159	Re-Concrete	I	Nothing	Net	no opinion	strongly disagree
160	Re-Concrete	Family	Nothing	Net	no opinion	strongly agree
161	Re-Concrete	Family	Some	Net	no opinion	no opinion
162	Adobe brick	Family	Nothing	Net	strongly disagree	disagree
163	Re-Concrete	Family	Little	Since Papers	strongly disagree	disagree
164	Concrete	Family	Nothing	Net	disagree	no opinion
165	Clay	Family	Little	Net	strongly disagree	agree
166	Adobe brick	Family	Little	Since Papers	strongly disagree	disagree
167	Adobe brick	Family	Little	Since Papers	strongly disagree	disagree
168	Adobe brick	I	Nothing	Net	strongly disagree	disagree
169	Adobe brick	Family	Nothing	Other people	strongly disagree	no opinion
170	Concrete	Family	Some	Net	strongly disagree	no opinion
171	Re-Concrete	I	Little	Since Papers	strongly disagree	disagree
172	Concrete	Family	Little	Other people	strongly agree	agree
173	Other	Family	Little	Net	disagree	no opinion
174	Adobe brick	Family	Nothing	Net	strongly disagree	disagree
175	Concrete	Family	Some	Net	disagree	strongly agree
176	Concrete	Family	Some	TV	agree	strongly agree
177	Re-Concrete	Family	Some	Net	disagree	strongly disagree
178	Adobe brick	Family	Nothing	Other people	no opinion	disagree
179	Re-Concrete	Family	Some	Net	disagree	strongly agree
180	Concrete	Family	Little	TV	agree	agree
181	Concrete	Family	Little	Net	strongly disagree	strongly disagree
182	Adobe brick	Family	Some	Net	agree	no opinion
183	Adobe brick	Family	Little	Other people	disagree	disagree

Q	**Neighborhood Safe**	**Frightened**	**I am prepared**	**EQ. threat**
147	disagree	disagree	disagree	agree
148	disagree	agree	strongly disagree	agree
149	disagree	disagree	disagree	agree
150	strongly disagree	strongly agree	strongly disagree	strongly agree
151	strongly disagree	strongly disagree	strongly disagree	disagree
152	disagree	strongly agree	disagree	strongly agree
153	disagree	strongly agree	disagree	strongly agree
154	strongly agree	no opinion	strongly disagree	no opinion
155	no opinion	strongly disagree	strongly disagree	strongly agree
156	no opinion	no opinion	no opinion	no opinion
157	strongly disagree	disagree	no opinion	strongly agree
158	no opinion	strongly agree	strongly disagree	strongly disagree
159	strongly agree	no opinion	disagree	agree
160	strongly agree	no opinion	disagree	agree
161	agree	no opinion	no opinion	strongly agree
162	strongly disagree	disagree	disagree	agree
163	disagree	strongly disagree	disagree	strongly disagree
164	no opinion	no opinion	agree	agree
165	strongly agree	disagree	agree	no opinion
166	no opinion	strongly agree	strongly disagree	no opinion
167	no opinion	strongly agree	strongly disagree	strongly agree
168	no opinion	agree	strongly disagree	strongly disagree
169	strongly disagree	agree	strongly disagree	agree
170	no opinion	agree	no opinion	agree
171	disagree	strongly disagree	strongly agree	agree
172	agree	agree	no opinion	strongly agree
173	disagree	no opinion	strongly agree	strongly agree
174	agree	no opinion	no opinion	agree
175	disagree	no opinion	strongly disagree	agree
176	strongly agree	disagree	disagree	strongly agree
177	strongly disagree	no opinion	strongly disagree	strongly agree
178	agree	no opinion	disagree	strongly agree
179	disagree	strongly agree	strongly disagree	strongly agree
180		strongly agree	agree	no opinion
181	strongly disagree	agree	strongly disagree	agree
182	disagree	strongly agree	no opinion	no opinion
183	agree	disagree	strongly disagree	strongly disagree

Q	**Laws safety exist**	**City is prepared**	**Education Role**	**Preventive measures Role**
147	no opinion	no opinion	strongly agree	agree
148	disagree	no opinion	strongly disagree	strongly agree
149	no opinion	no opinion	agree	agree
150	strongly disagree	strongly disagree	disagree	strongly disagree
151	no opinion	no opinion	no opinion	agree
152	no opinion	disagree	strongly agree	strongly disagree
153	no opinion	disagree	strongly agree	strongly disagree
154	disagree	disagree	agree	no opinion
155	strongly disagree	strongly agree	strongly agree	strongly agree
156	disagree	strongly disagree	strongly agree	strongly agree
157	no opinion	disagree	strongly agree	strongly agree
158	agree	strongly disagree	strongly disagree	disagree
159	no opinion	no opinion	strongly agree	strongly agree
160	no opinion	no opinion	strongly agree	strongly agree
161	no opinion	no opinion	agree	agree
162	disagree	no opinion	strongly agree	agree
163	disagree	strongly disagree	strongly disagree	disagree
164	strongly disagree	strongly disagree	no opinion	agree
165	disagree	agree	no opinion	strongly agree
166	strongly agree	strongly agree	strongly agree	strongly disagree
167	strongly disagree	strongly disagree	strongly agree	strongly agree
168	disagree	no opinion	strongly disagree	strongly disagree
169	strongly disagree	strongly disagree	strongly disagree	strongly disagree
170	strongly disagree	strongly disagree	agree	agree
171	strongly disagree	strongly disagree	agree	agree
172	strongly disagree	no opinion	agree	agree
173	agree	strongly disagree	strongly disagree	disagree
174	strongly disagree	strongly disagree	strongly agree	strongly agree
175	strongly disagree	disagree	agree	agree
176	strongly agree	strongly agree	strongly agree	strongly agree
177	agree	no opinion	disagree	disagree
178	disagree	strongly disagree	no opinion	disagree
179	no opinion	no opinion	strongly agree	strongly agree
180	no opinion	no opinion	agree	agree
181	agree	strongly agree	strongly agree	strongly agree
182	strongly disagree	no opinion	agree	no opinion
183	no opinion	no opinion	strongly agree	strongly agree

Q	Building Codes exist	Citizens have a responsibility	Preparedness Gov. duty	Buildings built better
147	strongly agree	agree	no opinion	agree
148	disagree	strongly disagree	agree	disagree
149	agree	agree	disagree	agree
150	no opinion	strongly agree	strongly disagree	strongly agree
151	agree	agree	no opinion	no opinion
152	no opinion	no opinion	no opinion	agree
153	no opinion	no opinion	no opinion	agree
154	agree	agree	disagree	disagree
155	strongly disagree	strongly agree	strongly agree	strongly agree
156	agree	strongly disagree	agree	disagree
157	no opinion	strongly agree	no opinion	agree
158	agree	disagree	no opinion	strongly disagree
159	no opinion	agree	agree	agree
160	no opinion	agree	disagree	strongly agree
161	agree	no opinion	agree	agree
162	disagree	no opinion	agree	strongly agree
163	no opinion	disagree	disagree	strongly disagree
164	strongly disagree	agree	no opinion	disagree
165	strongly disagree	strongly disagree	strongly disagree	no opinion
166	disagree	strongly disagree	no opinion	no opinion
167	strongly agree	strongly disagree	strongly agree	strongly disagree
168	strongly disagree	disagree	strongly disagree	disagree
169	strongly disagree	strongly disagree	strongly disagree	disagree
170	strongly disagree	strongly disagree	agree	agree
171	strongly disagree	strongly disagree	no opinion	strongly disagree
172	agree	agree	agree	no opinion
173	no opinion	disagree	strongly disagree	agree
174	disagree	disagree	strongly disagree	strongly disagree
175	no opinion	agree	agree	no opinion
176	strongly agree	agree	agree	agree
177	strongly agree	strongly agree	agree	strongly disagree
178	strongly disagree	disagree	no opinion	disagree
179	no opinion	agree	strongly disagree	disagree
180	no opinion	agree	disagree	strongly disagree
181	agree	no opinion	strongly disagree	no opinion
182	agree	strongly disagree	strongly disagree	strongly disagree
183	no opinion	no opinion	no opinion	strongly agree

Q	**Preparedness against faith**	**EQ. safety not Com. priorities**	**EQ. safety not Gov. Priorities**
147	disagree	strongly disagree	disagree
148	no opinion	disagree	disagree
149	strongly disagree	disagree	disagree
150	strongly disagree	strongly disagree	strongly disagree
151	no opinion	no opinion	agree
152	no opinion	disagree	no opinion
153	no opinion	disagree	no opinion
154	strongly disagree	strongly disagree	disagree
155	strongly agree	strongly agree	strongly agree
156	disagree	agree	agree
157	strongly disagree	disagree	strongly disagree
158	no opinion	strongly agree	strongly agree
159	strongly disagree	strongly disagree	strongly disagree
160	no opinion	strongly disagree	strongly disagree
161	agree	disagree	disagree
162	strongly disagree	disagree	no opinion
163	strongly disagree	disagree	disagree
164	no opinion	disagree	agree
165	agree	strongly agree	agree
166	no opinion	disagree	strongly disagree
167	strongly disagree	strongly disagree	strongly disagree
168	disagree	disagree	disagree
169	disagree	disagree	disagree
170	strongly disagree	agree	strongly disagree
171	no opinion	strongly disagree	strongly disagree
172	no opinion	agree	agree
173	strongly agree	no opinion	disagree
174	strongly disagree	strongly agree	agree
175	agree	strongly disagree	strongly disagree
176	strongly disagree	strongly disagree	strongly disagree
177	agree	strongly disagree	no opinion
178	disagree	no opinion	strongly disagree
179	strongly disagree	strongly disagree	strongly disagree
180	strongly disagree	strongly disagree	strongly disagree
181	strongly disagree	strongly disagree	strongly disagree
182	no opinion	strongly disagree	strongly disagree
183	strongly agree	no opinion	agree

Q	**Addrs**	**Y-Live**	**Age**	**Sex**	**Edu**	**Income**	**Felt EQ.**	**# EQ. felt**	**When last EQ.**
184	N-Marj	>21	31-40	F	Colg	50>	Yes	3	1-12M
185	N-Marj	>21	21-30	F	Colg	50>	Yes	3	1-12M
186	Farm	>21	21-30	M	Colg	50>	Yes	1	1-12M
187	N-Marj	>21	15-20	M	Colg	50>	Yes	1	1-12M
188	N-Marj	>21	21-30	M	Colg	125 - 250	Yes	2	1-12M
189	N-Marj	>21	21-30	M	Colg	250<	Yes	2	1-10Y
190	Farm	>21	21-30	F	Colg	50>	Yes	1	1-10Y
191	Farm	11-15	15-20	F	Colg	50>	Yes	2	1-12M
192	N-Marj	>21	21-30	F	Colg	50 - 125	Yes	3	1-10Y
193	Farm	16-20	21-30	F	Colg	50>	Yes	4mor	1-12M
194	N-Marj	>21	21-30	M	Colg	50>	Yes	3	1-12M
195	N-Marj	>21	21-30	F	Colg	50 - 125	Yes	2	1-12M
196	N-Marj	1-5	21-30	F	Colg	50>	Yes	4mor	1-12M
197	N-Marj	>21	21-30	F	Colg	50>	Yes	3	1-12M
198	N-Marj	1-5	15-20	F	Colg	50>	Yes	3	1-10Y
199	Farm	1-5	15-20	F	Colg	50 - 125	Yes	2	1-10Y
200	N-Marj	>21	21-30	M	M-H	50 - 125	Yes	3	1-12M
201	Farm	1-5	21-30	M	Colg	125 - 250	Yes	2	1-12M
202	N-Marj	>21	21-30	M	Colg	125 - 250	Yes	4mor	1-12M
203	Farm	>21	21-30	M	M-H	250<	Yes	3	1-10Y
204	N-Marj	16-20	41-50	F	Colg	250<	Yes	1	1-12M
205	N-Marj	>21	21-30	F	Colg	50 - 125	Yes	4mor	1-12M
206	N-Marj	1-5	21-30	F	Colg	50>	Yes	1	1-12M
207	N-Marj	16-20	21-30	F	Colg	50>	Yes	2	1-12M
208	N-Marj	11-15	15-20	F	Colg	50>	Yes	4mor	1-12M
209	Farm	16-20	21-30	F	Colg	50>	Yes	2	1-10Y
210	Farm	1-5	15-20	F	Colg	50>	Yes	1	1-12M
211	N-Marj	16-20	15-20	F	Colg	50>	Yes	3	1-12M
212	Farm	16-20	21-30	F	Colg	50>	Yes	3	1-10Y
213	N-Marj	1-5	21-30	F	Colg	50>	Yes	3	1-10Y
214	N-Marj	>21	21-30	M	Colg	125 - 250	Yes	2	1-10Y
215	Farm	16-20	21-30	M	Colg	125 - 250	Yes	2	1-12M
216	Farm	>21	21-30	M	Colg	125 - 250	Yes	1	1-10Y
217	Farm	>21	21-30	F	Colg	50>	Yes	2	1-12M
218	N-Marj	>21	21-30	F	Colg	50>	Yes	2	1-12M
219	N-Marj	1-5	21-30	F	Colg	50>	Yes	4mor	1-12M
220	Farm	6-10	21-30	F	Colg	50>	Yes	2	1-10Y

Q	What Did	Will EQ.	When next EQ.	Why EQ. happen	Dange rous in	Safer place	Aware E. S.
184	Cover	Yes	God know	tectonic slip	O-Marj	Othr	No
185	Scream	I don't know	God know	I don't know	O-Marj	Othr	No
186	Pray	I don't know	God know	I don't know	O-Marj	Othr	No
187	Nothing	I don't know	God know	I don't know	O-Marj	1st Flr	No
188	Nothing	Yes	Years	tectonic slip	N-Marj	1st Flr	Yes
189	Pray	I don't know	God know	I don't know	O-Marj	Cornr	No
190	Nothing	I don't know	God know	I don't know	O-Marj	1st Flr	No
191	Nothing	I don't know	God know	I don't know	O-Marj	Cornr	No
192	Pray	I don't know	God know	tectonic slip	N-Marj	1st Flr	No
193	Scream	I don't know	God know	I don't know	O-Marj	Cornr	No
194	Nothing	I don't know	God know	I don't know	N-Marj	Cornr	No
195	Nothing	I don't know	God know	tectonic slip	O-Marj	Cornr	No
196	Scream	I don't know	God know	tectonic slip	O-Marj	1st Flr	No
197	Scream	Yes	God know	tectonic slip	O-Marj	Cornr	No
198	Pray	I don't know	God know	Allah test	O-Marj	U-table	Yes
199	Nothing	I don't know	God know	I don't know	O-Marj	Cornr	No
200	Pray	I don't know	God know	Allah test	N-Marj	U-table	Yes
201	Nothing	I don't know	God know	I don't know	Farm	1st Flr	No
202	Nothing	I don't know	God know	Allah test	O-Marj	U-table	No
203	Pray	I don't know	God know	tectonic slip	O-Marj	Othr	No
204	Nothing	I don't know	God know	tectonic slip	N-Marj	Cornr	No
205	Scream	I don't know	God know	tectonic slip	O-Marj	Cornr	No
206	Pray	I don't know	God know	I don't know	O-Marj	1st Flr	No
207	Scream	I don't know	God know	tectonic slip	N-Marj	1st Flr	No
208	Scream	I don't know	God know	I don't know	O-Marj	Cornr	No
209	Pray	Yes	God know	Allah test	O-Marj	1st Flr	No
210	Nothing	I don't know	God know	I don't know	Farm	Halway	No
211	Pray	I don't know	God know	I don't know	N-Marj	Othr	No
212	Nothing	I don't know	God know	I don't know	O-Marj	Cornr	No
213	Nothing	I don't know	God know	Allah test	O-Marj	1st Flr	No
214	Pray	I don't know	God know	Allah test	O-Marj	1st Flr	No
215	Nothing	I don't know	God know	tectonic slip	Farm	Cornr	No
216	Nothing	Yes	God know	I don't know	O-Marj	1st Flr	No
217	Scream	I don't know	God know	I don't know	O-Marj	1st Flr	No
218	Scream	I don't know	God know	tectonic slip	O-Marj	1st Flr	No
219	Nothing	I don't know	God know	I don't know	O-Marj	Cornr	No
220	Cover	I don't know	God know	tectonic slip	O-Marj	Cornr	No

Q	**Building Type**	**Own House**	**know EQ.**	**Get information**	**Gov. is prepared**	**House is Safe**
184	Re-Concrete	Family	Little	Net	no opinion	agree
185	Re-Concrete	Family	Little	Net	strongly disagree	agree
186	Concrete	Family	Nothing	1	strongly disagree	agree
187	Concrete	Family	Much	Net	strongly disagree	strongly disagree
188	Re-Concrete	Family	Some	Net	no opinion	strongly disagree
189	Re-Concrete	I	Little	Net	disagree	agree
190	Re-Concrete	Family	Nothing	Net	no opinion	disagree
191	Adobe brick	Family	Nothing	Net	disagree	disagree
192	Clay	Family	Little	TV	strongly disagree	agree
193	Concrete	Family	Little	Net	no opinion	strongly agree
194	Re-Concrete	Family	Some	Net	strongly disagree	agree
195	Re-Concrete	Family	Little	Other people	strongly disagree	no opinion
196	Re-Concrete	Family	Little	Net	strongly disagree	agree
197	Concrete	Family	Little	Net	disagree	disagree
198	Concrete	Family	Some	Other people	disagree	agree
199	Concrete	Family	Little	Other people	no opinion	agree
200	Re-Concrete	Family	Little	Net	disagree	disagree
201	Re-Concrete	Family	Little	TV	disagree	strongly agree
202	Re-Concrete	Family	Some	Net	strongly disagree	agree
203	Adobe brick	Family	Some	Net	strongly disagree	agree
204	Concrete	Family	Little	Net	strongly disagree	disagree
205	Re-Concrete	Family	Little	TV	strongly disagree	strongly agree
206	Re-Concrete	Family	Little	Since Papers	no opinion	agree
207	Adobe brick	Family	Little	Net	no opinion	agree
208	Concrete	Family	Some	TV	strongly disagree	disagree
209	Adobe brick	Family	Little	Net	strongly disagree	agree
210	Adobe brick	Family	Little	Since Papers	strongly disagree	agree
211	Concrete	Family	Some	Net	no opinion	no opinion
212	Concrete	Family	Little	Net	no opinion	agree
213	Concrete	Family	Little	Radio	disagree	disagree
214	Concrete	I	Little	Net	strongly disagree	disagree
215	Re-Concrete	Family	Little	Radio	strongly disagree	disagree
216	Re-Concrete	Family	Little	TV	disagree	agree
217	Concrete	Family	Little	Net	no opinion	strongly agree
218	Concrete	Family	Much	Net	disagree	agree
219	Concrete	Family	Some	TV	strongly disagree	no opinion
220	Concrete	Family	Little	Net	strongly disagree	disagree

Q	Neighborhood Safe	Frightened	I am prepared	EQ. threat
184	strongly disagree	strongly agree	disagree	agree
185	disagree	strongly disagree	no opinion	strongly disagree
186	agree	disagree	agree	agree
187	strongly disagree	disagree	strongly disagree	strongly agree
188	strongly disagree	agree	disagree	strongly disagree
189	no opinion	strongly disagree	no opinion	agree
190	strongly disagree	strongly agree	disagree	disagree
191	disagree	strongly agree	disagree	agree
192	strongly disagree	disagree	no opinion	no opinion
193	no opinion	strongly agree	disagree	strongly agree
194	strongly disagree	no opinion	strongly disagree	strongly disagree
195	no opinion	agree	no opinion	agree
196	disagree	strongly agree	strongly agree	agree
197	disagree	strongly agree	strongly disagree	agree
198	strongly disagree	strongly agree	strongly disagree	agree
199	agree	strongly agree	disagree	no opinion
200	disagree	agree	agree	strongly disagree
201	disagree	strongly disagree	agree	strongly disagree
202	no opinion	agree	strongly disagree	strongly disagree
203	no opinion	no opinion	disagree	disagree
204	no opinion	strongly agree	strongly disagree	no opinion
205	agree	strongly agree	no opinion	agree
206	strongly agree	agree	no opinion	agree
207	strongly agree	strongly agree	strongly disagree	strongly agree
208	strongly disagree	strongly agree	disagree	agree
209	no opinion	agree	no opinion	no opinion
210	agree	strongly agree	no opinion	no opinion
211	no opinion	agree	no opinion	strongly agree
212		strongly disagree	agree	no opinion
213	disagree	strongly agree	disagree	agree
214	disagree	agree	strongly disagree	strongly disagree
215	disagree	agree	strongly disagree	strongly disagree
216	agree	no opinion	no opinion	agree
217	strongly agree	strongly agree	strongly agree	agree
218	disagree	strongly disagree	strongly disagree	agree
219	no opinion	agree	agree	no opinion
220	disagree	agree	strongly disagree	agree

Q	Laws safety exist	City is prepared	Education Role	Preventive measures Role
184	no opinion	strongly disagree	strongly agree	strongly agree
185	strongly disagree	strongly disagree	strongly agree	strongly agree
186	no opinion	no opinion	agree	agree
187	strongly disagree	strongly disagree	strongly agree	strongly agree
188	disagree	strongly disagree	agree	disagree
189	no opinion	strongly disagree	strongly agree	agree
190	no opinion	no opinion	disagree	agree
191	disagree	disagree	agree	agree
192	agree	no opinion	no opinion	disagree
193	no opinion	no opinion	agree	agree
194	agree	disagree	strongly agree	strongly disagree
195	strongly disagree	strongly disagree	strongly agree	strongly agree
196	agree	no opinion	agree	disagree
197	disagree	disagree	agree	strongly agree
198	strongly disagree	strongly disagree	strongly agree	strongly agree
199	agree	no opinion	strongly agree	no opinion
200	disagree	strongly disagree	strongly agree	agree
201	disagree	strongly disagree	agree	strongly agree
202	no opinion	no opinion	agree	strongly agree
203	strongly disagree	strongly disagree	strongly agree	agree
204	agree	strongly disagree	strongly agree	agree
205	no opinion	agree	agree	agree
206	strongly agree	no opinion	strongly agree	agree
207	strongly agree	strongly disagree	disagree	strongly disagree
208	no opinion	agree	strongly agree	strongly agree
209	no opinion	strongly disagree	agree	agree
210	agree	agree	no opinion	disagree
211	no opinion	no opinion	agree	no opinion
212	no opinion	no opinion	strongly agree	agree
213	disagree	disagree	agree	no opinion
214	disagree	disagree	no opinion	agree
215	disagree	disagree	strongly agree	no opinion
216	disagree	strongly disagree	agree	disagree
217	strongly agree	disagree	no opinion	no opinion
218	disagree	strongly disagree	strongly agree	no opinion
219	strongly disagree	disagree	agree	disagree
220	disagree	disagree	agree	agree

Q	**Building Codes exist**	**Citizens have a responsibility**	**Preparedness Gov. duty**	**Buildings built better**
184	strongly disagree	disagree	strongly disagree	agree
185	strongly disagree	strongly disagree	strongly disagree	strongly agree
186	disagree	no opinion	agree	agree
187	strongly disagree	agree	disagree	strongly disagree
188	disagree	disagree	disagree	strongly disagree
189	disagree	agree	strongly disagree	agree
190	strongly agree	strongly agree	disagree	no opinion
191	no opinion	agree	disagree	agree
192	no opinion	strongly agree	disagree	no opinion
193	no opinion	no opinion	strongly agree	no opinion
194	disagree	strongly disagree	disagree	agree
195	strongly disagree	no opinion	no opinion	agree
196	strongly disagree	no opinion	no opinion	agree
197	strongly disagree	disagree	disagree	disagree
198	strongly disagree	agree	strongly disagree	agree
199	disagree	no opinion	strongly disagree	no opinion
200	no opinion	no opinion	disagree	no opinion
201	agree	agree	strongly agree	agree
202	agree	agree	disagree	agree
203	strongly disagree	disagree	disagree	agree
204	agree	agree	strongly disagree	strongly agree
205	strongly disagree	no opinion	no opinion	strongly agree
206	strongly agree	strongly disagree	strongly disagree	no opinion
207	disagree	strongly disagree	strongly disagree	no opinion
208	no opinion	no opinion	strongly disagree	no opinion
209	strongly disagree	strongly disagree	no opinion	no opinion
210	strongly disagree	agree	agree	no opinion
211	no opinion	no opinion	agree	agree
212	no opinion	disagree	strongly agree	strongly disagree
213	disagree	disagree	disagree	agree
214	strongly agree	no opinion	disagree	strongly agree
215	disagree	strongly disagree	agree	agree
216	disagree		no opinion	disagree
217	disagree	strongly agree	disagree	strongly agree
218	strongly disagree	disagree	disagree	agree
219	strongly disagree	no opinion	disagree	no opinion
220	disagree	agree	disagree	disagree

Q	**Preparedness against faith**	**EQ. safety not Com. priorities**	**EQ. safety not Gov. Priorities**
184	strongly disagree	strongly agree	strongly agree
185	strongly agree	strongly disagree	disagree
186	no opinion	disagree	strongly disagree
187	agree	strongly disagree	strongly disagree
188	strongly agree	no opinion	no opinion
189	strongly agree	strongly disagree	strongly disagree
190	no opinion	agree	strongly disagree
191	disagree	agree	agree
192	strongly disagree	no opinion	agree
193	no opinion	disagree	disagree
194	strongly agree	strongly agree	disagree
195	strongly disagree	strongly disagree	agree
196	strongly agree	strongly agree	strongly agree
197	disagree	agree	agree
198	strongly disagree	strongly agree	strongly agree
199	no opinion	strongly disagree	strongly disagree
200	strongly disagree	no opinion	no opinion
201	strongly disagree	disagree	disagree
202	disagree	no opinion	no opinion
203	strongly disagree	agree	agree
204	strongly disagree	disagree	agree
205	strongly disagree	disagree	strongly agree
206	strongly disagree	strongly agree	strongly agree
207	strongly disagree	strongly agree	strongly disagree
208	no opinion	strongly disagree	no opinion
209	agree	strongly disagree	strongly disagree
210	disagree	disagree	disagree
211	no opinion	strongly disagree	strongly disagree
212	no opinion	strongly agree	strongly disagree
213	disagree	strongly disagree	strongly disagree
214	strongly disagree	disagree	no opinion
215	no opinion	strongly agree	strongly agree
216	disagree	agree	agree
217	no opinion	disagree	disagree
218	disagree	strongly agree	strongly agree
219	no opinion	no opinion	no opinion
220	strongly disagree	agree	disagree

Q	**Addrs**	**Y-Live**	**Age**	**Sex**	**Edu**	**Income**	**Felt EQ.**	**# EQ. felt**	**When last EQ.**
221	N-Marj	1-5	21-30	F	Colg	50>	Yes	2	1-12M
222	N-Marj	21	21-30	F	Colg	50 - 125	Yes	2	1-10Y
223	N-Marj	21	51-60	M	M-H	50 - 125	Yes	4mor	1-12M
224	N-Marj	11-15	15-20	M	Colg	250<	Yes	4mor	1-10Y
225	N-Marj	16-20	15-20	F	Colg	50>	Yes	2	1-12M
226	N-Marj	21	15-20	F	Colg	50>	Yes	4mor	1-10Y
227	N-Marj	16-20	15-20	F	Colg	50 - 125	Yes	3	1-10Y
228	Farm	1-5	15-20	F	Colg	50>	Yes	2	1-12M
229	Farm	16-20	15-20	F	Colg	125 - 250	Yes	2	1-12M
230	N-Marj	21	21-30	M	Colg	125 - 250	Yes	1	1-10Y
231	Farm	21	15-20	M	Colg	50 - 125	Yes	1	1-12M
232	N-Marj	21	21-30	M	Colg	50>	Yes	2	1-10Y
233	Farm	21	15-20	F	Colg	50 - 125	Yes	4mor	1-12M
234	N-Marj	16-20	15-20	F	Colg	50>	Yes	4mor	1-12M
235	N-Marj	1-5	15-20	F	Colg	50>	Yes	3	1-12M
236	N-Marj	21	21-30	F	Colg	125 - 250	Yes	3	1-12M
237	N-Marj	21	21-30	M	Colg	50>	Yes	2	11-20Y
238	Farm	11-15	21-30	F	Colg	50>	Yes	2	1-12M
239	N-Marj	21	21-30	M	Colg	250<	Yes	1	1-12M
240	N-Marj	16-20	15-20	F	Colg	125 - 250	No	0	0
241	N-Marj	1-5	15-20	F	Colg	50>	Yes	1	1-12M
242	N-Marj	11-15	21-30	M	Colg	50>	Yes	2	1-10Y
243	N-Marj	1-5	21-30	M	Colg	50>	Yes	3	1-10Y
244	Farm	11-15	15-20	F	Colg	50>	Yes	1	1-12M
245	Farm	11-15	21-30	M	Colg	125 - 250	Yes	2	1-12M
246	O-Marj	1-5	21-30	M	Colg	50>	Yes	1	1-10Y
247	N-Marj	1-5	21-30	F	Colg	50>	Yes	2	1-10Y
248	N-Marj	1-5	21-30	F	Colg	50>	Yes	1	1-10Y
249	N-Marj	6-10	31-40	M	Colg	250<	Yes	2	1-10Y
250	Farm	21	21-30	F	Colg	50>	Yes	3	1-12M
251	Farm	21	21-30	F	Colg	50>	Yes	1	1-10Y
252	N-Marj	21	21-30	F	Colg	50>	Yes	3	1-10Y
253	Farm	11-15	21-30	F	Colg	50 - 125	Yes	2	1-10Y
254	N-Marj	1-5	21-30	F	Colg	50>	Yes	4mor	1-12M
255	Farm	16-20	21-30	F	Colg	50>	No	0	0
256	N-Marj	16to20	15-20	M	Colg	125 - 250	Yes	4mor	1-12M

Q	What Did	Will EQ.	When next EQ.	Why EQ. happen	Dange rous in	Safer place	Aware E. S.
221	Cover	I don't know	God know	I don't know	O-Marj	Cornr	No
222	Pray	I don't know	God know	tectonic slip	O-Marj	Cornr	No
223	Pray	Yes	God know	Allah test	O-Marj	Cornr	No
224	Cover	Yes	God know	I don't know	O-Marj	Halway	Yes
225	Pray	I don't know	God know	Allah test	O-Marj	1st Flr	No
226	Pray	I don't know	God know	Allah test	O-Marj	Cornr	No
227	Nothing	I don't know	God know	tectonic slip	O-Marj	1st Flr	No
228	Nothing	I don't know	God know	tectonic slip	O-Marj	U-table	Yes
229	Pray	I don't know	God know	I don't know	Farm	1st Flr	Yes
230	Nothing	Yes	God know	I don't know	N-Marj	1st Flr	Yes
231	Nothing	I don't know	God know	Allah test	O-Marj	1st Flr	No
232	Nothing	I don't know	God know	I don't know	O-Marj	Cornr	No
233	Nothing	I don't know	God know	I don't know	Farm	U-table	No
234	Other	I don't know	God know	tectonic slip	O-Marj	Cornr	No
235	Scream	Yes	God know	Allah test	O-Marj	Cornr	No
236	Nothing	I don't know	God know	I don't know	O-Marj	1st Flr	No
237	Other	I don't know	God know	I don't know	O-Marj	1st Flr	Yes
238	Pray	Yes	God know	Allah test	Farm	Othr	Yes
239	Nothing	I don't know	God know	I don't know	N-Marj	1st Flr	No
240	Other		God know	Allah test	O-Marj	1st Flr	No
241	Nothing	I don't know	God know	Allah test	O-Marj	Othr	No
242	Pray	Yes	God know	I don't know	O-Marj	1st Flr	No
243	Nothing	I don't know	God know	I don't know	N-Marj	1st Flr	No
244	Pray	I don't know	God know	Allah test	O-Marj	U-table	No
245	Nothing	I don't know	God know	I don't know	O-Marj	U-table	No
246	Nothing	I don't know	God know	Other	Farm	Othr	Yes
247	Nothing	I don't know	God know	Allah test	O-Marj	1st Flr	No
248	Nothing	I don't know	God know	Allah test	O-Marj	1st Flr	No
249	Nothing	No	God know	I don't know	N-Marj	Halway	Yes
250	Nothing	I don't know	God know	I don't know	O-Marj	1st Flr	No
251	Nothing	I don't know	God know	I don't know	O-Marj	1st Flr	No
252	Pray	Yes	God know	tectonic slip	O-Marj	Cornr	No
253	Scream	I don't know	God know	Allah test	O-Marj	U-table	No
254	Pray	Yes	Months	tectonic slip	O-Marj	Cornr	No
255	0	0	God know	I don't know	O-Marj	Othr	No
256	Nothing	Yes	God know	Allah test	N-Marj	1st Flr	No

Q	**Building Type**	**Own House**	**know EQ.**	**Get information**	**Gov. is prepared**	**House is Safe**
221	Clay	Family	Little	TV	strongly disagree	strongly agree
222	Concrete	Family	Little	TV	strongly disagree	strongly disagree
223	Re-Concrete	I	Nothing	TV	strongly disagree	agree
224	Re-Concrete	Gov.	Nothing	Gov. brochure	disagree	agree
225	Adobe brick	Family	Little	Other people	no opinion	agree
226	Concrete	Family	Nothing	Net	disagree	agree
227	Adobe brick	Family	Some	Net	strongly disagree	agree
228	Adobe brick	Family	Little	Other people	no opinion	no opinion
229	Adobe brick	Family	Nothing	TV	no opinion	agree
230	Re-Concrete	Family	Little	Other people	strongly disagree	disagree
231	Re-Concrete	Family	Little	Net	strongly disagree	disagree
232	Re-Concrete	Family	Some	Net	strongly disagree	no opinion
233	Clay	Family	Nothing	Other people	no opinion	strongly agree
234	Re-Concrete	Family	Some	TV	disagree	no opinion
235	Concrete	Family	Little	Net	strongly disagree	agree
236	Adobe brick	Family	Nothing	Other people	strongly disagree	agree
237	Re-Concrete	I	Some	Net	strongly disagree	no opinion
238	Adobe brick	Landlord	Nothing	Net	strongly disagree	strongly agree
239	Re-Concrete	I	Nothing	Net	disagree	disagree
240	Re-Concrete	Family	Nothing	Other people	strongly disagree	agree
241	Adobe brick	Gov.	Nothing	TV	no opinion	strongly disagree
242	Concrete	Family	Some	Net	strongly disagree	agree
243	Adobe brick	Family	Nothing	TV	agree	strongly agree
244	Adobe brick	Family	Little	Net	agree	disagree
245	Concrete	Family	Little	TV	strongly disagree	strongly disagree
246	Adobe brick	Family	Little	TV	strongly disagree	strongly disagree
247	Adobe brick	Family	Little	Net	no opinion	disagree
248	Clay	Family	Little	Net	no opinion	disagree
249	Re-Concrete	Family	Nothing	TV	disagree	no opinion
250	Adobe brick	Family	Some	TV	strongly disagree	no opinion
251	Clay	Family	Nothing	TV	strongly disagree	disagree
252	Re-Concrete	Family	Some	Other people	agree	strongly agree
253	Adobe brick	Family	Little	Net	strongly disagree	strongly agree
254	Adobe brick	Family	Some	Since Papers	no opinion	strongly disagree
255	Adobe brick	Family	Little	Net	strongly disagree	strongly disagree
256	Adobe brick	Family	Little	TV	strongly disagree	no opinion

Q	**Neighborhood Safe**	**Frightened**	**I am prepared**	**EQ. threat**
221	disagree	agree	strongly disagree	strongly agree
222	strongly disagree	agree	strongly disagree	agree
223	disagree	disagree	disagree	agree
224	disagree	agree	agree	agree
225	agree	strongly agree	agree	agree
226	strongly disagree	strongly agree	strongly disagree	disagree
227	disagree	strongly agree	agree	strongly disagree
228	disagree	disagree	no opinion	no opinion
229	strongly disagree	strongly disagree	agree	agree
230	disagree	no opinion	no opinion	agree
231	agree	disagree	no opinion	no opinion
232	no opinion	no opinion	no opinion	strongly agree
233	agree	agree	strongly disagree	agree
234	disagree	strongly disagree	strongly disagree	strongly disagree
235	strongly disagree	strongly disagree	disagree	strongly agree
236	strongly disagree	disagree	strongly disagree	agree
237	agree	strongly agree	disagree	agree
238	disagree	agree	no opinion	disagree
239	agree	agree	no opinion	no opinion
240	no opinion	no opinion	no opinion	no opinion
241	strongly disagree	strongly agree	strongly disagree	strongly agree
242	agree	no opinion	agree	strongly agree
243	no opinion	agree	strongly disagree	no opinion
244	strongly disagree	agree	agree	agree
245	no opinion	agree	disagree	no opinion
246	strongly disagree	strongly disagree	strongly disagree	disagree
247	agree	strongly agree	strongly disagree	agree
248	agree	strongly agree	strongly disagree	agree
249	agree	agree	no opinion	strongly agree
250	strongly disagree	strongly disagree	strongly agree	strongly agree
251	disagree	strongly agree	strongly disagree	agree
252	disagree	strongly agree	strongly disagree	no opinion
253	no opinion	agree	strongly disagree	strongly disagree
254	strongly disagree	agree	no opinion	strongly disagree
255	strongly disagree	no opinion	no opinion	strongly agree
256	no opinion	no opinion	no opinion	disagree

Q	**Laws safety exist**	**City is prepared**	**Education Role**	**Preventive measures Role**
221	strongly disagree	strongly disagree	strongly disagree	no opinion
222	disagree	disagree	agree	agree
223	agree	disagree	agree	agree
224	agree	disagree	disagree	disagree
225	no opinion	no opinion	agree	strongly agree
226	no opinion	agree	no opinion	
227	disagree	disagree	disagree	strongly agree
228	no opinion	disagree	disagree	no opinion
229	agree	agree	strongly agree	no opinion
230	no opinion	disagree	agree	agree
231	disagree	disagree	disagree	no opinion
232	strongly agree	no opinion	agree	strongly agree
233	no opinion	no opinion	no opinion	agree
234	strongly disagree	strongly disagree	strongly agree	no opinion
235	strongly disagree	strongly disagree	strongly agree	strongly agree
236	disagree	disagree	agree	disagree
237	strongly disagree	strongly disagree	strongly agree	agree
238	agree	disagree	strongly agree	no opinion
239	no opinion	strongly disagree	strongly disagree	strongly disagree
240	no opinion	no opinion	no opinion	no opinion
241	no opinion	no opinion	no opinion	no opinion
242	strongly disagree	strongly disagree	agree	agree
243	strongly disagree	strongly agree	agree	no opinion
244	agree	no opinion	agree	agree
245	strongly disagree	disagree	agree	agree
246	no opinion	agree	agree	strongly disagree
247	no opinion	no opinion	strongly agree	strongly agree
248	strongly disagree	strongly disagree	strongly agree	strongly disagree
249	strongly agree	agree	no opinion	strongly agree
250	strongly disagree	strongly disagree	strongly agree	strongly agree
251	disagree	agree	agree	agree
252	agree	strongly disagree	strongly agree	strongly agree
253	strongly disagree	no opinion	strongly agree	strongly agree
254	strongly disagree	no opinion	strongly agree	strongly agree
255	strongly disagree	strongly disagree	no opinion	strongly agree
256	strongly disagree	disagree	disagree	strongly disagree

Q	**Building Codes exist**	**Citizens have a responsibility**	**Preparedness Gov. duty**	**Buildings built better**
221	no opinion	strongly disagree	strongly disagree	strongly agree
222	disagree	no opinion	agree	no opinion
223	no opinion	disagree	agree	agree
224	disagree	disagree	agree	agree
225	no opinion	strongly agree	agree	no opinion
226	agree	no opinion	disagree	strongly agree
227	disagree	agree	disagree	disagree
228	agree	no opinion	no opinion	no opinion
229	agree	no opinion	agree	no opinion
230	agree	agree	no opinion	no opinion
231	disagree	no opinion	agree	disagree
232	strongly disagree	strongly disagree	strongly agree	strongly disagree
233	agree	disagree	strongly agree	strongly agree
234	strongly agree	agree	strongly agree	agree
235	agree	strongly agree	strongly agree	strongly agree
236	disagree	no opinion	agree	no opinion
237	strongly agree	agree	disagree	strongly disagree
238	disagree	agree	no opinion	disagree
239	strongly disagree	strongly disagree	strongly disagree	strongly disagree
240	no opinion	no opinion	no opinion	no opinion
241	strongly disagree	strongly disagree	strongly disagree	strongly disagree
242	no opinion	agree	agree	agree
243	strongly disagree	no opinion	no opinion	no opinion
244	no opinion	agree	disagree	no opinion
245	no opinion	strongly disagree	disagree	agree
246	disagree	strongly disagree	disagree	agree
247	strongly disagree	strongly agree	disagree	no opinion
248	strongly disagree	strongly agree	strongly agree	no opinion
249	agree	no opinion	strongly agree	agree
250	strongly disagree	strongly agree	strongly disagree	strongly disagree
251	strongly disagree	no opinion	disagree	agree
252	strongly agree	disagree	strongly agree	strongly agree
253	strongly disagree	no opinion	no opinion	strongly disagree
254	strongly disagree	no opinion	no opinion	strongly disagree
255	no opinion	no opinion	no opinion	no opinion
256	disagree	strongly disagree	disagree	no opinion

Q	**Preparedness against faith**	**EQ. safety not Com. priorities**	**EQ. safety not Gov. Priorities**
221	strongly disagree	strongly disagree	strongly agree
222	strongly disagree	disagree	disagree
223	disagree	agree	agree
224	disagree	agree	agree
225	no opinion	no opinion	disagree
226	agree	disagree	agree
227	disagree	strongly disagree	strongly disagree
228	agree	no opinion	no opinion
229	no opinion	agree	disagree
230	no opinion	disagree	disagree
231	agree	no opinion	disagree
232	no opinion	strongly agree	strongly disagree
233	strongly disagree	disagree	no opinion
234	no opinion	disagree	disagree
235	strongly disagree	strongly disagree	strongly agree
236	strongly agree	disagree	disagree
237	no opinion	strongly disagree	strongly disagree
238	agree	strongly disagree	agree
239	strongly disagree	strongly disagree	strongly disagree
240	no opinion	no opinion	no opinion
241	strongly disagree	strongly disagree	strongly disagree
242	agree	strongly disagree	strongly disagree
243	strongly disagree	disagree	disagree
244	agree	disagree	disagree
245	no opinion	strongly disagree	strongly disagree
246	strongly agree	strongly disagree	strongly disagree
247	no opinion	strongly disagree	strongly disagree
248	no opinion	strongly disagree	strongly disagree
249	strongly agree	no opinion	strongly agree
250	strongly disagree	strongly disagree	strongly disagree
251	disagree	agree	strongly disagree
252	strongly disagree	strongly disagree	strongly disagree
253	no opinion	strongly disagree	no opinion
254	no opinion	strongly disagree	no opinion
255	strongly disagree	no opinion	no opinion
256	agree	strongly disagree	strongly disagree

Q	**Addrs**	**Y-Live**	**Age**	**Sex**	**Educ**	**Income**	**Felt EQ.**	**# EQ. felt**	**When last EQ.**
257	N-Marj	>21	21-30	F	Colg	50>	Yes	2	1-12M
258	N-Marj	>21	31-40	F	Colg	50 - 125	Yes	2	1-12M
259	N-Marj	1-5	21-30	F	Colg	250<	Yes	3	1-10Y
260	N-Marj	>21	21-30	F	Colg	50 - 125	Yes	2	1-10Y
261	N-Marj	16-20	15-20	F	Colg		No	0	0
262	N-Marj	16-20	15-20	M	Colg	50 - 125	No	0	0
263	Farm	16-20	21-30	M	Colg	250<	Yes	2	1-12M
264	N-Marj	1-5	21-30	M	Colg	125 - 250	Yes	1	1-10Y
265	N-Marj	>21	21-30	M	Colg	50 - 125	Yes	4mor	1-12M
266	N-Marj	>21	21-30	M	Colg	50 - 125	Yes	4mor	1-10Y
267	N-Marj	16-20	15-20	F	Colg	50 - 125	Yes	1	1-12M
268	N-Marj	>21	21-30	M	Colg	125 - 250	Yes	1	1-10Y
269	N-Marj	16-20	21-30	F	Colg	125 - 250	Yes	1	1-12M
270	N-Marj	16-20	21-30	M	Colg	125 - 250	Yes	4mor	1-10Y
271	Farm	11-15	15-20	M	Colg	250<	Yes	3	1-12M
272	N-Marj	16-20	21-30	M	Colg	50 - 125	Yes	3	1-12M
273	Farm	>21	21-30	M	Colg	50 - 125	Yes	4mor	1-12M
274	N-Marj	1-5	21-30	F	Colg	50>	Yes	2	1-12M
275	N-Marj	>21	21-30	M	Colg	50>	Yes	2	1-12M
276	N-Marj	>21	21-30	M	Colg	125 - 250	Yes	3	1-10Y
277	N-Marj	>21	21-30	M	Colg	50>	Yes	4mor	1-12M
278	N-Marj	11-15	15-20	F	Colg	50>	Yes	4mor	1-10Y
279	Farm	11-15	15-20	F	Colg	50>	Yes	1	1-10Y
280	N-Marj	>21	15-20	M	Colg	50>	Yes	2	1-12M
281	N-Marj	>21	21-30	M	Colg	250<	Yes	3	1-10Y
282	Farm	6-10	15-20	M	Colg	50 - 125	Yes	1	1-10Y
283	Farm	16-20	21-30	M	Colg	125 - 250	Yes	1	1-12M
284	N-Marj	16-20	21-30	M	Colg	50>	Yes	1	1-10Y
285	Farm	16-20	15-20	F	Colg	125 - 250	Yes	2	1-12M
286	N-Marj	>1-5	15-20	F	Colg	50 - 125	Yes	2	1-12M
287	N-Marj	16-20	15-20	F	Colg	50 - 125	Yes	2	1-12M
288	O-Marj	>21	15-20	F	Colg	50>	Yes	3	1-12M
289	N-Marj	>21	15-20	F	Colg	50>	Yes	3	1-12M
290	Farm	>21	15-20	F	Colg	50>	Yes	2	1-12M
291	N-Marj	>21	15-20	M	Colg	50>	Yes	2	1-12M
292	N-Marj	6-10	15-20	M	Colg	50>	Yes	3	1-12M
293	N-Marj	>21	15-20	M	Colg	125 - 250	Yes	2	1-12M

Q	What Did	Will EQ.	When next EQ.	Why EQ. happen	Dange rous in	Safer place	Aware E. S.
257	Other	I don't know	God know	I don't know	N-Marj	U-table	No
258	Scream	I don't know	God know	I don't know	O-Marj	U-table	No
259	Nothing	I don't know	God know	I don't know	N-Marj	Othr	No
260	Scream	Yes	God know	tectonic slip	N-Marj	Cornr	No
261	0	0	God know	I don't know	O-Marj	1st Flr	No
262	0	0	God know	I don't know	O-Marj	1st Flr	No
263	Pray	I don't know	God know	I don't know	Farm	1st Flr	Yes
264	Nothing	I don't know	God know	Allah test	O-Marj	Othr	No
265	Nothing	I don't know	God know	tectonic slip	O-Marj	Halway	No
266	Pray	I don't know	God know	Allah test	O-Marj	Othr	No
267	Nothing	I don't know	God know	tectonic slip	Farm	Cornr	No
268	Nothing	I don't know	God know	tectonic slip	Farm	Halway	No
269	Pray	I don't know	God know	I don't know	N-Marj	1st Flr	Yes
270	Pray	I don't know	God know	Allah punish	O-Marj	Halway	No
271	Nothing	I don't know	God know	tectonic slip	Farm	Cornr	No
272	Nothing	I don't know	God know	I don't know	O-Marj	1st Flr	No
273	Nothing	Yes	God know	tectonic slip	N-Marj	Othr	No
274	Pray	I don't know	God know	tectonic slip	Farm	Othr	No
275	Nothing	I don't know	God know	Allah punish	O-Marj	Halway	No
276	Scream	I don't know	God know	Allah test	N-Marj	U-table	No
277	Nothing	I don't know	God know	Allah test	N-Marj	Cornr	No
278	Pray	I don't know	God know	I don't know	O-Marj	1st Flr	No
279	Nothing	I don't know	God know	I don't know	O-Marj	1st Flr	No
280	Nothing	I don't know	God know	I don't know	O-Marj	Othr	No
281	Nothing	I don't know	God know	I don't know	O-Marj	Halway	No
282	Nothing	Yes	Years	Allah punish	O-Marj	Othr	No
283	Nothing	I don't know	God know	I don't know	O-Marj	Othr	No
284	Nothing	I don't know	God know	I don't know	O-Marj	Cornr	No
285	Nothing	I don't know	God know	I don't know	O-Marj	Othr	No
286	Pray	I don't know	God know	tectonic slip	N-Marj	U-table	No
287	Pray	Yes	God know	I don't know	O-Marj	Cornr	No
288	Other	Yes	God know	I don't know	O-Marj	1st Flr	No
289	Scream	I don't know	God know	I don't know	O-Marj	Othr	No
290	Pray	I don't know	God know	tectonic slip	O-Marj	U-table	No
291	Pray	I don't know	God know	I don't know	O-Marj	1st Flr	Yes
292	Nothing	I don't know	God know	I don't know	O-Marj	Cornr	No
293	Pray	Yes	Years	Allah test	O-Marj	Othr	No

Q	**Building Type**	**Own House**	**know EQ.**	**Get information**	**Gov. is prepared**	**House is Safe**
257	Concrete	Family	Some	Net	strongly disagree	agree
258	Concrete	Family	Little	Net	strongly disagree	agree
259	Re-Concrete	Family	Little	TV	no opinion	strongly disagree
260	Concrete	Family	Little	TV	strongly disagree	disagree
261	Re-Concrete	Family	Little	Net	strongly disagree	agree
262	Adobe brick	Family	Little	Net	no opinion	agree
263	Re-Concrete	Family	Nothing	TV	strongly disagree	disagree
264	Concrete	Family	Little	Religious/B	strongly disagree	no opinion
265	Concrete	Family	Little	Since Papers	agree	strongly agree
266	Concrete	Family	Nothing	Other people	no opinion	strongly agree
267	Re-Concrete	Family	Little	TV	strongly disagree	strongly disagree
268	Re-Concrete	Family	Nothing	Net	no opinion	no opinion
269	Adobe brick	Family	Nothing	TV	strongly disagree	disagree
270	Re-Concrete	Family	Little	Net	strongly disagree	agree
271	Concrete	Family	Some	Net	strongly disagree	strongly agree
272	Concrete	Family	Nothing	Gov. brochure	disagree	no opinion
273	Concrete	I	Much	Other people	disagree	agree
274	Adobe brick	Landlord	Nothing	Radio	strongly disagree	no opinion
275	Re-Concrete	Family	Little	Radio	strongly disagree	no opinion
276	Re-Concrete	I	Nothing	Net	strongly disagree	disagree
277	Concrete	Family	Little	Net	strongly disagree	disagree
278	Re-Concrete	Family	Little	Other people	no opinion	strongly disagree
279	Re-Concrete	Family	Little	Other people	no opinion	strongly disagree
280	Concrete	Family	Little	Other people	strongly disagree	no opinion
281	Concrete	I	Little	Other people	strongly disagree	strongly disagree
282	Concrete	Family	Little	Other people	disagree	agree
283	Concrete	Family	Nothing	Since Papers	no opinion	no opinion
284	Re-Concrete	Family	Nothing	Net	disagree	agree
285	Concrete	Family	Some	Other people	strongly disagree	agree
286	Re-Concrete	Gov.	Some	Radio	disagree	strongly disagree
287	Re-Concrete	Family	Little	Radio	strongly disagree	agree
288	Adobe brick	Family	Much	Other people	strongly disagree	strongly disagree
289	Adobe brick	Family	Nothing	Other people	strongly disagree	strongly disagree
290	Re-Concrete	Family	Nothing	Net	agree	agree
291	Concrete	Family	Little	Net	strongly disagree	agree
292	Concrete	Family	Some	Religious books	disagree	disagree
293	Adobe brick	Family	Little	Radio	strongly disagree	disagree

Q	**Neighborhood Safe**	**Frightened**	**I am prepared**	**EQ. threat**
257	no opinion	strongly agree	strongly disagree	strongly agree
258	disagree	strongly agree	no opinion	strongly agree
259	strongly disagree	strongly disagree	no opinion	strongly disagree
260	strongly disagree	strongly disagree	no opinion	strongly disagree
261	agree	disagree	no opinion	agree
262	disagree	agree	disagree	no opinion
263	strongly disagree	strongly agree	agree	no opinion
264	agree	strongly disagree	no opinion	agree
265	no opinion	strongly agree	no opinion	agree
266	agree	disagree	agree	no opinion
267	disagree	no opinion	strongly disagree	disagree
268	strongly agree	strongly agree	strongly disagree	strongly agree
269	agree	no opinion	disagree	agree
270	agree	strongly agree	agree	no opinion
271	strongly agree	no opinion	no opinion	strongly agree
272	disagree	no opinion	agree	no opinion
273	strongly disagree	strongly disagree	strongly disagree	strongly disagree
274	strongly disagree	agree	strongly disagree	strongly agree
275	strongly agree	disagree	agree	no opinion
276	no opinion	agree	strongly agree	agree
277	no opinion	agree	strongly agree	strongly agree
278	no opinion	disagree	no opinion	strongly disagree
279	no opinion	disagree	no opinion	strongly disagree
280	no opinion	disagree	strongly agree	no opinion
281	strongly disagree	strongly disagree	strongly disagree	strongly agree
282	strongly agree	disagree	disagree	strongly disagree
283	no opinion	no opinion	no opinion	
284	disagree	strongly agree	no opinion	agree
285	disagree	agree	strongly disagree	agree
286	strongly disagree	no opinion	no opinion	strongly agree
287	strongly disagree	agree	strongly disagree	strongly disagree
288	strongly disagree	strongly disagree	strongly agree	no opinion
289	strongly disagree	strongly agree	strongly disagree	agree
290	strongly disagree	strongly agree	strongly agree	agree
291	disagree	no opinion	disagree	agree
292	strongly disagree	agree	no opinion	agree
293	agree	no opinion	strongly disagree	disagree

Q	**Laws safety exist**	**City is prepared**	**Education Role**	**Preventive measures Role**
257	no opinion	no opinion	strongly agree	strongly agree
258	strongly disagree	agree	agree	agree
259	strongly disagree	disagree	agree	agree
260	strongly disagree	disagree	agree	agree
261	strongly disagree	agree	disagree	no opinion
262	agree	strongly agree	no opinion	no opinion
263	disagree	strongly agree	agree	disagree
264	strongly disagree	strongly disagree	agree	agree
265	no opinion	agree	agree	strongly agree
266	strongly disagree	strongly disagree	no opinion	no opinion
267	strongly disagree	no opinion		no opinion
268	strongly agree	no opinion	agree	agree
269	disagree	agree	strongly agree	no opinion
270	strongly disagree	disagree	strongly agree	no opinion
271	no opinion	no opinion	agree	strongly agree
272	agree	strongly disagree	disagree	disagree
273	disagree	agree	strongly agree	strongly agree
274	strongly disagree	disagree	agree	disagree
275	disagree	no opinion	agree	no opinion
276	strongly disagree	disagree	no opinion	no opinion
277	agree	no opinion	disagree	strongly disagree
278	no opinion	strongly disagree	no opinion	no opinion
279	no opinion	agree	strongly agree	no opinion
280	strongly disagree	strongly disagree	agree	agree
281	strongly disagree	strongly disagree	strongly agree	agree
282	disagree	strongly disagree	strongly agree	strongly agree
283	no opinion	no opinion	no opinion	no opinion
284	no opinion	disagree	strongly disagree	no opinion
285	strongly disagree	no opinion	disagree	agree
286	strongly agree	strongly disagree	no opinion	disagree
287	disagree	disagree	agree	strongly agree
288	strongly disagree	strongly disagree	strongly agree	strongly disagree
289	strongly agree	strongly disagree	strongly agree	strongly agree
290	disagree	disagree	strongly agree	strongly disagree
291	no opinion	agree	strongly agree	strongly agree
292	strongly agree	no opinion	strongly agree	strongly agree
293	strongly disagree	strongly disagree	strongly disagree	disagree

Q	**Building Codes exist**	**Citizens have a responsibility**	**Preparedness Gov. duty**	**Buildings built better**
257	no opinion	agree	no opinion	no opinion
258	strongly agree	strongly disagree	agree	agree
259	agree	agree	disagree	strongly disagree
260	agree	agree	disagree	strongly disagree
261	strongly agree	agree	disagree	strongly disagree
262	strongly agree	no opinion	agree	no opinion
263	strongly disagree	no opinion	strongly disagree	no opinion
264	agree	strongly disagree	strongly disagree	agree
265	no opinion	no opinion	disagree	agree
266	strongly disagree	strongly disagree	no opinion	strongly disagree
267	no opinion	no opinion	agree	no opinion
268	no opinion	no opinion	no opinion	no opinion
269	no opinion	agree	no opinion	no opinion
270	disagree	agree	disagree	agree
271	strongly agree	no opinion	no opinion	agree
272	disagree	agree	disagree	no opinion
273	strongly agree	agree	strongly agree	strongly disagree
274	no opinion	disagree	strongly agree	agree
275	disagree	strongly disagree	strongly disagree	disagree
276	disagree	strongly disagree	disagree	strongly disagree
277	disagree	no opinion	agree	strongly agree
278	no opinion	no opinion	disagree	no opinion
279	strongly agree	agree	disagree	agree
280	strongly agree	disagree	disagree	no opinion
281	strongly disagree	strongly agree	strongly disagree	agree
282	disagree	agree	disagree	disagree
283	no opinion	no opinion	no opinion	no opinion
284	disagree	disagree	no opinion	agree
285	disagree	strongly disagree	strongly disagree	strongly disagree
286	agree	agree	strongly disagree	strongly disagree
287	strongly agree	no opinion	strongly disagree	disagree
288	strongly disagree	strongly disagree	strongly agree	agree
289	strongly disagree	strongly agree	agree	disagree
290	strongly disagree	strongly disagree	disagree	strongly disagree
291	agree	disagree	disagree	agree
292	no opinion	no opinion	strongly disagree	no opinion
293	disagree	agree	strongly disagree	disagree

Q	**Preparedness against faith**	**EQ. safety not Com. priorities**	**EQ. safety not Gov. Priorities**
257	strongly disagree	strongly disagree	strongly disagree
258	strongly agree	strongly disagree	strongly disagree
259	strongly disagree	strongly disagree	strongly disagree
260	strongly disagree	strongly disagree	strongly disagree
261	strongly agree	no opinion	strongly agree
262	agree	disagree	agree
263	disagree	agree	strongly agree
264	strongly disagree	strongly disagree	agree
265	no opinion	disagree	strongly disagree
266	no opinion	no opinion	no opinion
267	no opinion	no opinion	no opinion
268	no opinion	strongly disagree	strongly disagree
269	agree	no opinion	no opinion
270	agree	disagree	no opinion
271	no opinion	agree	disagree
272	strongly disagree	disagree	disagree
273	strongly disagree	strongly agree	agree
274	no opinion	agree	disagree
275	no opinion	disagree	strongly agree
276	disagree	no opinion	agree
277	agree	strongly disagree	no opinion
278	strongly disagree	strongly agree	strongly agree
279	strongly disagree	disagree	disagree
280	disagree	disagree	agree
281	no opinion	strongly disagree	strongly disagree
282	disagree	strongly disagree	strongly disagree
283	no opinion	no opinion	no opinion
284	disagree	disagree	disagree
285	agree	disagree	agree
286	strongly disagree	strongly disagree	disagree
287	disagree	strongly disagree	strongly disagree
288	strongly disagree	strongly disagree	strongly disagree
289	strongly disagree	no opinion	agree
290	agree	agree	agree
291	no opinion	strongly disagree	strongly disagree
292	no opinion	strongly disagree	strongly disagree
293	disagree	disagree	disagree

Q	**Addrs**	**Y-Live**	**Age**	**Sex**	**Edu**	**Income**	**Felt EQ.**	**# EQ. felt**	**When last EQ.**
294	N-Marj	16-20	41-50	M	M-H	50 - 125	Yes	4mor	1-12M
295	N-Marj	>21	31-40	F	Mstr	250<	Yes	1	1-10Y
296	O-Marj	>21	21-30	M	Colg	125 - 250	Yes	2	1-12M
297	O-Marj	16-20	15-20	M	Colg	50>	Yes	1	1-10Y
298	N-Marj	>21	21-30	M	Colg	50 - 125	Yes	2	1-12M
299	Farm	11-15	21-30	M	Colg	50>	Yes	4mor	1-12M
300	N-Marj	>21	21-30	M	Colg	250<	Yes	4mor	1-10Y
301	Farm	>21	21-30	M	Colg	50>	Yes	1	1-12M
302	N-Marj	>21	15-20	M	Colg	50>	Yes	2	1-10Y
303	N-Marj	>21	21-30	M	Colg	50>	Yes	1	1-10Y
304	N-Marj	>21	21-30	M	Colg	250<	Yes	2	1-12M
305	N-Marj	>21	21-30	M	Colg	125 - 250	Yes	3	1-12M
306	Farm	16-20	15-20	M	Colg	50 - 125	Yes	2	1-12M
307	Farm	16-20	15-20	F	Colg	50>	Yes	2	1-12M
308	Farm	>21	21-30	F	Colg	50>	Yes	2	1-12M
309	Farm	>21	31-40	F	M-H	50>	Yes	2	1-10Y
310	N-Marj	1-5	15-20	F	Colg	250<	Yes	2	1-10Y
311	N-Marj	>21	21-30	F	Colg	50>	Yes	2	1-12M
312	Farm	>21	21-30	F	Colg	50>	Yes	3	1-12M
313	Farm	11-15	15-20	F	Colg	50 - 125	Yes	2	1-10Y
314	N-Marj	>21	21-30	F	Colg	50>	Yes	2	1-12M
315	Farm	>21	31-40	M	Colg	125 - 250	Yes	1	1-12M
316	O-Marj	16-20	41-50	F	Colg	50>	Yes	3	1-10Y
317	N-Marj	1-5	15-20	F	Colg	50>	Yes	1	1-10Y
318	O-Marj	16-20	21-30	M	Colg	50 - 125	Yes	4mor	1-12M
319	Farm	>21	15-20	M	Colg	50>	Yes	1	1-12M
320	Farm	16-20	21-30	F	Colg	50>	Yes	1	1-10Y
321	N-Marj	16-20	15-20	F	M-H	50>	Yes	1	1-10Y
322	N-Marj	>21	21-30	M	Colg	50 - 125	Yes	3	1-10Y
323	N-Marj	>21	21-30	M	Mstr	125 - 250	Yes	4mor	1-12M
324	N-Marj	16-20	15-20	M	M-H	50>	Yes	1	1-12M
325	N-Marj	16-20	15-20	M	Colg	50 - 125	Yes	2	1-12M
326	N-Marj	>21	21-30	M	Colg	50 - 125	Yes	3	1-12M
327	N-Marj	>21	21-30	F	Colg	50>	Yes	2	1-10Y
328	N-Marj	>21	21-30	M	Colg	50 - 125	Yes	1	1-12M
329	Farm	>21	21-30	F	Colg	50>	Yes	3	1-12M
330	N-Marj	>21	21-30	F	Colg	50>	Yes	2	11-20Y

Q	**What Did**	**Will EQ.**	**When next EQ.**	**Why EQ. happen**	**Dange rous in**	**Safer place**	**Aware E. S.**
294	Nothing	I don't know	God know	I don't know	O-Marj	Cornr	No
295	Scream	I don't know	God know	I don't know	O-Marj	1st Flr	No
296	Nothing	I don't know	God know	tectonic slip	O-Marj	Cornr	No
297	Nothing	I don't know	God know	Allah test	N-Marj	Cornr	No
298	Nothing	I don't know	God know	Allah test	Farm	1st Flr	No
299	Pray	I don't know	God know	tectonic slip	N-Marj	Cornr	No
300	Nothing	I don't know	God know	I don't know	O-Marj	Cornr	No
301	Nothing	I don't know	God know	I don't know	O-Marj	Othr	Yes
302	Nothing	I don't know	God know	Allah test	O-Marj	Othr	No
303	Nothing	I don't know	God know	I don't know	O-Marj	1st Flr	No
304	Nothing	I don't know	God know	tectonic slip	N-Marj	Cornr	No
305	Pray	I don't know	God know	Allah punish	O-Marj	Cornr	No
306	Nothing	I don't know	God know	Allah test	Farm	Othr	No
307	Nothing	I don't know	God know	Allah test	O-Marj	Othr	No
308	Nothing	Yes	God know	I don't know	O-Marj	Othr	No
309	Pray	I don't know	God know	Allah test	O-Marj	Othr	No
310	Nothing	Yes	God know	tectonic slip	O-Marj	U-table	No
311	Pray	Yes	God know	I don't know	O-Marj	1st Flr	No
312	Pray	Yes	God know	tectonic slip	O-Marj	Cornr	No
313	Scream	Yes	God know	Allah test	Farm	Othr	No
314	Pray	I don't know	God know	I don't know	O-Marj	1st Flr	No
315	Nothing	I don't know	God know	tectonic slip	O-Marj	U-table	No
316	Pray	Yes	God know	Allah test	O-Marj	Cornr	No
317	Scream	Yes	God know	I don't know	N-Marj	1st Flr	No
318	Pray	Yes	God know	Allah punish	O-Marj	Cornr	No
319	Pray	I don't know	God know	Allah test	Farm	U-table	No
320	Scream	I don't know	God know	tectonic slip	O-Marj	U-table	No
321	Nothing	I don't know	God know	Allah punish	O-Marj	Cornr	Yes
322	Pray	Yes	God know	tectonic slip	O-Marj	Cornr	No
323	Pray	Yes	God know	Allah test	O-Marj	U-table	Yes
324	Nothing	I don't know	God know	I don't know	N-Marj	1st Flr	No
325	Nothing	I don't know	God know	I don't know	O-Marj	Cornr	No
326	Nothing	I don't know	God know	I don't know	O-Marj	Cornr	No
327	Scream	I don't know	God know	I don't know	N-Marj	Cornr	No
328	Cover	I don't know	God know	tectonic slip	O-Marj	1st Flr	No
329	Pray	Yes	God know	Allah test	O-Marj	1st Flr	No
330	Pray	I don't know	God know	I don't know	O-Marj	Othr	No

Q	**Building Type**	**Own House**	**know EQ.**	**Get information**	**Gov. is prepared**	**House is Safe**
294	Re-Concrete	I	Nothing	Net	strongly disagree	disagree
295	Re-Concrete	Family	Nothing	Net	strongly disagree	strongly disagree
296	Re-Concrete	Family	Some	TV	strongly disagree	agree
297	Concrete	Family	Little	TV	strongly disagree	agree
298	Re-Concrete	Family	Nothing	Net	strongly disagree	strongly disagree
299	Concrete	Family	Little	Net	agree	disagree
300	Concrete	Family	Little	Since Papers	disagree	agree
301	Re-Concrete	Family	Little	Net	strongly disagree	agree
302	Concrete	I	Nothing	Net	disagree	disagree
303	Re-Concrete	Family	Little	Net	strongly disagree	agree
304	Re-Concrete	Family	Some	Net	strongly disagree	strongly agree
305	Re-Concrete	Family	Some	Net	strongly disagree	agree
306	Concrete	Family	Little	Radio	strongly disagree	disagree
307	Concrete	Family	Nothing	Net	disagree	agree
308	Re-Concrete	Family	Some	Net	disagree	agree
309	Re-Concrete	Family	Little	Net	disagree	agree
310	Adobe brick	Family	Some	Net	no opinion	disagree
311	Adobe brick	Family	Little	Net	strongly disagree	no opinion
312	Concrete	Family	Nothing	Net	no opinion	no opinion
313	Concrete	Family	Much	Net	no opinion	disagree
314	Concrete	Family	Much	Net	strongly disagree	no opinion
315	Concrete	I	Little	TV	strongly disagree	disagree
316	Adobe brick	Gov.	Nothing	Net	disagree	disagree
317	Adobe brick	Family	Nothing	TV	strongly disagree	no opinion
318	Concrete	Family	Nothing	TV	disagree	disagree
319	Concrete	Family	Nothing	Net	disagree	strongly disagree
320	Concrete	Family	Little	Since Papers	no opinion	agree
321	Concrete	Family	Some	Other people	strongly disagree	disagree
322	Re-Concrete	I	Little	Net	disagree	agree
323	Re-Concrete	Family	Much	Net	disagree	agree
324	Other	Family	Little	Other people	strongly disagree	disagree
325	Re-Concrete	I	Nothing	Since Papers	disagree	no opinion
326	Re-Concrete	Family	Some	Radio	no opinion	no opinion
327	Re-Concrete	Family	Little	Other people	no opinion	disagree
328	Concrete	Family	Some	Since Papers	strongly disagree	agree
329	Clay	Family	Nothing	Other people	disagree	no opinion
330	Other	Family	Nothing	TV	no opinion	no opinion

Q	**Neighborhood Safe**	**Frightened**	**I am prepared**	**EQ. threat**
294	strongly disagree	agree	disagree	disagree
295	strongly disagree	disagree	strongly disagree	strongly disagree
296	disagree	no opinion	disagree	agree
297	disagree	no opinion	no opinion	agree
298	strongly disagree	strongly agree	strongly agree	strongly disagree
299	disagree	disagree	no opinion	agree
300	disagree	disagree	agree	strongly agree
301	agree	strongly disagree	agree	agree
302	disagree	disagree	strongly agree	agree
303	strongly agree	strongly disagree	agree	disagree
304	strongly disagree	disagree	strongly agree	disagree
305	disagree	strongly disagree	strongly disagree	agree
306	no opinion	strongly disagree	disagree	strongly disagree
307	agree	disagree	agree	no opinion
308	disagree	agree	agree	agree
309	disagree	agree	strongly disagree	strongly agree
310	disagree	agree	disagree	agree
311	no opinion	strongly agree	strongly agree	strongly agree
312	strongly disagree	strongly agree	no opinion	disagree
313	disagree	strongly disagree	strongly agree	strongly agree
314	agree	strongly agree	strongly disagree	strongly disagree
315	strongly disagree	strongly disagree	strongly agree	strongly disagree
316	disagree	agree	strongly disagree	disagree
317	strongly disagree	strongly agree	strongly disagree	strongly agree
318	disagree	no opinion	agree	disagree
319	disagree	agree	no opinion	disagree
320	agree	no opinion	disagree	no opinion
321	disagree	strongly agree	no opinion	agree
322	disagree	agree	disagree	strongly agree
323	agree	strongly disagree	strongly disagree	agree
324	disagree	strongly agree	strongly disagree	no opinion
325	disagree	disagree	strongly disagree	agree
326	strongly disagree	disagree	no opinion	strongly agree
327	disagree	agree	strongly disagree	no opinion
328	no opinion	disagree	disagree	agree
329	disagree	agree	strongly agree	strongly disagree
330	no opinion	agree	no opinion	agree

Q	**Laws safety exist**	**City is prepared**	**Education Role**	**Preventive measures Role**
294	disagree	disagree	agree	agree
295	strongly disagree	strongly disagree	no opinion	agree
296	strongly disagree	strongly disagree	strongly agree	agree
297	strongly disagree	disagree	strongly disagree	agree
298	no opinion	strongly disagree	no opinion	strongly agree
299	no opinion	no opinion	no opinion	agree
300	agree	disagree	strongly agree	strongly agree
301	strongly agree	agree	strongly agree	strongly agree
302	strongly disagree	strongly disagree	strongly agree	agree
303	agree	agree	strongly agree	strongly agree
304	disagree	disagree	no opinion	strongly disagree
305	strongly disagree	strongly disagree	strongly agree	strongly agree
306	disagree	strongly disagree	disagree	no opinion
307	strongly disagree	disagree	agree	disagree
308	disagree	disagree	agree	agree
309	strongly disagree	disagree	disagree	disagree
310	disagree	disagree	strongly agree	disagree
311	strongly disagree	strongly disagree	strongly disagree	no opinion
312	strongly disagree	disagree	strongly agree	disagree
313	no opinion	strongly disagree	strongly agree	strongly agree
314	disagree	agree	strongly agree	disagree
315	strongly disagree	strongly disagree	strongly agree	strongly agree
316	strongly disagree	disagree	no opinion	no opinion
317	strongly disagree	strongly disagree	agree	agree
318	disagree	disagree	agree	agree
319	disagree	strongly disagree	agree	strongly agree
320	no opinion	no opinion	strongly agree	agree
321	disagree	disagree	agree	agree
322	disagree	strongly disagree	strongly agree	agree
323	agree	agree	agree	agree
324	disagree	no opinion	agree	strongly agree
325	agree	no opinion	agree	agree
326	no opinion	strongly disagree	strongly agree	strongly agree
327	disagree	no opinion	agree	agree
328	agree	strongly agree	agree	strongly agree
329	no opinion	disagree	disagree	no opinion
330	no opinion	no opinion	agree	disagree

Q	**Building Codes exist**	**Citizens have a responsibility**	**Preparedness Gov. duty**	**Buildings built better**
294	agree	disagree	agree	agree
295	no opinion	no opinion	disagree	strongly disagree
296	no opinion	agree	disagree	no opinion
297	no opinion	agree	disagree	no opinion
298	strongly agree	strongly agree	strongly disagree	disagree
299	no opinion	agree	disagree	disagree
300	no opinion	agree	disagree	agree
301	no opinion	no opinion	strongly agree	
302	disagree	agree	disagree	agree
303	no opinion	disagree	strongly disagree	strongly agree
304	strongly disagree	strongly agree	strongly agree	strongly agree
305	disagree	no opinion	no opinion	disagree
306	disagree	no opinion	agree	disagree
307	strongly disagree	no opinion	strongly disagree	agree
308	no opinion	no opinion	disagree	agree
309	no opinion	no opinion	no opinion	disagree
310	disagree	disagree	disagree	agree
311	strongly disagree	strongly agree	strongly agree	strongly disagree
312	strongly disagree	no opinion	disagree	strongly agree
313	no opinion	strongly disagree	strongly disagree	strongly disagree
314	agree	strongly agree	disagree	agree
315	strongly disagree	strongly disagree	strongly agree	strongly disagree
316	no opinion	strongly disagree	strongly disagree	no opinion
317	agree	strongly disagree	disagree	no opinion
318	disagree	disagree	disagree	agree
319	strongly disagree	agree	disagree	agree
320	disagree	no opinion	disagree	agree
321	agree	disagree	strongly disagree	strongly disagree
322	agree	disagree	agree	no opinion
323	agree	strongly agree	strongly disagree	strongly disagree
324	agree	disagree	no opinion	agree
325	no opinion	disagree	agree	no opinion
326	strongly disagree	strongly disagree	agree	no opinion
327	no opinion	no opinion	no opinion	agree
328	agree	no opinion	agree	agree
329	agree	strongly disagree	no opinion	disagree
330	no opinion	no opinion	disagree	disagree

Q	**Preparedness against faith**	**EQ. safety not Com. priorities**	**EQ. safety not Gov. Priorities**
294	no opinion	agree	disagree
295	no opinion	disagree	strongly disagree
296	strongly disagree	disagree	agree
297	disagree	agree	strongly agree
298	agree	no opinion	strongly agree
299	strongly disagree	no opinion	no opinion
300	no opinion	disagree	strongly agree
301	strongly disagree	strongly disagree	strongly disagree
302	strongly disagree	strongly disagree	strongly disagree
303	strongly disagree	no opinion	no opinion
304	disagree	strongly disagree	strongly disagree
305	disagree	strongly agree	strongly agree
306	agree	no opinion	agree
307	strongly disagree	agree	disagree
308	no opinion	no opinion	no opinion
309	agree	no opinion	no opinion
310	disagree	disagree	disagree
311	strongly disagree	strongly disagree	strongly disagree
312	disagree	strongly disagree	strongly agree
313	strongly agree	strongly disagree	strongly disagree
314	agree	strongly agree	strongly agree
315	strongly disagree	strongly agree	strongly disagree
316	agree	agree	agree
317	strongly disagree	strongly disagree	strongly disagree
318	no opinion	disagree	agree
319	strongly disagree	strongly disagree	agree
320	strongly disagree	disagree	disagree
321	strongly agree	agree	agree
322	disagree	disagree	agree
323	strongly disagree	strongly disagree	strongly disagree
324	no opinion	disagree	no opinion
325	strongly agree	disagree	agree
326	strongly disagree	no opinion	strongly disagree
327	no opinion	no opinion	no opinion
328	strongly disagree	disagree	agree
329	strongly disagree	agree	no opinion
330	disagree	disagree	agree

Q	**Addrs**	**Y-Live**	**Age**	**Sex**	**Edu**	**Income**	**Felt EQ.**	**# EQ. felt**	**When last EQ.**
331	N-Marj	>21	21-30	M	Colg	50 - 125	Yes	3	1-12M
332	N-Marj	16-20	15-20	F	Colg	50>	Yes	1	1-12M
333	N-Marj	>21	31-40	M	Colg	125 - 250	Yes	2	1-12M
334	N-Marj	>21	41-50	M	Colg	250<	Yes	3	1-12M
335	Farm	16-20	31-40	M	Mstr	250<	No	0	0
336	N-Marj	11-15	21-30	M	Colg	125 - 250	Yes	4mor	1-10Y
337	N-Marj	>21	21-30	M	Colg	50 - 125	Yes	3	1-10Y
338	Farm	1-5	15-20	F	Colg	250<	Yes	1	1-12M
339	N-Marj	1-5	15-20	F	Colg	50>	Yes	2	1-10Y
340	N-Marj	>21	21-30	F	Colg	50>	Yes	2	1-10Y
341	N-Marj	6-10	15-20	F	Colg	50>	No	0	0
342	Farm	11-15	21-30	F	Colg	50>	Yes	1	1-10Y
343	Farm	>21	21-30	M	Colg	125 - 250	No	0	0
344	N-Marj	>21	21-30	F	Colg	50>	Yes	4mor	1-12M
345	N-Marj	>21	21-30	M	Colg	125 - 250	Yes	2	1-10Y
346	Farm	16-20	21-30	M	Mstr	250<	No	0	1-10Y
347	O-Marj	>21	21-30	F	Colg	50 - 125	Yes	3	1-10Y
348	N-Marj	>21	21-30	F	Colg	50>	Yes	1	1-10Y
349	N-Marj	>21	21-30	F	Colg	50>	Yes	2	1-10Y
350	O-Marj	>21	21-30	F	Colg	50 - 125	Yes	2	1-12M
351	N-Marj	>21	21-30	F	Colg	50 - 125	Yes	3	1-12M
352	Farm	16-20	15-20	M	Colg	250<	No	0	0
353	Farm	1-5	15-20	F	Colg	250<	Yes	2	1-12M
354	Farm	>21	21-30	M	Colg	125 - 250	Yes	1	1-12M
355	N-Marj	6-10	15-20	M	Colg	50>	Yes	3	1-12M
356	N-Marj	1-5	15-20	F	Colg	50 - 125	Yes	3	1-10Y
357	N-Marj	16-20	31-40	M	Colg	125 - 250	Yes	4mor	1-10Y
358	N-Marj	11-15	41-50	F	Elm	50>	Yes	4mor	1-10Y
359	N-Marj	>21	31-40	M	M-H	50 - 125	Yes	4mor	11-20Y
360	N-Marj	>21	21-30	M	M-H	50>	Yes	3	1-10Y
361	O-Marj	>21	21-30	M	Elm	50>	Yes	2	11-20Y
362	Farm	11-15	21-30	F	Mstr	125 - 250	Yes	4mor	11-20Y
363	N-Marj	16-20	15-20	F	M-H	50>	Yes	1	1-10Y
364	O-Marj	>21	15-20	F	M-H	50>	Yes	2	1-10Y

Q	What Did	Will EQ.	When next EQ.	Why EQ. happen	Dange rous in	Safer place	Aware E. S.
331	Nothing	I don't know	God know	tectonic slip	O-Marj	Cornr	No
332	Pray	I don't know	God know	Allah punish	O-Marj	Cornr	Yes
333	Pray	I don't know	God know	I don't know	O-Marj	Cornr	No
334	Nothing	I don't know	God know	I don't know	O-Marj	Othr	No
335	0	I don't know	God know	I don't know	Farm	U-table	Yes
336	Pray	I don't know	God know	Allah test	O-Marj	Cornr	No
337	Nothing	I don't know	God know	I don't know	O-Marj	Cornr	No
338	Pray	I don't know	God know	Allah test	O-Marj	U-table	Yes
339	Nothing	I don't know	God know	I don't know	Farm	U-table	No
340	Nothing	Yes	Months	Allah test	O-Marj	U-table	No
341	0	0	Years	I don't know	O-Marj	Othr	No
342	Scream	Yes	God know	tectonic slip	Farm	Cornr	No
343	0	0	God know	I don't know	O-Marj	Cornr	No
344	Nothing	Yes	God know	Allah test	O-Marj	U-table	No
345	Pray	I don't know	God know	I don't know	O-Marj	Othr	No
346	Nothing	I don't know	God know	I don't know	Farm	Othr	No
347	Pray	Yes	God know	I don't know	N-Marj	Cornr	No
348	Pray	Yes	God know	I don't know	N-Marj	Cornr	No
349	Scream	I don't know	God know	I don't know	O-Marj	1st Flr	No
350	Pray	I don't know	God know	I don't know	O-Marj	Halway	No
351	Nothing	I don't know	God know	Allah test	Farm	Othr	No
352	0	0	God know	Allah test	Farm	Halway	Yes
353	Cover	Yes	God know	I don't know	Farm	U-table	No
354	Pray	Yes	God know	tectonic slip	O-Marj	U-table	No
355	Nothing	I don't know	God know	I don't know	O-Marj	1st Flr	No
356	Cover	I don't know	God know	Allah test	O-Marj	1st Flr	No
357	Pray	I don't know	Years	Allah punish	O-Marj	1st Flr	Yes
358	Scream	I don't know	Years	Allah punish	O-Marj	1st Flr	No
359	Nothing	I don't know	God know	I don't know	O-Marj	Cornr	No
360	Scream	Yes	God know	I don't know	N-Marj	Cornr	No
361	Other	I don't know	God know	I don't know	O-Marj	1st Flr	No
362	Cover	I don't know	God know	tectonic slip	Farm	1st Flr	Yes
363	Other	I don't know	God know	Allah punish	O-Marj	Cornr	Yes
364	Scream	No	God know	Allah punish	O-Marj	1st Flr	Yes

Q	**Building Type**	**Own House**	**know EQ.**	**Get information**	**Gov. is prepared**	**House is Safe**
331	Re-Concrete	Family	Some	Other people	strongly agree	disagree
332	Clay	Landlord	Nothing	Net	disagree	agree
333	Concrete	Family	Some	TV	strongly disagree	strongly agree
334	Re-Concrete	Family	Little	TV	no opinion	strongly agree
335	Re-Concrete	Family	Little	TV	disagree	disagree
336	Adobe brick	Family	Some	Since Papers	strongly agree	strongly agree
337	Concrete	Family	Little	Other people	strongly disagree	disagree
338	Re-Concrete	Family	Little	Gov. brochure	no opinion	agree
339	Adobe brick	Family	Little	Since Papers	no opinion	no opinion
340	Adobe brick	Family	Nothing	Other people	no opinion	no opinion
341	Re-Concrete	Family	Little	Other people	no opinion	strongly disagree
342	Concrete	Family	Nothing	Net	strongly disagree	agree
343	Re-Concrete	Family	Little	Radio	disagree	agree
344	Adobe brick	Family	Little	Net	strongly disagree	disagree
345	Adobe brick	Family	Little	Radio	no opinion	strongly disagree
346	Adobe brick	I	Little	TV	strongly disagree	agree
347	Adobe brick	I	Nothing	Other people	strongly disagree	strongly agree
348	Re-Concrete	Family	Little	TV	no opinion	no opinion
349	Re-Concrete	Family	Little	Other people	no opinion	no opinion
350	Clay	Family	Nothing	Net	disagree	strongly disagree
351	Adobe brick	Family	Nothing	Net	no opinion	disagree
352	Adobe brick	Landlord	Nothing	Other people	strongly agree	strongly agree
353	Re-Concrete	Family	Little	TV	disagree	agree
354	Re-Concrete	Family	Nothing	TV	strongly disagree	agree
355	Concrete	Family	Little	TV	strongly disagree	agree
356	Re-Concrete	Family	Little	TV	no opinion	agree
357	Re-Concrete	Family	Some	Radio	strongly disagree	strongly disagree
358	Clay	I	Nothing	TV	strongly disagree	strongly disagree
359	Adobe brick	Gov.	Nothing	Other people	strongly disagree	strongly disagree
360	Adobe brick	Family	Little	TV	strongly disagree	strongly disagree
361	Concrete	Gov.	Nothing	Radio	strongly disagree	no opinion
362	Re-Concrete	Gov.	Little	Net	strongly disagree	strongly disagree
363	Concrete	Family	Some	Other people	strongly disagree	disagree
364	Clay	Family	Nothing	TV	agree	agree

Q	**Neighborhood Safe**	**Frightened**	**I am prepared**	**EQ. threat**
331	strongly disagree	agree	agree	no opinion
332	disagree	strongly agree	no opinion	strongly disagree
333	strongly agree	strongly disagree	strongly agree	strongly disagree
334	disagree	strongly disagree	agree	no opinion
335	no opinion	strongly disagree	strongly agree	strongly disagree
336	strongly agree	strongly disagree		strongly agree
337	disagree	no opinion	disagree	agree
338	no opinion	strongly agree	strongly disagree	strongly agree
339	agree	strongly disagree	agree	no opinion
340	no opinion	agree		agree
341	no opinion	no opinion	no opinion	no opinion
342	disagree	agree	agree	agree
343	strongly disagree	disagree	strongly disagree	strongly agree
344	strongly disagree	no opinion	no opinion	agree
345	agree	agree	strongly disagree	strongly disagree
346	strongly agree	strongly disagree	agree	strongly disagree
347	no opinion	agree	agree	agree
348	no opinion	disagree	agree	no opinion
349	no opinion	agree	agree	no opinion
350	disagree	agree	no opinion	agree
351	disagree	agree	disagree	no opinion
352	strongly agree	strongly agree	strongly agree	agree
353	disagree	disagree	agree	agree
354	no opinion	no opinion	agree	agree
355	agree	strongly disagree	agree	strongly agree
356	no opinion	strongly agree	strongly disagree	strongly agree
357	strongly disagree	strongly disagree	disagree	disagree
358	strongly disagree	agree	disagree	no opinion
359	strongly disagree	no opinion	no opinion	strongly agree
360	strongly disagree	no opinion	no opinion	strongly disagree
361	agree	agree	no opinion	strongly disagree
362	strongly disagree	strongly disagree	strongly disagree	strongly disagree
363	disagree	strongly agree	no opinion	agree
364	strongly agree	strongly agree	strongly agree	agree

Q	Laws safety exist	City is prepared	Education Role	Preventive measures Role
331	no opinion	strongly agree	strongly disagree	agree
332	agree	disagree	agree	strongly agree
333	strongly disagree	strongly disagree	strongly agree	strongly agree
334	strongly disagree	disagree	agree	agree
335	strongly disagree	no opinion	strongly disagree	agree
336	strongly agree	strongly agree	no opinion	no opinion
337	strongly disagree	disagree	agree	agree
338	no opinion	no opinion	strongly agree	strongly agree
339	disagree	no opinion	agree	no opinion
340	no opinion	no opinion	no opinion	no opinion
341	no opinion	no opinion	no opinion	no opinion
342	strongly agree	disagree	no opinion	disagree
343	strongly disagree	strongly disagree	strongly agree	strongly agree
344	strongly disagree	strongly disagree	agree	agree
345	strongly disagree	agree	agree	agree
346	strongly disagree	disagree	strongly agree	strongly agree
347	agree	no opinion	no opinion	agree
348	no opinion	no opinion	agree	no opinion
349	strongly agree	no opinion	agree	agree
350	no opinion	no opinion	disagree	strongly disagree
351	disagree	disagree	agree	agree
352	agree	strongly agree	strongly agree	agree
353	no opinion	no opinion	no opinion	agree
354	strongly disagree	strongly disagree	agree	strongly disagree
355	disagree	strongly disagree	agree	strongly agree
356	no opinion	no opinion	strongly agree	agree
357	disagree	disagree	strongly agree	agree
358	disagree	no opinion	agree	strongly agree
359	strongly disagree	strongly disagree	strongly disagree	strongly disagree
360	strongly disagree	strongly disagree	disagree	agree
361	disagree	strongly agree	agree	disagree
362	strongly disagree	disagree	no opinion	no opinion
363	disagree	disagree	agree	agree
364	no opinion	disagree	strongly disagree	strongly disagree

Q	**Building Codes exist**	**Citizens have a responsibility**	**Preparedness Gov. duty**	**Buildings built better**
331	disagree	strongly disagree	agree	agree
332	strongly disagree	no opinion	agree	strongly agree
333	strongly disagree	strongly disagree	strongly disagree	strongly agree
334	agree	agree	disagree	strongly agree
335	agree	agree	disagree	agree
336	strongly agree	agree	disagree	agree
337	no opinion	agree	disagree	agree
338	no opinion	agree	strongly disagree	agree
339	no opinion	agree	agree	no opinion
340	no opinion	strongly agree	no opinion	no opinion
341	no opinion	no opinion	no opinion	no opinion
342	disagree	no opinion	agree	disagree
343	strongly disagree	agree	strongly disagree	strongly disagree
344	strongly disagree	strongly disagree	strongly disagree	agree
345	agree	strongly disagree	agree	agree
346	no opinion	no opinion	agree	no opinion
347	agree	agree	agree	agree
348	agree	agree	agree	strongly disagree
349	agree	agree	no opinion	agree
350	agree	agree	agree	agree
351	disagree	disagree	agree	agree
352	strongly agree	agree	strongly agree	agree
353	no opinion	agree	no opinion	agree
354	agree	strongly disagree	agree	agree
355	no opinion	no opinion	strongly disagree	strongly disagree
356	no opinion	no opinion	agree	agree
357	no opinion	disagree	strongly disagree	disagree
358	disagree	agree	disagree	strongly disagree
359	strongly disagree	strongly disagree	strongly disagree	strongly disagree
360	strongly agree	no opinion	strongly disagree	no opinion
361	no opinion	strongly disagree	strongly agree	agree
362	agree	agree	no opinion	no opinion
363	agree	disagree	strongly disagree	strongly disagree
364	strongly disagree	disagree	disagree	no opinion

Q	**Preparedness against faith**	**EQ. safety not Com. priorities**	**EQ. safety not Gov. Priorities**
331	strongly disagree	disagree	strongly disagree
332	strongly disagree	agree	disagree
333	strongly disagree	strongly disagree	strongly disagree
334	strongly disagree	agree	agree
335	agree	disagree	agree
336	strongly agree	no opinion	strongly disagree
337	disagree	strongly disagree	strongly disagree
338	no opinion	disagree	no opinion
339	no opinion	strongly disagree	no opinion
340	agree	strongly disagree	strongly disagree
341	no opinion	no opinion	no opinion
342	no opinion	disagree	disagree
343	strongly disagree	disagree	disagree
344	no opinion	strongly disagree	strongly disagree
345	agree	agree	agree
346	no opinion	agree	agree
347	disagree	disagree	disagree
348	agree	strongly disagree	strongly disagree
349	agree	agree	strongly disagree
350	no opinion	strongly disagree	strongly disagree
351	disagree	agree	disagree
352	strongly agree	agree	strongly agree
353	no opinion	disagree	no opinion
354	strongly agree	agree	strongly agree
355	no opinion	no opinion	no opinion
356	agree	strongly agree	agree
357	no opinion	agree	strongly agree
358	disagree	no opinion	agree
359	strongly disagree	strongly disagree	strongly disagree
360	disagree	strongly disagree	disagree
361	no opinion	disagree	strongly disagree
362	no opinion	strongly agree	strongly agree
363	strongly agree	agree	agree
364	agree	agree	agree

To:	Somaia Suwihli
From:	Douglas James Adams, Chair IRB Committee
Date:	09/10/2018
Action:	**Exemption Granted**
Action Date:	09/10/2018
Protocol #:	1802100625
Study Title:	Geospatial Analyses of Seismic Hazards and Risk Perception in Libya

The above-referenced protocol has been determined to be exempt.

If you wish to make any modifications in the approved protocol that may affect the level of risk to your participants, you must seek approval prior to implementing those changes. All modifications must provide sufficient detail to assess the impact of the change.

If you have any questions or need any assistance from the IRB, please contact the IRB Coordinator at 109 MLKG Building, 5-2208, or irb@uark.edu.

cc: Thomas R Paradise, Investigator

D: Photograph Archive Al-Marj, Libya

Photograph of the devastation caused by an earthquake in the eastern Libya town of Al-Marj on this day in 1963. https://twitter.com/MaryFitzger/status/966249345812172800

The residents of Al-Marj were left homeless by the 1963 Al Marj earthquake.
tamimi.own0.com/t137284-topic

Photographs of the devastation caused by the 1963 earthquake in Al-Marj, Libya.
http://tamimi.own0.com/t19653-topic. https://en.wikipedia.org/wiki/Marj

Damage in Al Marj in northeastern Libya from the 1963 earthquake.
https://commons.wikimedia.org/wiki/File:El_Marj_earthquake.JPG

The residents of Al-Marj were left homeless by the 1963 Al Marj earthquake.
tamimi.own0.com/t19653-topic

Amid utter devastation, British troops searched for life in . . .

THE TOWN THAT DIED

TORRENTIAL rain dripped from the flowering almond trees and hammered on the flimsy roofs of Arab houses as women prepared the evening meal. In the main square, the hands of the town clock ticked to 7.18 pm. Then, without warning, an earthquake struck—and the ancient Libyan farming town of Barce shook to its death.

Like some grotesque city of playing cards, Barce crumbled and collapsed helplessly in the grip of violent earth tremors. Under a hail of masonry, hundreds of families were crushed, trapped and suffocated; those who could escape from their homes stumbled blindly to open spaces away from the devastation.

Cruel nature could not have struck at a worse time. Nearly the whole of Barce was indoors, waiting to start the evening meal after a day-long fast of Ramadan, when the earthquake reduced every house to a heap of rubble, burying whole families as they sat down to eat.

More than half the town's population of 17,000 was made homeless in minutes. Only the modern Government buildings and the church held out—and even these were seriously cracked.

Within two hours of the first tremor, British soldiers answered an SOS call and left Benghazi, 60 miles away, to help with rescue operations.

First on the scene were men of "C" Company of 1st Battalion, The Devonshire and Dorset Regiment. In pouring rain and high winds they arrived at the stricken town in pitch dark. Divided into search parties of four or five men, the soldiers began the grim task of pulling injured people from beneath the wreckage and digging out bodies. Working by the light of their quarter-ton vehicles, the troops toiled with picks and shovels amid the anguished wailing of women searching for their husbands and children.

Newspapers reported the event of 1963 Al-Marj earthquake on the same day and through the week of the event.

With picks, shovels and bare hands, British troops dig for victims buried in their homes.

Nearly 300 people died in the disaster, and shifting tons of rubble became a grim job.

An emergency hospital was set up outside the town, where a team of three Royal Army Medical Corps personnel was helping, and some casualties were sent to the British Military Hospital at Benghazi. *Ferrets* of 14th/20th King's Hussars were quickly on the scene and a convoy of vehicles from 43 Independent Platoon, Royal Army Service Corps, shuttled non-stop between the airport and Barce to bring in supplies.

In Benghazi an emergency headquarters was set up to co-ordinate British, American and Libyan aid and 245 Signal Squadron established contact between the headquarters and Barce.

A new car is abandoned in a rubble-strewn street—it was wrecked within minutes by falling masonry.

This picture sums up the horror of Barce—a British soldier tunnels into the rubble in the desperate search for survivors trapped in the town of ruins.

Bewildered and homeless, these Arab children are comforted by Corporal Michael Glover in the tented refugee camp which was erected outside the dead town.

The seething, rubble-strewn town was desperately in need of blankets, tents, medical supplies, food, electricity and rescuers. Within five hours of the SOS the British Army had sent 2000 blankets, stretchers, tents and cooking utensils.

As the first fingers of light crept over the town, the full extent of the damage was revealed. By daybreak, 100 bodies had been recovered and many living victims had been rushed to hospital. In the pathetic town centre, remnants of families squatted round fires built on the ruins which had claimed their relatives while the legions of homeless were sent off to a tented refugee camp erected on the outskirts of the town.

In the daylight a systematic search of the town was organised with the help of The Devonshire and Dorset Regiment. By now the cries for help that had guided the rescuers during the night were heard no more. Quiet descended over Barce. It was a heart-breaking job for the troops. At one house a woman was found under the rubble shielding her children with her arms—they all died together.

One platoon, still searching 36 hours after the death blow, heard signs of life beneath ruins and pulled out a small dog—but the terrified animal was shot when it was found he had a broken back.

Outside the town a Royal Engineers bulldozer had the grisly job of digging a communal grave for nearly 300 people who had died in the earthquake.

A company of 1st Battalion, The Somerset and Cornwall Light Infantry, moved into Barce to give further help when the town was closed to all but the military, and a dusk-to-dawn curfew was imposed to prevent looting.

Last British troops to leave the ill-fated town were members of 245 Signal Squadron, exactly one week after the first tremor. They had been supplying power to the hospital in the Libyan Army barracks on the outskirts of the town but, following another tremor which made the area dangerous, the patients were evacuated, the hospital abandoned, and the British troops' task was completed.

Among the tributes to the work of the British Army was one from the Bishop of Benghazi, leader of the Catholic Church in Libya, who said: "Your work of mercy, in spite of danger and bad weather, will never be forgotten by those with hearts who feel, and with eyes to see. You will be remembered in our prayers for ages."

Now, engineers are drawing up plans for a new town to be built on another site, for what is left of Barce is uninhabitable. It has become a ghost town.

Newspaper reports provided a whole description of the event with the most notable effects in the epicentral area and ancillary detail. tamimi.own0.com/t137282-topic