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Analysis of Seismicity and Related Seismic Risk in Muslim Countries: Case Studies from Afghanistan and Pakistan

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Analysis of Seismicity and Related Seismic Risk in Muslim Countries: Case Studies from Afghanistan and Pakistan

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ABSTRACT

How communities respond to a natural hazard is influenced by how they perceive it. This dissertation evaluated the gap between ***intent*** and ***action*** regarding earthquake hazards in Muslim countries with a focus on Afghanistan and Pakistan. Cultural biases provided predictions of risk perceptions and risk-taking preferences that were often more powerful than measures of knowledge and experience. In Muslim communities, perception of risk was influenced by the teachings of Islam and related rituals, traditions, and culture.

This study evaluated the seismicity and earthquake hazard in Afghanistan and Pakistan. Assessments of seismic risk and perception of danger were conducted to examine experiences, knowledge, attitudes, and perceptions. In a series of surveys, assessment of perceived earthquake danger was undertaken. Findings revealed (i) an understanding collective earthquake knowledge, (ii) community preparedness for imminent quakes, and (iii) overall trust in religious and/or political institutions. Respondents demonstrated a deeply traditional, and conservative outlook bearing fatalistic attitudes toward earthquakes, and associating them with increased religious impropriety or unfaithfulness, the day of judgement, divine retribution, and punishment for the collective sins of the society.

This crucial research was then compared to similar studies from Morocco and Libya. In the assessment of seismic risk perception in these four countries study findings revealed that participants were (a) not sufficiently knowledgeable, (b) had limited earthquake knowledge had no scientific basis, (c) held strong fatalistic attitudes toward them, (d) mostly unprepared or ill-prepared, (e) governed by religious and cultural attitudes that often censured discussions of quakes, and (6) in the case of Kabul City, everyday worries of armed conflicts and political violence were reported as the primary sources of concern downplaying the dangers of an earthquake.

Key words: Afghanistan, Pakistan, earthquakes, seismic risk, risk perception, natural hazards

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DEDICATION

This entire dissertation and my journey through PhD and the rest of my life shall remain dedicated to my parents for their unwavering love and support. While the rest of the world learned to support each other through remote means to overcome COVID-19 Pandemic psychologically, I learned it long time ago. Though my parents remained 12 thousand kilometers away from me in Afghanistan and Pakistan and now in Canada, their unconditional love and support have not diminished for a minute. To their unconditional parental love and dedication to their son, I dedicate this dissertation with least hesitation.

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Chapter 6: Bahram, I. & T. R. Paradise (2020) Seismic Risk Perception Assessment of Earthquake Survivors: A Case Study from the 2005 Kashmir Earthquake. *Open Journal of Earthquake Research,* 9**,** 403-416. (Published)

Chapter 5: Bahram, I. & T. R. Paradise (2022) Earthquake Risk Perception in High Conflict Geographies: A Case Study of Kabul, Afghanistan, (In Preparation).

Chapter 7: Bahram, I., Suwihli, S. and Paradise, T. (2022) A Survey of Seismic Risk Perception in the Muslim Majority Countries of Afghanistan, Pakistan, Libya and Morocco, (In Preparation)

Due to the transliteration of English words from Dari (Farsi), Pashto, Urdu, and Tajiki, there are varied spellings for the same location throughout this dissertation. However, all attempts have been made to adhere to the most common spellings in English.

CHAPTER 1: Introduction

Humans have been continually exposed to natural hazards such as earthquakes and volcanoes (Davoudi 2014). Since the earliest descriptions of earthquakes by Chinese historians, Roman and Greek philosophers, such as, Seneca and Aristotle earthquakes have captured the imagination of people in every age (Barnikel and Vetter 2012). Earthquakes have been associated with deities (Chester 2005) and have been addressed across all religions (Chester, Duncan and Dhanhani 2013). In this discourse, hazards were seen often seen as acts of divine retribution or 'acts of God' (White 1974) and human action seemed incapable of changing these '*strokes of fate*' decreed by divine forces such as Fortuna—the Roman goddess of fate (WBGU 2000). Modernity and its *"technoscience turned what was nonhuman Nature into something contingent and coincident with human society"*, and by doing so it transformed hazards into risks. The distinction between the two lies in the role of human intervention in nature. *"Risks are made, hazards naturally occur"* (Davoudi 2014, Montz, Tobin and Hagelman 2017).

This dissertation investigated the hazard of seismicity and earthquakes, and the perception of earthquake risk in Afghanistan and Pakistan. Further, it compared and contrasted findings from these two countries with similar studies in Agadir, Morocco and Al-Marj, Libya to assess the similarities and differences in perceptions of seismic risk in these countries and evaluate the impact of cultural influences on the perceptions of seismic risk.

How a ruined community rebuilds itself after a catastrophic event like an earthquake, or would prepare to face an impending disaster may be related to how the community perceives the hazard within its cultural armature (Paradise 2005). Most earthquake research focuses on earthquake hazard, while ignoring the crucial role that individuals, communities, and institutions play in increasing or decreasing the potential earthquake risk directly or indirectly. In most cases, the victims lack any preparation to face an earthquake although they live in an earthquake prone area. Fundamental to their lack of preparedness is their attitude to seismic hazard. Influences on perception include factors as diverse as age, gender, economic well-being, level of education, voluntariness of hazard site choice, risk-taking behavior, and cultural elements.

This study assesses the perception of respondents in Kabul City, Afghanistan, and Khyber Pakhtunkhwa (KP) of Pakistan in the hopes of understanding their perceptions of seismic risk and hazard in a Muslim region within its social and cultural context – a key concept in post-event response and pre-event preparation and mitigation. The region is defined by numerous major active faults, and a history of devastating earthquake recurrence. It will probably experience more high magnitude earthquakes in the future. This dissertation attempts to understand key questions: How do the communities perceive earthquake hazard? Are they prepared for an earthquake? Do they feel safe? Further, in the case of Afghanistan, the conflict dimension of disasters makes it unique as the country struggles with an unceasing state of violence for the past four decades.

First, a comprehensive study of seismicity in Afghanistan was accomplished to understand the level of exposure of the country to earthquakes owing to its tectonic location. In the study on perception of seismic risk in Kabul City, the behavior of respondents to earthquakes was assessed. One objective was to explain how the region's Islamic culture has influenced their perception. Has formal education influenced their perception demonstrated by their response to earthquakes? Using comparative studies of seismic risk in Afghanistan, Pakistan, Libya and Morocco, similarities, and differences in responses to the same questions were analyzed.

Discourse on hazards and risk management has become part of human affairs across multiple disciplines (Garschagen et al. 2016). The debate constitutes a complex social construct and is tied to human interaction with environment. Often, it is not the earthquake hazard that delivers misery to the exposed populace but the intersection of the intricately woven social, socio-economic, and physical vulnerabilities that combine to construct a catastrophic situation.

Chapter 2 presents a review of key terms, concepts, and theories related to hazards, risks, disasters, disaster risk management, and perception studies. Distinctions are made between (a) hazards and risks, (b) how hazards interact with elements of vulnerability in a community, and (c) how they create risk and how that risk manifests in a disaster: this is elaborated from a technical as well as social perspective here. Further, how earthquake hazard and earthquake disasters interact with various factors in a community to wreak havoc is discussed. Attempts are made to describe elements and pre-existing conditions that exacerbate a disaster situation.

Scientific principles mandate a clear, and replicable methodology be adopted in studying a phenomenon. Chapter three presents the various qualitative and quantitative methods which were adopted, consulted, and implemented in achieving studies of seismic risk perception and data analyses.

In chapter 4, this study investigated the seismicity of Afghanistan to better understand earthquake hazard across the region, related tectonic areas, faults, and sources of seismicity to create a baseline of past earthquake occurrences. This represents an assessment of earthquake hazard in the country and provide an explanation of the geomorphic and tectonic elements of seismicity. Further, a comprehensive catalog of earthquakes (2002-2022) for Afghanistan and the vicinity has been compiled. The study provided a detailed review of the seismicity of Afghanistan and the region. Earthquake history of Afghanistan constrains the sites of active seismicity and helps predict where future earthquakes might occur. Further, a list of the destructive earthquakes in the past 20 years in Afghanistan indicates where earthquakes might be destructive in the future as well.

How a community perceives and evaluates its risk regarding a hazard is fundamentally important to how it would respond to it (Paradise 2006). Chapter 5 of this dissertation investigated the perception of seismic risk in Kabul City where earthquakes are poorly understood, and a high magnitude earthquake on the ‘seismic gap’ south of Kabul City could cause inconceivable losses in human capital as well as in economic terms (Bilham 2014).

A landlocked country located geographically, historically, and geopolitically in Central Asia (Khan 1998), culturally, Afghanistan is a continuation of the Middle East (Bonine 2012). What exacerbates the hazard situation in Afghanistan is that the governance has remained fragile for decades (FFP 2020) and corruption pervasive (CPI 2021). The country has consistently ranked 168 of 189 on the Human Development Index (UNDP 2018), has consistently occupied the 9th most fragile state status on the Fragile States Index for the years 2018 through 2021 and categorized ‘high alert’ (Messner et al. 2018), and has been ranked by the Transparency International in the top 10 most corrupt countries in the world (CPI 2021) ranked between 165-180 out of 180 countries since 2007.

Like Afghanistan, northwest Pakistan is transected by Quaternary active thrust faults such as Main Mantle Thrust, Main Boundary Thrust, and Main Karakoram Thrust (Hussain and Yeats 2009). Major cities and population centers such as Islamabad, Abbottabad, Gilgit City, and Skardu in the north, Quetta, and Karachi in the south are exposed to high seismic events (Bilham and Hough 2006, Szeliga et al. 2012).

The population of Pakistan is predominantly Muslim and Islam dominates all aspects of life in the country (Halvorson and Hamilton 2010). An assessment of seismic risk perceptions, presented in chapter 6, was accomplished by the analysis of survey data collected in the aftermath of the 2005 Kashmir earthquake. The quake was defined as the worst disaster in the history of Pakistan (Bendick et al. 2007, Durrani et al. 2005). Such perception studies help in identifying individual and community behavior toward future earthquakes. High levels of risk perception might encourage hazard mitigation while low levels might encourage laissez-faire (Alexander 1993). Assessments of perceptions of seismic risk in Afghanistan and Pakistan were accomplished to assess individual and communal behavior toward earthquakes, prediction of earthquakes, and mitigation against earthquakes.

Understanding the public's perception of risk is important for improving risk communications and designing effective mitigation policies (Ho et al. 2008). An individual's risk perception is valuable as it determines his/her response to a risk situation (Slovic, Fischhoff and Lichtenstein 1982). It is inadequate to evaluate risks only from the perspective of the experts (in terms of direct losses). Indirect effects need to be taken into account (Schmidt 2004, Slovic 2010). To explain risk perception, it is crucial to address several perspectives, such as, social, psychological, cultural, and their interactions (Crescimbene et al. 2015).

In chapter 7, studies of perception of risks in various countries and across Afghanistan, Pakistan, Libya, and Morocco have been evaluated, compared, and contrasted. A comprehensive comparative study of perception of hazards in general and earthquakes in the wider Muslim World has been accomplished, and a tabulated summary has been compiled. Answers to important questions such as how the perception of earthquakes in the two Southwest Asian countries of Pakistan and Afghanistan might differ from the two North African countries of Libya and Morocco which are located thousands of miles away and speak different languages and have had a different historical trajectory. What similarities might one encounter and how could those similarities and difference be explained regarding earthquakes. What cultural influences might have played a role in shaping their perceptions of earthquake hazard? Based on this study, could a statement be made regarding the perception of earthquake hazards in the Muslim World? How do similar studies in other Muslim majority countries align with findings of this study? What kind of attitudes (general) of earthquake risk could be observed? How does fatalism regarding hazards in general and earthquakes in particular influence policies, plans, and mitigation measures in these countries.

This study will finish with evidence from the individual studies integrated to compile a list of meaningful recommendations for future academic studies, improve strategies for practitioners, and seismic disaster management agencies in hopes of improving the science of seismic risk assessments, and improving seismic risk communications across vulnerable communities while taking into consideration the various cultural sensitivities, traditions, rituals, and doctrine – all in the hopes of reducing losses, and helping save lives.

CHAPTER 2: Literature Review

2.1. An Overview of Hazards

Hazard is best viewed as a naturally occurring, or human-induced, process or event with the potential to cause consequences. The consequences might include, but not be restricted to death, damages, and financial loss. Risk is the actual exposure of something of human value to a hazard and is often measured as a product of probability and loss. Thus, a *hazard* may be defined as a potential threat to humans and their welfare based on an analysis of past extreme phenomenon (or substances) that may cause loss of life, injury, damage, and other community loss or damage (Smith 2013). The concept of *risk* then implements hazards analyses to create probabilistic nature of the phenomenon, with an understanding of related consequences. Hazards use past frequency and magnitude while risk include the potential consequences associated with the hazard recurrence in an affected area and community most vulnerable to those consequences. The distinction between the two lies in the role of human intervention in nature. *"Risks are made, hazards naturally occur"* (Davoudi 2014).

UNISDR (2009) defined hazard as

> "*A dangerous phenomenon, substance, human activity or condition 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*."

Hazards arise from a variety of geological, meteorological, hydrological, oceanic, biological, and technological sources, sometimes acting in combination. Following the United Nations Office for Disaster Risk Reduction and Guha-Sapir (2016) EM-DAT classification of hazards, table 2.1 is compiled:

Table 2. 1. Classification of Hazard types after UNISDR (2009).

Hazard Class Type	***Definition***	***Examples***
Natural	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.	Earthquakes Droughts
Hydro-meteorological	Process or phenomenon of atmospheric, hydrological, or oceanographic nature 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.	Hurricanes, thunderstorms, Typhoons, hailstorms, tornados, blizzards, heavy snowfall, avalanches, storm surges, floods including flash floods, drought, heatwaves, and cold spells.
Geological	Geological 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.	Earthquakes, volcanic activity and emissions, landslides, mass movements, rockslides, surface collapses, debris, or mud flows.
Biological	Organic processes or phenomena, or those conveyed by biological vectors, including exposure to pathogenic micro-organisms, toxins and bioactive substances that may cause loss of life, injury, illness, health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.	Outbreaks of epidemic diseases, plant or animal contagion, insect or other animal plagues and infestations
Technological	A hazard originating from technological or industrial conditions, including accidents, dangerous procedures, infrastructure failures or specific human activities, that may cause loss of life, injury, illness or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.	Industrial pollution, nuclear radiation, toxic wastes, dam failures, transport accidents, factory explosions, fires, and chemical spills.

2.2. Risk and Components of Risk

Without humans in the equation, hazards are simply natural events and irrelevant (Haque and Etkin 2007). Therefore, human and societal elements are important not only because people are usually victims when extreme events occur, but also because humans define the very essence of ‘natural’ hazards (Montz et al. 2017). Also, it is important to understand that different countries experience similar hazards in very different ways. Experience shows that people’s responses to apparently similar facts (hazards) can vary widely across times, places and societies (Hewitt 2012). Exemplified by an M6.6 the Bam Earthquake of 2003 that killed 33,000 (Berberian, 2005) and a similar earthquake, an M6.9 in Northridge, California resulted in 57 deaths. The determinant of losses in both cases is physical vulnerability, i.e. variation in building typologies and building codes (Haque and Etkin 2007). Therefore, it is imperative to address risks and its components.

Risk is defined differently by experts and by layman (Slovic 1987). Defined as '*the combination of the probability of an event and its negative consequences'* risk has two distinctive connotations: in popular usage the emphasis is usually placed on the concept of chance or possibility, such as in "the risk of an accident"; whereas in technical settings the emphasis is usually placed on the consequences, in terms of "potential losses" for some cause, place and period (UNISDR 2009). However, it should be noted that people do not necessarily share the same perceptions of the significance and underlying causes of different risks (Slovic 2000). Risks are affected by human actions that increase or decrease vulnerability, such as where people live and how they build.

2.3. Vulnerability

Vulnerability is defined as 'the characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard' (UNISDR 2009). It encompasses the pre-existing conditions that make infrastructure, processes, services, and productivity prone to the impact of an external event. There are many aspects of vulnerability, arising from various physical, social, economic, and environmental factors. Examples may include poor design and construction of buildings, inadequate protection of assets, lack of public information and awareness, limited official recognition of risks and preparedness measures, and disregard for wise environmental management (Wenzel, Bendimerad and Sinha 2007). Vulnerability varies significantly within a community and over time.

The highest levels of vulnerability tend to occur amongst the poorest people living in informal settlements and inner-city slums who inhabit unsafe structures, on steep slopes or near dangerous industrial sites prone to hazards like earthquakes, landslides, and fires. Smith (2013) observed that most of the fastest growing urban centers in the world are located in earthquake-prone areas. Bilham (2014) warned of imminent big earthquakes along the Hindukush-Himalayan belt, which is home to over a billion people and multiple mega cities in South Asia including Afghanistan and Pakistan. Vulnerability in the risk equation constitutes socio-economic factors that define the impact of hazards on human systems and their environment with which they interact on a daily basis (Haque and Etkin 2007).

Three salient types of vulnerabilities are discussed hereunder:

2.3.1. Social Vulnerability

Social vulnerability accounts for the inability of people and society to withstand the effects of the multiple stresses to which they are exposed. This definition identifies vulnerability as a characteristic of the element of interest (community, system, or asset) which is independent of its exposure. However, in common use the word is often used more broadly to include the element's exposure. For example, one significant element of vulnerability in developing countries like Afghanistan and Pakistan is an uncontrolled increase in population and low-medium Human Development Index (HDI), a measure of human capital and capacity in terms of overall economic wellbeing (Guha-Sapir et al. 2016).

2.3.2. Physical Vulnerability

Physical vulnerabilities encompass the probability (or the potential) of a given physical component or element to be affected or damaged under a certain external excitation, e.g., an earthquake (Meslem and Lang 2017). It refers to the degree of susceptibility within the physical environment and as such to the negative impacts of hazards (Fuchs, Frazier and Siebeneck 2018) determined by aspects such as population density levels, remoteness of a settlement, the site, design and materials used for critical infrastructure and for housing (UNISDR 2009). It is constrained by the hazard magnitude and intensity. Peduzzi et al. (2009) noted that least developed countries represent 11% of the population exposed to hazards but account for 53% of casualties due to high physical and socio-economic vulnerabilities.

2.3.3. Socio-economic Vulnerability

Socio-economic vulnerability which encompasses the economic health of individuals, communities, and nations is an important aspect of risk. In other words, the poor are usually more vulnerable to hazards because they lack the resources to build sturdy structures in place to protect themselves from being negatively impacted by the impending hazard. This is evident in the fact that the most developed countries represent 15% of human exposure to hazards, but account only for 1.8% of all victims (Peduzzi et al. 2009). Socio-economic characteristics may influence public perception of risk in communities such as the one found in Khyber Pakhtunkhwa province of Pakistan (Qasim et al. 2015). Social vulnerability is increased for low income and low status persons, females, the elderly, young children, the rural poor and those dependent on extraction economies, those who rent, migrant workers in the service economy, large families, single-parent families, and special-needs populations (Hewitt 2012, Halvorson and Hamilton 2010, Cutter, Boruff and Shirley 2003). The differential vulnerability of women to hazards is evident in the injury and mortality data associated with such events (Garschagen et al. 2016) . For instance, in the 1991 floods in Bangladesh, five times as many women as men died; in the Southeast Asia 2004 Tsunami, death rates for women across the region averaged 3 to 4 times more than that of men. These figures reveal the ways in which women experience disproportionate levels of risk and impact owing to spatial location, patriarchy, gendered social structures, and political marginalization (Hewitt 2012).

Violent conflict is often one of the main causes of social vulnerability (Wisner 2012). In the case of Afghanistan and Tajikistan, Halvorson & Hamilton (2007) note that intense armed conflicts and political instabilities have destabilized societies and weakened the economies. War and conflict create dynamic pressure that interact with earthquake hazards in several complex ways (Wisner et al. 2004) For example, they led to the creation of a marginalized group of maimed and disabled persons due to landmines and forced displacement. Additionally, critical infrastructure, local and national institutions, and communication systems are destroyed or are made dysfunctional (Wisner 2012).

Further, a set of cultural issues hamper timely interventions for safety (Schmuck 2000). For example, the concept of *Purdah*, which requires women to cover themselves completely (Halvorson and Hamilton 2007), and *Mahram*, which requires women to avoid interacting with men outside of their immediate family male members, directly impact women and their response to hazards in countries like Afghanistan, Pakistan, Bangladesh and other Muslim majority countries. Schmuck (2000) notes that women hesitate to leave the homestead for the official shelter for the same reasons in Bangladesh. Similar findings are reported by Halvorson & Hamilton (2010) in the aftermath of Kashmir earthquake of 2005 in Pakistan. Similarly, women are the least likely to have a place to go in case of an evacuation; when given a safe place to go to, they are the least likely to have the means to get there in such communities (Wisner et al. 2004).

2.4. Exposure

People, property, systems, or other elements present in hazard zones that are thereby subject to potential losses constitute exposure (UNISDR 2009). Exposure and vulnerability to natural disasters pose a major threat to human security. It exposes individuals to the threats of physical, economic, societal, health, personal, cultural, and psychological insecurities. Exposure of population centers to hazards in the developing countries trigger considerable social, economic, and physical losses (Badri et al. 2006). Disasters bring death, displacement, and socioeconomic insecurity to the population exposed to hazards such as earthquakes, floods, debris flows and storms thereby preying on physical as well as social vulnerabilities. The impact of a disaster is compounded in communities that are already hard-hit by past or continuing disasters or human conflicts owing to their presence in the path of a recurrent hazard (Ariyabandu and Fonseka 2009). Therefore, measures of exposure may include the number of people or types of assets in an area. These can be combined with the vulnerability of the exposed elements to any hazard to estimate the quantitative risks associated with that hazard in the area of interest.

2.5. Capacity

Defined as the combination of all the strengths, attributes, and resources available within a community, a society, or an organization that can be used to achieve agreed goals (UNISDR 2009), capacity may include resources in infrastructural, physical, and institutional terms as well as societal coping abilities, human knowledge, skills, and collective attributes such as social relationships, leadership, and management. In the context of risk reduction, capacity may also be described as capability to absorb and overcome the impacts of a disaster with minimum repercussion. It may as well be defined as the ability to cope with disaster, this includes identifying positive conditions or deficiency in preparedness and coping capacity—the community's ability to cope with disaster.

2.5.1. Adaptive Capacity

Adaptive capacities refer to the social and technical skills, and strategies of individuals and groups that are impacted by a hazard and are forced to respond. In the context of disaster risk reduction, adaptive capacity is shown to maintain a minimum functioning system within a community that responds actively to the reduction of impact of the disaster in question. The ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences of hazards constitute the adaptive capacity of a community (IPCC 2014).

2.5.2. Coping Capacity

Coping capacity is the ability of a system to respond to and recover from the effects of stress or perturbations that have the potential to alter the structure or function of the system (Burkett 2013). In the context of disaster risk reduction, it is the ability of people, organizations, and systems, using available skills and resources, to face and manage adverse conditions, and emergencies. The capacity to cope requires continuing awareness, resources, and good management, both in normal times as well as during crises or adverse conditions. Higher coping capacities contribute to the reduction of disaster risks (UNISDR 2009). The capacity for coping with a natural hazard is generally inversely related to vulnerability i.e., the higher the coping capacity, the lower the vulnerability of a system, region, community, or individual (Burkett 2013). Conversely, the higher the capacity, lower is the overall risk posed to a system, community, or organization. The capacity of a system to cope with a natural hazard is determined by the ability of the system to adjust to a disturbance, moderate potential damage, take advantage of opportunities, and adapt to the consequences (Gallopín 2006). Coping capacity is an attribute of the community prior to the occurrence of a disaster event.

2.6. Hazard vs. Risk

In disaster science, ‘hazards’ are the natural occurrence of earthquakes or other phenomena over which we have no control, whereas ‘risks’ are the dangers they pose to lives and property. In this formulation, risk is the product of hazard and vulnerability (Steckler et al. 2017). Hazards use past frequency and magnitude, while risk includes the potential consequences associated with the hazard recurrence, affected area, and community most vulnerable to those consequences in the future. Important components of risk evaluation are hazards, vulnerabilities, and exposures (Wisner et al. 2004, Blaikie et al. 1994). These components have been discussed above. Thus, while hazard is defined as a naturally occurring, or human-induced, process or event with the potential to cause death, damages and financial loss, risk is the actual exposure of something of human value to a hazard and is often measured as a product of deaths, injuries, and financial damages (Smith 2013, Montz et al. 2017). Risk can be estimated using the following formula:

$$\text{Risk} \sim \frac{\text{Hazard x } (\text{Vulnerability} + \text{Exposure})}{\text{Capacity}}$$

According to this formulation, risk is directly proportional to the presence of a potential hazard, vulnerability (both physical and social), and exposure of a population to a certain hazard. In other words, risk is the combination of hazard, exposure, and vulnerability (UNDRR 2020). By the same argument, estimation of risk is inversely proportional to the capacity of a population living in a hazard zone meaning the higher the capacity of a local population, both adaptive and coping, lower shall be the risk and vice-versa. Therefore, death, loss and damage are the function of the context of hazard, exposure, and vulnerability.

2.7. Disaster

Disaster is a serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources (UNISDR 2009). This requires the activation of a hazard that causes widespread damage and losses which cannot be immediately overcome by utilizing available local resources and often require a determined effort from external sources to restore the pre-disaster situation.

Disasters are often described as a result of the combination of: a) the exposure to a hazard; b) the conditions of vulnerability that are present; and c) insufficient capacity or measures to reduce or cope with the potential negative consequences. Disaster impacts may include loss of life, injury, disease and other negative effects on human physical, mental and social well-being, together with damage to property, destruction of assets, loss of services, social and economic disruption, and environmental degradation.

While hazards owe their existence to some geophysical phenomena such as earthquakes and volcanoes, hydrometeorological processes, or a meteoric incursion, and risks exist because of these hazards causing losses to human interests, natural disasters do not happen. In fact, there is no natural disaster. When a hazard situation is exacerbated due to human activities, disasters take place. ‘There is no such thing as natural disaster, only natural hazards’ (UNDRR 2019). However, the term natural disaster is repeatedly used by academics, practitioners, policy makers, disaster managers, and layman alike. Thus, natural (or unnatural) disasters encompass a wide-ranging and often conflicting definitions. Disaster, as defined earlier, are usually associated with the extent of losses due to the activation of a hazard. They are often constrained by subjective views of the observer. Therefore, disasters constitute ‘an extreme event the management of which exceeds local capacities and resources. Quantitatively defined, disasters are constrained by the number of fatalities, injuries, economic, and environmental losses of disproportionate magnitude. And if, in the creation of disaster, a central role is determined for a natural hazard such as an earthquake, a volcano, or a tornado, or a flood, it is conveniently referred to as a natural disaster.

Center for Research on Epidemiology of Disasters (CRED) defines a disaster as “a situation or event that overwhelms local capacity, necessitating a request at the national or international level for external assistance; an unforeseen and often sudden event that causes great damage, destruction and human suffering”. For a disaster to be entered into the database, at least one of the following criteria must be fulfilled (CRED 2020):

- 10 or more people reported killed
- 100 or more people reported affected
- declaration of a state of emergency
- call for international assistance

2.8. Perception of Risk

Risk perception has been defined as people’s beliefs, attitudes, judgments, and feelings, as well as the wider social or cultural values and dispositions that people adopt, towards hazards and their consequences (Pidgeon et al. 1992). In general terms, risk perception can be considered as an individual’s interpretation or impression based on an understanding of a threat that may potentially cause loss of life or property (Ainuddin and Mukhtar 2014). Risk perception is defined by Slovic (2000) as ‘*the intuitive judgement of individuals and groups in the context of limited and uncertain information*’.

The way in which the public perceive risk is complex and is heavily influenced by situational and cognitive factors (Montz et al. 2017). Situational factor includes the proximity to a given source or hazard while cognitive factors, on the other hand, reflect the personal and psychological composition of an individual and include affective and behavioral attributes that account respectively for specific emotions evoked by hazards and tendencies to act in specific ways to risk events. The complexity of how risk is perceived by the public is at odds with how risk is defined in the scientific community (Slovic 2000).

2.9. Why Study Risk Perception?

Understanding the public’s perception of risk is important for improving risk communications and designing effective mitigation policies (Ho et al. 2008). An individual's risk perception is important as it determines his/her response to a risk situation (Slovic et al. 1982). Studies about risk perception began in the 1940s with the writings of Gilbert White about human adjustment to floods. The two well-known approaches for explaining risk perception are the psychometric and cultural theory approaches. The former is related to psychology and the latter to the fields of sociology and anthropology. In the psychometric approach, developed by Fischhoff (1978) and Slovic et al. (1986, 1982), researchers use psychological scaling and multivariate analysis techniques to produce quantitative representations or ‘cognitive maps’ of risk attitudes and perceptions. Within the psychometric paradigm, people make quantitative judgments about the current and desired riskiness of diverse hazards and the desired level of regulation of each. The cultural theory approach holds that perception and acceptance of risk are rooted in social and cultural norms (Shaw, Kobayashi and Kobayashi 2004). Cultural influences guide peoples’ perceptions and their decisions on risk taking and avoidance.

Perceptions of hazards are thought to provide important insights for risk management and risk communication strategies. A main reason for this is their expected positive relationship with the willingness of individuals to undertake mitigation measures (Bubeck, Botzen and Aerts 2012). Becker et al. (2013) argue that three core belief systems impact preparedness including hazard beliefs, preparedness beliefs, and personal beliefs. Hazard beliefs are beliefs related to risk perception; preparedness beliefs aligned with people's understanding about what preparedness means and the effectiveness of that preparedness; and personal beliefs described a person's understanding of impacts of disasters on themselves and how they might deal with it. UNDRR (2020) held ‘broken perceptions’, if not addressed on time, accountable for reversing global progress. Therefore, this dissertation is fundamentally significant and timely in addressing the gap in knowledge and earthquake safety practices worldwide.

2.10. Culture and Risk Perception

Cultural biases provide predictions of risk perceptions and risk-taking preferences that are often more powerful than measures of knowledge and personality (Wildavsky and Dake 1990). Dake (1991) has conceptualized worldviews as orienting dispositions, because of their role in guiding people’s responses. These dispositions may include but are not restricted to (a) fatalism (I have very little control over risks to me and my family; God takes care of it!) and (b) hierarchy (Decisions about risks should be left to experts). In the context of Muslim communities, this perception is often influenced by the teachings of Islam (Chester et al. 2013, Dhanhani 2010, Homan 2001). For example, Paradise (2005) found that the perceptions of seismic risk in Agadir, a coastal city in Morocco devastated by a moderate earthquake in 1963, were less influenced by experience and more by Islamic training, ritual, and culture.

Schmidt (2004) stressed that in earthquake-prone regions, people have expressed higher trust in religious or political institutions. Under Islam, earthquakes are treated differently than other natural hazards. They are associated with the apocalyptic day of judgment. One *surah* (chapter) of the Qur'an is entirely dedicated to quakes—the 99th *surah* of the Qur'an called *Surat-al-Zilzalah*— (the chapter of the Earthquake) (Paradise 2005). Such references in Islam seek to guide the belief and thus perception of Muslim adherents, and their behavior. In fact, the word "earthquake" is linked directly to signs of God's punishment for sins, ultimate divine retribution, and as a warning of the looming judgment day (Ghafory-Ashtiany 2009) or God's testing when the Iranian leaders and media called the Bam Earthquake , "*Emtihan-e-Elahi* " (a test by God) (Farhang 2004).

It is important to address social, political, and cultural factors in relation to natural hazards since they constitute root causes of vulnerability. It is the social, political and cultural factors that determine access to power, structures and resources in the event of any disaster (Degg and Homan 2005). These phenomena manifest themselves in unsafe conditions such as fragile physical environment and local economy, a vulnerable society and a lack of disaster preparedness (Blaikie et al. 1994).

2.11. Major Seismic Disasters in the Muslim Countries

Geologically, several Muslim majority countries are located in the vicinity of Quaternary active fault systems and corridors. For example, Northwest Pakistan is located on the northwestern Indian plate where it subducts beneath the Eurasian plate and constitutes the seismicity in the region (Monalisa, Khwaja and Jan 2007). Compression along the Arabian plate and southwestern fringes of the Eurasian plate accommodates stress and releases it in seismic events across Iran and Turkey causing major earthquakes (Quittmeyer and Jacob 1979, Berberian 2005). Similarly, Afghanistan due to its geotectonic location on the southern edge of the Eurasian plate receives deep crustal earthquakes in the northeast and shallow ones in the eastern regions due to active collision between the Eurasian plate and the Indian plate (Shroder 2014).

Several high magnitude earthquakes in Afghanistan and Pakistan have caused major disasters. For example, a 7.7 Mw earthquake in 1935 killed ~35,000 people in the garrison town of Quetta in Baluchistan, then part of British-India (Bilham 1988). Similarly, the 8th October earthquake in Muzaffarabad, Kashmir claimed the lives of 87,000 people, and incurred ~5 billions of dollars of losses in infrastructure and economy (Durrani et al. 2005). Similarly, in 1998, a pair of earthquakes in Takhar, Afghanistan killed around 7,000 and left ill-built towns demolished. A 7.5 magnitude deep earthquake centered in the Hindukush in October 2015 shook cities and towns as far as New Delhi in India and caused 399 deaths and caused millions of dollars in losses. The following, table 2.2, presents a list of destructive earthquakes in the Muslim majority countries—spanning from Indonesia in southeast Asia to the farthest limits of northwest Africa— in the last century and the first two decades of the 21st century.

Table 2. 2. A list of some of the major earthquake disasters in some of the Muslim majority countries (1901-2020) ranked based on the highest number of fatalities.

Fatalities	***Magnitude (Mw/Ms/ML)***	***Event***	***Location***	***Date***
220,000	9.1	Sumatra Earthquake and Tsunami	Indonesia	December 26, 2004
110,000	7.3	1948 Ashgabat earthquake	Turkmenistan	Oct 5, 1948
87,000	7.6	Kashmir Earthquake	Pakistan	October 8, 2005
60,000	7.7	1935 Quetta earthquake	Pakistan	May 31, 1935
50,000	7.4	1990 Manjil–Rudbar earthquake	Iran	June 21, 1990
35,000	6.7	Bam Earthquake	Iran	December 26, 2003
32,700	7.8	1939 Erzincan earthquake	Turkey	December 26, 1939

Table 2.2 (Cont.)

Fatalities	***Magnitude (Mw/Ms/ML)***	***Event***	***Location***	***Date***
17,127	7.6	1999 İzmit earthquake	Turkey	August 17, 1999
15,000	7.4	1978 Tabas earthquake	Iran	September 16, 1978
15,000	7.4	1968 Dasht-e Bayaz and Ferdows earthquakes	Iran	August 31, 1968
12,225	7.1	1962 Buin Zahra earthquake	Iran	September 1, 1962
12,000	7.3	1907 Qaratog earthquake	Tajikistan	October 21, 1907
15,000	5.8	1960 Agadir earthquake	Morocco	February 29, 1960
5,782	6.4	Indonesia	2006 Yogyakarta Earthquake	May 26, 2006
4,340	7.5	Indonesia	2018 Sulawesi Earthquake, Tsunami	September 28, 2018
4,500	6.5	Takhar Earthquake	Afghanistan	May 30, 1998
2,323	5.9	Takhar Earthquake	Afghanistan	February 04, 1998
2,266	6.8	2003 Boumerdes Earthquake	Algeria	May 21, 2003
1,313	8.6	2005 Nias–Simeulue Earthquakes	Indonesia	March 28, 2005
1,115	7.6	2009 Sumatra Earthquakes	Indonesia	September 30, 2009
1,000	7.4	2002 Hindukush Earthquakes	Afghanistan	March 25, 2002
400	7.5	Hindukush Earthquake	Afghanistan	October 26, 2015
825	7.7 and 6.8	Baluchistan Earthquake	Pakistan	September 24, 2013
630	7.3	2017 Iran-Iraq Earthquake	Iran-Iraq Border	November 12, 2017
600	7.2	SE Turkey Earthquake	Turkey	October 23, 2011
300	6.4 & 6.3	Tabriz Earthquake	Iran	August 11, 2012

2.12. Summary of Risk Perception Studies Globally and in Muslim Majority Countries

Important aspects of seismic risk assessment include the presence of seismic activity (earthquake hazard), elements of vulnerability (physical, social, socioeconomic), and lack of capacity to deal with the activated hazard. They combine and create a situation best defined as Seismic Risk. Northeast Afghanistan and northwest Pakistan, in the vicinity of the Eurasian-Indian collision boundary, where population is defined by low-medium HDI, high physical and socioeconomic vulnerabilities and a low regard for seismic risk, provide the perfect site to study the perception of seismic risk and evaluate the significance of cultural (dominated by the Islamic faith) influences on their perceptions.

Perception refers to the organization and interpretation of experiences, beliefs, thoughts, knowledge, and behavior of individuals in order to make sense of their circumstances or environment in general (Paradise 2005, Ainuddin, Routray and Ainuddin 2014). People hold a myriad of perceptions regarding various hazards. These perceptions are often deeply rooted in their training, education, local cultural peculiarities (Dhanhani 2010), and often in their personality traits (Slovic 2010). However, how risk is perceived by the layman is at odds with how risk is defined or perceived by the expert (Slovic 2000). Experts define and estimate risk in terms of annual mortalities, while lay people often include other factors including catastrophic potential, equity, effects on future generations, controllability, and involuntariness (Schmidt 2004, Slovic 1987). Many people understand some things quite well, but their path to knowledge and its storage may be quite different from that of technical experts. Generally, people are willing to tolerate higher risks from hazard events seen as highly beneficial to them (Slovic 2010).

It is often inadequate to evaluate risks only from the perspective of the experts in terms of fatalities, persons injured, or economic losses. Indirect effects also need to be taken into consideration (Schmidt 2004). Due to the complex and subjective nature of risk and its definitions, many interesting things manifest when people judge risks. Recent studies have shown that factors such as gender, race, political worldviews, religious views, affiliation, emotional affect and trust are strongly correlated with risk judgments (Slovic 1987, Paradise 2005).

Risk perception research had its origins in studies of judgment and decision-making (Slovic et al. 1982). However, the first significant work in understanding the perception of hazards in general was accomplished by White (1974) to investigate the interaction of social and natural systems in a variety of environments and cultures beyond North America. White (1974) concluded that variation in hazard perception can be accounted for by a combination of (a) magnitude and recency of the hazard, (b) recency and frequency of personal experiences, (c) importance of hazard to income or locational interest, and (d) personality factors such as risk-taking propensity, fate control, and views of nature. He further concluded that for individuals living in a hazard zone, the choice of adjustment is a function of (a) perception of the hazard, (b) perception of the choice open to them, (c) their command of technology, (d) the relative economic efficiency of the alternatives, and (e) the perceived linkages with other people. However, for communities, the choice of adjustment is a function of perception of hazard, choice, and economic efficiency as influenced by the stability and the power structure of the government. Recently, psychophysical scaling methods (Slovic 1982, 2009) and statistical analyses (Ainuddin et al. 2014) have been utilized to produce quantitative representations of risk attitudes and perceptions.

In the Muslim majority countries, early studies on perception of tropical cyclones were accomplished in Bangladesh by Islam (1974) where he concluded that the prevailing mood was *'Almighty God knows everything'*, a response reported widely by other researchers in other Muslim majority countries; from Morocco (Paradise 2005) to Indonesia (Adiyoso and Kanegae 2013), and from Egypt (Homan 2001) to Saudi Arabia (Alshehri, Rezgui and Li 2013). One feature which is similar to the situation in some Christian cultures, such as southern Italy (Chester et al. 2013), is that even when people accept divine responsibility for disasters, there is no evidence to suggest that such beliefs have either prevented policies of hazard reduction being put in place or of people refusing help either from the state and Non-Governmental Organizations (NGOs). For example, people in rural Pakistan may be fatalistic about some government initiatives but there is no evidence of active resistance towards them (Cheema 2012). A study of risk perceptions of the UAE by Dhanhani (2010) concluded that, although people may by skeptical about initiatives to mitigate risk especially in rural areas, this has not prevented the federal government from developing policies which include. (a) establishing a system to respond to national emergencies; (b) the identification and training of UAE nationals in responding to disasters; and, (c) the encouragement of volunteering and developing co-operation between the State, its agencies and the private sector.

Several studies have confirmed individual and collective fatalistic attitudes in several Muslim majority countries. Paradise (2005) found that residents of Agadir, a coastal city in Morocco devastated by a moderate earthquake in 1963, held fatalistic perceptions of seismic risk influenced by Islamic training, ritual, and culture. Similarly, studies by Alshehri (2013) in Saudi Arabia, Homan (2001) in Egypt, Adiyoso & Kanagae (2013) in Indonesia, and Halvorson and Hamilton (2010) in Pakistan consistently report a fatalistic attitude where earthquakes, floods, and Tsunamis are defined as acts of divine retribution, test or punishment.

2.13. Summary and Conclusion

Hazard refers to a phenomenon or a process that has the potential to precipitate loss in terms of fatalities, injuries, economic, and environment. In the paradigm of time, it encompasses a past event that can recur and cause losses while risk is the probability of a hazard to cause damage and loss. In this formulation, risk includes additional elements such as exposure, vulnerability, and a diminished capacity. At any rate, seismic risk is explained as a combination of earthquake event that has the potential to incur losses to a vulnerable community which is exposed to the earthquake hazard. In the same manner, earthquake disaster would be described as a major earthquake hazard event that causes extreme losses coping with which stands outside the capacity of the communities impacted. In such cases, external assistance is sought to redress the situation usually, immediately, in terms of relief and response.

How a community prepares for an impending disaster is determined by several factors, such as, experience, dread of the hazard, knowledge of the hazard, existing vulnerabilities, and their overall assessment of the hazard. A fundamentally important question is whether they take active role in ameliorating the hazard situation or do they passively wait for it to happen and then blame fate? This premise determines their basic paradigm of thinking and perception regarding a hazard. Key questions that beg attention are. how and in what ways is this perception influenced by external factors? What are the sources of these influences? Where do these sources come from?

A basic knowledge of one's geographical location i.e., proximity to hazard source imparts some basic kind understanding of the hazard, but is it sufficient to inspire action to mitigate it? What and how influential is one's cultural outlook in this regard? Can one escape this aspect of risk assessment? Overall, how do these socio-cultural nuances inform one's perceptions?

Now that key terms and concepts relating to hazards, risks, and disasters have been elaborated, it is appropriate to investigate and evaluate the status of seismicity and earthquakes in Afghanistan, a land-locked central Asian country (Lee 2018), located at the collisional boundary of the Indian and Eurasian tectonic plates, and home to intense seismicity and high magnitude earthquakes that have claimed thousands of lives in the past two decades and have precipitated into major economic losses. The population of Afghanistan adheres to the Islamic faith with as much as 99% of the population identifying themselves as Muslims (Esposito and Mogahed 2007), the association of Islamic cultural influences on seismic risk perception is evaluated as well.

CHAPTER 3: Methods

This dissertation utilized a mixed method scheme. Qualitative data were collected in a series of interviews. The selection of individuals interviewed for these studies adopted a snowball sampling strategy. Although a purely random method is ideal for such studies, a stratified scheme was preferred owing to the cultural nuances of the communities studied. For example, in conservative Muslim communities, it is often quite difficult to arrange interviews with women (Alshehri et al. 2013) owing to the concept of *Purdah,* which requires women to cover themselves completely (Schmuck 2000), and *Mahram*, which requires women to avoid interacting with men outside of their immediate family (Halvorson and Hamilton 2010). Consequently, access to 50% of population (female) for a random sampling method is limited.

The data from these interviews were analyzed using both inferential and descriptive statistics to arrive at conclusions best suited for an explanation of correlations, associations, and regression. The construction of these survey tools adopted a constructivist approach following Crescimbene et al. (2015) and addressed both psychometric and cultural theory of risk approach following both Slovic (2000, 2000) and Wildavsky and Dake (1990) with additional components to address other influences on risk perception such as causes attributed to earthquakes, several demographic characteristics, and earthquake experiences. The two sections of our survey instrument addressed hazard, vulnerability (physical, social, socio-economic), degree of exposure, earthquake experience, dread, trust in government (local and national), and demographic features. The seismic risk and its sources were investigated by multiple choice and Likert scale questions.

3.1. Seismicity, Earthquakes and Earthquake Catalog of Afghanistan (2002-2022)

Ambraseys and Bilham (2003) compiled an extensive list of earthquakes of Afghanistan and the region from 734 AD to 2002. More than 1,300 earthquakes and narrative accounts of damage sustained during 47 of the more significant events were compiled from sources as diverse as Arabic, Persian, Indian, Afghan, Central Asian, anecdotes, diaries, and lately newspapers. They assigned moment-magnitudes to each event as well

The list of earthquakes for Afghanistan on Ambraseys and Bilham's catalog ends in March 2002. Afghanistan is seismically active (Dewey 2006), and high magnitude earthquakes hit the country more often than many other regions in the world (Boyd, Mueller and Rukstales 2007). For example, between 1998 and 2022, there have been 16 destructive earthquakes (earthquakes with fatalities). This catalog was compiled to complement the existing catalog of earthquakes for Afghanistan. The region constrained for this catalog is the same region as defined originally by Ambraseys and Bilham (2003). Improved instrumentation and deployment of a number of seismometers in Afghanistan in the last 20 years has allowed for more reliable seismic data to be recorded by the USGS, and GFZ in Afghanistan (Mohadjer et al. 2016). This catalog was compiled primarily from the available data sources of USGS's earthquake hazard program – ANSS Comprehensive Earthquake Catalog (ComCat) Documentation.

Following is step-by-step description of the process utilized for compiling this important catalog for Afghanistan and the region between March 1, 2002 and March 31, 2022 – a catalog of two decades of earthquake activity in one of the most seismically active regions in the world.

1. Visit the USGS website's earthquake hazard program page at: https://earthquake.usgs.gov/
2. Click on the label EARTHQUAKE on the left side column under Explore the Website [now you are at https://www.usgs.gov/programs/earthquake-hazards/earthquakes]

3. On the left column, click Search Earthquake Catalog
4. Now, fix your criteria for magnitude, date and time, and geographic region [geographic coordinates]. In this study, Magnitude = 4.0-8.0; Date = March 1, 2002-March 31, 2022; and geographic region = 29°N - 38°N and 58°E - 73°E.
5. Select your choice of Event Type under the drop-down menu [Earthquake in this case]
6. Select your Output Option [cvs, kml, html, map & list]
7. Select the order in which you would like your catalog to appear. [Oldest to newest; newest to oldest]
8. Finally, select the number of events you would like your catalog to be limited to.
9. Click Search. This will download your file based on your Output Option.

A comprehensive list of earthquake events was obtained, customized, and cleaned. The process included filling in for the missing information especially locational data arrived at by ground truthing i.e., locating the given earthquake event using its geographic coordinates and placing it on a rectified map and finding the appropriate geographic feature to name it. For example, the 5.3 Mw earthquake at 36.59° E and 71.1783°E was missing the appropriate local name i.e., location. The given geographic coordinates were placed on the map in googleEarthPro and the location was identified as Warduj valley, Badakhshan. Thus, the catalog was compiled and incorporated in this study.

3.2. Earthquake Risk Perception in High Conflict Geographies: A Case Study of Kabul, Afghanistan

Of the six schools of thoughts Alexander (1993) presented, this study examined the geographical, sociological, development, and technical approaches to explain the continued status of geophysical hazards, risks and disasters in the study sites.

The geographical approach stems from Harland Barrow's works in the 1920s on human ecological adaptation to environment, and Gilbert F. White's seminal monograph on human adjustment to floods in the mid 1940's. Social science methods are widely used, and emphasis is given to the spatio-temporal distribution of hazard, impacts, and vulnerability. Geographers have also paid attention to the question of how choices are made between different types of adjustment to natural hazards. In the sociological approach, vulnerability and impacts are considered in terms of patterns of human behavior and the effects of disasters upon community functions and organization. The development studies approach associates the rates of disaster impacts (e.g., over 80% of disaster impacts occur in developing countries), and the phenomenon of poverty, which is associated with increase in human vulnerability to natural hazards: locational constraints tend to place the poor more firmly in the path of impacts. The technical approach prevails among natural and physical scientists. Emphasis is given to seismology, volcanology, geomorphology, and other predominantly geophysical approaches to disasters and to engineering solutions.

This study utilized surveys to collect data on various aspects of seismic risk perception of communities to elicit collective attitudes regarding earthquake danger. Central to the methodology adopted in this survey study has been that of Likert Scale. Likert Scales are conventionally used to measure respondent attitudes to a particular subjects such as danger (Boone and Boone 2012).

In addition, this study utilized multiple classes of questions to present a holistic picture of attitudes regarding earthquake hazards in Kabul City, Afghanistan's capital. Surveys were administered to residents of Kabul City during the summer of 2019 and were conducted in English, Dari (Farsi) and Pashto – the two official and national languages of Afghanistan. A stratified spatial sampling method was chosen to guide the sampling across Kabul's neighborhoods. Respondents included male and female college students, professionals, citizens, farmers, teachers, mullahs, vendors, businessmen, city workers, and housewives.

The survey instrument was designed according to the University of Arkansas's Institutional Review Board (IRB) guidelines (See Appendix A for IRB protocol). The survey form included three sections. The first addressed the respondent demographics; the second section addressed their knowledge and past experiences of earthquakes in Kabul City; the third section tested their knowledge of emergency response to earthquakes. Surveys were only sought from individuals who had previously experienced an earthquake –moderate to severe earthquake shaking and as potential victims of earthquake damages. The questionnaires were administered across Kabul City over an eight-week period June-July 2019. Of a total of 338 surveys completed, 335 had experienced an earthquake at least once. Another five surveys were rejected for incomplete responses. Therefore, 330 were accepted (n=330) for final analyses.

3.3. Seismic Risk Perception Assessment of Earthquake Survivors: A Case Study from the 2005 Kashmir Earthquake

Survey data were obtained from a team of Pakistani geography, environmental studies, and geology students from the University of Sindh, Jamshoro who conducted the surveys in the Spring of 2006. The survey team interviewed 215 respondents who were identified as witnesses, survivors, and/or victims of the October 8th Kashmir Earthquake 2005. Of the 215 interviews, 25 surveys were removed for their incomplete responses; 190 respondent surveys were used in this study. The survey was created for canvassing witnesses in villages where the greatest damages and losses were sustained. An arbitrary systematic sampling method was used for sampling survivors in the five target sites. Respondents were asked about their experience with the quake.

Survey questions had provided boxed answers, and Likert-scale questions. The survey questions were divided into two parts: the first part addressed the demographic data, while the second part sought answers to questions related to a seismic event, preparedness, and perception.

Inferential statistical analysis was employed to analyze the response of the target population during the earthquake, their understanding of earthquake recurrence, and their level of trust toward the local and national governments about their preparation for another earthquake. Descriptive statistics was used to elaborate on the characteristics of the target population who were surveyed for this study.

3.4. A Survey of Seismic Risk Perception in the Muslim-majority Countries of Afghanistan, Pakistan, Libya, and Morocco

Findings from individual studies on seismic risk perceptions accomplished in Afghanistan, Pakistan, Morocco, and Libya were compared. To better understand the seismic risk perception in the Muslim-majority countries, this comparative study evaluated four case studies from North Africa (Libya, Morocco) and South Asia (Afghanistan, Pakistan). The objective of this research was to assess how perceptions of peoples in regions of high seismicity differed from those in regions of lower seismicity; if they had not differed, why not? These studies can help create meaningful generalizations about relationships between perception and response, and subsequently to address those elements most pertinent and successful in hazards and risk-related decision-making.

Likert-scale survey responses were administered in all our study sites following Fowler (2013) and Slovic (1987, 2000). Revealed preference approaches to understand individual behavior through their actions during and after an earthquake was adopted. This method assumes that people (respondents) can provide sensible answers to difficult questions. Furthermore, it is assumed that risk is subjectively defined by individuals who may be influenced by a myriad of psychological, social, institutional, and cultural factors (Bahram and Paradise 2020).

The survey instruments were designed, written, and administered in the national languages of the sites. In North Africa, Arabic and French were used, in Afghanistan, Dari and Pashto, and in Pakistan, Urdu and English were used in surveying (Table 3.1).

Systematic stratified and ‘snowball’ sampling methods were implemented to locate and survey earthquake survivors, witnesses, and/or relatives of victims (Kothari 2004, Haring, Lounsbury and Frazier 1992) in the studies of Agadir, Morocco and Al-Marj, Libya.

3.4.1. Agadir, Morocco

Questionnaires were administered, in the summers of 2002 and 2004, to residents of Agadir who survived the 1960 earthquake or were directly related to survivors (e.g., children, grandchildren). The survey consisted of five demographic questions (*sex, age, religion, birthplace, education attained*), four questions used to determine socio-economic status (*do you own a television, car or phone; do you smoke*), and two questions designed to assess general quake historical knowledge (*when the last large earthquake was; if and when will another quake occur in Agadir*). Finally, five Likert questions (1-10) were designed to illicit respondents’ perceptions. This survey style and questions were utilized at all research sites in this study to facilitate comparison (Paradise 2005).

The questionnaires were administered across the city of Agadir over a five-week period. 243 surveys were accepted (n=265). 52 earthquake survivors were surveyed and interviewed and the remaining 191 were survivors’ relatives. 22 surveys were rejected as incomplete, having contradictory information.

3.4.2. Al-Marj, Libya

The survey was administered during the Spring 2019, and included questions regarding demographic, economic status, hazard knowledge, and perceived vulnerability (Suwihli 2020). Questionnaires were administered across Al-Marj, including the campus of the University of Al-Marj. Earthquake survivors and their family members (aged 20-70) were identified for face-to-face surveys. Over four months, 364 survey interviews were completed (n=368) while four incomplete surveys were rejected. 27 earthquake survivors were interviewed, and the remaining 337 were residents with direct memories from oral histories of the 1963 earthquake (Suwihli and Paradise 2020).

For methods utilized in studies of Kabul, Afghanistan and KP, Pakistan, consult the foregoing discussion on methods employed for these two studies.

Table 3. 1. Six languages were employed in four countries to design, write and administer survey instruments for maximum participation and accurate data collection**.**

Site	***Country***	***Survey Season***	***Languages***	***Sample size***	***Surveys (n)***
Agadir	Morocco	Summer 2002, 2004	Arabic, French	265	243
Al-Marj	Libya	Spring 2019	Arabic	368	364
Khyber Pakhtunkhwa	Pakistan	Spring 2006	Urdu, English	215	190
Kabul City	Afghanistan	Summer 2019	Dari, Pashto, English	339	320
			Total	***1187***	***1117***

CHAPTER 4: Seismicity, Earthquakes, and Earthquake Catalog of Afghanistan

4.0. Introduction

Rustaq is a small farming town in the northern province of Takhar in Afghanistan. In 1998, two medium magnitude earthquakes (5.9 Mw and 6.5 Mw), three months apart, wreaked havoc and claimed ~ 7,000 lives, thousands were injured, and heavy economic losses were incurred to this town and adjacent multiple other small towns. At the time, decades of war had left the town impoverished and the locals relied heavily on subsistence farming while the country was engulfed in civil war. Four years later, in 2002, another northern province, Baghlan was hit with a 6.1 Mw earthquake. The small town of Nahrin in Baghlan and the surrounding villages lost 1,000 lives, incurred heavy economic losses and thousands were injured. Yeats and Madden (2003) surveyed damage in 68 villages affected by the earthquake and found that areas within 25 km of the epicenter experienced modified Mercalli intensities of between VI and VII. Shaking intensities were strong enough to cause complete building collapse in many villages. Medium to high magnitude with depths ranging from shallow to deep earthquakes are prevalent in Afghanistan particularly in the north and northeastern regions owing to the tectonic settings of the region (Figures 4.1 & 4.4). The biggest population center faced with the biggest threat of earthquake hazard in Afghanistan is the city of Kabul (Ambraseys and Bilham 2003).

A catalog of more than 1,300 earthquakes of Afghanistan from 734 AD to 2002 was compiled by Ambraseys and Bilham (2003) in their seminal paper on earthquakes in Afghanistan. Instrumentally recorded earthquakes have become universal since the establishment of the World-Wide Standard Seismic Network (Peterson and Orsini 1976). Currently, earthquake data is collected by a network of seismometers deployed globally and integrated with other global seismic networks such as TIPAGE (2008-2010) and ANSS Comprehensive Catalog (ComCat) of the USGS (1900-2022) (Mohadjer et al. 2016).

A catalog of Afghanistan earthquakes from 2002-2022 was long overdue and has been compiled here. Following Ambraseys and Bilham (2003), the region covered for the catalog presented here lies between 29°N - 38°N and 58°E - 73°E. Overall, 246 earthquakes of magnitudes ≥ 5 have been recorded. 16 have been destructive with considerable number of fatalities. Except the 7.6 Mw Kashmir earthquake, the epicenters of all other destructive earthquakes have been located inside the territories of Afghanistan.

While northeast Afghanistan, in the Transpressional Boundary tectonic region, is home to the Hindukush deep seismic zone where deep earthquakes with high magnitudes occur, the central and western parts of Afghanistan remain seismically inactive. Southeast and eastern Afghanistan, transected by the famous Chaman Fault for 1,000 km, has been the epicenter of major destructive earthquakes in the past (Ambraseys and Bilham 2003).

In Afghanistan, earthquakes of moderate magnitude 5.0-5.9 have been destructive (Table 4.1) and have caused fatalities. Therefore, the catalog presented here covers all earthquakes greater than five in magnitude. However, a catalog of earthquakes with magnitudes ≥ 5, for the same region, is provided in Appendix B.

4.1. Regional Tectonic Setting and Seismicity

The tectonics of Southwest Asia, where Afghanistan is located, is controlled by convergence of major tectonic plates including the African, Eurasian, Arabian, Persian and Indian plates (Morgan 1968). No fewer than four major tectonic plates (Arabia, Eurasia, India, and Africa) and one smaller tectonic block (Anatolia) are responsible for seismicity and tectonics in the region (Jenkins et al. 2013) (Figure 4.1).

Afghanistan forms the most stable promontory that projects south from the Eurasian plate. West of Afghanistan, the Arabian plate subducts northward under Eurasia, and the Indian plate does the same to the east of Afghanistan. South of Afghanistan, the Arabian and Indian plates adjoin and both subduct northward under the Eurasian promontory. The plate boundaries west, south, and east of Afghanistan are hundreds of kilometers wide (Wheeler et al. 2005). The collision between these continental plates for the past ~60 million years, have resulted in the formation of the Himalaya-Hindukush-Pamir syntaxis—some of the highest mountain systems in the world. In addition, seismicity in the region is defined by the collision of these plates, which are converging at a relative rate of 40-50 mm/yr (Ambraseys and Bilham 2003). Northward underthrusting of India beneath Eurasia generates numerous earthquakes and consequently makes this area one of the most seismically active regions of the world (Molnar and Bendick 2019, Shroder, Weihs and Schettler 2011).

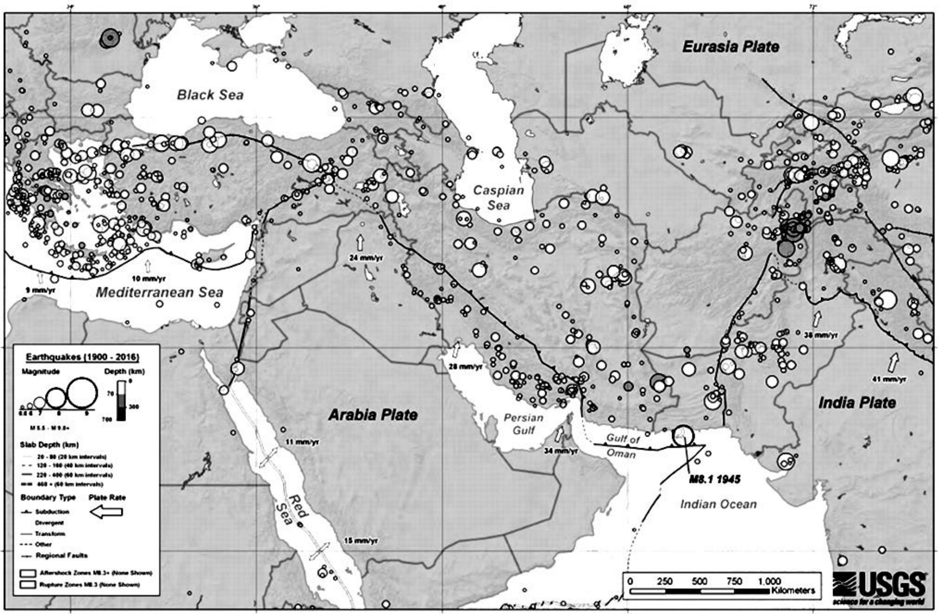


Figure 4. 1. Interactions between major tectonic plates (India, Arabia, Africa, and Eurasia) along plate boundaries define the seismicity of the region. Seismic data from 1900-2016 indicate that bulk of the earthquakes have been recorded mainly from the Hindukush deep seismic zone in the northeast, Afghanistan (Ambraseys and Bilham, 2003), the Zagros Mountains in Iran (Berberian 2005) and the Anatolian block in Turkey (Özerdem 2006). Map Source: USGS

4. 2. Tectonic History of Afghanistan

Afghanistan forms the southern projecting promontory of the Eurasian plate (Wheeler and Rukstales 2007, Wheeler et al. 2005). The North Afghanistan Platform has been part of the Eurasian plate for 350-250 million years—mostly as an offshore continental shelf. Over the past 250 million years, several volcanic island arcs and fragments of continental and oceanic crust have collided with, and been added to the southern limits of the North Afghanistan Platform (Dewey 2006). Modern discourse on the plate-tectonic process concerning Afghanistan is indicative of several crustal fragments of western Afghanistan (Farad block, Helmand block) that were moving through the Tethys Seaway Ocean basin as islands in the Late Triassic (~210 million years ago). By the Jurassic (170 mya), however, the Farad block had been accreted to the Eurasian plate while the Helmand block was still moving across the Tethys following a similar fate. In the meanwhile, the Indian plate had detached from Gondwanaland and had moved progressively northward over late Mesozoic and Cenozoic. By ~70 mya this northward movement of the Indian plate had led to the formation of the volcanic Kohistan-Ladakh Island Arc (now mostly in Pakistan). This island arc would ultimately get arrested between the colliding Indian and Eurasian plates and was squeezed to become part of the mountains of the Himalaya and Hindukush. This continued process of convergence and suturing to the present day has formed some of the highest mountains in the world. The rocks, mountains, and landforms of Afghanistan are a legacy of this plate-tectonic motion that guided the fusing of such, a diverse blend of materials as well as shattering the rocks into countless small fragments bounded by a variety of faults (Shroder 2014). It was in this geotectonic context of active collision, convergence, and suturing that the geology of Afghanistan evolved into distinguishable tectonic provinces (Figure 4.2).

4.3. Tectonic Regions of Afghanistan

In the seismotectonic map of Afghanistan, Wheeler et al. (2005) divided Afghanistan into four distinct tectonic regions. These regions are briefly discussed hereunder:

4.3.1. Transpressional Plate Boundary

Transpression constitutes strike-slip zone with an additional and simultaneous shortening across the zone. The ongoing collision between India and Eurasia plates occur along the Chaman-Paghman-Panjshir-Central Badakhshan fault zones (Shroder 2014). In the south, the left lateral, strike-slip Chaman fault has the highest slip rate (Mohadjer et al. 2010).

The broad Transpressional Plate Boundary, outlined in figure 4.2, is the zone along which the Indian plate moves northward past central and western Afghanistan at a relative rate of at least 39 mm/yr. The plate boundary is dominated by numerous active strike-slip faults of many sizes, and it displays abundant seismicity (Wheeler et al. 2005). The boundary generates more crustal seismicity than does the rest of Afghanistan, with the notable but local exception of the eastern part of the North Afghanistan platform that is home to the Hindukush deep seismic zone (Stübner et al. 2013b). Five of the ten individual faults that have been suggested to be seismically active are within the plate boundary. One of these five faults is the Chaman fault, which has stronger evidence of activity than any other Afghan fault (Wheeler et al. 2005).

4.3.2. Accreted Terranes

The accreted terranes coalesced against the North Afghanistan platform throughout the Mesozoic Era. Most of the large faults within and between the terranes were reactivated in strike slip during the Tertiary Period (Wheeler et al. 2005). Important faults in this tectonic region include the Kaj Rud, Helmannd, Darafshan, and Mokur fault systems. The accreted terranes are not seismically as active as the central and western parts of the North Afghanistan Platform The rocks here preserve evidence of the fact that they were formed elsewhere and then accreted and sutured to the Asian plate over several hundred million years (Shroder 2014).

4.3.3. Middle Afghanistan Shear-Zone

Middle Afghanistan lies between the Hari Rod fault, on the north, and the Qarghanaw, Bande Bayan, and Onay faults, on the south (Figure 4.2). From the eastern end of the Middle Afghanistan suture zone in the vicinity of Kabul, the rocks that were deformed during Pennsylvanian to early Triassic time form a belt roughly 100 km wide that sweeps northeastward and then northward through northernmost Afghanistan into Tajikistan (Wheeler et al. 2005).

4.3.4. North Afghanistan Platform

North of the Harirud fault and west of the Central Badakhshan fault, comprises the North Afghan platform. Most faults within the platform strike west or west-northwest and lack significant offset. Mapped faults on the platform are more abundant near its southern and eastern limits than within its interior.

North Afghan platform is part of the original continental shelf of the formerly flat-lying sediments in southern Asia before they were uplifted to become high plateaus, mountains, and plains. It borders an active plate boundary (Wheeler et al. 2005). The plate boundary forms a continental transform system. The region is transected by large faults of various types because of collision and accretion of terranes into it. Major fault systems of the North Afghanistan platform include the Andarab fault in the southeast of the region and the Darvaz fault and Henjavan fault in the northeast (Figures 4.2 & 4.3).

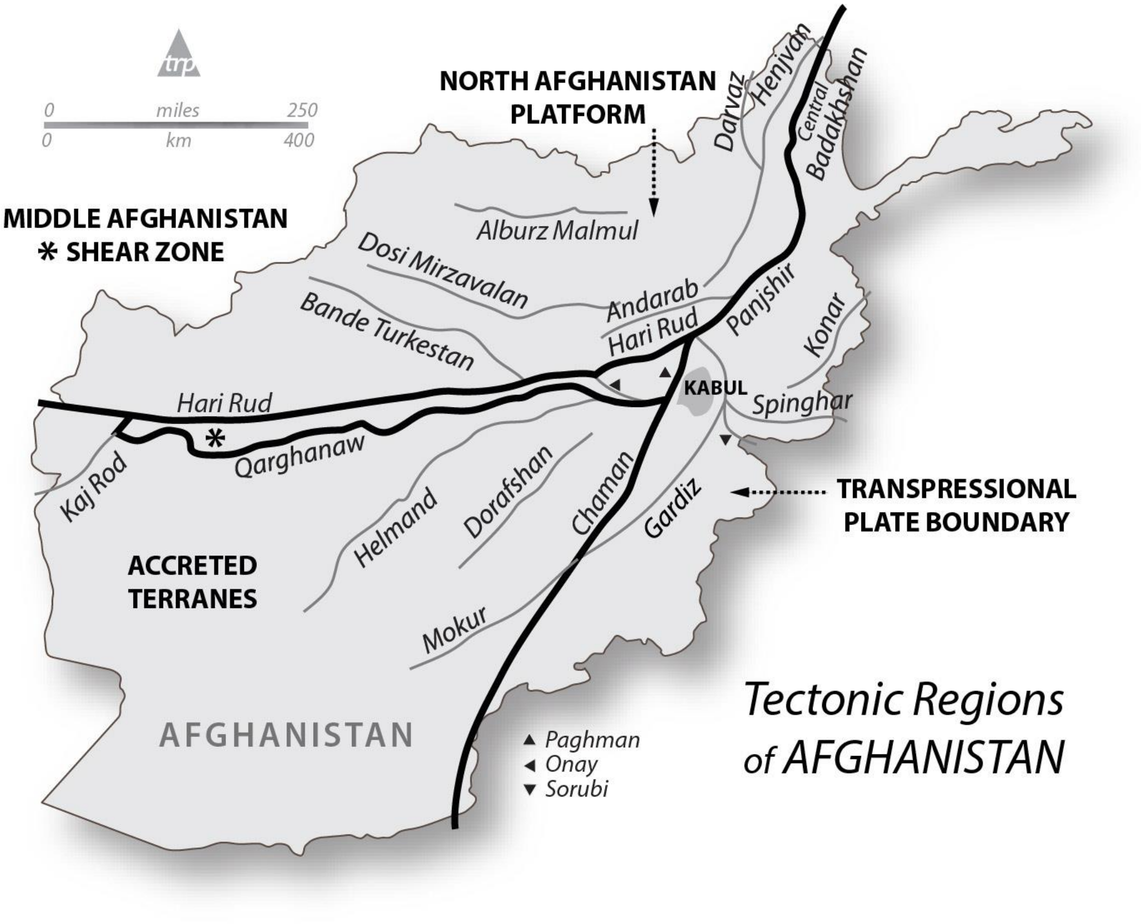


Figure 4. 2. Seismotectonic regions of Afghanistan. These tectonic provinces are crisscrossed by active Quaternary faults (Ruleman et al. 2007). Modified after (Shroder 2014, Ruleman et al. 2007, Wheeler et al. 2005).

4.4. Major Fault Systems of Afghanistan

Afghanistan is traversed by active Quaternary faults owing to the active convergence and collision of major continental plates (Figure 4.3). These faults have dimensions and surface expressions that are comparable to major, continent-scale, strike-slip fault systems worldwide, including better-studied faults such as the San Andreas, the Anatolian, and the Denali fault systems (Wheeler and Rukstales 2007). Each of these is capable of producing earthquakes in the moment-magnitude range from upper 7 to near 8 (Boyd et al. 2007). These faults are natural sources of shallow as well as deep seismic activity. While western and central Afghanistan appear to be aseismic, heavily populated north and eastern Afghanistan record the highest rates of earthquakes anywhere in the world (Shroder 2014, Wheeler et al. 2005). In particular, northeastern Afghanistan, near and north of the capital, Kabul, has a long history of damaging deep and shallow earthquakes (Ambraseys and Bilham 2003). In fact, northeast Afghanistan is defined by a unique phenomenon where the descending slab of continental lithosphere causes destructive deep earthquakes (Molnar and Bendick 2019, Kufner et al. 2016, Stübner et al. 2013a).

Boyd et al. (2007) considered it possible that the major strike-slip faults in Afghanistan were capable of producing high magnitude earthquakes. Presented here are major fault systems that control and define the seismicity of Afghanistan.

4.4.1. Chaman Fault

Also known as the Chaman Fault System, it is divided into four distinguishable subsidiary fault systems including Chaman fault, Mokur fault, Gardiz fault, and Paghman fault. It is more than 1,000 km long, extending from the Hindukush region in northeastern Afghanistan south-southwestward through eastern Afghanistan into western Pakistan (Boyd et al. 2007) (Figure 4.3). It is a major left-lateral strike-slip fault system that accommodates much of the convergence between the Indian and Eurasian plates in southeastern Afghanistan and adjacent Pakistan (Ruleman et al. 2007). Several large historical earthquakes have produced surface rupture on the fault in Afghanistan (Ambraseys and Bilham 2003).

Mohadjer et al. (2010) reported a slip rate of 18 ± 1 mm/yr across the northern end of Chaman Fault while they estimated a rate of 5.4 ± 2 mm/yr of sinistral shear across the Gardiz and Mokur faults. Based on GPS observations, they reported 16.8 ± 0.51 mm/yr of sinistral motion near Kabul, Afghanistan.

Historically, at least four major strike-slip earthquakes with M > 6 have been recorded on the Chaman fault: the 1505 earthquake (Ms 7.3) west of Kabul, the 1892 (Ms. 6.5) earthquake near the city of Chaman, the 1975 earthquake between Chaman and Nushki and the 1978 earthquake north of Nushki in Pakistan. No major historical earthquakes are noted between the 1892 Chaman rupture to the southern terminus of the 1505 rupture which made Ambraseys and Bilham (2003) concluded that a significant seismic gap exists along the Chaman fault, especially north of ~31 degree latitude. A magnitude 5 earthquake in 2005 ruptured the surface along the 6.5 km of the Chaman fault south of Kabul. The slow slip observed over a year after this event raises the possibility that other parts of the fault might rupture in slow slip events (Mohadjer et al. 2016).

4. 4.1.1. Paghman fault

The northern tip of the Chaman Fault System west of Kabul is referred to as the Paghman fault where primarily left-lateral strike-slip faulting to the south transitions into a region of apparent sinistral (left-lateral) oblique-thrust faulting and dip-slip displacement (Ruleman et al. 2007). It trends north and northeast and is marked by continuous, linear and arcuate fault scarps on piedmont alluvium and at the mountain front contact between alluvium and colluvium The 1505 (M 7.3) earthquake was associated with at least 40 km long surface rupture of the Paghman fault, 20 km north-west of Kabul, which strikes N20°E (Ambraseys and Bilham 2003). The earthquake caused vertical offsets of 3 meters on this fault and possibly some strike-slip faulting of unknown amount—evidence indicates movement on the Paghman Fault has been sustained throughout much of the Quaternary period (Ruleman et al. 2007).

4 .4.1.2. Gardez Fault

In the south, the Gardez fault splays off from the Chaman fault in the vicinity of Ghazni (Quittmeyer and Jacob 1979). South of the Kabul block the section east of the main Chaman fault system splays into the northeast trending Gardez fault and associated subsidiary faults. The southern section of the Gardez fault is marked by a 7 to 8 km wide zone of northeast-trending linear, discontinuous scarps on piedmont alluvium (Ruleman et al. 2007). Mohadjer et al. (2010) estimated 5.4 ± 2 mm/yr of sinistral shear across Gardez fault.

4.4.1.3. Sorubi Fault

Also spelled as Sarubi, the Sorubi fault northeast of Kabul, coincides with a precipitous, linear range front that has scarps along the bedrock-colluvium contact, but no scarps are on adjacent piedmont alluvium (Ruleman et al. 2007). Between Gardez and Chaman faults, Sorubi fault shows clear topographic expression on aerial photos, Landsat imagery, and from the ground. Movement along this fault is defined by right-lateral slip (Prevot et al. 1980).

4.4. 1.4. Kunar Fault

Also spelled as Konar fault or the Sorubi-Konar fault system. Kunar fault splays off from the Gardez fault just west of Jalalabad (Quittmeyer and Jacob 1979). Northeast of the Gardez-Sorubi fault junction, Ruleman et al. (2007) reported active left-lateral faulting. Both historical and modern data indicate that moderate to large magnitude earthquakes occur in this region (Quittmeyer and Jacob 1979).

4.4.2. Harirud Fault

Also known as the Harirud Fault System, and the Herat Fault, Harirud fault is a 730-km-long, right-lateral, extends from its intersection with the Chaman fault north of Kabul westward to the Iran border (Boyd et al. 2007). It is a major continental-scale suture that coincides with the boundary between the relatively stable, mildly deformed Eurasian continent to the north and the extensively deformed, accreted terrains to the south (Ruleman et al. 2007). It forms a sutured boundary between the North Afghanistan Platform and the Middle Afghanistan Shear Zone (Shroder 2014). The east-west trending Harirud fault evolved as a suture zone and transitioned into a left-lateral, strike-slip fault zone. The whole zone is 780 km long, 30-60 m km wide. The Harirud fault zone was reactivated during the Oligocene-Miocene (25-20 mya), in a series of pull-apart basins(Shroder 2014).

Ambraseys and Bilham (2003) traced the Harirud fault at 61°E near Herat and 69°E north of Kabul. There is little evidence that the Harirud fault is active, although an earthquake of Mw 7.4 on 9 June 1956 in the Bamiyan Valley struck a region not far from the fault. This earthquake occurred in a block bounded by the Andarab fault and the Herat fault, with no mapped fault between these two faults. According to Ambraseys and Bilham (2003), the western part of the fault has remained largely inactive historically. However, the apparent absence of large earthquakes on the Harirud fault for the past 1200 years should not be taken to imply that large events cannot occur (Boyd et al. 2007).

4.4.3. Central Badakhshan Fault

Schurr et al. (2014) traced Central Badakhshan Fault from central Badakhshan, Afghanistan across the Panj River to the northern margin of the Yazgulem dome in Tajikistan. Wheeler et al (2005) did not find a published slip rate for the Central Badakhshan fault. However, Boyd et al (2007) assigned a slip rate of 12 mm/yr for the Central Badakhshan Fault assuming that the slip rate is conserved at the junction of the HariRud and Chaman faults.

4.4.4. Darvaz Fault

Also known as Darvaz-Karakul Fault, the 380-km-long, left-lateral Darvaz fault parallels the Central Badakhshan fault in northeastern Afghanistan and, like it, extends northward into Tajikistan. Darvaz fault is within the North Afghan Platform (Figure 4.3), near its eastern border with the plate boundary (Wheeler et al. 2005). The Darvaz fault is located in a region of abundant seismicity (Boyd et al. 2007). In fact, it is the second fault with the strongest evidence for activity (Wheeler et al. 2005). This fault may connect southward with the northern end of the Chaman and Gardez fault system in Afghanistan. According to Ruleman et al. (2007), at the northern border of Afghanistan, the Darvaz-Karakul fault is truncated by northwest-trending, strike-slip fault zones. Schurr et al. (2014) suggested that the recent activity along this fault zone likely extends into the rear of the Pamir thrust system (Mohadjer et al. 2016).

Figure 4. 3. Major fault systems of Afghanistan (modified after Ruleman et al. (2007)). Chaman Fault extends from Baluchistan, Pakistan in the southwest to meet Paghman Fault, its northern extension, west of Kabul City. The Harirud Fault trends from Iran in the west to Kabul City in the east. Central Badakhshan Fault trends northeast into Tajikistan through central Badakhshan (modified after Prevot et al.(1980)).

4.5. Earthquakes in Afghanistan

Crustal earthquakes are most abundant in and around northeastern Afghanistan due to the northward subduction of the Indian plate. They are less common in much of the Transpressional Plate Boundary. Earthquakes with subcrustal focal depths (> 100 km) are associated with a descending slab beneath the Hindukush in the northeast (Ambraseys and Bilham 2003). Dewey et al. (2006) noted that increased earthquake activity within the Eurasian plate, due to the northward motion of the Arabian and Indian plates, occurred 1,000 km from the southern boundary of the Eurasian plate—the region occupied by Afghanistan (Figure 4.4).

Seismicity in the region, however, is not evenly distributed. Western and central Afghanistan characterized by Harirud Fault with a slow slip rate of ~2mm/yr (Mohadjer et al. 2010), have witnessed relatively little seismicity during the 20th century; in essence they behave like rigid blocks. Major active faults, such as, the Chaman Faults (strike-slip) which continue the left-lateral motion as far north as Kabul, where they join the Herat Fault and ultimately the Hindukush and Pamir ranges, accommodate as much as 2-3 cm/yr of strike-slip motion (Ruleman et al. 2007). Mohadjer et al. (2010)) calculated a total shortening within the Hind Kush and Central Pamir 16 ± 2 mm/yr with east-west extension in Central Pamir of 9 ± 2 mm/yr.

Afghanistan's boundaries with the Lut Block in the west, and with the Indian Plate in the east, are defined by high magnitude earthquakes M <_ 7.7 and shape a promontory of the Eurasian Plate creeping toward the Arabian Plate at 3-4 cm/yr while central Afghanistan is largely seismically inactive and appears to move as part of the Eurasian Plate (Ambraseys and Bilham 2003).

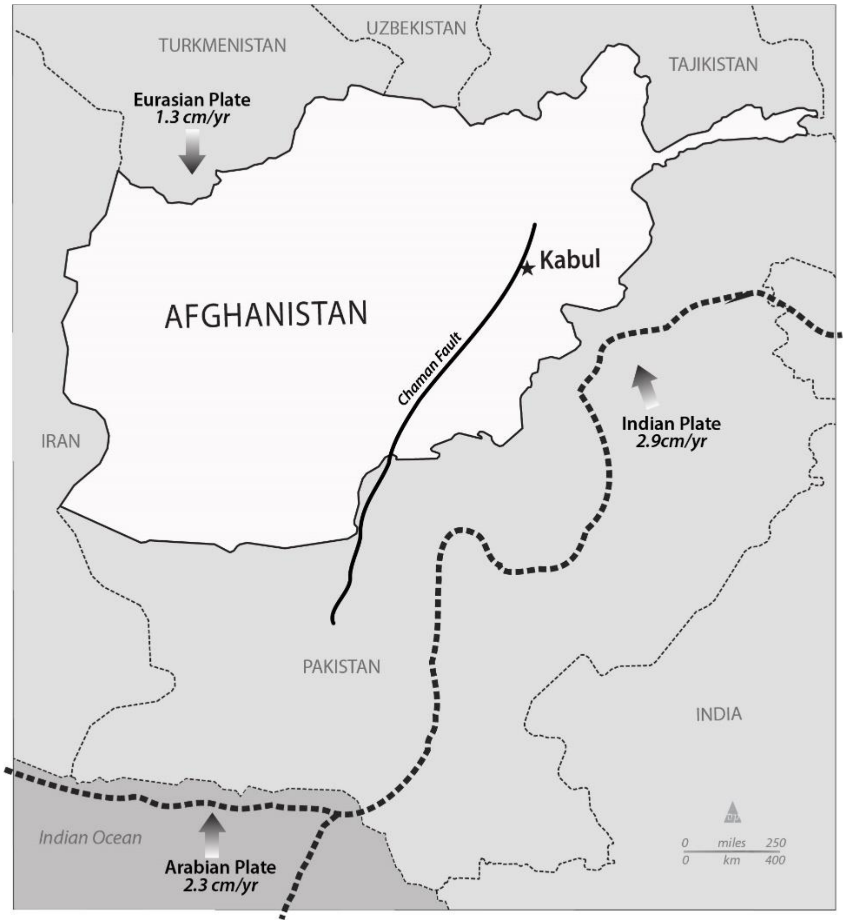


Figure 4. 4. Location of study area in the greater Alpine-Himalaya orogenic belt after Ambraseys and Bilham (2003). Vectors show relative plate motions and velocities between the Indian, Eurasian, and Arabian plates (plate boundaries shown and labeled in thick, dashed black line). Adopted from and modified after Ruleman et al. (2007).

4.6. Earthquake Hazard in Afghanistan

The continued northward push of the Indian plate into the stable Eurasian plate has produced the magnificent Himalayan-Hindukush ranges in Afghanistan and Pakistan (Jenkins et al. 2013). This phenomenon causes high seismicity rates for the Himalayas-Hindukush region (Mohadjer et al. 2010) constraining earthquakes in the northeast of Afghanistan (Figure 4.5).

Destructive earthquakes have been known in Afghanistan for more than four millennia (Shroder 2014). Each year Afghanistan is struck by moderate to strong earthquakes; within each decade a powerful earthquake causes significant damage and fatalities (Fattahi and Amelung

2016) (Figure 4.6). Earthquakes in Afghanistan are most abundant in the northeastern portion of the country where the effects of the plate collision between India and Asia are most pronounced. In this region, tectonic forces have created the mountains of the Hindukush and Pamirs, in tandem with frequent moderate to large earthquakes (Kufner et al. 2016).

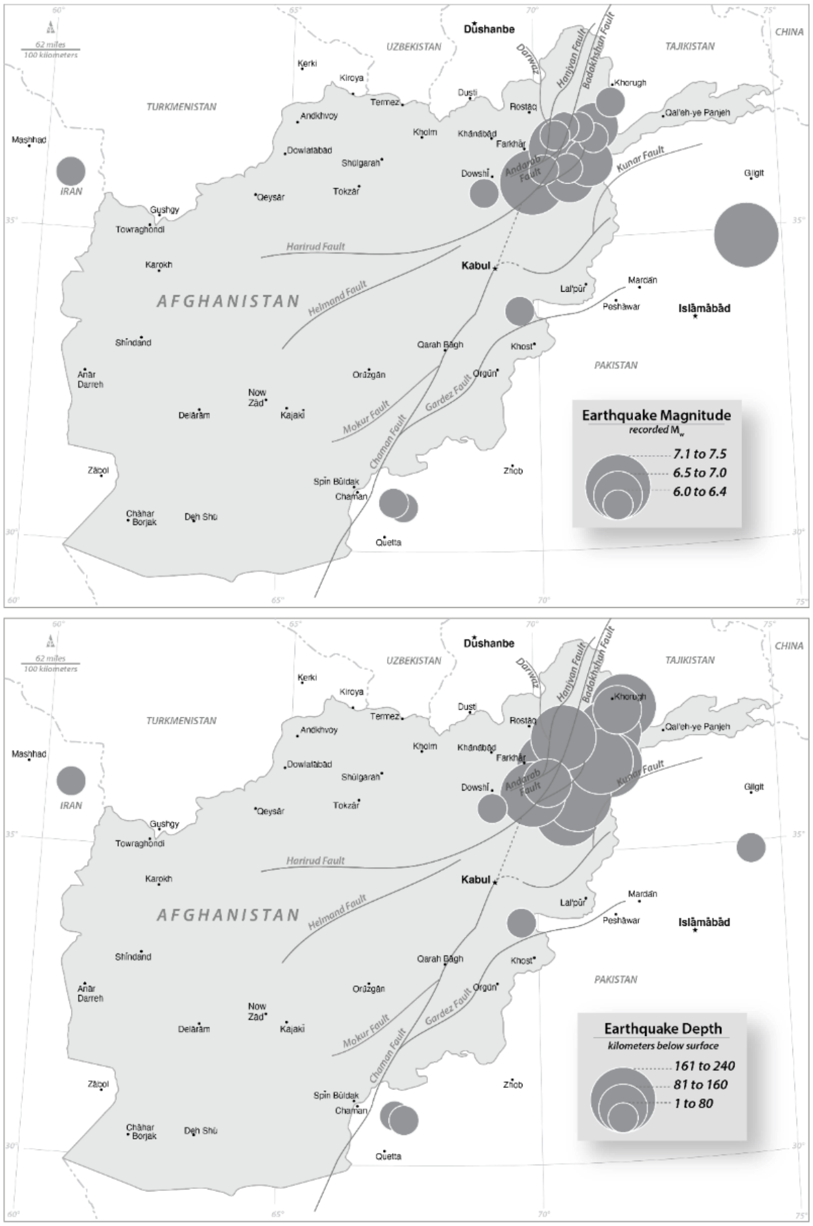


Figure 4. 5. Major faults and earthquakes constrained by magnitude ≥ 6 Mw (March 01, 2002-March 31, 2022) and variable depths in Afghanistan. High magnitude and deep earthquakes are focused on NE Afghanistan close to Kabul. Earthquake data from USGS (USGS 2022a) and fault data from Ambraseys and Bilham (2003).

Moreover, many moderate magnitude earthquakes in Afghanistan have caused death and severe injuries due largely to inadequate construction practices. For example, earthquakes have killed more than 9,500 Afghans in the last 20 years, including the two 5.9 Mw and 6.5 Mw Takhar Earthquakes in February and May 1998 that killed 6,823 people (Haziq and Kiyotaka 2017, Boyd et al. 2007) (Table 4.1). In many instances it is the poor structural integrity, with weak construction standards and enforcement that has turned a moderate quake into a major disaster. Earthquakes are most likely to occur in the tectonically active regions hit with historical earthquakes. Therefore, seismically active areas have comparatively high seismic hazards and increasing risks. Driven by ongoing active geologic processes in the region, future earthquakes are expected to strike close to population centers with a consequent risk for greater casualties and damage (Bilham 2014). The seismic hazard must be considered in the siting, construction, and restoration of communities and facilities across Afghanistan (Boyd et al., 2007), and in turn the infrastructure, and related disaster services must be better linked to seismicity and possible mitigation.

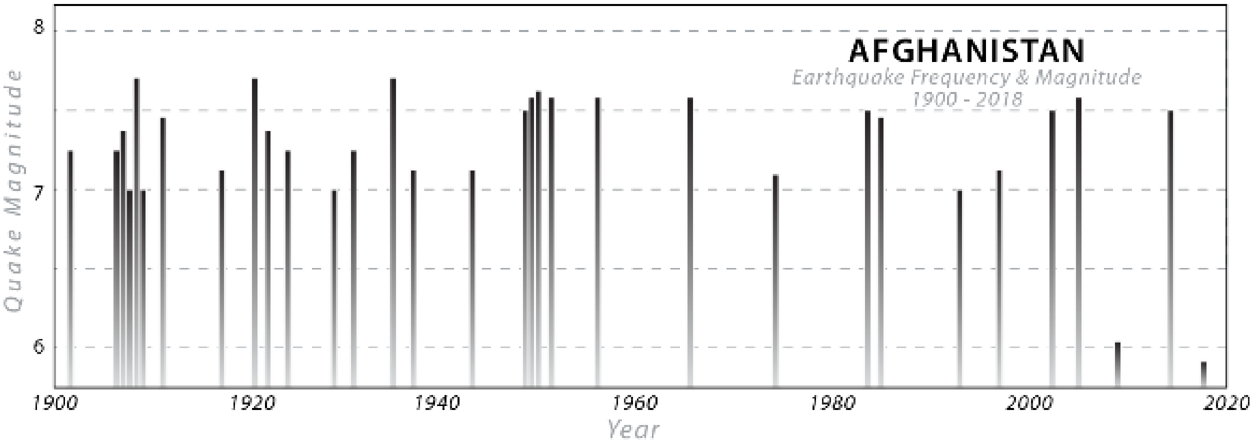


Figure 4. 6. Afghanistan has been home to medium-high magnitude earthquakes. Majority of them concentrated in the northeastern Hindukush Deep Seismic Zone. Data from (USGS 2021, Mohadjer et al. 2016, Ambraseys and Bilham 2003)

Table 4. 1. Earthquake fatalities in Afghanistan (1998-2019). Magnitudes for majority of earthquakes are not significantly high but the impact is severe in terms of human losses: a strong indicator of human and structural vulnerabilities, and low standard building typology across the country. (Sources: USGS (2022a), Ruleman et al. (2007), Dewey (2006), Wheeler et al.(2005), Ambraseys & Bilham (2003), and Yeats & Madden (2003)).

No.	***Date***	***Mag (Mw)***	***Depth (km)***	***MMI***	***Deaths***	***Injuries***	***Location***
1.	1998-02-04	5.9	30	VII	2,323	818	23 km ESE of Rustaq, Afghanistan
2.	1998-05-30	6.5	30	VII	4,500	10,001	24 km E of Rustaq, Afghanistan
3.	2002-03-03	7.4	225.6	VI	166	Some	51 km SW of Jurm, Afghanistan
4.	2002-03-25	6.1	8	VII	1,000	200	16 km E of Nahrin, Afghanistan
5.	2005-12-12	6.5	224.6	V	5	1	53 km SW of Ishkashim, Afghanistan
6.	2008-10-29	6.4	14	VIII	215	>200	13 km NNW of Alik Ghund, Pakistan
7.	2009-10-22	6.2	186	VI	5		39 km SSE of Jurm, Afghanistan
8.	2009-04-16	5.2 & 5.1	5.9 & 4.0	VI	19	51	39 km SE of Azra, Afghanistan
9.	2010-04-18	5.6	13	VI	11	>70	77 km SSW of Aybak, Afghanistan
10.	2012-06-11	5.4 & 5.7	29 & 16	V	75	13	24 km E of Nahrin, Afghanistan
11.	2013-04-24	5.6	63.8	V	18	130	Jalalabad-Mehtarlam, Afghanistan
12.	2015-10-26	7.5	212.5	VII	399	2536	Hindukush region, Afghanistan
13.	2016-04-10	6.6	212	V	6	28	42 km WSW of Ishkashim, Afghanistan
14.	2018-01-31	6.2	193.73	IV	2	22	37 km S of Jurm, Afghanistan
15.	2022-01-17	5.3	11.4	VI	30	49	45 km E of Qala i Naw, Afghanistan
16.	2022-02-05	5.8	212	IV	3	0	45 km SW of Ishkashim, Afghanistan

4.7. The Case of Kabul City

Kabul City has served as the capital city of the modern Afghan State since 1776 (Dupree 1973). It is currently the largest city in Afghanistan with an estimated population of more than four million people housed in over 600,000 housing units (CSO 2016). The city is exposed to high seismic risk due to its location adjacent to the active faults. Numerous past regional earthquakes have damaged structures in Kabul, while future earthquakes are expected to strike in the region resulting in heavy damages and severe human losses in Kabul. Bilham (2014), Dewey et al. (2006), and Wheeler et al. (2005) warned that a magnitude 7.9 Mw earthquake could occur owing to the slip on the seismic gap (Figure 4.7) barely 20 - 30 kilometers south of Kabul (32° - 34° latitude) on the northern Chaman Fault. Therefore, a crustal earthquake occurring nowadays on this fault might be large enough to result in catastrophic losses to the metropolitan Kabul region with its present huge and growing population (Bilham 2014, Szeliga et al. 2012).

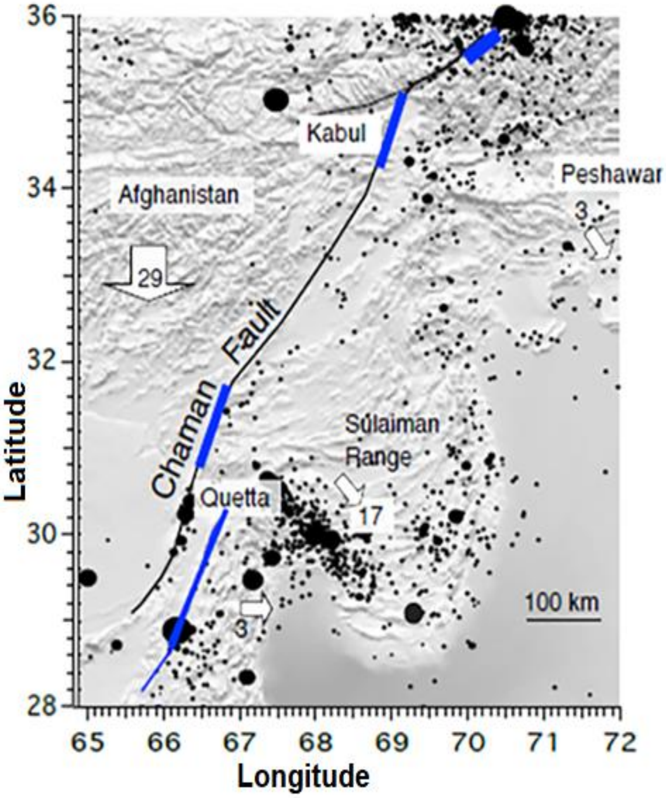


Figure 4. 7. The Seismic gap at 32°-34° Latitude on the regionally active Chaman Strike-Slip Fault could be the epicenter of a 7.9 Magnitude earthquake. Modified after Bilham (2014).

4.8. The Catalog

Data of seismic frequency and magnitude on a global scale have been instrumentally recorded since 1960s after the establishment of the World-Wide Standard Seismic Network (Peterson and Orsini 1976). Currently, this is complemented by, and integrated with other global seismic networks such as TIPAGE (2008-2010) and Advanced National Seismic System (ANSS) Comprehensive Catalog (ComCat) of the United States Geological Survey (USGS) (1900-2022), a repository of data from participating seismic network managed by USGS.

Ambraseys and Bilham (2003) presented the written history of earthquakes in Afghanistan from 734 A.D. to 2002 as a catalog of more than 1,300 earthquakes and narrative accounts of damage sustained during 47 of the more significant events. They assigned moment-magnitudes to each event as well. This catalog extends the catalog of Ambraseys and Bilham beyond 2002. Following Ambraseys and Bilham (2003), the study area is defined by the coordinates 29° to 38° N latitude and 58° to 73°E longitude and includes the whole of Afghanistan; the eastern part of Iran; southernmost Turkmenistan, Uzbekistan, and Tajikistan; western Baluchistan; and northwestern Pakistan. This catalog presents earthquake occurrences from March 1, 2002, through March 31, 2022.

4.8.1. Methods

The earthquake event data presented here has been compiled from the USGS-ComCat 2022. Elaborated here is the step-by-step description of the process undertaken for this paper:

1. Visit the USGS website’s earthquake hazard program page at: https://earthquake.usgs.gov/
2. Click on the label EARTHQUAKE on the left side column under Explore the Website [now you are at https://www.usgs.gov/programs/earthquake-hazards/earthquakes.
3. On the left column, click Search Earthquake Catalog
4. Now, fix your criteria for magnitude, date and time, and geographic region. In this case date = March 1, 2002, through March 31, 2022, and geographic coordinates are 29° to 38° N for latitude, and 58° to 73°E for longitude.
5. Select your choice of Event Type under the drop-down menu [Earthquake in this case]
6. Select your Output Option [cvs, kml, html, map & list]
7. Select the order in which you would like your catalog to appear

8. Finally, select the number of events you would like your catalog to be limited to.
9. Click Search. This will download your file based on your Output Option.

A comprehensive list of earthquake events was obtained, customized, and cleaned. The process included filling in for the missing information especially locational data arrived at by ground truthing i.e., locating the given earthquake event using its geographic coordinates and placing it on a rectified map and finding the appropriate geographic feature to name it. For example, the 5.3 Mw earthquake at 36.59° E and 71.1783°E was missing the appropriate local name i.e., location. The given geographic coordinates were placed on the map in googleEarthPro and the location was identified as Warduj Valley, Badakhshan. Thus, the catalog was accomplished and presented here. Earthquake events with magnitude ≥ 5 was compiled and is presented in this study. A summary description of earthquake event data is presented in Table 4.2 below while Table 4.3 presents a comparison of seismicity of Afghanistan with the estimated number of seismic events worldwide annually.

Table 4. 2. A summary of the total number of earthquake events with magnitude ≥ 4 against magnitude classes for March 1, 2002, through March 31, 2022. Source: USGS (2022a).

Magnitude	***Total***
4.0-4.9	3,945
5.0-5.9	224
6.0-6.9	19
7.0-7.9	2
8.0-8.9	0

In Afghanistan, due primarily to high physical vulnerability, earthquakes with moderate magnitude ≥ 5 have caused significant damage to buildings and losses of life. For example, on January 17, 2022, a 5.3 Mw earthquake with an intensity of VI in the western province of Badghis claimed 30 lives and injured 49 as well as causing multiple buildings to collapse.

Therefore, all 224 earthquakes of magnitude ≥ 5.0 are tabulated here. In addition, damage data for all ‘significant’ earthquakes are detailed hereunder.

Table 4. 3. Description of earthquakes based on their magnitude and expected level of damages. This table represents classification based on California building typology. This may not be true for Afghanistan where buildings are built poorly and do not follow building codes (Lang et al. 2018, Haziq and Kiyotaka 2017, Mohammadi and Fujimi 2016). For example, 5.3 magnitude earthquake caused 30 deaths and multiple building collapses in the western province of Badghis. So, for Afghanistan the table maybe modified as 5.0-5.9 with significant damages. Source: California Earthquake Authority.

Magnitude Interval	***Descriptor***	***Expected Damage***	***Number of Quakes Recorded 2002-2022***	***Worldwide Estimate Number per Year***
4.0-4.9	Light	Likely felt	3,945	~10,000
5.0-5.9	Moderate	Minor damage may occur	224	~1,000
6.0-6.9	Strong	Damage may occur	19	~200
7.0-7.9	Major	Damage expected	2	~20
8.0 or larger	Great	Significant damage expected	0	>3

Presented, herein, is Table 4.4 containing a list of all 21 earthquakes in the region with magnitudes ≥ 6, considered major (6.0-6.9) and strong (7.0-7.9), for the two decades of earthquakes. For a complete list of all earthquakes of magnitude 5.0-5.9 see Appendix B.

Table 4. 4. Catalog of strong and major earthquakes (March 1, 2002-March 31, 2022). Most of these earthquakes have caused damage to infrastructure and buildings and fatalities. Source USGS (2022b) at https://earthquake.usgs.gov/earthquakes/search/.

No	***Date***	***Latitude***	***Longitude***	***Depth (km)***	***Mag***	***Mag Type***	***Location***
1	2002-03-03	36.429	70.438	209	6.3	Mb	54 km ESE of Farkhar, Afghanistan
2	2002-03-03	36.502	70.482	225.6	7.4	Mw	51 km SW of Jurm, Afghanistan
3	2002-03-25	36.062	69.315	8	6.1	Mw	16 km E of Nahrin, Afghanistan
4	2004-04-05	36.512	71.029	187.1	6.6	Mw	20 km E of Yamgan, Afghanistan
5	2004-08-10	36.444	70.796	207	6	Mw	46 km S of Jurm, Afghanistan
6	2005-12-12	36.357	71.093	224.6	6.5	Mw	53 km SW of Ishkashim, Afghanistan
7	2007-04-03	36.451	70.688	222.1	6.2	Mw	47 km SSW of Jurm, Afghanistan
8	2008-10-05	33.886	69.47	10	6	Mw	35 km SSW of Azra, Logar, Afghanistan
9	2008-10-28	30.639	67.351	15	6.4	Mw	23 km NW of Alik Ghund, Pakistan
10	2008-10-29	30.598	67.455	14	6.4	Mw	13 km NNW of Alik Ghund, Pakistan

Table 4.4. (Cont.)

11	2009-01-03	36.419	70.743	204.8	6.6	Mw	50 km S of Jurm, Afghanistan
12	2009-10-22	36.517	70.95	185.9	6.2	Mw	39 km SSE of Jurm, Afghanistan
13	2009-10-29	36.391	70.722	210	6.2	Mw	53 km S of Jurm, Afghanistan
14	2010-09-17	36.443	70.774	220.1	6.3	Mw	47 km S of Jurm, Afghanistan
15	2015-10-26	36.5244	70.3676	231	7.5	Mw	Hindukush region, Afghanistan
16	2015-12-25	36.4935	71.1263	206	6.3	Mw	42 km WSW of Ishkashim, Afghanistan
17	2016-04-10	36.4725	71.1311	212	6.6	Mw	42 km WSW of Ishkashim, Afghanistan
18	2017-04-05	35.7755	60.4363	13	6.1	Mw	61 km NNW of Torbat-e Jam, Iran
19	2018-01-31	36.5261	70.8507	193.73	6.2	Mw	37 km S of Jurm, Afghanistan
20	2018-05-09	36.9942	71.3822	116	6.2	Mw	36 km NW of Ishqoshim, Tajikistan
21	2019-12-20	36.5374	70.4555	212	6.1	Mw	49 km SW of Jurm, Afghanistan

4.9. Summary and Conclusion

In Afghanistan, serious damages and losses of lives sustained during earthquakes result from falling structures. Sometimes on the slopes, earthquakes trigger mudslides, which slip down mountain slopes and bury habitations below. For example, a pair of mudslides in Argo District of Badakhshan in May 2014 buried around 300 houses and affected over 14,000 people.

Extensive research on the seismicity of Afghanistan has concluded that seismic hazards are high in northeastern part of Afghanistan and much lower in the western half of the country (Ruleman et al. 2007). Regional seismicity and the nearby Chaman fault contribute to the hazard level in Kabul, and it increases northeast of Kabul through the Hindukush Mountain ranges, near the traces of the Central Badakhshan and Darvaz faults (Ambraseys and Bilham 2003). Analyses by the U.S. Geological Survey showed that that although parts of Afghanistan lie within a relatively stable promontory of the Eurasian plate, the country is, nevertheless, surrounded on the east, south, and west by active plate boundaries that are associated with deformation, faults, and earthquakes.

The accretion of terranes to the southern fringes of the Eurasian plate, the suturing of the island arcs, and the India-Eurasia collision have shaped the tectonic history of Afghanistan.

These processes have resulted in the distinction of the four tectonic provinces of Afghanistan. Thus, faults large enough to have been mapped at a scale of 1:500,000 are least abundant in the stable North Afghanistan platform, more abundant in the accreted terranes of southern Afghanistan, and most likely to slip rapidly and generate earthquakes in eastern and southeastern Afghanistan in the broad Transpressional Plate Boundary with the Indian plate.

Of the major cities in Afghanistan, Kabul has by far the greatest seismic hazard, primarily due to its proximity to the fast-moving Chaman Fault. The estimated peak ground acceleration (PGA) value of 50 percent g for 2 percent in 50 years is comparable to the seismically active regions of the intermountain west in the United States. Northeast of Kabul, the modeled faults and high rates of background seismicity combine to give hazard values approaching those found in some seismically active regions of California (Boyd et al. 2007).

Kabul City is defined by high socio-economic vulnerability and low adaptive capacity (Garschagen et al. 2016), all in conjunction with poor housing conditions: a perfect recipe for a catastrophic earthquake disaster. Therefore, it is crucial to study and analyze Kabul's seismic risk to reduce damages, deaths, injuries, and losses in the event of a moderate-high magnitude earthquake.

A common assumption in probabilistic hazard analysis is that seismicity in the future will resemble the seismicity of the past. The further back one examines the geologic past, the less likely it is that past seismicity represents the future. At present, the main way to test the assumption is with paleo-seismological studies. Most of these studies have characterized the prehistoric record of individual large earthquakes back to several thousands of years before the present (Wheeler et al. 2005). These findings and perspectives have been vital in reinforcing the notion that the past simply gives us an idea as minimal magnitudes and consequences. However, as vulnerability factors increase in urban settings (population density, structural integrity, infrastructure ruin, decreased medical services), then past seismicity represents a state of dramatically lesser consequence, and risk planning must compensate and address these increases—such is the case in Kabul, Afghanistan. Past events can only act to establish frequencies and magnitudes, but not intensities, consequences, and vulnerabilities.

CHAPTER 5: Earthquake Risk Perception in High Conflict Geographies: A Case Study of Kabul, Afghanistan

Ikramuddin Bahram and Thomas R. Paradise

5.1. Abstract

Earthquakes present the most serious threat to the residents of Kabul City owing to its complex geological setting. In its recent history, the city has been a center-stage of political violence and social instability and continues to be a high-intensity conflict zone. The residents of Kabul are highly vulnerable and are affected deeply by earthquakes socially, economically, and psychologically. This study was accomplished to evaluate the status of experiences, knowledge, attitudes, and perceptions of the public regarding damaging earthquakes and their sociocultural impacts. A total of 320 questionnaire-based surveys were completed. The data for the research were collected through a Likert-scaled, stratified survey instrument with the use of a structured questionnaire form. Findings indicate that participants are not sufficiently knowledgeable about earthquakes, that their limited earthquake knowledge has no scientific basis, that an overwhelming majority of respondents are not prepared for a major earthquake, that local culture and religious attitudes dominate the paradigm of any discussion around earthquakes, and that heightened concerns regarding the on-going armed conflict in the country impact earthquake risk perception. The findings of this study are intended to help disaster management practitioners and policymakers in planning and enacting policies that are efficacious in the context of this city.

5.2. Introduction

Afghanistan presents a unique instance of multi-hazard landscape, with social, political and ecological hazards exacerbated by its volatile recent history. Natural hazards affect over 250,000 people annually (MRRD 2014) and have resulted in over 20,000 deaths per year since 1980 (GFDRR 2017). Afghanistan ranks first in the world in terms of the impact of disasters on its population (Mena and Hilhorst 2021) owing to the unabating status of war and social conflicts at all levels with consequent poverty and food insecurity, a fragile system of governance and reduced socio-economic development (GFDRR 2017). Indeed, with a score of 102.9, Afghanistan ranks 9th and is grouped under high alert – one of the more fragile states or states on the brink of total collapse— in the 2020 ranking of the Fragile States Index of the 178 countries by the Fund for Peace. Further, the political and socioeconomic challenges of the past 40 years have severely limited the adaptation and mitigation capacity of Afghanistan (UNDRR 2020). In the context of Afghanistan, the linkages between disaster risk, hazards, violence, conflict, and fragility must be recognized.

Most deaths caused by disasters occur in conflict-affected and fragile states (Peters 2017a) and the impact of a disaster on people's livelihoods is greater in conflict-affected and fragile contexts (Hilhorst 2013). For example, on average, 67% of the countries affected by conflicts also experienced a disaster each year between 1960 and 2018. The situation worsened in the decade 2009-2018, when average co-occurrences of conflicts and disasters soared to 78% annually (Castellón 2019). The co-occurrence of disasters and conflicts associated with both losses of life and resources necessitate the need to include conflict-affected areas in perception studies pertaining to risks (Mena and Hilhorst 2021).

In research and policy, comprehensive studies on disasters in high intensity conflict regions are rare even though a significant proportion of disasters occur in such contexts. There is evidence that conflict aggravates disaster and that disaster can intensify conflict (Mena 2019). The DRR community has long ignored the issue of confronting disasters in fragile and conflict-affected areas, although 58% of disaster deaths occur in those states (Peters 2017a).Only a few research studies of risk perception of the local population have been accomplished recently. For example, Ahmed et al. (2019) conducted a participatory rural appraisal study of perception of environmental hazards in in a border village of Indian-administered Kashmir. Further, the evaluation of seismic risk in a major city where conflicts also constitute a threat has received much less attention. Following Mena (Mena 2019) and Mena and Hilhorst (2021) we define high-intensity conflict zones as characterized by periods of large-scale violent conflict amid protracted crises, significant levels of state fragility, and a fractured governance system. While little is known about the intersection of DRR and conflict, as well as the limitations that conflicts place on disaster risk reduction initiatives, it is crucial to consolidate existing evidence to guide DRR implementation in a fragile setting (Peters, Holloway and Peters 2019). Despite three generations of post-disaster conflict research, an understanding of how disasters interact with, and unfold in, conflict-affected areas is still lacking (Siddiqi 2018). Therefore, this study takes an investigative and evaluative look into earthquake risk perception of residents of Kabul, Afghanistan, a high intensity conflict zone.

5.2.1. Kabul City – a City of High-Intensity Conflict

Kabul City (34°31' N, 69°12' E) with a total urban area of 48,493 hectares (Collier, Manwaring and Blake 2018) sits at an altitude of 1800 m (6,000 feet) and is situated in a valley surrounded by high mountains and a network of active faults (Wheeler and Rukstales 2007).

Kabul City has served as the capital city of the modern Afghan state since 1776 (Dupree 1973). It is the largest city in Afghanistan (Ahmadi and Kajita 2017), with 22 districts (Figure 5.1), and has experienced extensive expansion at a rate of 17 percent in last two decades (Figure 5.2). Its recent history is marked by political instability, clan conflict, and violence before, during, and following the 1979 Soviet invasion (CSO 2016).

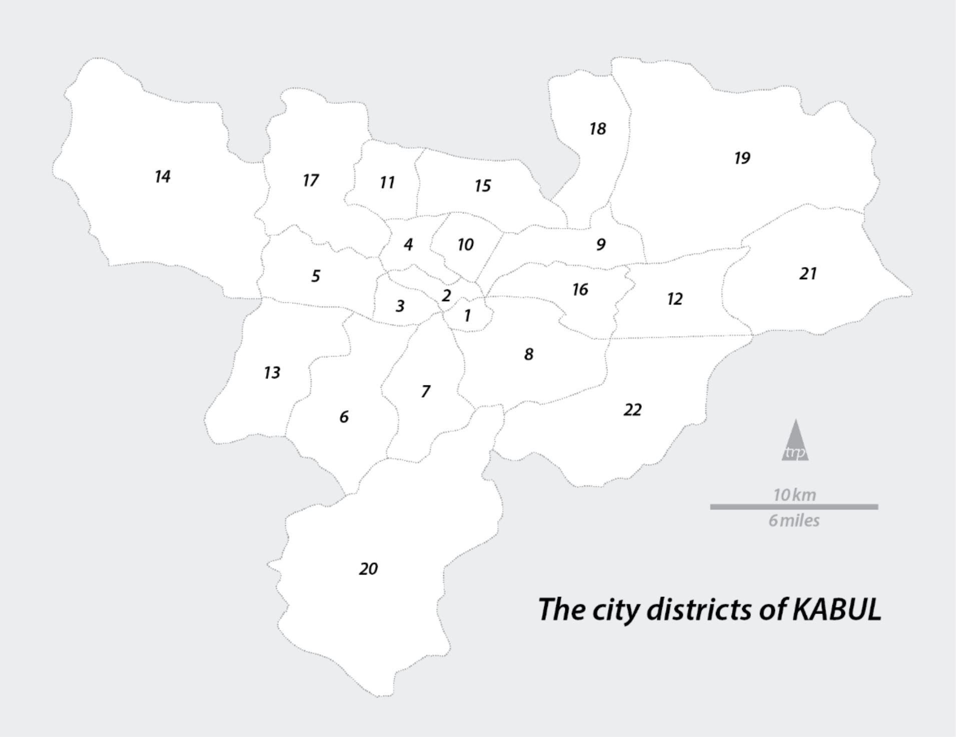


Figure 5. 1. The 22 districts of Kabul City. The city has expanded from 14 districts to 22 districts in the last two decades (GoIRA 2015)

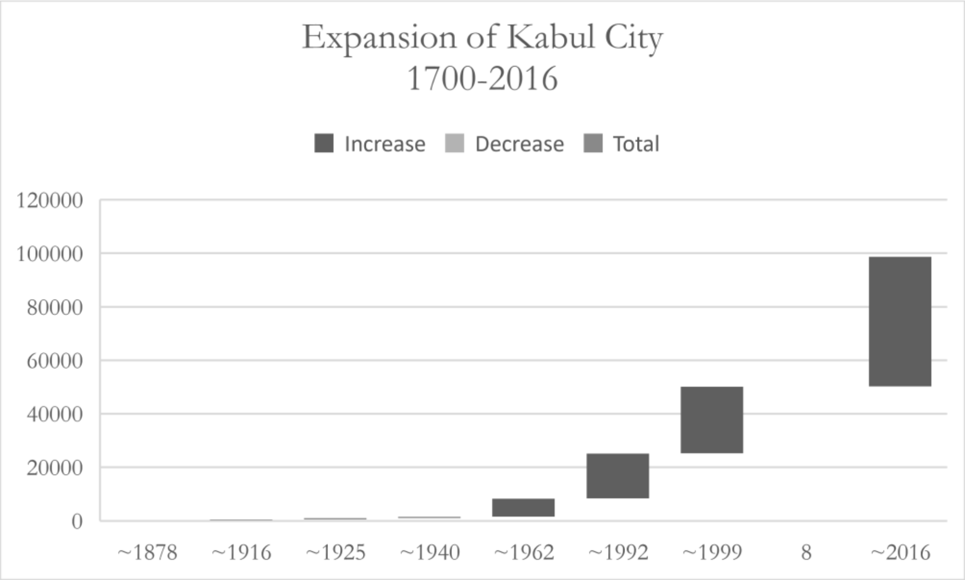


Figure 5. 2. of Kabul City area over time. The highest rate of expansion is noted in the years between 1999 and 2016. Data source: Kabul Master Plan 2011(JICA 2012) and Central Statistics Organization (2016).

According to estimates by GoIRA (2015), and CSO (2016) roughly 84% of the population of Kabul province resides in Kabul City. The city is home to 4.012 million people constituting 11% of the country's total population and 43.3% of the urban population of Afghanistan housed in over 600,000 domiciles (Figure 5.3) (Mack 2018, UNDESA 2018). It is home to even a greater percentage of the country's political, social, and business leaders. Therefore, disruption of normal activities in a large city due to a natural disaster has the potential to upset the social, economic, and political fabric of the country or surrounding region. The potential for large-scale urban disasters has been witnessed in the last decade exemplified by earthquakes and tsunamis in Japan and Indonesia 2004, Bam 2003, Kashmir 2005, Haiti 2010, and Fukushima 2011 (Wenzel et al. 2007, Bilham 2014).

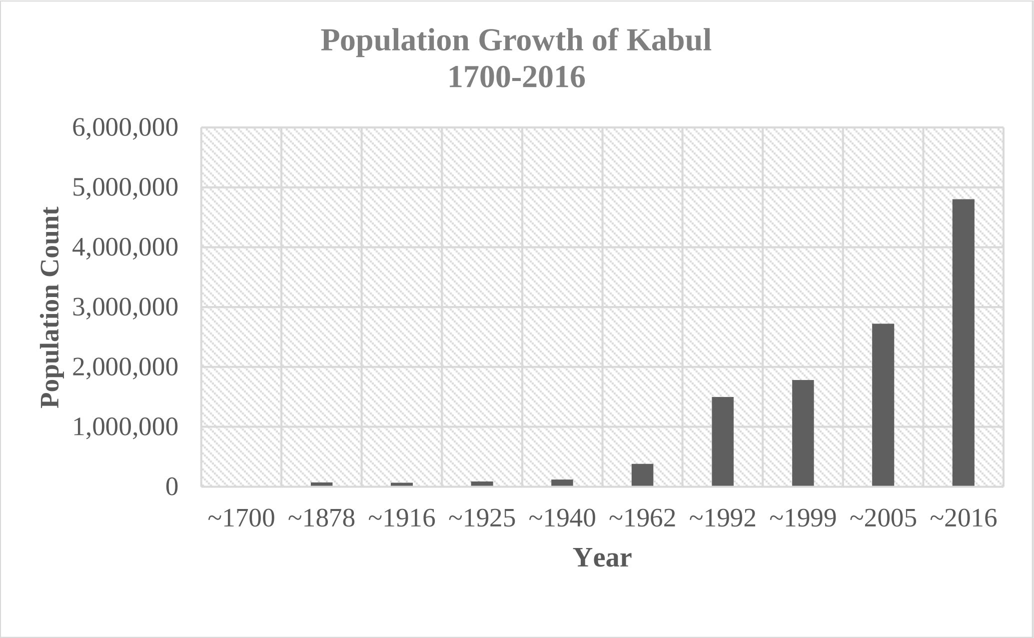


Figure 5. 3. Population graph of Kabul since founding. All populations are estimates and population counts are scattered around random times in the history of this city. The most rapid population increase has been noticed in the last two decades (2001-2016). Source: Kabul Master Plan 2011 (JICA 2012) and CSO (2016).

Historically, Kabul City has been a theater of continued political violence accompanied by frequent geophysical and hydrometeorological hazards. For example, salient earthquakes that have impacted Kabul City have been noted above. Since its establishment as the capital of the Durrani Empire and later the Afghan State, Kabul City has witnessed numerous tribal, internal and international wars including the three Anglo-Afghan Wars (1839-42; 1878-80; and 1919), four civil wars (First 1929; the Second 1989-92; the Third 1992-96; and the Fourth 1996-2001), the USSR invasion (1979-89) (Lee 2018), US invasion (2001-2021). Kabul has been restive unceasingly in the last four decades. This state of affairs has resulted in substantial reduction in adaptive and coping capacity of the populace (Montz et al. 2017).

Against this background, the objective of this paper is to understand Kabul residents' perceptions of seismic risk and assess community vulnerability to earthquake hazard in a zone of high intensity conflict – a study rare in disaster risk reduction and management studies.

5.2.2. Seismotectonic Settings of Kabul City

Seismotectonic of Afghanistan and the region is defined by the active collision between the Indian and Eurasian plates (Wheeler et al. 2005). Located at the southern edge of the Eurasian Plate (Figure 5.4), Afghanistan is crisscrossed by several active faults such as the Chaman Fault, the Harirud Fault, and the Central Badakhshan Fault that defines the deep seismic zone in the country's northeast. These numerous Quaternary active faults determine the distribution of earthquakes across the nation (Mohadjer et al. 2016, Mohadjer et al. 2010).

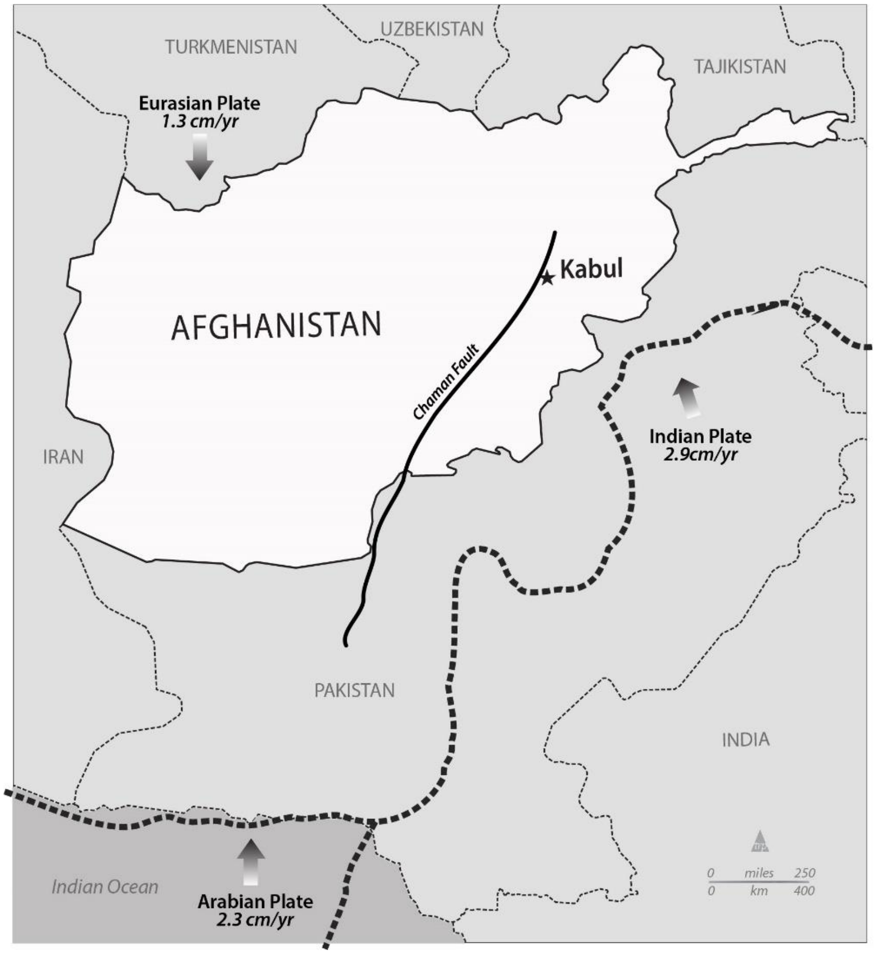


Figure 5. 4. Location of the Chaman Fault on the southern end of the Eurasian Plate. Gray-colored arrows indicate relative plate motion and velocity between the plates (after Ruleman et al., 2007).

Northeast of Kabul, faults create hazards approaching those found in other notable seismically active regions like California (Boyd et al. 2007). Several past regional earthquakes have damaged structures in Kabul (Table 5.1), while future earthquakes are expected to strike in the region resulting in heavy damages and severe human losses. Ambraseys & Bilham (2003), Dewey et al. (2006), and Wheeler et al. (2005) warned that a large earthquake on the Paghman Fault would result in significant damage across the region— especially in Kabul. Further, the city is defined by high socio-economic vulnerability and low adaptive capacity (Garschagen et al. 2016), all in conjunction with poor housing conditions— a perfect recipe for a catastrophic earthquake disaster.

Table 5. 1. Significant earthquakes associated with human losses in terms of fatalities in Afghanistan since 1998. Magnitudes for most earthquakes have not been high but the impact has been severe in terms of human losses. Sources: (USGS 2021, Ruleman et al. 2007, Dewey 2006, Wheeler et al. 2005, Ambraseys and Bilham 2003, Yeats and Madden 2003).

Year	***Magnitude***	***Location***	***Deaths***
1998	5.9	Takhar (N)	2,323
1998	6.5	Takhar (N)	4,500
2002	7.4	Hindukush (NE)	166
2002	6.1	Hindukush (NE)	1,000
2005	6.5	Hindukush (NE)	5
2009	6.2	Hindukush (NE)	5
2009	5.2	Near Kabul City	51
2010	5.6	Samangan (N)	11
2012	5.4 and 5.7	Baghlan (north of Kabul City)	75
2013	5.5	Jalalabad-Mehtarlam (E)	18
2015	7.5	Hindukush (NE)	399
2016	6.6	Ishkashim, Badakhshan (NE)	6
2018	6.1	Hindukush (NE)	2
2019	6.1	SW of Jurm, Badakshan (NE)	0

The Kabul Basin is part of the tectonically active Kabul Block in the Transpressional Plate Boundary region of Afghanistan (Wheeler et al. 2005). The western edge of the Kabul block is defined by the Paghman Fault within the Chaman Fault System (Ruleman et al. 2007). The Chaman Fault System is a major left-lateral strike-slip fault system and recorded displacement of 19–24 mm/year (Ruleman et al. 2007). The Chaman Fault, locally called the Paghman Fault, extends from at least the Afghanistan border with Pakistan in the south to the Koh-i-Paghman Range front west and northwest of the Kabul urban area. Along its eastern edge the Kabul Basin is juxtaposed with the Nuristan terrane at a large north-aligned structure called the Tagab Fault. The Ghazni Fault, a steep structure, with a northeast alignment, connects the southern extent of the Tagab Fault with the Chaman. The Ghazni Fault separates the southeast edge of the Kabul Block from the Katawaz area (Figure 5.5). A further problem is that Kabul City is located on the sediments of the Kabul River and alluvial deposits from the weathering of mountains surrounding Kabul Basin valley (Houben et al. 2009). Earthquake shaking in thick sediments is generally enhanced. Surface sediment is prone to liquefaction and sand boils, in which strong shaking causes saturated soil to lose strength or develop high pore pressure and sand eruptions (Steckler et al. 2017) – all major sources of increased seismic hazard or seismic hazard induced secondary hazards in the wider Kabul City area and its suburbs.

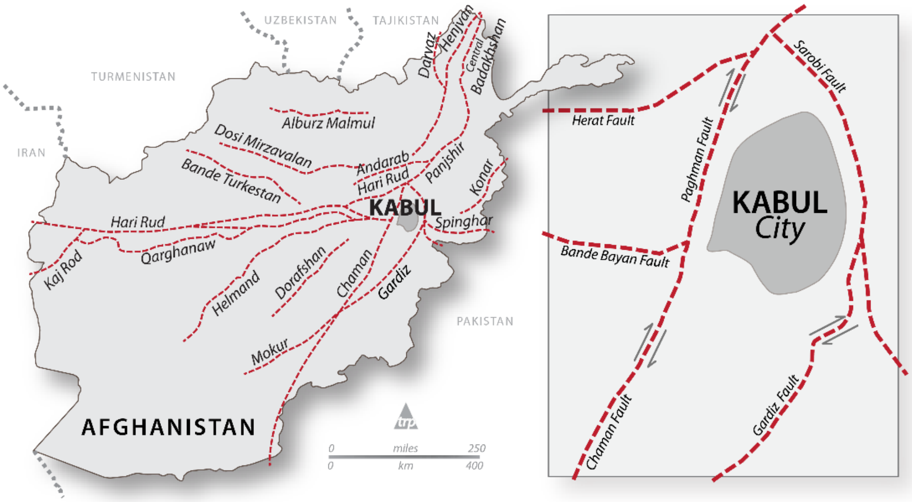


Figure 5. 5. After Bohannon (2010). Kabul massif, home to Kabul Basin, is bounded by active Quaternary faults. Chaman-Paghman faults bound the massif on the west and northwest; Tagab and Sorubi faults on the east, Ghazni Fault on the south-southeast.

Urban centers have faced devastating earthquakes with increased numbers of fatalities and economic losses (Bilham 2004). As Kabul is expanding in an unplanned and haphazard way, earthquake risk is not the only concern of the residents – elusive security, political instability, instable economy and services, healthcare and food security are equally important to them. Here we present the case of an in-conflict city, the capital of Afghanistan about the seismic risk perception of its residents.

5.3. Methods

This study utilized surveys to collect data on various aspects of seismic risk perception of communities to elicit collective attitudes regarding earthquake danger. Attitudes elicited in surveys have been found to often correlate highly with behavior (Liska 1975) and represent thought processes rather than historical preferences (Fischhoff et al. 1978). Central to the methodology adopted in this survey study has been that of Likert Scale. Likert Scales are conventionally used to measure respondent attitudes to a particular subjects such as danger (Boone and Boone 2012).

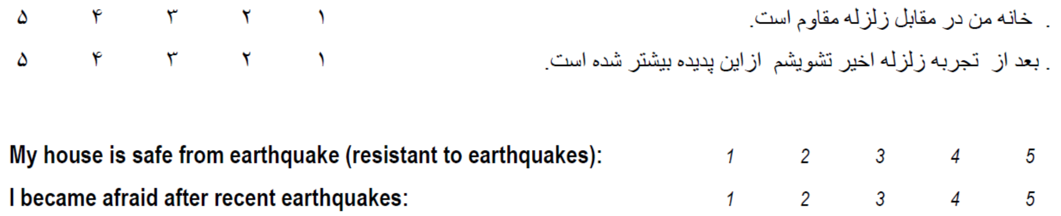
This study utilized multiple classes of questions, in addition to, Likert responses to present a holistic picture of attitudes regarding earthquake hazards in Kabul City. These included questions on demography, knowledge, and behavior parameters.

Surveys were administered to residents of Kabul City during the summer of 2019 and in Dari (Farsi) and Pashto, the two official and national languages of Afghanistan in addition to English language surveys that were provided upon request. A noticeable number of Afghans who were born abroad and learned English and adopted it in Afghanistan as a working language felt comfortable taking the survey in English rather than Dari or Pashto.

A total of 339 surveys were administered. A ***stratified*** spatial sampling method was chosen to guide the sampling across Kabul's neighborhoods. Respondents included male and female college students, professionals, citizens, farmers, teachers, mullahs, vendors, businessmen, city workers, and housewives.

The survey instrument was designed according to the University of Arkansas's Institutional Review Board (IRB) guidelines (See Appendix A for IRB protocol). It was designed to elicit information about the social and economic status of the individuals, the conditions in which they were obliged to make decisions in the face of earthquake hazard, and the types of responses to earthquakes of which they were familiar or which they had employed in the past. The survey form included three sections. The first addressed the respondent demographics; the second section addressed their knowledge and past experiences of earthquakes in Kabul City; the third section tested their knowledge of emergency response to earthquakes. Surveys were only sought from individuals who had previously experienced an earthquake –moderate to severe earthquake shaking and as potential victims of earthquake damages.

Two scaled response questions from the study in Dari with English translation follow:



. خانه من در مقابل زلزله مقاوم است.	۱	۲	۳	۴	۵
. بعد از تجربه زلزله اخیر تشویشم ازاین پدیده بیشتر شده است.	۱	۲	۳	۴	۵

My house is safe from earthquake (resistant to earthquakes):	*1*	*2*	*3*	*4*	*5*
I became afraid after recent earthquakes:	*1*	*2*	*3*	*4*	*5*

The survey consisted of 8 demographic questions *sex, age, birthplace, education attained, length of residence in Kabul city, household type, longest resided place*. Three questions were asked to determine socio-economic status *marital status, annual income, who owns your house*. Twelve questions designed to assess general quake historical knowledge *e.g., when was the last large earthquake; if, and when will another quake occur in Kabul City*. Finally, 16 Likert scaled questions were asked to seek respondents' perception of regional seismic danger.

In 2018, a pilot survey preceded the actual survey in Kabul City. After a positive evaluation of this prototype, it was decided to conduct the survey among general respondents in Kabul City in the summer of 2019.

The questionnaires were administered across Kabul City over an eight-week period June-July 2019. The five-member survey team consisted of Ikramuddin Bahram (author), Sekandar Zadran (Assistant professor at Kabul Polytechnic University), Drukhshan Farhad (an undergraduate student at Norwich University, Vermont), Akram Farahmand (an agribusiness development advisor at the Ministry of Agriculture, Irrigation & livestock), and Sherin Agha Khan Mandozai (an economic advisor at the Administrative Office of the President). The youngest surveyed individual was 18 years old and the oldest was a 68-year-old man. Schools, community centers, college campuses, governmental ministries and non-governmental organizations, and mosques were visited. Respondents came from a diverse range of length of residence in Kabul. 71% of the respondents were individuals born outside of Kabul City (in provinces other than Kabul or even in the neighboring countries of Pakistan and Iran) but had been living in Kabul City for at least five years. Similarly, the respondents came from diverse backgrounds that included university students and faculty, clerics, shopkeepers, bankers, government officials, farmers, and non-government employees, youth activists, local artists, and housewives. Also, since it is often difficult for a man to interview an unrelated woman in a conservative Muslim community (Paradise 2005, Alshehri et al. 2013, Khan et al. 2019, Ainuddin and Mukhtar 2014), our female undergraduate student was ideal in facilitating interviews among women. Those survey participants who could read, understand, and write either in Farsi, Pashto, or English were given the survey to answer directly while the illiterate respondents were administered the instrument verbally and their responses were recorded.

Of a total of 339 surveys completed, 335 had experienced an earthquake at least once. This filter helped us limit our surveys to only those with prior earthquake experience. Another five surveys were rejected for incomplete responses. Therefore, 330 were accepted (n=330) for final analyses.

5.4. Results

This study was undertaken to offer a more detailed understanding of perception of the residents of seismically active and persistently in-conflict Kabul City to earthquakes.

Kabul City was chosen because it has been growing and has experienced frequent earthquakes. The three most significant earthquakes, prior to this survey, were the 6.1 M_w on the 31st of January 2018, the 6.6 M_w earthquake of April 10, 2016, centered in the Hindukush in Ishkashim, Badakhshan, and the 7.5 M_w earthquake of the 26th of October 2015 centered in the Hindukush Mountains in the northeastern province of Badakhshan.

Further, due to a centralized form of government, all social, economic, political and intellectual resources of Afghanistan are concentrated in Kabul City (Pasarlay 2016). Any major disruption due to an earthquake could cause billions of dollars in losses and hundreds of thousands of lives lost in such a major city (Steckler et al. 2017, Bilham 2014)

5.4.1. Demographics of Survey Participants

87% of respondents were aged 18 to 50. Afghanistan has one of the youngest populations in the world. In fact, 79 percent of the Afghan population is less than 35 years old making Afghanistan one of the youngest countries in the world (CSO 2016, GoIRA 2015). Therefore, this analysis should truly reflect the perceptions of a young but relatively better educated population of a city that is engulfed in a persistent state of violent political conflict. 69% of respondents were male while females constituted only 31% owing to cultural sensitivities. 65%

were born and raised in cities, and 68% had attended an undergraduate program at a college. 68% of our respondents lived in joint families, and 22% live in nuclear families, while 8% live in communal settings such as student dormitories (Table 5.2).

A majority (52%) of our respondents had obtained grade 12 diploma while 16% had some form of college education (Figure 5.6). A noticeable number of our participants took the survey in English language since it was the language in which they were educated either in Pakistan, during the immigration years, or abroad somewhere else. 75% of the respondents live in their own house, while 20% of the respondents are tenants in rented spaces. This finding concurs with the Afghanistan Research and Evaluation Unit. This also reflects the property ownership of the respondents as a reflection of general Afghan society's preference to own their residential spaces rather than rent them.

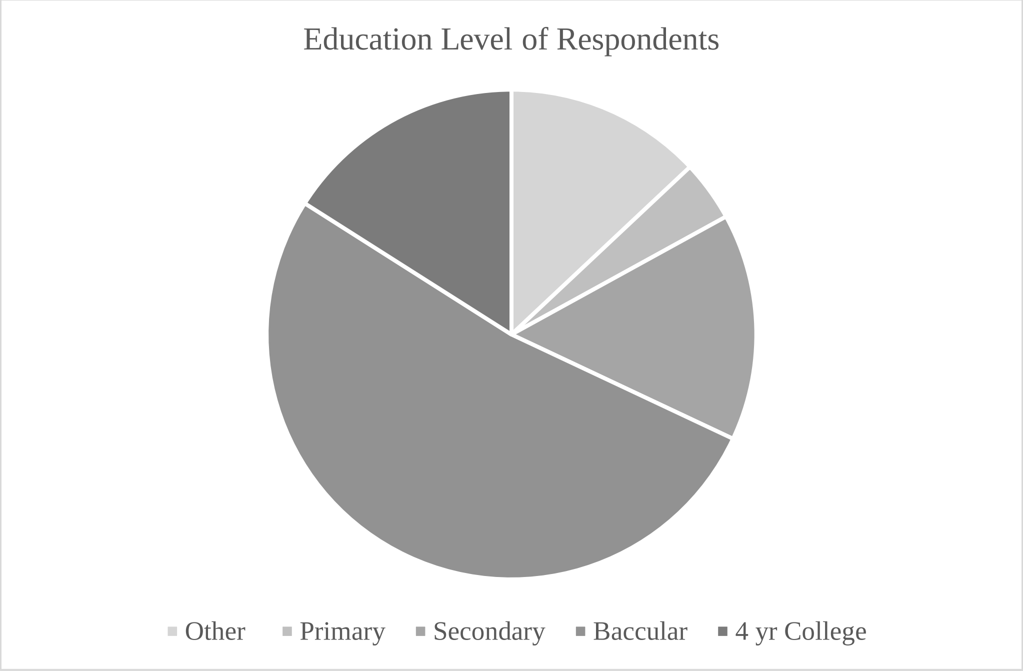


Figure 5. 6. A majority of respondents had a high school diploma in Kabul City. Overall, the surveyed population represented a young (90% ≥ 40 years of age) and educated group.

5.4.2. Earthquake Experience and Reaction to Earthquake

The existence of a substantial seismic hazard threatening Kabul City is well-established (Ruleman et al. 2007, Boyd et al. 2007, Wheeler et al. 2005, Ambraseys and Bilham 2003). In the survey 99% of the respondents have experienced an earthquake in Kabul City (Figure 5.7). In fact, 90% of the survey population experienced an earthquake in the last five years prior to the survey. Kabul had been struck by three high to medium magnitude earthquakes between October 2015 and January 2018 (Table 5.2). 52% of the respondents believed another earthquake might strike in the coming five years while 45% did not want to predict another earthquake at all. Yet, 51% of the respondents ascribed the occurrence of future earthquakes to God’s will saying ‘only God knows’ when another earthquake might hit Kabul City. Such reasons as increased indecency, loss of faith and religious practice rooted in social and religious sources were consistently observed as reasons for earthquake occurrence and are found in previous research (Khan et al. 2019).

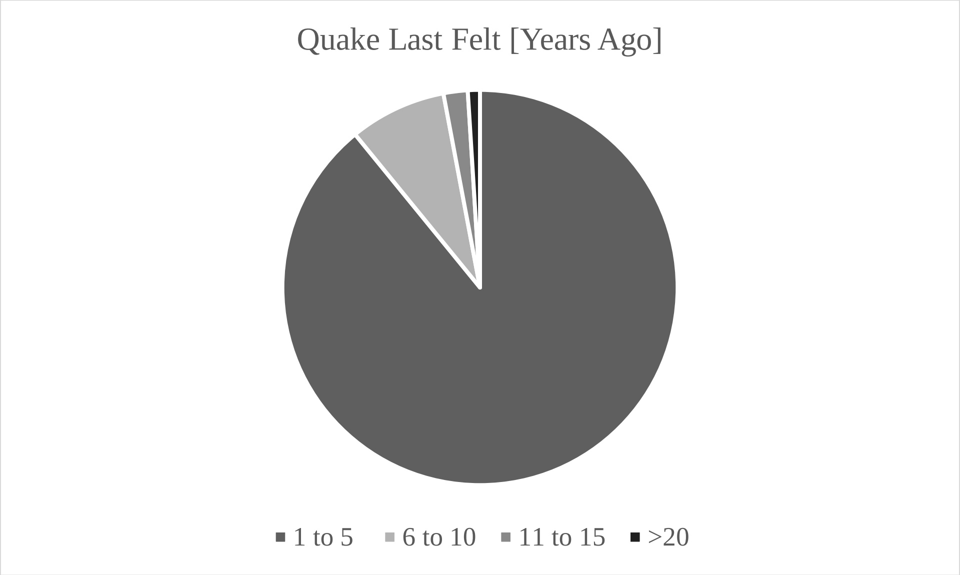


Figure 5. 7. A significant majority (90%) felt an earthquake in the last 5 years.

25% of the respondents had resided in Kabul City for less than 5 years. However, 75% of the residents had experienced an earthquake more than three times and 88% of the population have felt one at least three times supporting the local seismic data.

In response to the earthquake shaking, 25% of respondents prayed to in response to the jolts, 14% stated that they did nothing while 4% sought cover and 44% ran away (Figure 5.8). These findings closely replicated similar findings in the context of the 2005 Kashmir Earthquakes where an overwhelming majority of the people ‘ran away’ or ‘prayed’(Bahram and Paradise 2020).

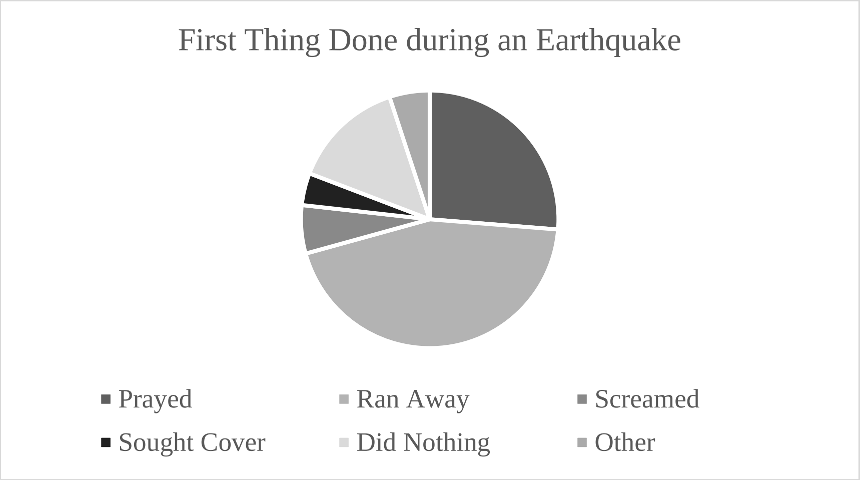


Figure 5. 8. While a substantial number of respondents chose to run during the last quake, a significant percentage also chose to stay put and pray while a tiny minority sought cover.

5.4.3. Earthquake Occurrence and Prediction

As to the prediction of earthquakes, respondents appeared hesitant to make any educated guesses on any future occurrence of an earthquake in their city. 52% of the respondents believed that there will be another earthquake while 45% of the respondents expressed a lack of knowledge on any future occurrences responding with ‘I don’t know’. While 30% of the respondents speculated the recurrence of an earthquake in Kabul in the coming 1-5 years (Figure 5.9). This might be explained in the prevailing belief that “only God knows” when an earthquake happens. It might as well be held in the realm of divine as a ‘divine retribution’ (Haque 1988) for inappropriate behavior – a widely held belief in a many Muslim majority countries (Esposito and Mogahed 2007). While individuals perceived risks in a certain way and had concerns, it is often culture that provides social constructed myths about nature – systems of beliefs that are reshaped and internalized by persons becoming part of their worldview and influencing their interpretation of natural phenomenon (Dake 1992). In Egypt, Homan (2001) noted that it was predictable in a society where religious literalism can be strongly evident that ideas regarding disasters are often going to be centered around divine interpretations.

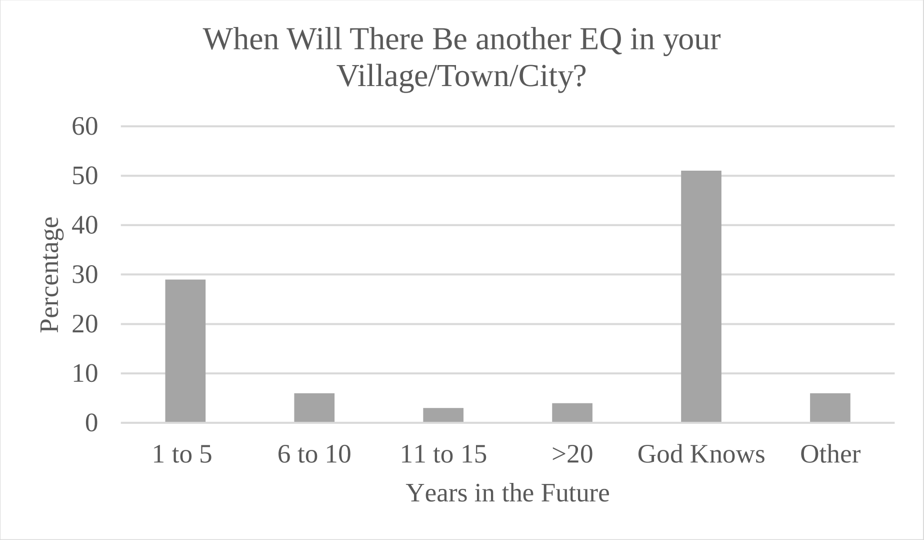


Figure 5. 9. Respondents were shy in predicting an earthquake referring to ‘*Khuda Mefahma’* God knows.

High magnitude earthquakes have shaken the city repeatedly in the recent past. Experiences seemed to have limited impact on the respondents. Their staunch beliefs that events of the future could only be known to the divine, and was out of the sphere of man’s knowledge or capacity to predict, hinted at a fatalistic understanding of seismic events. Similar respondents in Muslim countries avoided making simple predictions about future events especially pertaining to earthquakes and held a fatalistic attitude e.g., Suwihli and Paradise (2020) in Libya, Khan et al. (2019) in Pakistan, Alshehri (2013) in Saudi Arabia, Tekeli-Yeşil (2010) in Turkey, Paradise (2005) in Agadir, Morocco, and Homan (2001) in Egypt. For instance, Ainuddin et al. (2014) noted that in response to questions regarding the future earthquakes, study participants insisted that they would not leave the area and their lives depended on the 'mercy of God'.

Interestingly, 45% of the respondents associated the occurrence of earthquakes to tectonic activity by choosing the option "***Tectonic plates slip alongside each other***". A cumulative 21% of the respondents held it as a manifestation of divine intervention to either "***Allah punishes the sinful"***, or ***"Allah tests the believers"***. The two options were intentionally provided separately based on previous works by Paradise (2008; 2005), Alshehri (2013), Ainuddin et al. (2014) to compare prior levels of agreements.

Table 5. 2. Results of surveys conducted in Kabul, Afghanistan presented in percentages.

Sex:	Male: 69	Female: 31				
Age:	<20yrs: 20	21-30yrs: 54	31-40yrs: 16	40-50yrs: 7	51-70yrs: 4	
Birthplace:	city: 53	village: 35	country: 4			
Resided Longest:	city: 53	village: 35	country: 12			
Education:	Other: 13	primary: 4	Secondary:15	baccalaureate: 52	4yr college:16	
Annual Income	<100: 61	101-300: 19	301-600: 11	601-1100: 6	>1100: 3	
Household Type	Nuclear: 22	Joint: 68	Communal: 8	Others: 2		
Ever Felt a Quake?	yes: 99	no: 1				
Times Quake Felt	Once: 4	Twice: 8	Thrice: 12	>3: 76		
Last Quake?	1-5yrs: 90	6-10yrs: 8	11-15yrs: 2	20yrs: 1		
First Thing Done During Eq	Prayed: 26	Ran Away: 44	Screamed:6	Sought Cover: 4	Did Nothing: 14	Other: 5

Table 5.2. (Cont.)

Another Quake Soon?	Yes: 52	No: 3	I don't know: 45			
Next Quake?	1-5yrs: 29	6-10yrs: 6	11-15yrs: 3	>20yrs: 4	God Knows: 51	Other: 6
Why Quakes Happen?	IDK: 24	Allah Punishes the Sinful: 10	Allah Tests the Believers: 11	Tectonic Plates Slip Alongside Each Other: 45	Other: 9	
Dangerous Place to Live in During A Quake:	Village: 32	City:62	Other: 6			
Type Of Building Resistant to Quakes:	Adobe:10	Concrete: 8	Re-enforced Concrete: 65	Steel: 15	Others: 2	
Aware Of Any Emergency Services Close to Your Office or Home?	Yes:36	No:64				
Who Owns Your House?	My Family: 74	Landlord: 20	City: 1	Government: 3	Other: 1	
Know About Quakes?	nothing: 8	little: 21	somewhat: 59	Much: 10	All: 2	
Source Of Info on Quakes	TV: 27	Radio: 4	Internet: 30	Newspaper: 4	Religious Books: 4	Other People: 21 Other: 6
My House Is Safe from Earthquakes (Resistant to Earthquakes)	Strongly Disagree: 8	Disagree: 21	No Opinion: 26	Agree: 39	Strongly Agree: 7	
Got Frightened After the Recent EQ	Strongly Disagree: 12	Disagree: 16	No Opinion: 23	Agree: 35	Strongly Agree:15	
Am Prepared for Another EQ	Strongly Disagree: 20	Disagree: 26	No Opinion: 29	Agree: 19	Strongly Agree: 5	
Believe EQs Are a Serious Threat	Strongly Disagree: 11	Disagree: 23	No Opinion: 22	Agree: 29	Strongly Agree: 16	

Table 5.2. (Cont.)

Edu Has a Significant Role in Reducing EQ Damages	Strongly Disagree: 5	Disagree: 7	No Opinion: 12	Agree: 35	Strongly Agree:41	
Preventive Measures Are Important in Reducing EQ Damages	Strongly Disagree: 12	Disagree:9	No Opinion: 11	Agree:36	Strongly Agree: 32	
Building Codes and Laws Exist and Are Implemented	Strongly Disagree:20	Disagree: 24	No Opinion: 30	Agree: 18	Strongly Agree: 8	
We CANNOT Do Much about EQs	Strongly Disagree: 23	Disagree: 33	No Opinion: 17	Agree: 19	Strongly Agree:8	
It's ONLY Govt's Responsibility to Prepare for EQs	Strongly Disagree: 21	Disagree: 38	No Opinion: 16	Agree: 20	Strongly Agree: 6	
After 2015 Quake, Buildings Were Built Better in Kabul	Strongly Disagree: 10	Disagree: 14	No Opinion: 39	Agree:25	Strongly Agree: 12	
Taking Preventive Measures Is against Divine Fate	Strongly Disagree: 20	Disagree: 22	No Opinion: 30	Agree:19	Strongly Agree: 9	

5.4.4. Earthquake Safety

62% of respondents believed ‘City’ was the more dangerous place to live in an earthquake in comparison to village while 32% of the respondents determined ‘villages’ to be more dangerous in the event of an earthquake.

65% of the respondents agreed that re-enforced concrete buildings are more resistant to earthquakes versus 10% who believed traditionally constructed adobe buildings performed better. Only 15% respondents responded in favor of steel buildings. Haziq and Kiyotaka (2017) observed that insufficient capacity in building construction in both government and private sectors resulted in a serious threat to the public safety and institutions across Afghanistan.

Construction methods were mainly dictated by the availability of materials and equipment in Afghanistan. So, building designs outside of the major cities have followed the traditional methods of construction without any modern building code influence, with rarely any consideration for earthquake forces. Typically, house owners designed and constructed their houses with help from family members, neighbors, and local masons. Adobe and clay bricks were commonly used in wall construction in Afghanistan, most bricks are made by hand and sun or kiln dried (Haziq and Kiyotaka 2017).

Lang et al. (2018) defined 29 building typologies in the regions of Central and South Asia. Table 5.3 presents their building typology for Afghanistan. According to their classifications, the prevalent building types in the suburban and urban centers in Afghanistan included burnt clay brick masonry, concrete block masonry walls, and Reinforced Concrete (RC) moment-resistant frames –RC shear walls were regularly observed in the south-central and western cities. Building types that dominate rural Afghanistan included stone masonry walls, mud (adobe) walls, and load-bearing timber frames. Most of these building typologies are vulnerable to earthquake shocks. Often, these buildings collapse and kill its inhabitants (Appendix C). Improvements have been made in terms of individual buildings in the last two decades, however, most buildings still ignore building codes and are susceptible to shocks from earthquakes (Ahmadi and Kajita 2017).

A staggering 64% respondents expressed absolute ignorance of the existence of any emergency services close to their residence or workplace while 36% knew there were some forms of emergency services nearby. A lack of awareness of emergency services by the respondents served as evidence of a lack of interest on the part of the stakeholders of the basic services in a city that is often in a state of unrest and/or natural hazards.

Table 5. 3. The 29 building typologies classes in Afghanistan (Lang et al. 2018).

No.	***Load-bearing System***	***Building Typology***	***Afghanistan***			
			East-North-Central		***South-Central and West***	
1	Stone Masonry Walls	SM-1	■■	R	■	R
2		SM-2	■	R	■	R
3		SM-3	■■	SR	■	SR
4		SM-4	■■	R	—	
5	Mud (Adobe) Walls	AM-1	■■■	SR	■■■	R
6		AM-2	■	R	—	
7		AM-3	■■■	SR	■■■	SR
8		AM-4	■	R	■	R
9	Burnt Clay Brick Masonry	BM-1	■	SR	■	SR
10		BM-2	—		—	
11		BM-3	■■	SU	■■■	SU
12		BM-4	■■	SU	■■	SU
13		CM-1	■■	SU	■■■	SU
14	Concrete Block Masonry Walls	CM-2	■■	SU	■■	SU
15		CM-3	■■	SU	■	SU
16	RC Moment-resistant Frames	MRCF-1	■	SU	■	U
17		MRCF-2	■■	U	■■■	U
18		MRCF-3	■	U	■	U
19		MRCF-4	■■	U	■	U
20	RC Shear Walls	SWC-1	■	U	■■	U
21		SWC-2	—		■	U
22	Steel Moment-resistant Frames	MRSF-1	■	U	■	U
23		MRSF-2	—		—	
24		MRSF-3	—		■	U
25	Light Metal Frame	LMF-1	■	U	■	U
26	Load-bearing Timber Frames	LBTF-1	■	R	■	SU
27		LBTF-2	■	R	—	
28		LBTF-3	■	R	—	
29		LBTF-4	■	R	—	

Legends for the Table.

■■■	Frequently/Common	(Share of building stock 30-70 %)
■■	Regularly Observed	(Share of building stock 5-30 %)
■	Sparsely Observed	(Share of building stock < 5 %)
—	Not Available	
R	Rural	
S	Suburban	
U	Urban	

5.4.5. Earthquake Knowledge and Information Source

Three out of five respondents (59%) believed they knew ‘some’ about earthquakes. A cumulative 29% had little knowledge of earthquakes while 12% of respondents believed they knew a lot about earthquakes. It was found that the individuals in the study were not equipped with the necessary information on earthquakes and that they were not accurately informed about earthquakes and seismic activity. Taghizadeh et al. (2012) showed that poor knowledge about earthquake was significantly associated with higher age groups and lack of previous earthquake experience. Also, Tkeli-Yeşil et al.(2010) found that education level, direct experience of an earthquake, and socio-economic level significantly influenced action.

Most of the participants (30%) who followed discussions about earthquakes in Afghanistan preferred to use the internet as their first choice for information (Figure 5.10). Notably, however, a large proportion (27%) preferred the television as their source for information regarding earthquakes. Furthermore, most of the participants preferred using cell phones as a secondary information source to gain safety advice. Internet and phone accessibility increased substantially in Kabul City only in the last two decades (CSO 2016). Still, 21% of the respondents reported scientific books as their source of information in this study.

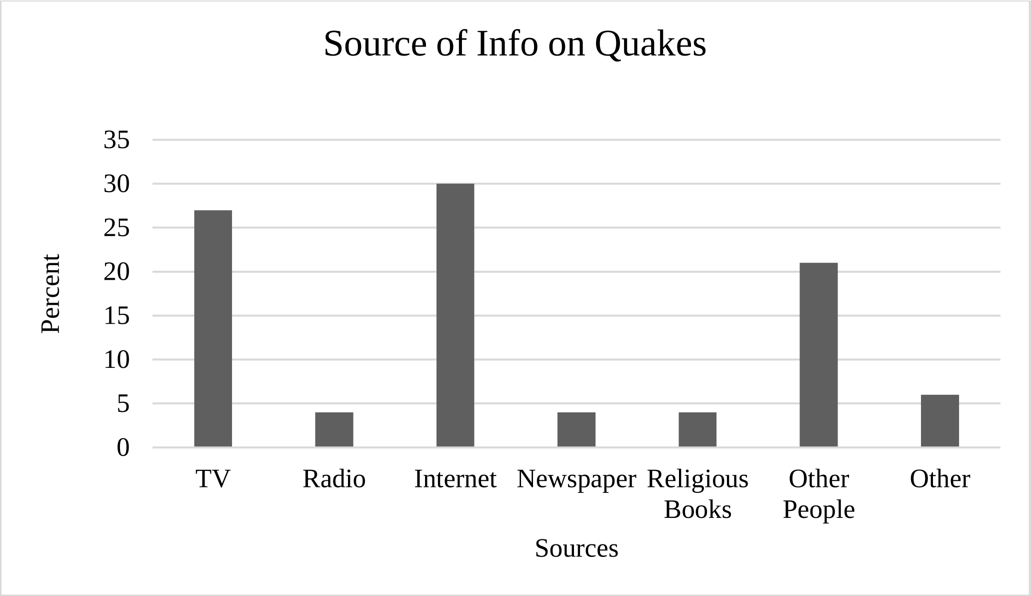


Figure 5. 10. Sources of information reported by respondents in Kabul City.

5.4.6. Level of Trust on the Government

An overwhelming majority of our respondents (75%) did not trust the local or national government regarding preparedness for an earthquake (Figure 5.11). Yet, 18% of the respondents agreed that the national government had preparations in place in the event of an earthquake. These respondents were not confident whether the national government prioritized their safety in the event of an earthquake since problems of corruption and bribery were continually mentioned in the surveys. Afghanistan ranks 165 out of 180 countries on the Corruption Perception Index of the Transparency International (CPI 2021) (figure 5.12). Funds and resources to be used in disaster risk management may be misappropriated and be used for other initiative – if at all.

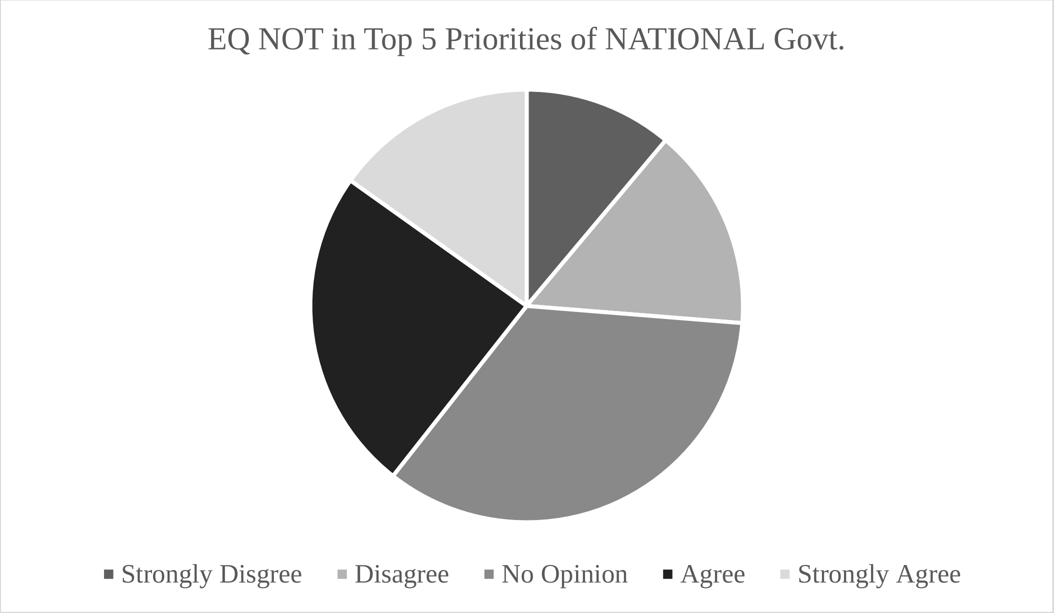


Figure 5. 11. Levels of distrust on national government regarding earthquake preparedness.

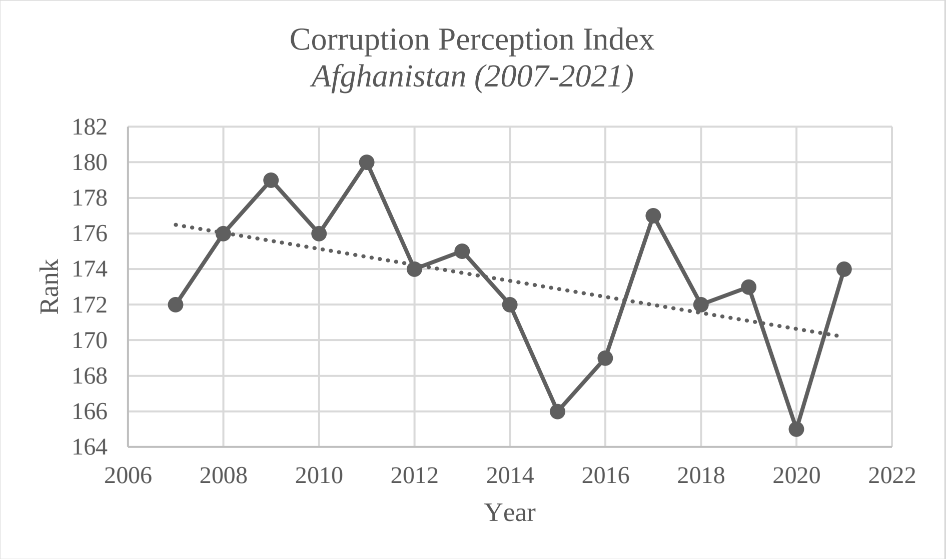


Figure 5. 12. Corruption Perception Index for Afghanistan (2007-2021) Source: Transparency International

46% of the respondents believed that their residential unit was safe from earthquakes and resistant to an earthquake in the future. However, 29% of the respondents believed that their housing unit was not safe and not built to resist an earthquake in the future. Further, 26% did not know anything about this aspect of their residential unit. This corroborated the findings by

Rafiee et al. (2018) that a greater majority of the houses built in Kabul City were substandard or followed no building standards at all.

5.4.7. Fear of Earthquakes

Half (50%) of the respondents agreed that earthquakes frightened them and expressed their fear that in the event of another earthquake they might experience negative consequences (Figure 5.13). While, 28% of the respondents disagreed and believed that 'Allah' would save them from any consequences since they believed deeply in divine justice that nothing would happen to the ones who did not commit sins (*Be-Gunaha*), supporting prior work of Khan et al. (2019) in Malakand, Pakistan. Another 22% held no opinions on this. They expressed more worries about other imminent issues in life such as ongoing armed conflict in the country, elusive state of peace, unemployment, and pollution as causes of more worries and concerns than an earthquake since they are more infrequent. People were more concerned about their daily preoccupation as Holdren (1983) states:

> *"A much simpler description might suffice: people worry most about the risks that seem most directly to threaten their wellbeing at the moment; environmental concerns predominate only where and when people imagine the risks of violence and economic ruin to be under control. ... that worries about more subtle and complex threats will materialize if, and only if, the most direct and obvious threats are taken care of? (Holdren 1983)."*

Despite having felt earthquakes in Kabul City more than three times, 34% of respondents rejected earthquakes as a serious threat to them while 45% believed that earthquakes posed a serious threat. Whereas one would presume a higher percent considered earthquakes as a serious threat to the communities exposed to the hazard, a lower percent of respondents believed it to be a serious threat (Figure 5.14). These respondents might have prioritized threats of earthquake risk as lower than visible hazards that occurred daily and had the national psyche for more than four decades. The frequent recurrence of medium magnitude earthquakes might have attenuated fear due to habitation though the technical risk remained the same (Slovic et al. 1986)

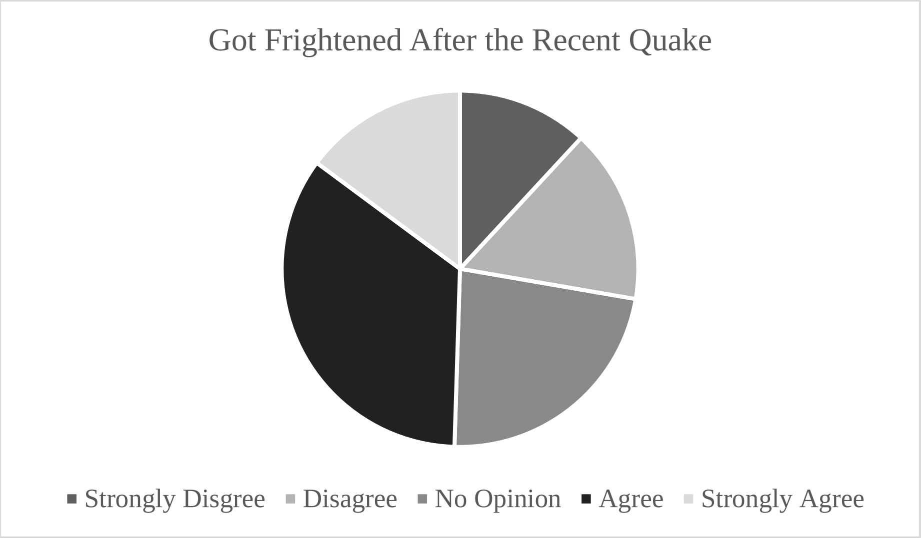


Figure 5. 13. Did earthquakes frighten respondents in Kabul City?

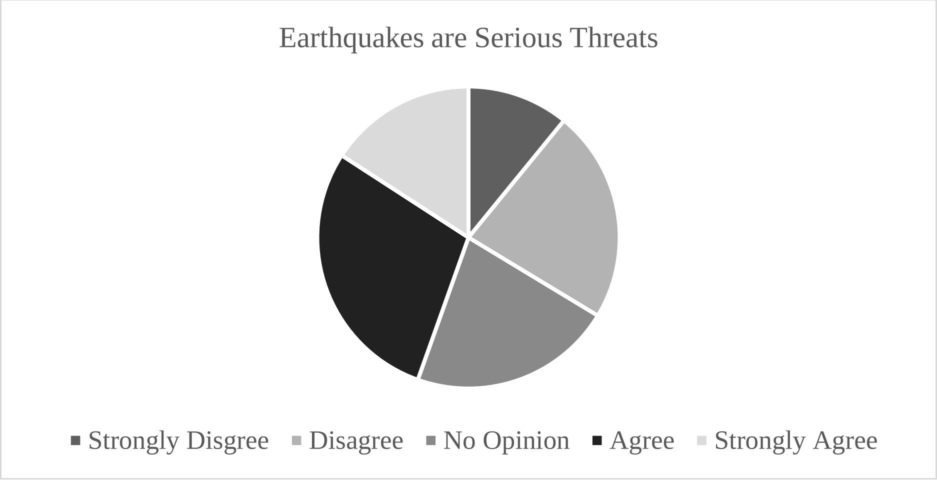


Figure 5. 14. Noticeable percentage of respondents do not think earthquakes pose a serious threat to Kabul City.

5.4.8. Earthquake Preparedness

46% percent of respondents believed they were not prepared for an earthquake believing it would be devastating with long term consequences. 29% held no opinion regarding preparedness specifically citing concerns of unemployment, daily security challenges, crimes, and immigration as more deserving issues than allocating resources in anticipation of an earthquake (Figure 5.15). Nearly every one of our survey participants (99%) referred to a lack of physical and mental security as their primary concern when prioritizing earthquake safety. It would be hard to ignore imminent and immediate threats which strike without warning (Figure 5.16). These findings contradict Ahmed et al. (2019) who found the mountainous community highly aware of their surrounding disaster risks regardless of differences in age, sex, education, occupation, religion, ethnicity, and family status.

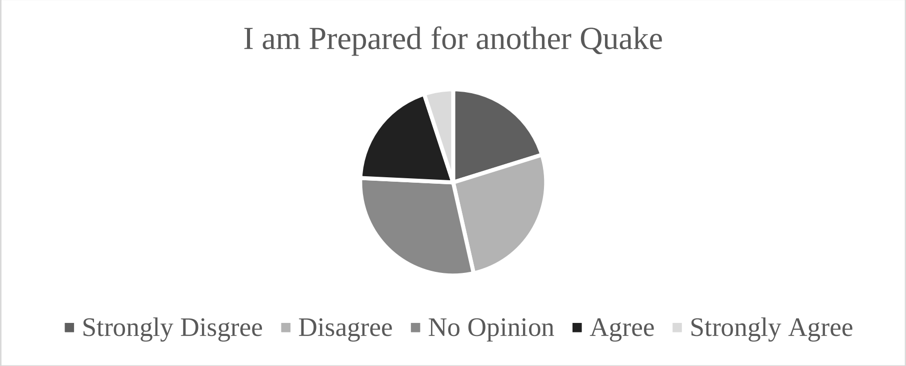


Figure 5. 15. Level of preparedness of respondents in Kabul for earthquakes.

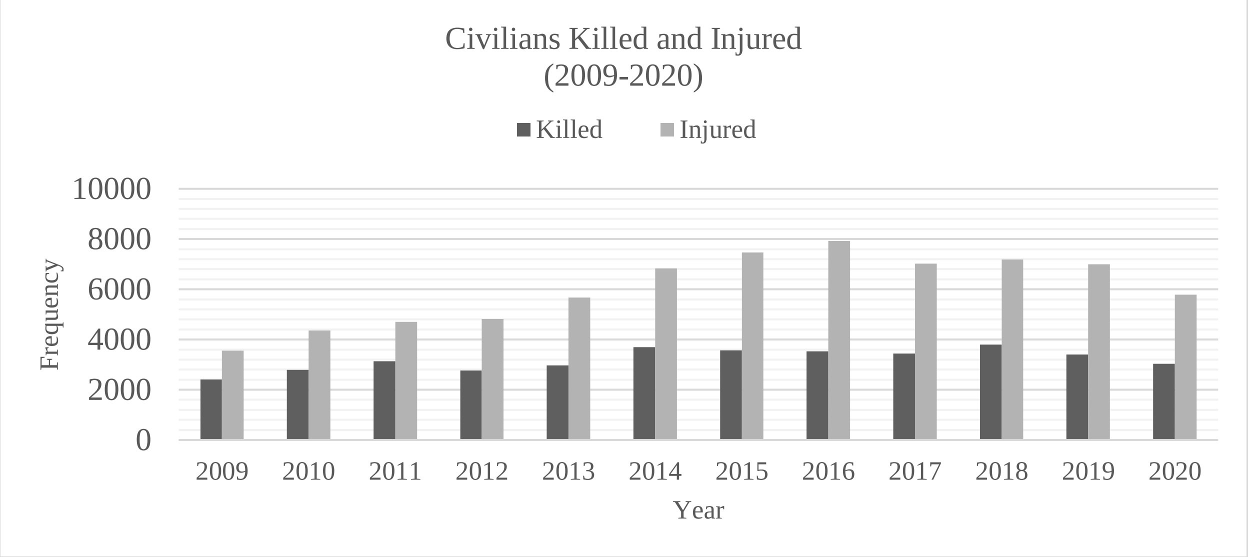


Figure 5. 16. The unceasing strife in Afghanistan claimed thousands of lives annually. Source UNAMA (2021)

5.4.9. Earthquake Risk Reduction

An overwhelming majority of the respondents (76%) agreed that education is vital in creating awareness and reducing damages from earthquakes (Figure 5.17). However, a smaller group of respondents (12%) disagreed by believing that "there is no escape from God's wrath and that it is either Allah's will, justice or retribution". In some cases, some participants lamented the fact that buildings are built so poor that no matter how informed citizens are, there would be little escape from falling debris once a powerful earthquake razed them.

Similarly, 68% agreed that mitigative strategies could play a significant role in reducing the number of anticipated damages from a powerful earthquake. Such measures as retrofitting older buildings and public awareness programs could help as well. However, nearly 20% of the respondents dismissed any strategy. They believed no strategy could effectively reduce damages to older buildings. It could only be done if the whole city were rebuilt.

56% percent of respondents believed citizens could play a role in reducing earthquake damages. However, they were hesitant in if they would consider doing anything substantial quoting the daily issues associated with political violence and instability, immigration, flight of investments, and brain-drain as more pressing issues than an earthquake event. Further, 27% of the respondents expressed absolute faith in '*Allah' would protect the believers* in any case and that if an earthquake is sent as a punishment upon them as a 'punishment', they could not escape it. Therefore, doing anything to try to reduce earthquake damages is futile (Khan et al. 2019).

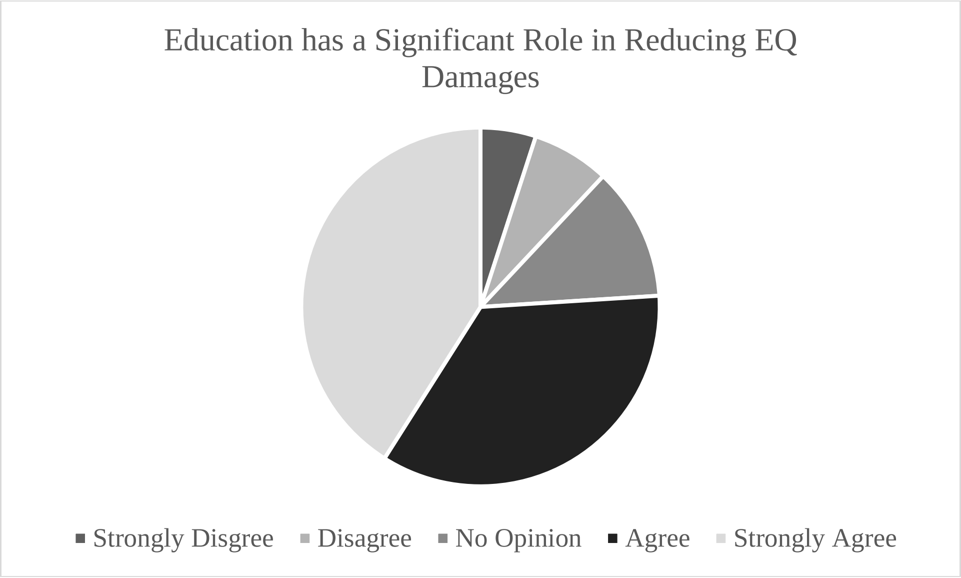


Figure 5. 17. Role of education as a mitigation measure.

5.4.10. Existence and Implementation of Building Codes and Laws

45% of the respondents do not believe any laws existed 30% did not know any such laws and often did not express any opinion at all. They stated that the level of corruption in the housing ministry and government contributed to the non-existence of any laws that could benefit citizens. Still, 25% respondents did believe there existed a few laws regarding building safety, but they were not sure if these laws were implemented in construction.

5.4.11. Prevention of Earthquake Damages

While 25% of the respondents disagreed that any initiatives were taken to build more resistant buildings, 40% of the respondents expressed a complete lack of knowledge regarding any policies. 37% respondents agreed that the last earthquake did scare builders and common citizens which influenced houses built after the 2015 earthquakes and were built to high standards.

When it came to personal responsibility, 44% agreed that it was possible to take measures to counter earthquake consequences. They believed it is well in the human authority to take actions to remedy any untoward event that is within human capacity. However, 27% agreed that earthquakes fell outside of the community's capacity to deal with, and therefore invest in any measure to counter consequences. 32% of the respondents expressed no opinion regarding this matter. They were not sure where to classify any preventive measures when it came to earthquakes. This is explained in lack of knowledge about earthquake safety programs.

59% believed citizens should share responsibility in preparing for earthquakes. Similar to findings by Khan et al. (2019), a majority of the respondents believed citizens have a bigger role than the government.

> *"Should an effective action be adopted as an effective strategy to prepare for an earthquake, the citizens have a bigger and more significant role than a failing government that cannot protect itself from Taliban bombs",* one respondent said. "*It comes down to the actual common people to try to build communities,"* another stated.

Another 26% of respondents believed it was only the government that had the mandate to take any such measures. One elderly respondent criticized the government saying

> *"They got billions from khariji-ha (foreigners) and poured them into their own pockets. They could build stronger buildings and help people too but who cares about us, jaan-e-biyadar (dear brother).*"

Another pointed out that there exists a disaster management authority and that they are the people mandated to prepare for earthquake. Common people should be left to take care of their immediate responsibilities toward their families and communities. Another respondent replied saying,

> *"Earthquakes are too big for citizens to do anything. It does not destroy one or two houses it destroys the whole city. Therefore, asking citizens to do anything to curb its impacts is useless.*"

5.5. Discussion

Seismic Risk is amplified by socio-economic conditions in Kabul City. The rapid rise in population, in-migration from the restive countryside into the city, bigger households, poorly designed homes and structures, low income, low education and literacy rates, contribute to increased risk (CSO 2016). The City has witnessed rapid and extensive urban development especially in the last 20 years (Mohammadi and Fujimi 2016). Further complicating the situation is a lack of national seismic risk management policy, and plan (MRRD 2014).

Earthquake risk is especially high in the developing countries, like Afghanistan, because of poor construction methods and high socio-economic vulnerabilities (Bilham 2004, Shroder 2014). Bilham and Gaur (2013) compared, albeit figuratively, the risk of earthquakes in South Asia—including Afghanistan—to the “weapons of mass destruction” owing to the poorly located and substandard housing (Anhorn, Lennartz and Nüsser 2015).

Earthquakes are most damaging when their epicenters are near big cities, even when those cities are of no great size (Bilham 1988). Ninety-five percent of deaths in earthquakes are due to building collapse (Alexander 1985). Recent earthquakes in developing countries have caused widespread loss of lives due to socio-economic vulnerability, physical vulnerability and building fragility coupled with rapid rise in urban population (Bilham 2004)). In fact, Khan et al. (2019) report significant influences on risk perception by the actual physical vulnerability of buildings. Tural et al. (2004) emphasize the need for more studies focused on earthquakes in developing countries considering that 91 of the 108 major earthquakes (with a death toll over 1,000 from 1900) in the twentieth century occurred in the developing countries, accounting for 83% of 1.8 million deaths worldwide. In the past 25 years, earthquakes in Afghanistan have claimed more than 20,000 lives (Mohammadi and Fujimi 2016, Boyd et al. 2007).

The differences in attitude to earthquake hazards found both in historical and in modern times cannot be explained in terms of the magnitude and frequency of such disasters alone (Ambraseys 2009). It is the perception of the disaster that controls the attitude and stimulates awareness.

How a community responds to disasters occurring or how it prepares for another one is often strongly influenced by their culturally derived perception from previous training, education, and experiences (Paradise 2005). Measures of contemporary worldviews and cultural biases are shown to predict public perceptions of risk, preferences for societal risk-taking, and a variety of other social, economic, political, and environmental concerns (Dake 1991).

To enhance risk communications and shape effective mitigation policies, it is vital to understand public's perception of risk (Ho et al. 2008). Setbon et al. (2005) suggested a direct causal link between flood safety related risk perception and actual behavior. Miceli (2008) reports a positive relationship between disaster preparedness and risk perception. Higher levels of risk perception might positively influence people's willingness to deal with an environmental risk (De Dominicis et al. 2015). It plays a crucial role in developing effective preparedness and mitigation measures at the household, community and national levels (Paul and Bhuiyan 2010). It is fundamentally important to evaluate people's perception of risk for the effective implementation of risk reduction policies (Khan et al. 2019).

For any theory of risk perception to function, it should be able to predict and explain what kinds of people will perceive which potential hazards to be how dangerous (Wildavsky and Dake 1990). Dake (1991) proposed that in studies pertaining to risk perceptions, the focus must remain on who fears what and why? To understand who fears what and why, genuine consideration of the political, historical, and social context in which risks are framed and debated need to be taken into account. Mental modeling undertaken through psychometry by Slovic (1987, 1982) and Fischhoff et al.(1978) of risks are not solely matters of individual cognition, but also correspond to worldviews involving deeply held beliefs and values regarding society, its functioning, and its potential outcome (Dake 1991).

Socially viable combinations of cultural biases and social relations are referred to in cultural theory as *ways of life*. More specifically, then, hierarchal, egalitarian, individualist, and fatalist forms of social structure, together with the cultural biases that justify them, are each hypothesized to engender distinctive representation of what constitutes a hazard and what does not. Those risks selected for worry or dismissal are said to be functional in the sense that they strengthen one of these ways of life and weaken the others (Dake 1991).

Risk perception is socially constructed (Dake 1991) and is fundamentally subjective (Slovic 1999). The concept 'risk' embodies different meanings to the experts and to the common man (Slovic et al. 1982, Slovic 2000, Slovic 1987). While experts associate risk with technical estimates of annual fatalities, laypeople's judgement of risk are sensitive to factors such as the catastrophic potential, controllability, and threat to future generation. However, perceived and acceptable risk appear to be systematic and predictable (Slovic 2000).

5.5.1. Risk Perception

People use an affect heuristic when judging risk (Finucane et al. 2000). In fact, reliance on affect (a subtle form of emotion, defined as positive (like) or negative (dislike) evaluative feelings toward an external stimulus) and emotion is a quicker, easier and more efficient way to navigate a complex, uncertain and sometimes dangerous world (Slovic 2000). Affective reactions are often the very first reactions, occurring automatically and subsequently guiding information processing and judgment (Zajonc 1980). Therefore, answers to the questions were provided in the form of options in tandem with Likert scaling methodology to evoke affect – immediate responses – that the respondents would prefer the most and not a questionnaire that would require any form of analytical skill or deep thought process.

Slovic (2000) concludes that both affect and worldviews function as orienting dispositions helping people assess and respond to risk. Experts' judgments, like those of laypersons, have also been found to be influenced by worldviews and affect. Hence, while this study focused on collecting responses to Likert scale questions invoked by affect, important questions regarding the cultural, and environmental settings were also asked to address both dimensions of 'affect' and 'worldviews' influenced by local culture and environment.

Following Wildavsky and Dake (1990), one measure of knowledge we have used is the individual's self-report of how much he or she knows about earthquakes. Self-ratings are the simplest and best way to address some psychological phenomena (who knows better than the individual how much dread a perceived hazard evokes for him?).

Although Kabul City is highly vulnerable to seismic activity centered around active Quaternary faults (Ruleman et al. 2007), results from this survey indicate that residents of Kabul do not consider it to be a serious threat to the region. For example, only 45% of respondents agreed that earthquakes are a serious threat to the region as opposed to a 91% agreement with the statement in the case of residents of Khyber Pakhtunkhwa province of Pakistan (Bahram and Paradise 2020). Even though this is a surprising finding, it is understandable when one ranks the number of threats residents of Kabul have to deal with including active terrorism manifested in the daily bombings, improvised explosive devices, increased pollution (Haziq and Kiyotaka 2017), increased rate of crimes, and increasing rates of unemployment (CSO, 2016) to the occurrences of earthquakes. In fact, Steckler et al. (2018) recognized that the discourse on earthquake risk in developing countries (like Afghanistan) is a challenge because crucial information is missing, socio-political problems are too many and investments towards risk reduction in general and seismic risk involve painful bargains with national issues often dominated by acts of terrorism and an on-going civil war. Moreover, these countries have profound immediate needs, including such ongoing rapid transformations as urbanization and political instability and violence in the case of Afghanistan, Pakistan and much of Middle East (Esposito and Mogahed 2007, Hamilton and Halvorson 2007). Afghanistan, a developing country with an ongoing state of violent political instability for the past four decades, is further faced with development issues such as accelerated population growth, rapid urbanization, poverty along with economic instability.

This extends further i.e., only 60% of the respondents agreed that they got frightened when a 7.5 magnitude earthquake shook Kabul in October 2015 and caused 399 fatalities across the region (70% of victims during the 7.5 magnitude Hindukush earthquake on 26 October 2015 were women and young girls (Hamidazada, Cruz and Yokomatsu 2019)), a 6.6 Mw earthquake in 2016 and another 6.1 Mw in January 2018.

Among other factors, individual perception is based on experience and memory. It is noted that disaster experience influences personal perceptions of hazards, and changes individual attitudes and behavior concerning hazard preparedness. Past earthquake experience tend to be a significant determinant of preparedness (Paul and Bhuiyan 2010). However, it does not seem to have left behind such an impact on the residents of Kabul interviewed for this study. This might explain the gap in perceptions of communities that live in peace and a community that is going through an unabating high intensity conflict daily (Mena and Hilhorst 2021).

Perception of danger is selective, it varies with the object of attention (Wildavsky and Dake 1990). Therefore, residents of Kabul, like their counterparts in other Muslim majority countries perceive seismic risk in a fatalistic manner owing to their cultural bias. Kabul City has experienced earthquakes of high magnitude in 2002, 2005, 2009, 2010, 2012, 2013, 2015, 2016, and 2018 in addition to medium magnitude earthquakes centered in the Hindukush region, the earth's most active region of intermediate-depth seismicity (Molnar and Bendick 2019). People with direct experiences of earthquakes have been found to have higher levels of risk perception (Khan et al. 2019), preparedness and are motivated to take action (Tekeli-Yeşil et al. 2010).

The association of earthquakes with divine intervention in the realm of man is deeply rooted in the Islamic teaching of the concept of Qayamat, the day of resurrection; and therefore, to the punishment of the wrongdoers (Paradise 2005, Khan et al. 2019). From the nascent years of the formation of the faith of Islam to this day *[The 5th year of Hijra is known as the year of the Earthquake according to Al-Biruni cited in Sherrard Beaumont Burnaby, Elements of the Jewish and Muhammadan calendars (1901) 376]*, it is commonplace to notice Muslim victims of an earthquake referring to the event as a divine intervention either as a test for believers, or a retribution for the evil doers or in the least as a 'manifestation of God's wrath' brought upon by bad deeds, public indecency, most often, of women (Khan et al. 2019, Farhang 2004).

Disaster risk reduction initiatives and studies are lacking in conflict zones. They are nearly absent in literature, as well as, policies, plans and approaches (Mena Flühmann, Hilhorst and Peters 2019). One of the fundamental challenges in studying DRR in high-intensity conflict regions is the relatively scant attention paid to disasters in relation to conflict (Mena Flühmann 2018). In high conflict zones such as Afghanistan, seismic risk or as a matter of fact any disaster is rarely seen as a priority rather violent conflict is usually conceived as being a higher concern for redress, and its resolution supersedes DRR (Peters 2017b). Protracted conflicts and high levels of state fragility (FFP 2020) have undermined disaster risk management, in general, and increased people’s vulnerability to natural hazards. More than four decades of civil strife has resulted in low levels of socio-economic development, the destruction of coping mechanisms, reduced disaster risk management efforts, ineffective governance and reduced capacities to recover and build resilience (GFDRR 2017, CSO 2016). In such settings, vulnerability is usually enhanced while capacity to respond or to adapt is eroded (Peters 2017b, Wisner 2012). Often, pre-existence of immense physical vulnerabilities, lack of social cohesion, heightened levels of distrust on the part of the local as well as national governments, continued state of war, national government’s fragility, and existing poverty levels undermine disaster risk reduction initiatives. Therefore, any investment toward seismic safety, and reduction of seismic risk takes a backseat in the context of high-conflict zones.

Violent conflicts can hamper DRR in multiple ways (Wisner 2012). For example, lack of capable national DRR governance structure is a commonplace in high conflict zones (Mena and Hilhorst 2020). Even less common is practical and operational knowledge of DRR in relation to peacebuilding, conflict prevention, do no harm principles and conflict sensitive approaches (Mena Flühmann et al. 2019). The links between disasters and conflict are elaborated in Afghan DRR policy documents, which articulate how conflict exacerbates the disaster situations and undermines the country’s abilities to anticipate, plan, prepare for, and respond to shocks.

Moreover, the level of trust in the government's response and preparedness was also tested. In politically violent and fragile states, corruption erodes trust. The corruption perception indices have consistently ranked Afghanistan and Pakistan, for the last 15 years, at 165-185 and 116-140 most corrupt nations in the world. For example, Afghanistan has been consistently placed in the list of10 most corrupt countries by Transparency International (CPI 2021) since 2007. Afghanistan ranked 180 in 2011 which is interpreted as the most corrupt nation in the world in the ranking of 180 countries by Transparency International through its corruption perception index, an index that ranks countries by their perceived levels of public sector corruption as determined by expert assessments and opinion surveys.

5. 6. Conclusion

Afghanistan is located on the southern edge of the Eurasian plate and the northern boundary of the Indian plate. It is in the vicinity of the great collision zone between the two plates (Ambraseys and Bilham 2003). By virtue of this type of geo-tectonic location, active Quaternary faults have been sources of earthquakes here. In fact, Kabul City was destroyed by a 1505 earthquake (Bilham 2004). Kabul City is one of the fastest growing cities in the world and is home to over 4 million people housed in over 600,000 housing (UNDESA 2018, CSO 2016) and is one of the many major urban centers threatened by earthquakes (Bilham 2014). The frequency of occurrence and magnitude of the earthquakes have a profound bearing on the socio-economic development of Kabul City and of Afghanistan in general. GFDRR (2017) estimate Kabul to have the highest average damage of all regions in Afghanistan amounting to an estimated loss of $17 million annually.

In conflict zones, communities have shifting interests and vulnerabilities are intensified as they face restrictions on free movement that hinders emergency relief and evacuation in the aftermath of a disaster. The findings of this study provide basic results for disaster and risk managers, planners, and urban policymakers to facilitate a reasonable evaluation of the current state of seismic risk in the city and to act in addressing the gaps in disaster management plans regarding earthquakes in the capital city.

From a social, economic and psychological perspective, earthquakes cause deep impacts on the society (Demirkaya 2008). Participants of this study display characteristics of strong traditional values and attitudes prevalent in Afghan society and similar societies such as those of Libya (Suwihli and Paradise 2020), Pakistan (Bahram and Paradise 2020, Ainuddin et al. 2014), Saudi Arabia (Alshehri et al. 2013), Turkey (Demirkaya 2008), and Morocco (Paradise 2005).

Anderson-Berry (2003) observed that people might reveal general hazard knowledge, however, it cannot be interpreted as sufficient enough to translate into hazard preparedness, and action (Tekeli-Yeşil et al. 2010). This study reveals that although a significant percentage of respondents believe that it is not solely the responsibility of the government to manage disasters, yet they remain shy to share what and how they could participate in reducing risks emanating from an impending earthquake.

CHAPTER 6: Seismic Risk Perception Assessment of Earthquake Survivors: A Case Study from the 2005 Kashmir Earthquake

Ikramuddin Bahram, and Tom Paradise

6.1. Abstract

Following the catastrophic earthquake of October 2005 in Kashmir, Pakistan 215 surveys were administered to earthquake survivors in villages within 50 miles (80km) of the epicenter near the town of Muzaffarabad. The survey questionnaires were designed to address perceptions of seismic knowledge, event-related behavior, and opinions of local, regional, and national seismic preparedness and mitigation –representing a rare opportunity in seismic risk assessment. The surveys were administered by a Pakistani team of university earth science students under the Guidance of the authors.

Some of the findings were similar to previous research results, while some were counter-intuitive, surprising, and valuable. Overwhelmingly, respondents stated that they ran away after the quake (vs. praying, taking cover, screaming, or doing nothing). Their trust in local and national governments regarding future earthquake preparedness and mitigation was high (~50%), contrary to most prior studies (e.g., Terpstra (2011)). Less than five percent of respondents believed that ‘no quake would occur again’, while nearly 75% responded that another quake would occur within 5-10 years – another opinion contrary to previous research. Overall, this research revealed new aspects of risk perception in the predominantly Muslim communities of Northern Pakistan regarding recurrence, post-event action, and regional preparedness.

Keywords: *2005 Kashmir Earthquake, risk perception, Islam, hazards studies*

6.2. Introduction

A major earthquake of magnitude 7.6 (MR) struck Pakistan-administered Kashmir on 8 October 2005 at approximately 8:50am (USGS 2005). The epicenter was located 12 miles (20km) northeast of Muzaffarabad, the administrative capital of Pakistani Kashmir, and only 61 miles (100km) northeast of Islamabad, Pakistan's capital (Özerdem 2006) (Figure 6.1). The earthquake resulted in ground-shaking intensity (Mercalli Scale) as high as IX to X in densely populated areas such of Balakot and Muzaffarabad (USGS 2005)—this study's survey sample sites. This quake is considered 'the worst natural disaster in Kashmir' over the past 100 years (Bendick et al. 2007). It caused 86,000 fatalities and damage to some 600,000 buildings, which included 6,298 schools and 782 health facilities (Bothara and Hiçyılmaz 2008, Reconstruction and Authority 2006) and left behind an estimated four million people homeless (Halvorson and Hamilton 2010). Damage was extensive and international efforts and support was widespread (Figure 6.2).

Figure 6. 1. Map (left) of Pakistan with epicenter of the Kashmir Earthquake of October 8, 2005, and study site. Close-up map (right) of the region most affected by the quake, Highlighted towns represent those where post-event surveys were administered. (Cartography by T. Paradise)

6.3. Tectonics and Seismicity of Northern Pakistan

The Himalayan, Karakoram, and Hindukush fault nexus represents one of the most seismically active regions in the world (Ismail and Khattak 2016). The location of northern Pakistan on this syntaxis is characterized by increased seismicity owing to the convergence of the Eurasian and Indian plates, with the latter slipping northwards beneath the former at a rate of 37- 48mm⁄year (USGS 2005). This region has a history of being affected by shallow earthquakes originating from the northwestern segment of the Karakoram Fault System (USGS 2013).

It was the first Himalayan earthquake to be accompanied by surface rupture, reactivating the Balakot–Bagh Reverse Fault (BBRF) and, locally, offsetting the Main Boundary Thrust (Hussain, Yeats and Lisa 2009). A field investigation by Yeats et al. (2006), Kumahara and Nakata (2006) and Kaneda et al. (2008) revealed a surface rupture 70 km long, with up to a seven-meter vertical separation, mostly along the preexisting BBRF (Hussain and Yeats 2009).

Across the affected region, mountainsides collapsed causing extensive rockfalls and debris flows that cut-off entire towns, villages, rivers, and roads, leaving many areas inaccessible to aid. The towns of Muzaffarabad and Balakot sustained terrible devastation. Because the earthquake occurred just before the beginning of the region's severe winter, it exacerbated the effects of the tremor while increasing the inability to assist the injured and attend to the dead (Akhtar 2006, Avouac et al. 2006) (Figures 6.2, 6.3, 6.4, 6.6).

Since earthquake preparedness and mitigation is related to perceptions of hazard and risk (Burton 1993), survey questionnaires were administered to survivors of the earthquake regarding their knowledge, fear, behavior, and concerns of the quake, seismic safety, and preparedness. Responses were analyzed in the hopes of revealing relationships important in understanding the influences of perception on risk assessment in a Muslim country like Pakistan. In addition to understanding perceptions of seismic risk and behavior, statistical analyses were conducted to help divulge respondent opinions of their local, regional, and national governments considering earthquake preparedness. The thrust of this research was to better understand links between behavior, belief, and policy in Muslim communities in the hopes of creating stronger policies that may decrease potential injury, loss, and death in seismically active Pakistan, and across the region.

Figure 6. 2. Destruction of structures and hillslopes in Muzaffarabad, near the epicenter.

6.4. Methods and Data Collection

Survey data were obtained from a team of Pakistani geography, environmental studies, and geology students from the University of Sindh, Jamshoro who conducted the surveys in the Spring 2006. The survey team interviewed 215 respondents who were identified as witnesses, survivors, and/or victims of the October 8th Kashmir Earthquake. Of the 215 interviews, 25 surveys were removed for their incomplete responses; 190 respondent surveys were used in this study. The survey was created for canvassing witnesses in villages where the greatest damages and losses were sustained. The sample size was designed to address the households of these villages and towns hit the hardest, based on recorded Modified Mercalli Intensity scale (MMI) values (I-XII) and actual damages to the region (USGS 2005) (Figure 6.3). All surveyed villages were located within 50 miles (80km) of the epicenter and included **Balakot**, **Kaghan**, **Battagram**, **Mansehra,** and **Galyat** (Figure 6.4). 40-50 surveys were administered in each village or town. An arbitrary systematic sampling method was used for sampling survivors in the five target sites. Respondents were asked about their experience with the quake; individuals were approached and asked whether they had experienced the earthquake as the first question to filter each respondent. As expected, some respondents refused to be interviewed due to fear, gender complications, and time availability—not a surprising circumstance in relatively strict Muslim communities such as mountainous Pakistan.

Survey questions had provided boxed answers, blank areas for comments, and Likert-scale questions. The survey questions were divided into two parts: the first part addressed the demographic data, while the second part sought answers to questions related to a seismic event, preparedness, and perception.

These questions were:

-- *Did you experience the recent earthquake on October 5?* ☐*Yes,* ☐*No*
-- *What did you do first during the last earthquake?*
    ☐*Did Nothing,* ☐*Ran Away,* ☐*Screamed,* ☐*Sought Cover,* ☐*Prayed*
-- *Will, there ever be another earthquake and if so, when?*
    ☐*Yes,* ☐*No:* ☐*1 year,* ☐*1-5 year,* ☐*6-10 years,* ☐*11-20 years*
-- *During an earthquake, it is more dangerous to live in the following:*
    ☐*Countryside,* ☐*Village,* ☐*City,* ☐*Skyscraper*

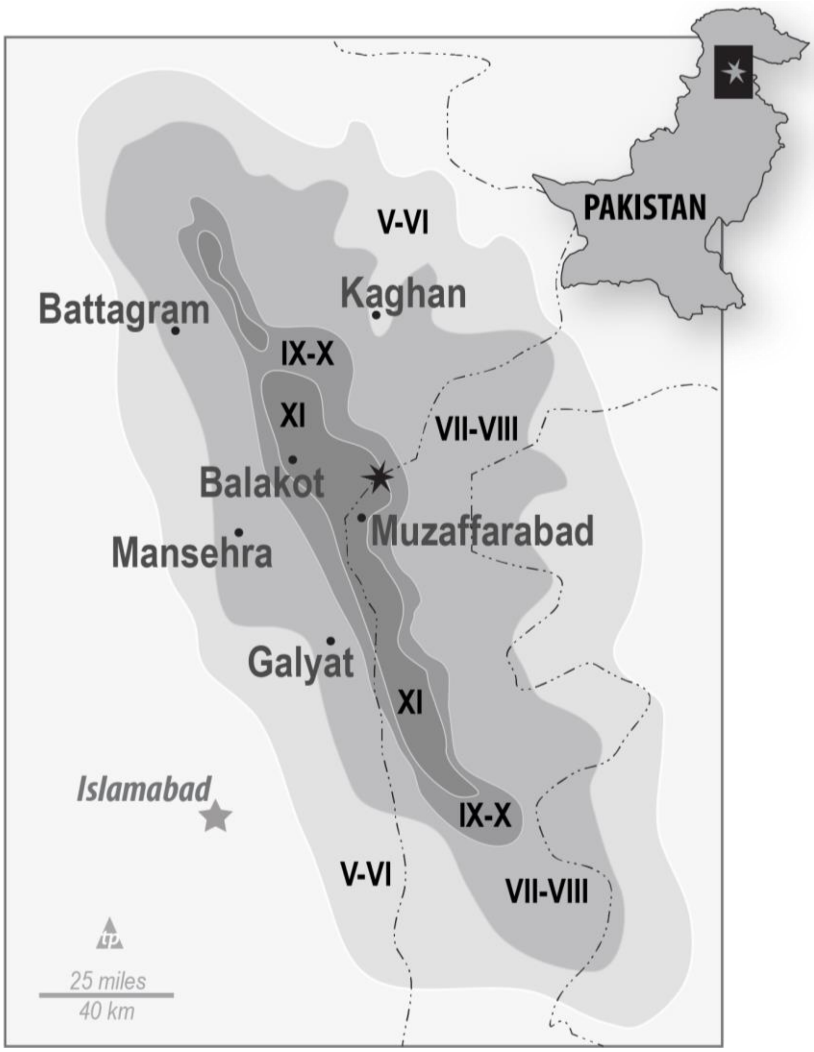


Figure 6. 3. Regional map of the area that sustained the most damage. Shaded areas represent the zones affected by the tremor: MMI or Modified Mercalli Intensity scale (I-XII) represents greatest damage (XI-XII: darkest) to moderate damage (V-VI). (Cartography by T. Paradise, data from USGS (2005).

The following questions were asked with the following provided options:

Fully Agree, Somewhat Agree, Neutral, Somewhat Disagree, Fully Disagree
< -- >

-- *I believe another earthquake will happen.*
-- *Earthquakes frighten me.*
-- *I believe the buildings in the region are unsafe.*
-- *Earthquakes pose a serious threat to the region.*
-- *I am confident that the local government is prepared for another earthquake.*
-- *I am confident that the national government is prepared for another earthquake.*

Statistical analysis was employed to ascertain the response of the target population during the earthquake, their understanding of earthquake recurrence, and their level of trust toward the local and national governments about their preparation for another earthquake. Descriptive statistics were conducted to elaborate on the characteristics of the target population who were surveyed for this study.

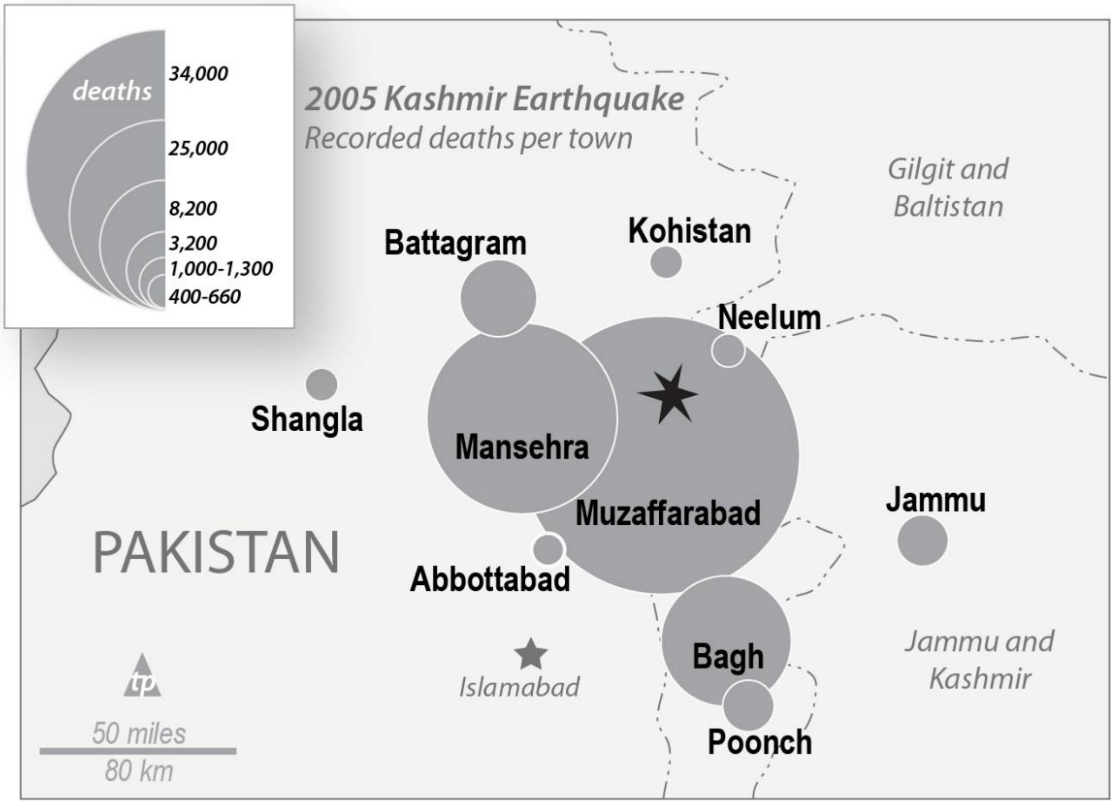


Figure 6. 4. Map representing the recorded deaths caused by the earthquake. Muzaffarabad was most affected with 34,000 deaths. (Cartography by T. Paradise, data from Artibees (2018)).

6.5. Demographic data and findings

The male-to-female ratio of respondents was dramatically off-balance; however, this is a common survey result in Muslim communities (male 80%, female 20%) unless female sites are specifically targeted (i.e., university campuses, clubs) (Paradise 2005). However, the age groups represented a more diverse and distributed group. The respondents were all adults ≥20 years in age while the greater share of the respondents (42%) fell between 31- 40 years of age. This can be interpreted as a relatively young community; ~79% of the respondents were younger than 50 years old. The level of attained education reflected in this survey revealed that 35.6% of the respondents never attended any formal schools (Figure 6.5).

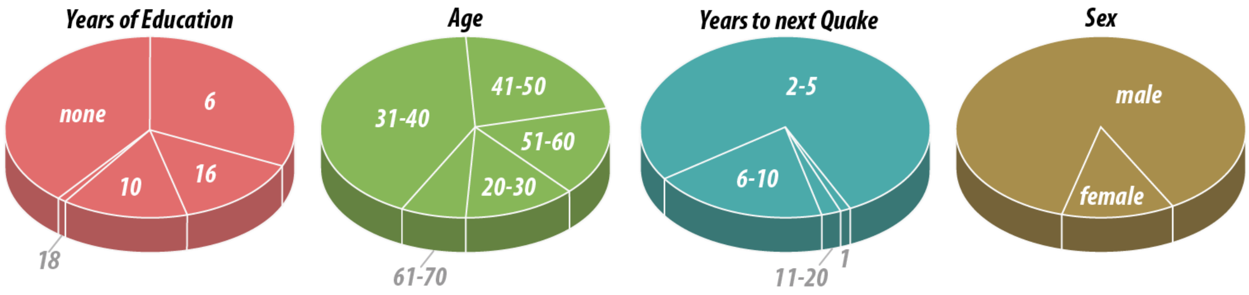


Figure 6. 5. Sectored coin diagrams illustrating the basic demographic information of the survey respondents. (n=190)

6.5.1. Earthquake Experience

98.9% of the respondents overwhelmingly said, ‘yes’ in response to the question ‘*did you experience an earthquake?*’. Only three respondents (2%) gave a negative response. Since nearly every respondent felt the Kashmir Earthquake, the three respondents with negative responses were confidently grouped as outliers. It is probable that these three individuals were not in their hometowns (survey target areas) during the earthquake. However, there is no way to confirm this since the survey questions do not identify individuals whether they were present or not at the time of the earthquake.

An overwhelming majority (80%) of the respondents believed that living in villages was more dangerous in the event of an earthquake. This can be due to the fact that the living environment influences one's risk perception (Burton 1993) and the observed destruction of the target sites would have enhanced their responses.

6.5.2. Earthquake Frequency

89.2% of the respondents 'fully agreed' with the statement *'I believe another earthquake will happen'* against 4.2% who either responded *'neutral'* or *'disagreed'.* Another important question that informs us of the respondent's perception of risk regards their understanding of earthquake frequency. Only 6.5% of the respondents believed there will NOT be an earthquake occurring ever again, while 93.5% believed there would be another earthquake in the area. However, they differed on the frequency of its occurrence – 71% of the respondents believed that another major destructive earthquake would strike the region within 2-5 years (Figure 6.7). While another 26.7% believed an earthquake would strike within 6-10 years. This question serves as an indicator of people's heightened understanding of seismic mechanisms and risk in the Kashmir region – relatively higher than related prior studies (Hutton and Haque 2004).


September 15, 2002

October 9, 2005

Figure 6. 6. Ikonos Satellite image of Makhri, a village on the northern outskirts of Muzaffarabad. Images of Makhri on a Neelum River meander before (left, 2002) and after a landslide inundated the river and bars (right, 2005), following the Kashmir Quake of 8 October 2005. (Imagery from NASA (2016))

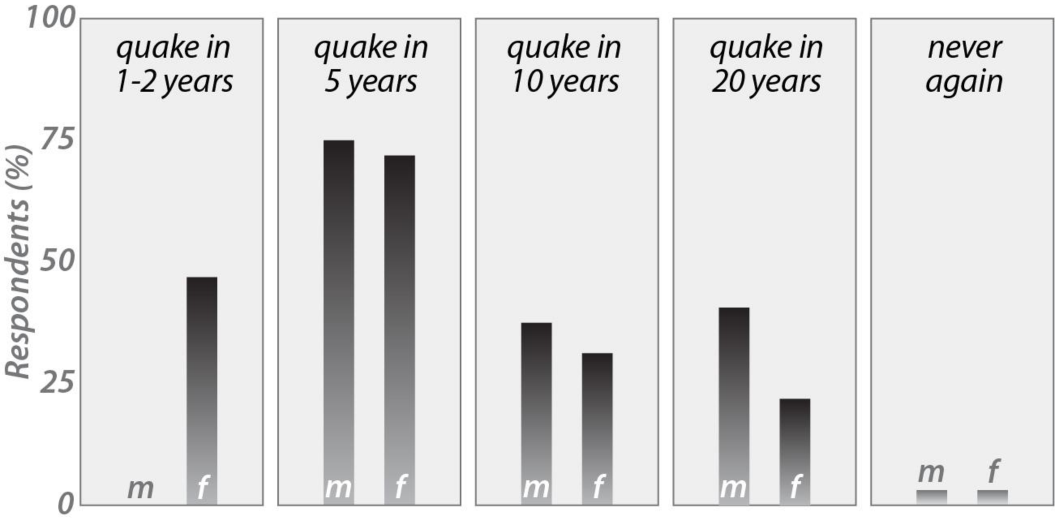


Figure 6. 7. Five bar graphs representing the survey responses regarding the question, "When do you believe the next Earthquake will occur in the region?". (N=190)

6.5.3. Building and Regional Safety

Surprisingly, 100% of the respondents stated that they inhabited buildings that they considered unsafe. 93% of them *fully* agreed that their home structures were unsafe to inhabit and insecure to quake-related damage and demolition. While another 7% were *'somewhat in agreement'* that their buildings were susceptible to earthquake damage and unsafe overall. Similarly, 92.5% of the respondents were in complete agreement (*fully)* that 'earthquakes posed a serious threat to the Kashmir region'.

6.5. 4. Confidence in Local and National Governments

24% of the respondents *fully* agreed that the local government was sufficiently prepared for another earthquake. While another 24% believed that local government was ready for such a situation. 31% remained *neutral*, while 21% expressed complete disagreement with the statement, exhibiting a complete distrust in regional and national earthquake preparedness to any degree. Overall, of the villagers surveyed 48% stated that the level of regional-national quake preparedness was adequate, while only 21% believed in no or little governmental seismic preparation of pre- and/or post-event mitigation.

Similarly, a majority of the respondents agreed that the national government is *fully* prepared (26%) for another earthquake and 23% stated that the national government was somewhat prepared. 30% stated that they remained *neutral*, and 21% disagreed with the current state of earthquake preparedness (Figure 6.8); hence 49% believed in apparent preparedness, and 21% disagreed with the assessment.

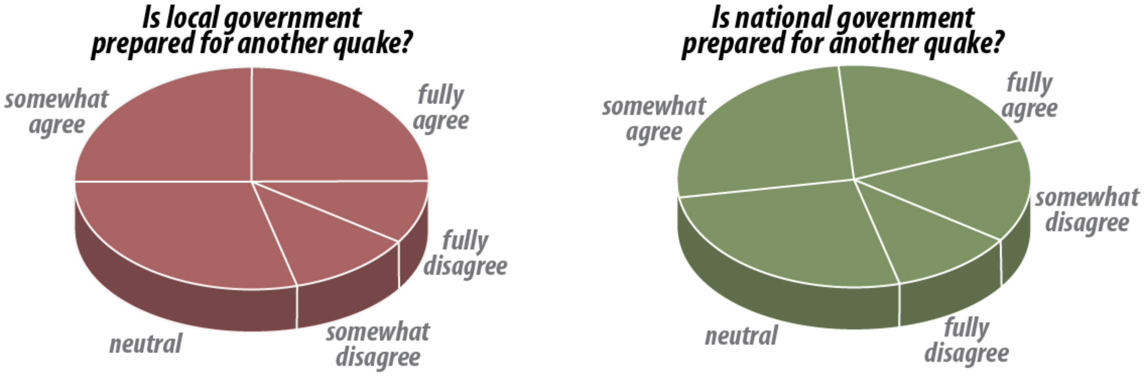


Figure 6. 8. Sectored coin diagrams illustrating respondents' perception of governmental assistance. (n=190)

6.5.5. Perception of Danger

The fundamental question that addressed preparedness, consequences and/or danger was related to the actions taken by respondents as the earthquake struck. Post-event behavior is a key to comprehending personal and community dread and can help assess a community's perceived state of preparedness and response (Burton 1993). 30% of the respondents did *nothing* while the majority (70%) responded to the earthquake by *running away, screaming*, or *praying* (Figure 6.10). Although *praying* can be attributed to inaction, it has been identified as an integral part of general risk perception facilitated by relatively fatalistic postures displayed in communal Islamic perceptions of earthquakes only, and not all-natural hazards (Alshehri et al. 2013, Paradise 2006, Hutton and Haque 2004). This has been attributed to the importance of the Quranic chapter (Surah 99: Chapter 99 *Az-Zalzalah*, or “the Earthquake”) that specifically associates divine retaliation with earthquakes (Paradise 2005).

The nature and proportion of the responses varied across age groups and education levels. When correlated against education attained, the type of action or inaction adopted by the respondents confirmed findings by researchers in prior seismic risk perception studies (Ainuddin et al. 2014). Their actions were found to be strongly correlated to their education (Figure 6.9) with a correlation of determination of $r^2=0.403$. When the behavior was separated into action *(running away, screaming, praying)* vs. inaction (did nothing), the r^2 revealed a 0.98 correlation indicating that inaction was rare or statistically non-existent. Hence, the higher the level of education, the stronger the tendency to *react actively* to the tremor.

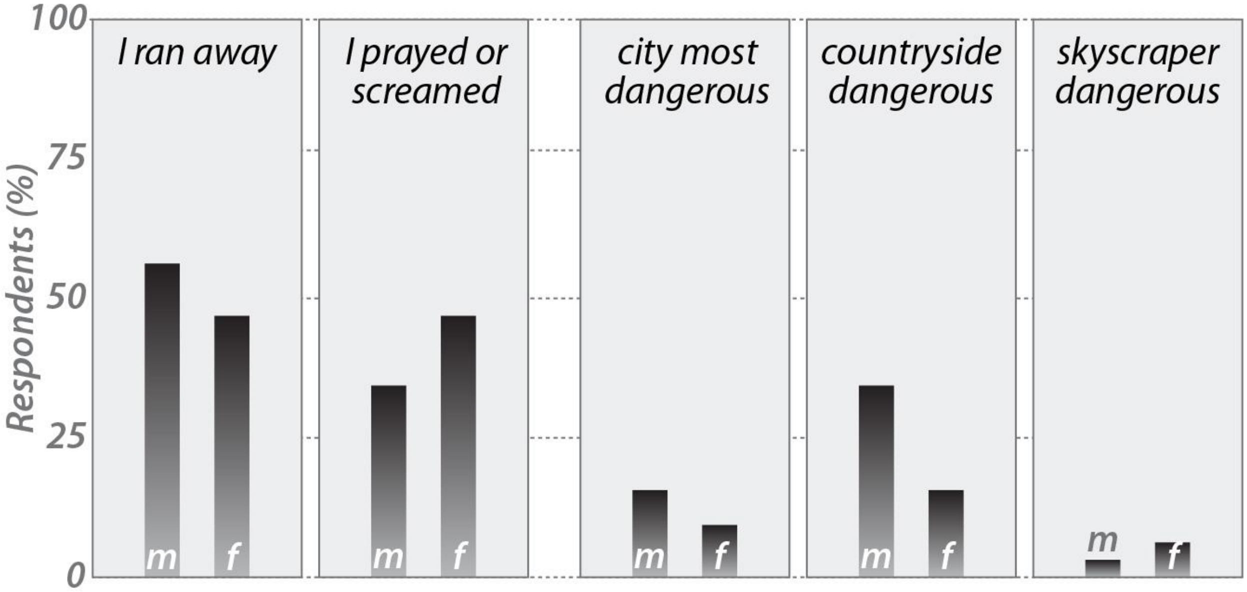


Figure 6. 9. Five bar graphs representing the survey responses regarding two questions, "What did you do once the quake struck?" (left), and "where is it most dangerous to live during an earthquake?" (right). (n=190).

The correlation of determination for the variable *ran away* was strongest at $r^2=0.97$ for the number of people who took action in response to the earthquake indicating that those with higher education were more apt to run away (escape) in response to the quake. Irrespective of the level of education or any other explanatory variable, a strong correlation was noted between all demographic categories and *running away*. This could be interpreted as the *first act* one would naturally perform -- an instinctive behavior among human (and creatures). It may be assumed that since the tremor was strong, people were frightened, and they reacted by escaping. However, none (0%) of the respondents sought cover (Figure 6.10), an act interpreted as a lack of knowledge of conventional earthquake preparedness.

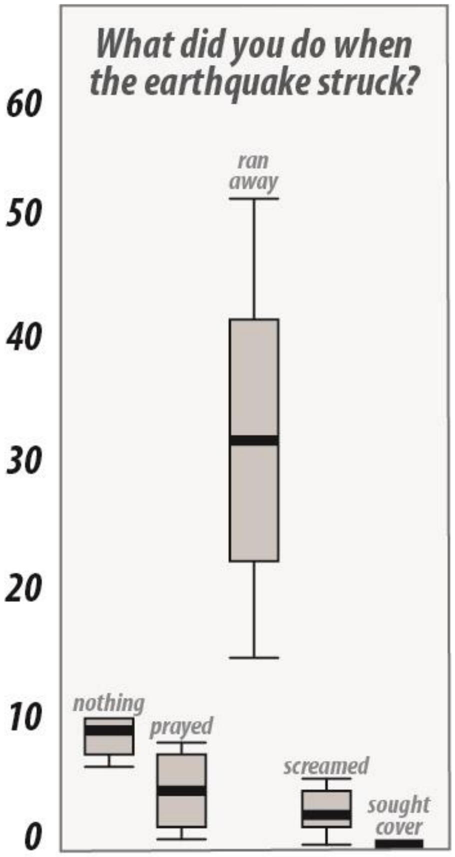


Figure 6. 10: Whisker bar diagrams representing the survey responses to the question, "What did you do when the earthquake struck?" (n-190).

6.6. Discussion and Conclusion

Risk perception in seismically active regions like Kashmir, is fundamentally important to disaster managers, research scholars, and emergency institutions and services. Perception is formed and defined by one's knowledge and experience gained over time, and the context of the situation (Paradise, 2005). In the paradigm of disaster management, the area of preparedness has been studied extensively through psychometric (Slovic 2010) and/or social-environmental approaches (Montz et al. 2017). In risk perception research, education, age, gender, and income levels are found to correlate strongly with various types and degrees of risk perception -- the freshness of an event is found to spike risk perceptions as well (Burton 1993). In this study, education was examined in the context of increased awareness and actions taken during the earthquake. The negative correlations between education *and no-action,* and the strong positive correlations between education *and action* provided evidence of the crucial role of education in increasing perceptions leading to action during an earthquake, whether formal education or informative discussions through conventional media outlets (e.g., radio, print, internet, tv). Similar findings regarding the importance and influence of media-sourced information have been previously identified and emphasized (Hutton and Haque 2004).

Moreover, the level of trust in the government's response and preparedness was also tested. Half of the respondents expressed some degree of trust in their local and national government regarding their capacity and preparedness for another earthquake event, a rare community opinion when compared to prior research (Ainuddin et al. 2014, Terpstra 2011).

Of interesting note is that none of the residents sought cover during the earthquake. This might be disputed as to whether it was the right thing to do in this specific event and context. However, a lack of information about *‘seeking cover'* as an appropriate action especially while indoors demonstrates a general lack of their awareness.

This analysis presents an individual and community perception that represents a relatively higher perception of seismic risk than many communities, although they appear as vastly unprepared to take appropriate actions. This more acute perception might be biased because of the short lag-time between the event and survey – a rare circumstance in perception studies and the power of this research project (Burton 1993). It is a rare occasion that individuals can be surveyed with six months of such a strong and dreadful event.

Overall, this research revealed both conventional findings and unexpected (and rare) results. The often-cited fatalistic influences of Islam on its communities was supported in these findings in that Muslim communities may have a lesser tendency to prepare for earthquake due to the singular link between divine retribution and earthquakes in the Qur'an (Paradise 2006). However, surprising results included the strong relationship between education and defensive actions during and after the event.

The point of perception studies in natural hazards and risk research is paramount in that as our technologies increase our understanding of seismic mechanisms and potential seismic forecasting, without further understanding of local, regional, and national perceptions of risk and influence, policymakers will not be able to effectively decrease injury, loss, and death from natural disasters – the ultimate goal of natural hazard and risk research today.

CHAPTER 7: A Survey of Seismic Risk Perception in the Muslim-majority Countries of Afghanistan, Pakistan, Libya, and Morocco

Bahram, I., Suwihli, S., and Paradise, T.

7.1. Introduction

Risk perception has been defined as beliefs, attitudes, judgments, and feelings of people, as well as the wider social or cultural values and dispositions that people adopt towards danger and its consequences (Pidgeon et al. 1992). In general terms, risk perception can be considered as an individual's interpretation or impression based on an understanding of a threat that may potentially have a consequence (Ainuddin et al. 2014). Risk perception consists of 'the intuitive judgement of individuals and groups, of risks, in the context of limited and uncertain information' (Slovic 2000). However, the complexity of how risk is perceived by the public is at odds with how risk is defined in the scientific community (Slovic 2000, Slovic 1987).

The way in which the public perceive risk is complex and is heavily influenced by situational and cognitive factors (Montz et al. 2017). Situational factors may include the physical vulnerability and exposure of a location to given hazard(s). It also includes the socio-economic vulnerabilities to which a community might be exposed. Cognitive factors on the other hand, reflect the personal and psychological makeup of an individual and include affective and behavioral attributes that account respectively for specific emotions evoked by hazards and tendencies to act in specific ways to risk events. Thus, one's risk perception is important as it determines one's response to a risk situation (Slovic et al. 1982) and public risk perception is considered to be one of the determinants of behavior (Ainuddin et al. 2014). A main reason for this is their expected positive relationship with the willingness of individuals to undertake mitigation measures (Bubeck et al. 2012).

The objective of this paper is to survey responses, interpretations and explanations to catastrophic earthquakes, collective and individual perceptions of cause and effect, and their relative relief and recovery in two south Asian Muslim-majority countries of Afghanistan and Pakistan, and north African Muslim-majority countries of Libya, and Morocco. Following (PEW 2021, WPR 2021) Muslim-majority country is one in which more than 50% of the people are followers of Islam (Table 7.1). There are currently approximately 57 Muslim-majority countries in the world though the precise number differs slightly depending upon the source. This paper addresses an earthquake event in each country as well as the findings from extensive surveys that were administered, in the aftermath of these seismic events, within the span of active collective and social memories, some surveys taken immediately following the quake (Pakistan, Afghanistan) in the hopes of sampling direct memory, and some taken within decades (Agadir, Morocco and Al-Marj, Libya) to tap into collective memories, both active, and through media, familiar, and social recollection.

Table 7. 1. Proportions of the Muslim populace in the four Muslim-countries countries addressed in this study (PEW 2021, WPR 2021)

Country	***Population 2020 (in 1000s)***	***Muslim Percentage***
Afghanistan	38928.3	99.6
Pakistan	220892.3	96.5
Morocco	36910.6	99
Libya	6871.3	97

7.1.1. Culture and Risk Perception

Cultural biases provide indicators of risk-taking preferences that are often more powerful than measures of knowledge and personality (Wildavsky and Dake 1990). Dake (1991) conceptualized worldviews as orienting dispositions, because of their role in guiding people’s responses. These dispositions may include (a) **fatalism** (I have very little control over risks to me and my family; God takes care of it!) and (b) **hierarchy** (Decisions about risks should be left to experts). However, Slovic (2000) concluded that both affect and worldviews function as orienting dispositions helping people assess and respond to risk. Experts' judgment—like those of laypersons— have also been found to be influenced by worldviews and affect.

Social, political, and cultural factors constitute the root causes of vulnerability and the likelihood and rate of relief and recovery. It is these complex and often interrelated factors that determine access to power, structures, and resources in the event of any disaster (Degg and Homan 2005). These phenomena manifest in unsafe conditions such as fragile physical environments and local economies, an unstable political system, and/or a lack of disaster preparedness by the individual, family, community, city, region and country (Blaikie et al. 1994).

7.2. Risk Perception Studies in Muslim Countries

Humans have been exposed to natural hazards since time immemorial (Davoudi 2014) . World cultures, religions, intellectual traditions and histories have recorded devastations due to hazards in anecdotes and stories to further their narratives (Hewitt 2012). In many cases, they have developed myths surrounding a historical past event like Noah's Flood (Barnikel and Vetter 2012). In fact, major world religions have specifically addressed hazards and described them as manifestations of God's wrath, testing, punishment and vengeance (Adiyoso and Kanegae 2013, Chester et al. 2013). In the pre-industrial times, these were seen as acts of divine retribution (White 1974). Lately, the discourse has transitioned into a social construct and is tied to human interaction with environment though not globally accepted. This modern discourse on disaster risk was dominated by a hazard centric approach until the mid-1980's when it was replaced with *vulnerability centric approaches* (Peduzzi et al. 2009, Haque and Etkin 2007, Degg and Homan 2005, Dao and Peduzzi 2004, Wisner et al. 2004).

Pedro de Lima (in Schmidt, 2004) noted that in earthquake-prone regions, people have expressed higher trust in religious or political institutions. In the context of Muslim communities, this perception is prevalently influenced by the teachings of Islam and related culture and ritual (Chester et al. 2013, Dhanhani 2010, Homan 2001). Under Islam, earthquakes are treated especially differently than other natural hazards where they are associated with the apocalyptic day of judgment. In fact, one *surah* (chapter) of the Qur'an is entirely dedicated to quakes: the 99th *surah* of the Qur'an is called *Surat-al-Zilzalah* (Chapter of the Earthquake) (Dhanhani 2010, Paradise 2005). Such references in Islam seek to guide the belief and thus perception of Muslim adherents, their behavior, and beliefs. In fact, the word “earthquake” is linked directly to signs of God’s punishment for sins, ultimate divine retribution, and as a warning of the looming judgment day in Islam (Ghafory-Ashtiany 2009).

Several studies have attributed a fatalistic attitude in several Muslim majority countries. Paradise (2005) found that the opinions and perceptions of seismic risk in Agadir, a coastal city in Morocco devastated by a moderate earthquake in 1960, were less influenced by experience than by Islamic training, ritual, and culture. Similarly, studies by Alshehri et al. (2013) in Saudi Arabia, Homan (2001) in Egypt, Adiyoso and Kanagae (2013) in Indonesia, and Halvorson and Hamilton (2010) in Pakistan consistently report a fatalistic attitudes where earthquakes, floods, and tsunamis were defined as acts of divine retribution, test or punishment. This perception was rooted in the general understanding of divine retribution (Farhang 2004) and it precipitates into a lack of any actions for preparedness and mitigation.

Kasapoğlu and Ecevit (2003) in Turkey, Ainuddin et al. (2014) in Pakistan, Farhang (2004) in Iran, Paradise (2006) in Morocco, Azim and Islam (2016) in Saudi Arabia, and Homan (2001) in Egypt conclude a low perception of seismic risk and a fatalistic attitude (Table 7.2).

While Turkey, Pakistan, and Iran are located across active Quaternary fault zones and corridors, Saudi Arabia and Egypt have experienced few moderate magnitude earthquakes. Seismic risk perception in each of these countries was reported low (Farhang 2004, Paradise 2005). Muslim communities in general and irrespective of proximity to fault corridors and earthquake zones appear to have lower perception of earthquake risk and tend to consider the occurrences of earthquakes as an act of divine against which little could be done.

Table 7. 2. Qualitative studies in Muslim majority countries on perception of risk compiled for this study. All these studies have concluded a fatalistic attitude for the respective populace surveyed in each of the respective countries.

Location and Country	***Hazard***	***Methodology***	***Author***
East Marmara, Turkey	Earthquake	Survey, Interview	(Kasapoğlu and Ecevit 2003)
Jamuna River Islands, Bangladesh	Floods	Survey, Interview	(Schmuck 2000)
Kashmir, Northwest Pakistan	Earthquake	Interview	(Halvorson and Hamilton 2010)
Fujairah Emirate, U.A.E.	Natural Disasters	Survey, Interview	(Dhanhani 2010)
Banda Aceh, Indonesia	Tsunami	Interview	(Gaillard and Texier 2010)
Banda Aceh, Indonesia	Tsunami	Interview	(Adiyoso and Kanegae 2013)
Saudi Arabia	Natural Disasters	Online Questionnaire Survey	(Alshehri et al. 2013)
Agadir, Morocco	Earthquake	Survey	(Paradise 2006, Paradise 2005)
Quetta, Pakistan	Earthquake	Survey, Interview; Focus Groups	(Ainuddin et al. 2014)
Khyber Pakhtunkhwa, Pakistan	Floods	Interview	(Qasim et al. 2015)
Jeddah, Saudi Arabia	Earthquake	Interview	(Azim and Islam 2016)
Middle East (Multi-Country)	Natural Disasters	Analysis of Educational Curriculum	(Baytiyeh and Naja 2014)
Bam, Iran	Earthquake	Analysis of Official Statements	(Farhang 2004)
Mansehra, KP, Pakistan	Floods	Survey, Interviews, Focus Groups	(Cheema 2012)
Cairo, Egypt	Earthquake	Interviews	(Homan 2001)
Burdur Province, Turkey	Earthquake	Semi-structured interviews	(Demirkaya 2008)
Galachipa, Bangladesh	Tropical Cyclone	Questionnaire Survey Interview	(Islam 1974)
Malakand, KP, Pakistan	Earthquakes	Questionnaire Survey, Visual Assessment of Buildings	(Khan et al. 2019)
Al-Marj, Libya	Earthquakes	Questionnaire Survey	(Suwihli and Paradise 2020)
Khyber Pakhtunkhwa, Pakistan	Earthquakes	Questionnaire Survey	(Bahram and Paradise 2020)

It is challenging to generalize about communities because of the different social, economic, political, and cultural contexts that, separately or in combination, provide both opportunities and constraints for response and adjustment. However, it is possible to detect common threads in responses in different communities' experiences (Montz et al. 2017). In this study, we present case studies from four countries in the Muslim World, 57 nation states (Esposito & Mogahed, 2007) that is home to 1.9 billion Muslims ("Muslim Population by Country", 2020 (Figure 7.1). Islam has played a fundamental role in shaping the cultures of these countries which is manifested, among many other things, in their perception of risk (Qasim et al. 2015, Chester et al. 2013). South Asian nations, for example, are also characterized by high population growth, medium-high socioeconomic vulnerability, high exposure to hazards, and low adaptive capacity (Guha-Sapir et al. 2016, Garschagen et al. 2016). Earthquake disasters have claimed hundreds of thousands of lives in the Muslim World over the past two decades (Sanderson and Sharma 2016).

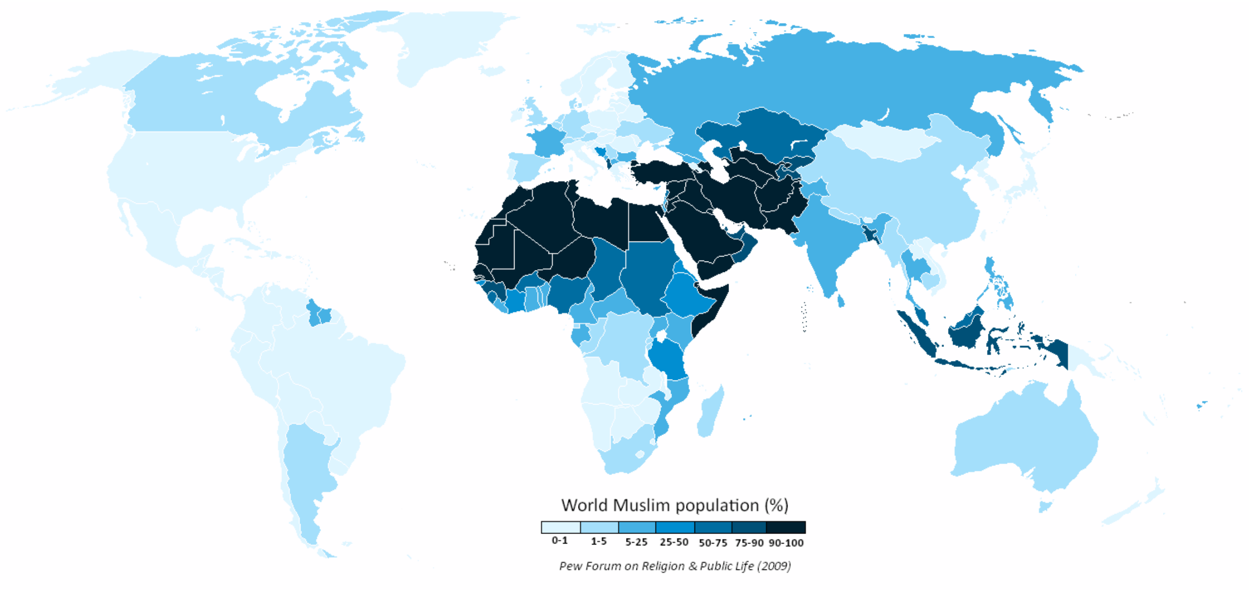


Figure 7. 1. Muslim World: A block of 57 Muslim majority countries; they are members of the Organization of Islamic Cooperation (PEW 2021, Esposito and Mogahed 2007).

In a span of 100 years, the Muslim world has been hit by roughly 400 significant earthquakes that have caused extensive fatalities (Figure 7.2. A) claiming more than 610,000 lives (Guha-Sapir et al. 2016). A disproportionately large number of these fatalities are concentrated in only four countries: Indonesia, Iran, Pakistan, and Turkey. Pakistan, one of the focus sites in this research, is not only seismically active but also sustained widespread damages and large number of deaths to medium-high magnitude earthquakes. On the other hand, Afghanistan, home to the unique phenomenon where the broken arm of the subducting Indian plate subducts beneath the Eurasian plate (Kufner et al. 2016, Mohadjer et al. 2016, Stübner et al. 2013b, Ambraseys and Bilham 2003) and causes many medium magnitude earthquakes, has only had 11,553 recorded deaths in the past 100 years yet a large number of earthquakes that places it in the top five Muslim countries with the highest number of earthquakes (Figure 7.2. B).

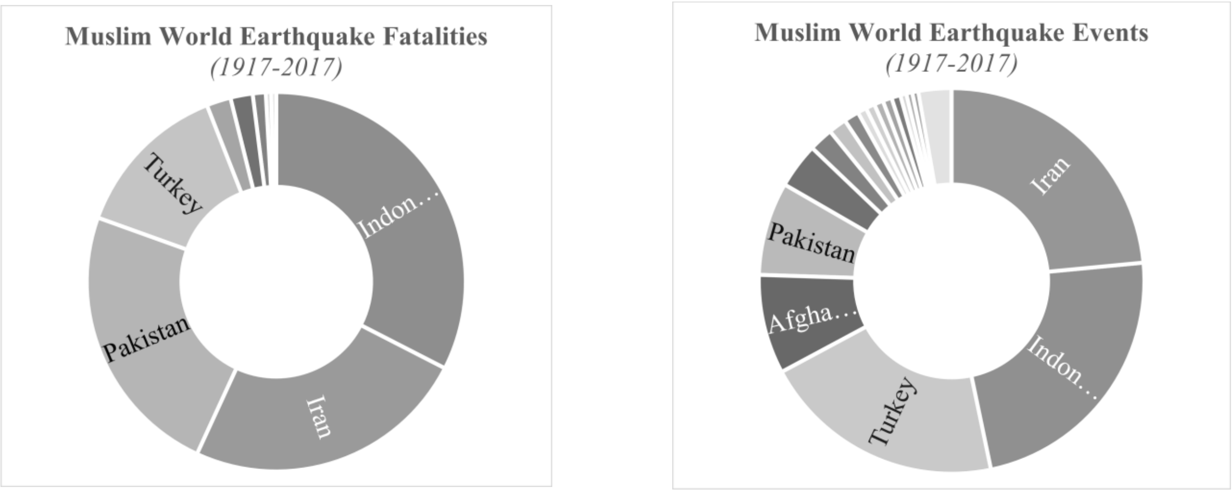


Figure 7. 2. **A.** Earthquake fatalities in the Muslim World. **B.** Concentration of significant earthquakes in the Muslim World.

In the past 100 years, our study sites have been seismically active with fatalities in the tens of thousands. Considering only five earthquakes that have historical significance in these countries. Table 7.3 demonstrates that losses in these five seismic events have been devastating.

In fact, cities such as Agadir, Al-Marj, and Muzaffarabad had been completely razed by three of these quakes.

Fatalities at our sites due to 68 earthquake events, constituted 28% of the total deaths in the Muslim World. Therefore, the selection of the highly vulnerable and seismically active northwest Pakistan, and Kabul City as well as the seismically active coastal cities of Agadir, Morocco and Al-Marj, Libya served as ideal locations for this comprehensive study of seismic risk perception. While Kabul City is a rapidly growing urban center, a theatre of natural and man-made disasters, exposed to high seismic activity (Mohammadi and Fujimi 2016, Wheeler et al. 2005, Ambraseys and Bilham 2003). Mountainous northwest Pakistan located on the northeastern boundary of the Indian plate has been the epicenter of many high magnitude earthquakes (USGS 2013, Hussain et al. 2009). Similarly, Agadir, Morocco and Al-Marj, Libya have been devastated by numerous earthquakes in the past (Suwihli and Paradise 2020, Paradise 2005, Minami 1965).

Table 7. 3. Comparative analysis of fatalities in the Muslim World and study sites (1917-2017) (EM-DAT: The International Disaster Database 2020, December 2).

Country	Number of Events	Total Fatalities
Afghanistan	33	11553
Libya	1	300
Morocco	3	12639
Pakistan	31	143846
Sub- Total	68	168338
Muslim World Total	396	609139
Percentage of Deaths & Earthquake Events in Sites	17.2	27.6

7.2.1. Agadir, Morocco

Agadir, Morocco occupies the northern end of a strand beach near the coastal border with the Western Sahara. It sits along the western flank of the Atlas and Anti-Atlas Mountains and the fertile plain of the Sousse Valley (Figure 7.3). Geologically, Agadir is located at the western edge of the Atlas Mountain fold-and-thrust belt which runs from Tunisia to Agadir (Bowen and Jux 1987), where the arcing mountain ranges create a series of en-echelon active faults. The devastating earthquake of 1960 in Agadir was due to displacement along the Kasbah Fault – Agadir's northern portion of a fault corridor that trends beneath the city (Meghraoui et al. 1999).

On February 29, 1960, at 11:40 pm, during the third night of Ramadan, an earthquake rocked the city. The Bureau Central International de Seismologie of Strasbourg (B.C.I.S) estimated the epicenter at 30°27'N, 9°37'W, approximately north-northwest of the Kasbah. The epicenter was shallow at 1.4km beneath the surface magnitudes estimated at 5.7 to 5.9, and a Mercalli intensity (MMI) of VIII-IX (Barrett, Fox and Stanier 1991). The total energy release was estimated at 1020 ergs (AISI 1962), shaking the region for 15 minutes. 15,000 persons died with an estimated 15,000-25,000 people injured, and 35,000+ left homeless (Figure7.4). The high mortality has been attributed to high population density in structures of poor architectural design and construction practices – overall 70% of all new buildings, and 20% of all industrial buildings were razes or severely damaged (Evison 1963)

Before the disaster, the most prevalent construction materials were stone and brick mortared masonry. The older mortars consisted of mud and sand with little lime added, while commercial mortars with reinforced cement blocks were rarely used. In the older structures, roofs were covered with wood rafters and metal corrugated sheets. Destroyed structures described during post-earthquake assessment was: (a) three to four stories, (b) non-reinforced masonry walls, (c), concrete slab floors and roofs, (d) with simple partitioned walls with plaster finishing (Evison 1963).

7.2.3. Al-Marj, Libya

The modern city of Al-Marj, (30°N, 20°W) is the ancient Greco-Roman Cyrenaican town of Barce established c.550 B.C. (Goodchild 1968). It sits along the eastern coastal province of Libya, at the western end of Green Mountain (*Al Jabal al Akhdar*) (Figure 7.3) and is situated on an alluvial plain which has provided fertile soil for agriculture for centuries. At the time of the quake, Al-Marj had a thriving population of 13,000 residents (Campbell 1968).

An earthquake (5.6 R) was recorded in Al-Marj on 21 February 1963 that destroyed the city completely (Gordon and Engdahl 1963). The shock was centered 13 km northwest of the city and the epicenter was estimated at 32.6°N, 20.9°E, and the focus of the quake was approximately 33km below the surface (Figure 7.4). The earthquake demolished most structures, killing 300 and injuring 375 people; the whole population was left homeless (Campbell 1968). The first shock was followed by five aftershocks with magnitudes greater than 4 which continued throughout the day (Gordon and Engdahl 1963) The next morning, while rescue work was in full swing, two more quakes struck.

Poorly constructed stone and clay structures were responsible for injuries, fatalities, and damages. The structures made up of rubble stone embedded in clay and/or mud sustained the greatest damages. Construction that used sandstone or limestone mortared with lime or cement but without reinforcement was susceptible to ground shakings and presented a danger to residents as well. Construction implementing hollow concrete blocks for one-floor dwelling houses sustained moderate damages. However, buildings with reinforced concrete frames did not sustain serious structural damages, but their walls were badly cracked. Only buildings with reinforced steel integration and concrete block and appropriate mortars survived the disaster (Minami 1965).

Al-Marj was rebuilt on a new location 3 miles (5 km) from the old city location and 90 km (56 miles) northeast of Benghazi, and it is the administrative seat of the Marj District. The city of Al-Marj and Darnah are the centers of major service, commercial, and agricultural activities including fisheries.

7.2.4. Khyber Pakhtunkhwa (KP), Pakistan

Seismicity in the northwestern region of Pakistan results from the continental collision of the India and Eurasia plates. Northward under-thrusting of India beneath Eurasia generates numerous earthquakes and consequently makes this area one of the most seismically hazardous regions on earth (USGS 2013). This region is traversed by various seismically active thrust faults such as Main Mantle Thrust, Main Boundary Thrust, and Main Karakoram Thrust (Hussain et al. 2009, Nakata, Otsuki and Khan 1990) due to its location at the northeastern edge of the Indian Plate (Monalisa et al. 2007). Main Boundary Thrust trends across the region of KP-Kashmir syntax of north Pakistan (Yeats and Lawrence 1982, Quittmeyer and Jacob 1979).

On the morning of 8th October 2005, a major earthquake (Mw 7.6) centered in Muzaffarabad, Kashmir (Figure 7.3) killed 86,000 (Hussain et al. 2009), injured more than 130,000, damaged more than 600,000 houses, and left behind 3.5 million homeless (Bilham 2014, World Bank 2014) (Figure 7.4).It is considered as the worst disaster in the history of Pakistan (Bendick et al. 2007, Durrani et al. 2005). This earthquake devastated several districts of the neighboring province of KP. The earthquake caused extensive damage to roads, water and sanitation facilities, power, and telecommunication infrastructure and other services while civil administration in affected areas became largely dysfunctional with the destruction of a large proportion of government buildings (World Bank 2014). The heaviest earthquake damage was centered in the cities of Muzaffarabad and Balakot – our research focus in Pakistan.

Before the quake, in addition to the *Katcha* style houses, which were built typically with mud or stone rubble walls and a flat thatch or mud roof, and the *Pucca* style house built with stone rubble or fired brick masonry walls and reinforced concrete flat slab roofs, reinforced concrete frames with infill walls were commonplace in Balakot and Muzaffarabad. While many of such semi-engineered buildings completely collapsed or suffered serious damage, some survived the earthquake with relatively small damage. The nature of the damage reveals poor quality construction, deficient detailing, and lack of seismic consideration (World Bank 2014).

7.2.5. Kabul, Afghanistan

The tectonic setting of Afghanistan is defined by its location on the southern fringe of the Eurasian plate subject to collision with the Arabian plate to the south and transpression with the Indian plate to the south-east (Ambraseys and Bilham 2003). Geologically, Afghanistan is composed of a complex collage of terranes which were accreted onto the southern margin of Eurasia prior to, and during, the India-Eurasia collision. The Kabul Block, one of these terranes, is approximately 200 km long and up to 50 km wide tectonic block bounded by major strike slip faults (Collett, Faryad and Mosazai 2015).

Kabul City is located on the fault bounded Kabul block and is exposed to high seismic activity emanating from the Paghman Fault to the west, and the Surobi Fault to the east (Ruleman et al. 2007). The city is situated on the sediments of the Kabul River and alluvial deposits from the weathering of mountains surrounding Kabul Basin Valley (Houben et al. 2009). Kabul region has, by far, the greatest seismic hazard in Afghanistan (Szeliga et al. 2012, Ambraseys and Bilham 2003). In addition, Kabul City gets impacted by earthquakes centered in the Himalaya-Hindukush-Pamir region. For example, Nahrin Earthquake of 2002 and the

Hindukush Earthquakes of 2015 and 2018 caused deaths and structural damage in the city albeit on a small scale (Figure 7.4).

Kabul is the capital and the largest city in Afghanistan with an estimated population of more than five million people housed in over 600,000 housing units (CSO 2016). It is one of the fastest growing urban centers in the world with a history shaped by political instability, and violence before, during, and following the 1979 Soviet Invasion. Numerous past regional earthquakes have damaged structures in Kabul, while future earthquakes are expected to strike in the region resulting in heavy damages and severe human losses in Kabul. Ambraseys and Bilham (2003), Dewey et al. (2006), and Wheeler et al. (2005) warn that a large earthquake on the Paghman Fault would result in significant damage across the region, and especially in Kabul. Further, the city is defined by high socio-economic vulnerability and low adaptive capacity (Garschagen et al. 2016) all in combination with poor housing—a perfect recipe for disaster.

The rapid rise in population, in-migration from the restive countryside into the city, bigger households, poorly designed homes and structures, low income, low education, and literacy rates, contribute to the vulnerabilities against hazards. It has witnessed rapid and extensive urban development especially in the last 20 years (Mohammadi and Fujimi 2016) which complicates the situation of a lack of national seismic risk management policy, and plans.

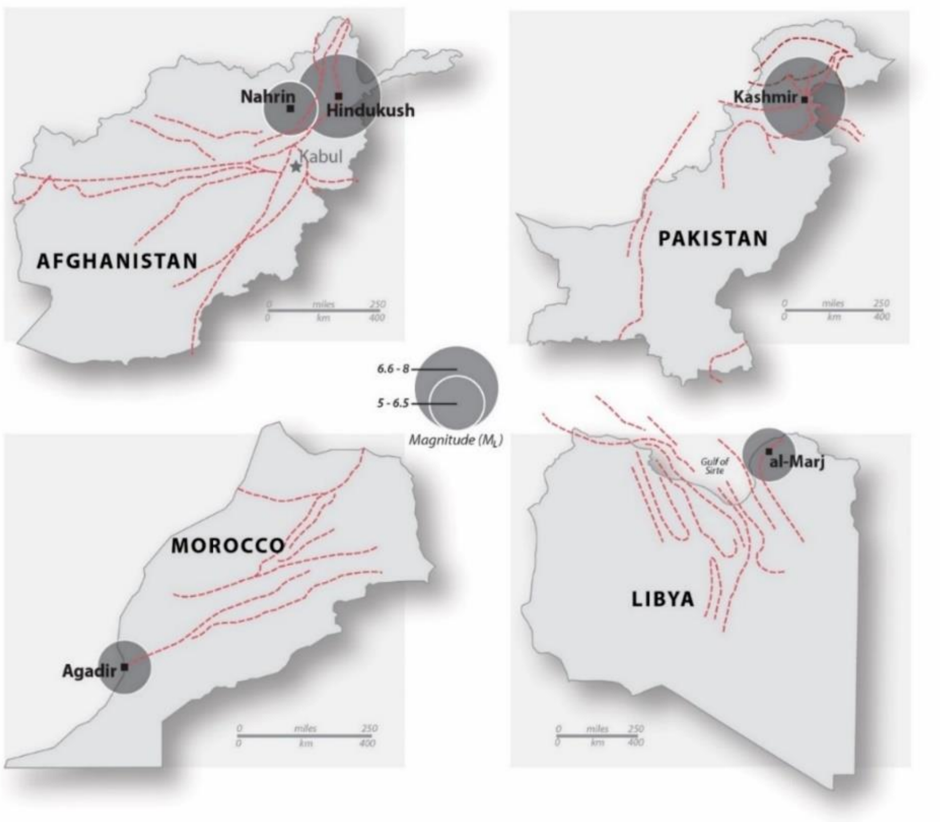
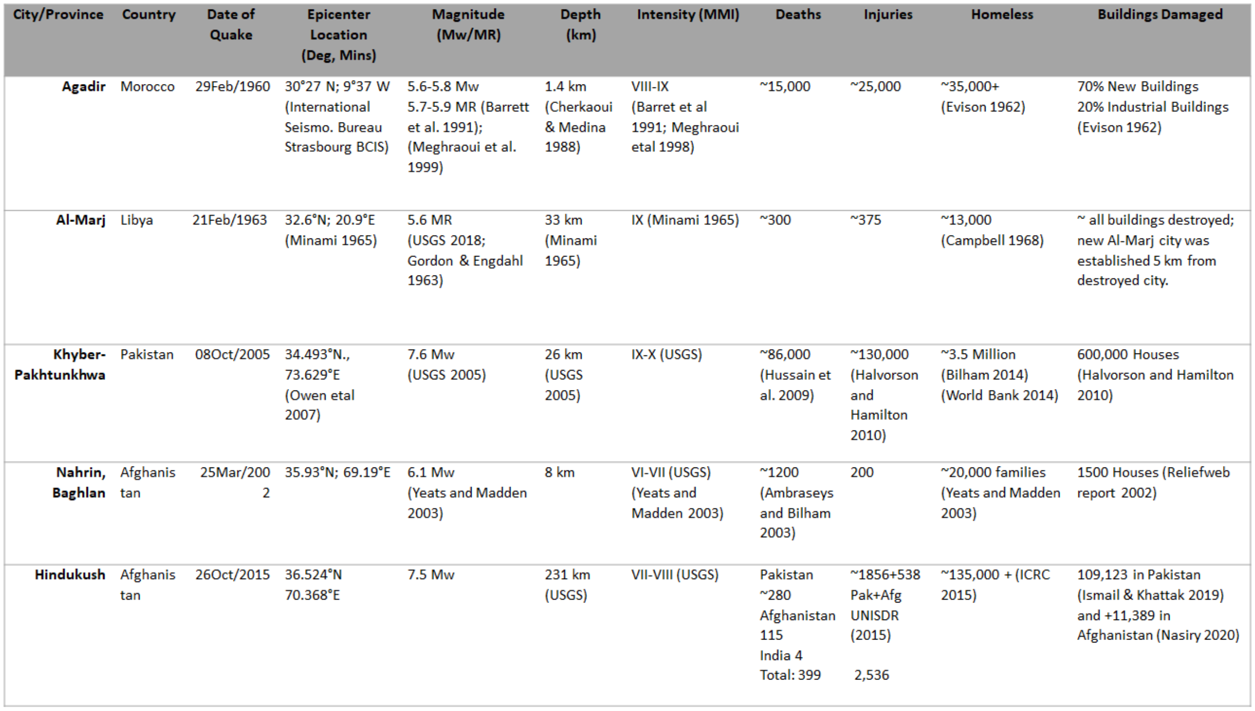


Figure 7. 3. Study sites have been epicenters of medium-high magnitude earthquakes accompanied by significant losses of life, infrastructure, and destruction to the environment. These earthquakes have caused relocation of entire city and community populations.



City/Province	Country	Date of Quake	Epicenter Location (Deg, Mins)	Magnitude (Mw/MR)	Depth (km)	Intensity (MMI)	Deaths	Injuries	Homeless	Buildings Damaged
Agadir	Morocco	29Feb/1960	30°27 N; 9°37 W (International Seismo. Bureau Strasbourg BCIS)	5.6-5.8 Mw 5.7-5.9 MR (Barrett et al. 1991); (Meghraoui et al. 1999)	1.4 km (Cherkaoui & Medina 1988)	VIII-IX (Barret et al 1991; Meghraoui etal 1998)	~15,000	~25,000	~35,000+ (Evison 1962)	70% New Buildings 20% Industrial Buildings (Evison 1962)
Al-Marj	Libya	21Feb/1963	32.6°N; 20.9°E (Minami 1965)	5.6 MR (USGS 2018; Gordon & Engdahl 1963)	33 km (Minami 1965)	IX (Minami 1965)	~300	~375	~13,000 (Campbell 1968)	~ all buildings destroyed; new Al-Marj city was established 5 km from destroyed city.
Khyber-Pakhtunkhwa	Pakistan	08Oct/2005	34.493°N., 73.629°E (Owen etal 2007)	7.6 Mw (USGS 2005)	26 km (USGS 2005)	IX-X (USGS)	~86,000 (Hussain et al. 2009)	~130,000 (Halvorson and Hamilton 2010)	~3.5 Million (Bilham 2014) (World Bank 2014)	600,000 Houses (Halvorson and Hamilton 2010)
Nahrin, Baghlan	Afghanistan	25Mar/2002	35.93°N; 69.19°E	6.1 Mw (Yeats and Madden 2003)	8 km	VI-VII (USGS) (Yeats and Madden 2003)	~1200 (Ambraseys and Bilham 2003)	200	~20,000 families (Yeats and Madden 2003)	1500 Houses (Reliefweb report 2002)
Hindukush	Afghanistan	26Oct/2015	36.524°N 70.368°E	7.5 Mw	231 km (USGS)	VII-VIII (USGS)	Pakistan ~280 Afghanistan 115 India 4 Total: 399	~1856+538 Pak+Afg UNISDR (2015) 2,536	~135,000 + (ICRC 2015)	109,123 in Pakistan (Ismail & Khattak 2019) and +11,389 in Afghanistan (Nasiry 2020)

Figure 7. 4. Quantitative details of five major earthquakes that caused significant damages in our study sites.

7.3. Survey Methods

Variations in the perceptions of seismic risk in the Muslim-majority countries were evaluated in a comparative study of four case studies from North Africa (Libya, Morocco) and South Asia (Afghanistan, Pakistan). The objective of this research was to better understand how perceptions of peoples in regions of high seismicity differed from those in regions of lower seismicity; if they had not differed, why not? These studies can help create meaningful generalizations about relationships between perception and response, and subsequently to address those elements most pertinent and effective in hazard and risk-related decision-making.

Ideally, a random sampling scheme was the preferred method for statistical analyses of survey data, however, such a scheme would have been improbable since administrators at our sites had no system or procedure for identifying or locating past quake survivors – an important aspect of these studies in the cases of Morocco and Libya. Adding to that, the limited access to female participants in Afghanistan and Pakistan owing to local conservative cultural nuances where interaction of unrelated men and women are limited and/or discouraged, translated into the adoption of a systematic stratified sampling method.

Therefore, systematic stratified and ‘snowball’ sampling methods were implemented to locate and survey earthquake survivors, witnesses, and/or relatives of victims (Kothari 2004, Haring et al. 1992). Likert-scale survey responses were administered in all our study sites following Fowler (2013) and Slovic (1987, 2000). We adopted ‘revealed’ preference approaches to understand individual behavior through their actions during and after an earthquake. This method assumes that people (respondents) can provide sensible answers to difficult questions. The results depend upon the set of hazards studied i.e., earthquakes, the questions asked about these hazards, the types of persons questioned, and the data analysis methods. Furthermore, it is assumed that risk is subjectively defined by individuals who may be influenced by a myriad of psychological, social, institutional, and cultural factors. Therefore, following Slovic (2010), we understand that with appropriate survey instruments many of these factors and their interrelationships can be quantified and modeled in order to illuminate the responses of individuals and their societies to the hazards they face. The survey instruments were designed, written, and administered in the national languages of the sites. In North Africa, Arabic and French were used, in Afghanistan, Dari and Pashto, and in Pakistan, Urdu and English were used in surveying (Table 7.4).

7.3.1. Agadir, Morocco

During the summers of 2002 and 2004, questionnaires were administered to residents of Agadir who survived the 1960 earthquake or were directly related to survivors (i.e., children, grandchildren). The survey consisted of five demographic questions (*sex, age, religion,* *birthplace, education attained*), four questions used to determine socio-economic status (*do you own a television, car, or phone; do you smoke*), and two questions designed to assess general quake historical knowledge (*when the last large earthquake was; if and when will another quake occur in Agadir*). Finally, five Likert questions (1-10) were designed to illicit respondents' perceptions. This survey style and questions were utilized at all research sites in this study.

The questionnaires were administered across the city of Agadir over a five-week period. Cafés, community centers, and mosques were visited first in the hopes of locating survivors or obtaining leads that could guide us to more interviews (snowball sampling). Relatives of survivors were diverse and included University students and faculty, clerics, shopkeepers, tourist industry workers, unemployed vagrants, and government officials.

243 surveys were accepted (n=265) over the following five weeks (2002) of interviews and two weeks of follow-up (2004). 52 earthquake survivors were surveyed and interviewed and the remaining 191 were survivors' relatives. 22 surveys were rejected as incomplete, having contradictory information.

7.3.2. Al-Marj, Libya

A combination of Al-Marj residents were surveyed including the 1963 Earthquake survivors from various social and economic strata, University students, faculty, and staff, shopkeepers, customers, government officials, housewives, and some unemployed. The survey was designed and written in Arabic and administered during the Spring 2019, and included questions regarding demographic, economic status, hazard knowledge, and perceived vulnerability.

Questionnaires were administered across Al-Marj, including the campus of the University of Al-Marj. Earthquake survivors and their family members (aged 20-70) were identified for face-to-face surveys. Over four months, 364 survey interviews were completed (n=368) while four incomplete surveys were rejected. 27 earthquake survivors were interviewed, and the remaining 337 were residents with direct memories from oral histories of the 1963 earthquake.

7.3.3. Khyber Pakhtunkhwa (KP), Pakistan

Following the earthquake, surveys were administered to examine the perceptions of seismic risk of the survivors and witnesses across the region. Three of the most impacted districts of KP namely Mansehra, Battagram, and Abbottabad were targeted for these surveys since they witnessed the greatest damages and losses of life.

Survey questionnaires were administered in face-to-face interviews during Spring, 2006. 190 surveys were completed (n = 215) from respondents who were identified as witnesses and/or survivors of the 2005 Kashmir Earthquake. 25 surveys were rejected as incomplete, having missing information. All surveyed villages were located within 80 km (50 mi) of the quake epicenter: (a) Mansehra was 43 km (27 mi) WSW with a population 115,2839, (b) Battagram was 54 km (34 mi) WNW with a population 307,278, and (c) Abbottabad at 56 km (36 mi) SW with a population of 880,666. The total number of surveys represented 10% from Abbottabad, 22% from Battagram, and 68% from Mansehra –the most devastated district of KP.

7.3.4. Kabul, Afghanistan

During the summer of 2019, surveys were administered to residents of Kabul City. The three most significant earthquakes before this survey occurred were the 6.1 M_w on the 31st of January 2018, the 6.6 M_w earthquake of April 10, 2016, centered in the Hindukush in Ishkashim, Badakhshan and the 7.5 M_w earthquake of the 26th October 2015 centered in the Hindukush Mountains in Badakhshan.

A total of 314 (n=339) survey questionnaires were completed, 25 had missing information and were rejected. Respondents were selected from different parts of Kabul City and different professional backgrounds which included college students, professionals, residents, farmers, teachers, mullahs, vendors, business owners, city workers, and housewives. The respondents only included current residents of Kabul City. The majority of respondents constituted male respondents (69%), a situation influenced by local cultural restraints where openly interacting with women is not a common nor simple practice, unless women were used in the survey process and questionnaire administrated.

Table 7. 4. Six languages were utilized in four countries to design, write and administer survey instruments for maximum participation and accurate data collection.

Site	***Country***	***Survey Season***	***Languages***	***Sample size***	***Surveys (n)***
Agadir	Morocco	Summer 2002, 2004	Arabic, French	265	243
Al-Marj	Libya	Spring 2019	Arabic	368	364
KP	Pakistan	Spring 2006	Urdu, English	215	190
Kabul City	Afghanistan	Summer 2019	Dari, Pashto, English	339	320
			Total	***1187***	***1117***

7.4. Results and Findings

This study explored various aspects of the communities in our target countries by comparison of outcomes of each study site. These findings converged on most aspects of perceptions of seismic risk. Discussed, hereunder, are the findings of this important study:

7.4.1. Demography

The gender ratio in our sites differed and were based on the cultural context. Overall, 60-65% of our respondents were male while 35-40% of the respondents were female (Figure 7.5). An overwhelming majority of our respondents (~90%) were below the age of 50. In Kabul City and Al-Marj, Libya, the respondents constituted relatively younger and better educated groups while survey respondents in Agadir, Morocco and KP, Pakistan were rather less educated. Also, overwhelming majority of respondents in KP, and Kabul City had experienced earthquakes while in Agadir and Al-Marj, a smaller group of respondents constituted survivors of earthquakes.

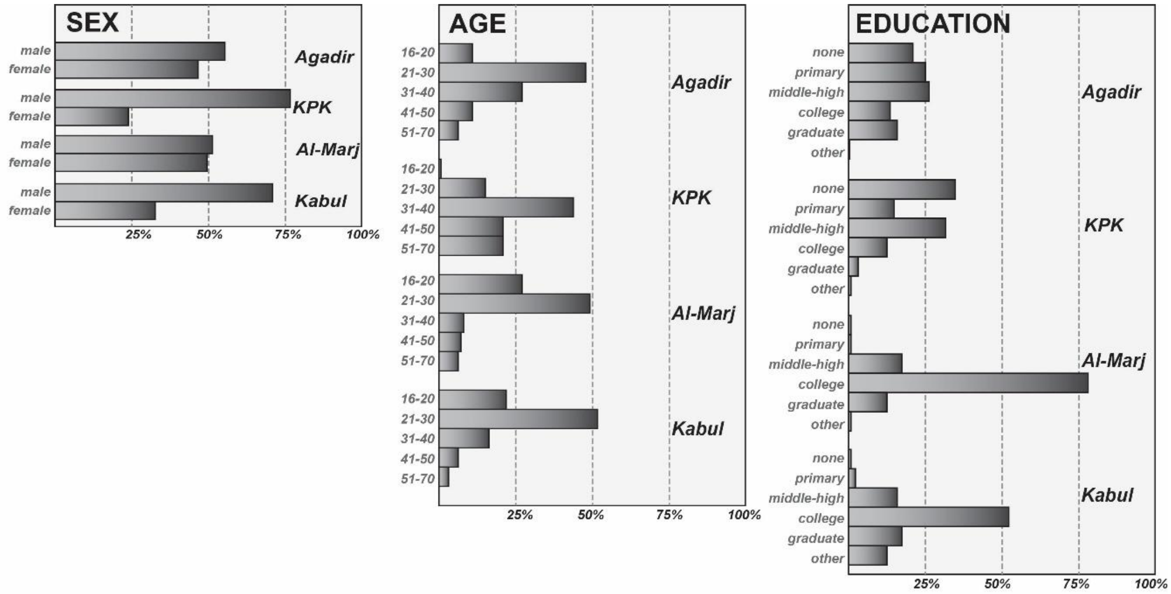


Figure 7. 5. Demographics, male to female ratio, and attained education levels of participants of study sites.

7.4.2. Earthquake Experience

An overwhelming majority of our respondents at our sites had experienced earthquake(s) in addition to the quakes that are the focus of this research. In fact, 99% respondents in Kabul, Afghanistan and KP, Pakistan said they had felt earthquake(s) in the past and 88% people in Al-Marj have experienced earthquakes previously. This question was used to canvass for earthquake survivors, witnesses, and/or relatives of witnesses. Agadir respondents rarely discussed having experienced any other earthquakes than the 1960 tremor.

7.4.3. Seismic Risk Perception

Many people in the Muslim world assigned the cause for natural events ‘to some supernatural agency, given that such events apparently lie outside any human’s ability to instigate them’ (Schlehe 2010).

In Al-Marj, the residents were found to be hesitant of prediction regarding earthquake or speculating about a future occurrence (when, where, how). 96% of the Libyan respondents believed that only ‘Allah knows’ when a next earthquake would occur - “Allahu a’lam”. Similarly, a staggering 69% did not want to predict *any* chances of an earthquake occurring anytime soon (Figure 7.6). This is reflected in their knowledge and/or awareness of earthquakes. 35% of the surveyed population said they knew NOTHING about quakes while 46% percent said they knew ‘a little’ about it. Although earthquakes did frighten them, there was an apparent fear and concern about such an event occurring again. 60% of the respondents did believe that earthquakes were a serious threat to Al-Marj. However, 40% of the population did NOTHING to protect themselves during the last quake, and another 26% only PRAYED for safety. No one ran away or sought cover to save themselves from the probable impacts of the quake. These observations support the notion of fatalism in a community which trusts an external force (often divine) regarding the causes of natural hazards and their protection.

In Kabul, the residents often mirrored those of respondents in Al-Marj. While respondents failed to deny future possible occurrences of earthquakes in Kabul, a majority (45%) declined to expect a quake soon and 51% outrightly maintained that only God Knows “*Khuda Mefahama*” when a next quake would hit. In Pakistan, the most extreme responses were observed where 94% of respondents believed another earthquake would occur soon. 70% respondents believed another earthquake would occur within 5 years. While another 27% believed another devastating earthquake would occur within 10 years (Figure 7.6). Similarly, 98% agreed that earthquakes frightened them while 93% strongly agreed with the statement ‘my house is not safe from earthquakes’ (Figure 7.7). Although the earthquake 7.6 MR was the strongest and the most devastating earthquake in the history of Pakistan, 12% respondents did

NOTHING and 16% only PRAYED for safety and protection. Whereas 50% of the respondents in Kabul agreed that earthquakes do frighten them. In the case of Kabul, which is surrounded by active faults, and experience frequent medium to high magnitude earthquakes, it is surprising that 34% population believed that earthquakes did not pose a serious threat to them; only 45% of the respondents believed earthquakes posed a serious threat.

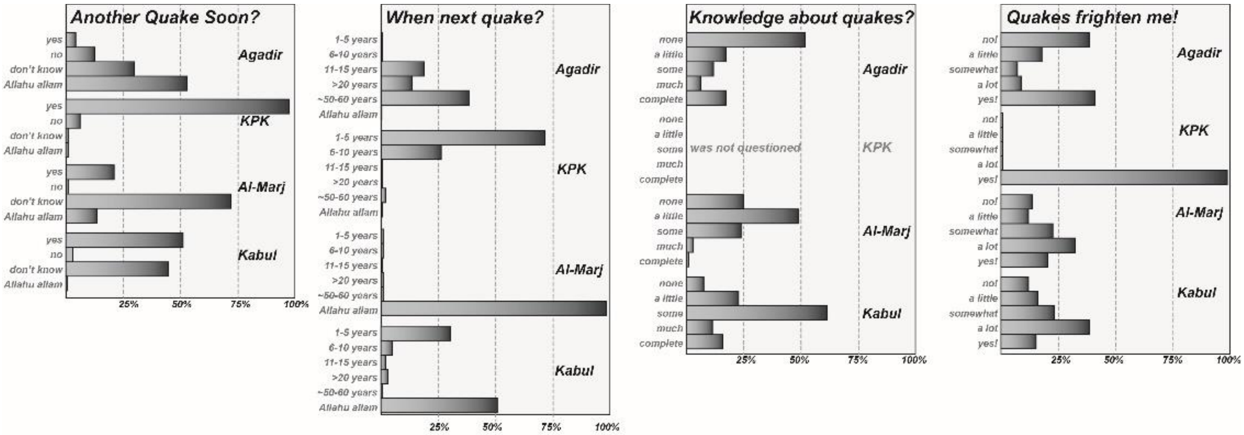


Figure 7. 6. Parameters of seismic risk perception from the study sites.

Responses to whether another earthquake were to happen soon, were varied across the four study sites. However, most of the respondents either avoided the question by choosing the option ‘I don’t know’ or simply adhering to the thought ‘Allah knows’. Whether another earthquake could be predicted or expected in a given number of years received the most distributed response across all options. For instance, in the case of KP, where a major earthquake had just devastated communities, heightened state of fear provoked respondents to predict an earthquake in 5 years, however, in the cases of Al-Marj, Kabul and Agadir people tended to predict an earthquake in the distant future or simply maintain ‘God knows’. Respondents in KP displayed a heightened state of fear from earthquakes where nearly 90% of the respondents said they were afraid of another earthquake. Responses across other options were varied but not significantly different from one another. The KP respondents recorded a heightened state of fear of earthquakes probably because of the freshness of the event. However, residents of Kabul, Agadir and Al-Marj and Kabul provide a similar range response.

In Kabul, during the last earthquake (Mw 6.1) on January 31, 2018, that killed two and injured two dozen people, 14% of our respondents did NOTHING to protect themselves from the earthquake shaking, while 26% people only PRAYED – 40% of Kabul respondents took ‘no action’ to save themselves (Figure 7.7). It is worth noting that except for male-female ratios, the demographic characteristics of Al-Marj and Kabul were similar.

In Agadir, 71% of the respondents believed earthquakes posed a serious threat to Agadir. Nearly half of the population (48%) did not feel frightened by an earthquake – this was surprisingly different from the respondents in the three other sites! Interestingly, 70% of the Agadir population admittedly had NO or little knowledge of earthquake phenomenon. In the meanwhile, two-third of the respondents (~60%) believed their houses were not safe from earthquakes.

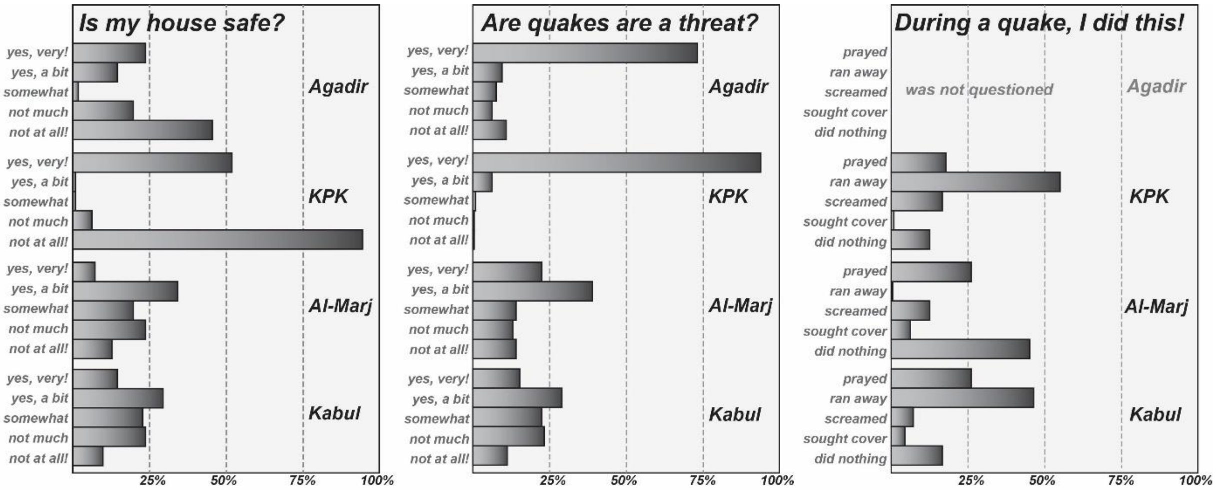


Figure 7. 7. Earthquake perception and responses recorded in the study sites.

A greater majority of respondents, in all study sites, know their houses are not seismically resistant. Residents of Agadir and KP believe earthquakes pose a serious threat to their cities. However, this is not the case in Kabul or Al-Marj. Resident of KP and Kabul chose to run away from their homes to the open spaces to avoid getting hurt during the last earthquake event, a significant number of residents across the study sites either prayed or did nothing to avoid the imminent danger while very few people in Al-Marj and Kabul sought cover.

7.5. Discussion and Conclusion

The two southwest Asian countries of Afghanistan and Pakistan are located thousands of kilometers apart from their two north African counterparts studied and compared in this study. Further, the four countries have their locally distinct cultures, languages, and peoples. Studies such as ours would presumably find quite varied responses to the same questions owing to the trajectories of evolution of cultures and recent histories in these countries. However, our findings, presented above, demonstrated interesting aspects of convergence of perceptions which are discussed hereunder:

7.5.1. Discussion

Montz et al. (2017) observed that a fundamental factor in heightened perception of risk is the actual experience of an earthquake that raises the perception of seismic risk, since people believe that future earthquake events will be comparable to those experienced; however, the effect of experience diminishes as time passes. In fact, it is quite natural for people to overestimate the probability of small seismic events and underestimate the probability of higher magnitude earthquakes (Mileti 1999). However, findings from four Muslim-majority countries contradicted this notion. Majority of the respondents in our study areas had felt an earthquake. Everyone surveyed in KP, Pakistan experienced the devastating 8 October earthquake; 76% of respondents in Kabul City had felt an earthquake three times in the past five years. Similarly, residents of Al-Marj, Libya considered their region to be seismically active and that their neighborhoods were not safe. Nevertheless, when it came to prediction, they refused to forecast any recurrence considering it against divine fate to predict an earthquake. For example, 96% of our respondents in Libya believed that only Allah knows when an earthquake would happen. Likewise, in Agadir, when respondents were asked if they believed the region was seismically active, and/or if more quakes were likely within their lifetimes, more than half of all respondents only answered with "*Allahu a'lam*" (God is wisest). Respondents often refused to make a simple guess, or a 'yes' or 'no' often stating this was a predictive notion only possible from the divine and was *haram* (forbidden). '*Allahu a'lam'* was not a survey choice but was commonly recurring reply in Agadir and KP.

Higher educated respondents were found to associate earthquakes with tectonic slip while lesser educated respondents attributed it to divine testing, punishment, justice, or retribution. In Agadir, not only did all survivors utter a small prayer when asked about their recollections of the quake, ~20 respondents recited passages from the 99th Surah specifically – nearly fifty percent of the 1960 Agadir earthquake survivors in the study! Ainuddin et al. (2014) in Quetta, Pakistan and Khan et al (2019) in Malakand, Pakistan found that the majority of the participants in his study related the future occurrence of earthquakes to God's will and that their lives depended on the mercy of God. Further, they believed that earthquakes occurred when bad deeds, and obscenity were commonplace. This relationship suggests that a fundamental adherence to the Islamic cultural training was more common amongst the majority of our target population.

Fischhoff et al. (1978) observed that the characteristic most highly correlated with perceived risk is the degree to which a hazard evokes feelings of dread. Hutton & Haque (2004) and Haque and Blair (1991) noticed that the freshness of a catastrophic event enhances the perception of risk. A collective 75% of our respondents feared future earthquakes would be devastating. The highest degree of fear was noted in KP, Pakistan where the memory of the devastating earthquake was fresh. 98% of the population in KP found the earthquake experience traumatic and frightening.

Ambraseys (2009) concluded that, in the Muslim societies, devastating earthquakes were one of the omens of the Day of Resurrection, and allusions to the terrors of judgement day, which were common in the accounts of earthquake reports of the medieval time. He concluded that this religious dimension to the perception of earthquakes in mediaeval Islamic society encouraged the believers to keep an accurate record of even minor shocks quite systematically when circumstances were favorable.

While Davoudi (2014), White (1974), and Dupree (1974) alluded fatalism regarding associations of divine retribution in the 'pre-modern' times, Hewitt (2012), Chester et al. (2013), and Suwihli (2020) showed that such notions were still prevalent in most human societies, western and non-western alike. Hewitt (2012) suggests that what should be of concern is not the belief, but where it hides, or what goes against evidence showing that many of the deaths and damages in recent disasters could have been prevented with readily available measures.

7.5.2. Summary

In the four countries in this survey, roughly half of the respondents believed there will be another earthquake, while roughly half of the respondents also expressed a lack of knowledge on quake recurrence responding often with "*Khuda Mefahma*"or "*Allahu alam*"(only God knows). Staunch beliefs that a future quake could only be known to God and is out of the sphere of man's knowledge, influence, or capabilities, supports the notion (and prior research) of fatalistic understandings of seismic events. This poses a challenge to the policy makers, disaster managers, and educators in the field of disaster management.

Gender has also been shown to influence disaster perception and is often closely linked to an understanding of risk and subsequent decision making. In our study, women perceived disaster events or threats as more serious and dangerous than men, especially if it threatened their family. In Afghanistan and Pakistan, 65% of women believed earthquakes posed a serious threat to Kabul City.

Direct experience with natural hazards has an important bearing on how communities respond to them (Montz et al. 2017). White (1974) hypothesized that variations in hazard perception and estimation can be accounted for by a combination of (a) magnitude and frequency of the hazard, (b) recency and frequency of personal experience, with (c) intermediate frequency generating greatest variation in hazard interpretation and expectation, and (d) the importance of the hazard to income or locational interest, personality factors such as risk-taking propensity, fate control, and views of nature. Therefore, the magnitude and recency of hazard events such as quakes is expected to enhance hazard awareness. However, as the event fades in memory, regardless of its magnitude, knowledge of it may diminish and no longer directly impact decision-making. Even though early studies on disasters and response argued that experience of a hazardous event influenced both individuals and communities to better prepare for future events, recent studies indicated that experience as a driver of decision -making was more nuanced and complicated by near-misses and media representation of relative. As seen in Pakistan, experience with an earthquake did not increase its fear nor translate into a higher perception of seismic risk, often witnessed in post-event actions taken to ameliorate risk (Bahram and Paradise 2020).

It is not uncommon to find policy-makers in hazard zones doing absolutely nothing to deal with an impending disaster (Montz et al. 2017) rather create future risks by building at the same site or nearby the demolished site. For example, the new city of Al-Marj was founded merely a few kilometers away from the site of the city razed by an earthquake in 1960. Similarly, Muzaffarabad of Kashmir, which was completely destroyed in the 2015 earthquake, was reestablished at the same location. In the cases of Al-Marj in Libya, KP, Pakistan and Kabul, Afghanistan, 10-40% of the respondents did nothing during these tragic events. These respondents underestimated the threat levels and vulnerability much like Bangladesh residents who did not take the risk of floods seriously when Hurricane Irene approached their communities (Schmuck 2000) and yet had experienced catastrophic hurricanes in the region every 5-10 years before. In fact, of the respondents in our study surveys roughly 10%-40% did not perceive earthquakes as posing any serious threat to their family, community, or region: Agadir (13%), Al-Marj (25%), and Kabul (34%).

Overall, the most educated respondents represented the highest regard for the tectonic explanation of earthquakes. 71% of the respondents in Afghanistan and 30% of respondents in Morocco and Libya indicated they had some knowledge of why earthquakes happen. Less educated respondents were more likely to deny or disregard scientific assessment, seismic forecasting, and earthquake-related safety and construction techniques as ‘haram’ (prohibited) explaining that such thinking or technology somehow interfered with the omnipotence of Allah. Less educated respondents stated that Allah protected those who were devout so that planning for earthquakes was unwarranted. 96% of respondents in Libya associated any future occurrence of an earthquake with the will of Allah. While men were less afraid, they generally considered themselves more knowledgeable of seismic cause, activity, and its effects. 85% of men in Afghanistan, 62% in Pakistan, 67% men in Morocco and 63% men in Libya denied any fear of earthquake.

7.5.3. Conclusion

An understanding of seismic risk perception in seismically active regions like Pakistan, Morocco, Libya and Afghanistan is fundamental to creating acceptable and sustainable policies for pre-event preparation and post-event relief and recovery. The often-cited fatalistic influences of Islam on its communities was supported in these findings in that Muslim communities may have a lesser tendency to prepare for earthquakes due to the singular link between divine retribution and earthquakes in the Qur'an (Paradise 2005). However, surprising results included the strong relationship between education and defensive actions during and after the events (Bahram and Paradise, 2020).

In communities that perceived seismic research as sacrilegious fortune-telling, and as, for example, where Agadir continues to develop atop and adjacent to active faults, it may prove to be the perfect prescription for deaths, injuries, and damages (Paradise 2006). The predictive nature of science has proven itself to be a valuable tool in seismic research and pre-quake preparation, however it might be an understanding of our individual and collective perceptions that may explain the difference between a prepared and safer community, or a society that flirts with injury, damage, and death. UNDRR (2022) rightly holds our broken perceptions of risk accountable for the reversal in human progress over centuries.

The point of perception studies in natural hazards and risk research is paramount in that as our technologies increase our understanding of seismic mechanisms and potential seismic forecasting, without further understanding of local, regional, and national perceptions of risk and influence, policymakers will not be able to effectively decrease injury, loss, and death from natural disasters – the ultimate goal of natural hazard and risk research today. Steckler (2017) recognized that the discourse on earthquake risk in developing countries is a challenge because crucial information is missing, socio-political problems are frequent, and investments towards risk reduction in natural hazards often involve painful bargains with national issues. Moreover, these nations have profound immediate needs, unchecked urbanization, political instability, and sporadic violence (Esposito and Mogahed 2007, Halvorson and Hamilton 2007).

CHAPTER 8: Conclusions and Recommendations

Risks and disasters are manifestations where humans and nature interact in ways that can bring about consequences. In simple terms, a threatening phenomenon or *hazard* can be exacerbated under certain conditions, which causes losses (e.g., fatalities, injuries, economic), and which can result in a greater consequence or *risk*. When that hazard exceeds local or regional capacities and external assistance is required, it becomes a *disaster*. A *hazard* is considered an extreme occurrence that is based on the past frequency and magnitude, while the *risk* is representation of that hazard with statistically predicted consequences in the future (White 1974). The thrust of this research was to:

- To update the existing earthquake catalog of Afghanistan and the vicinity of the country.
- To evaluate the extent of exposure and vulnerability of Afghanistan and Pakistan to earthquake activity.
- To assess the perceptions of seismic risk in Afghanistan and Pakistan.
- To evaluate the influences of Islamic culture, thought, and training regarding earthquakes in the Muslim countries of Afghanistan, Pakistan, Libya, Morocco.

In the geologic past, Afghanistan formed as a part of the accretion of island arcs along the southern fringes of the Eurasian Plate (Shroder 2014). These accreted terranes were later sutured to the Eurasian Plate and sandwiched in the collision between the northbound Indian Plate and southbound Eurasian Plate which created high mountainous terranes, fault systems, and corridors of crustal fractures and recurring seismicity (Ruleman et al. 2007).

In Afghanistan and Pakistan, chief among natural hazards are earthquakes which are often exacerbated to become disasters. Earthquakes dominate northwest Pakistan (Durrani et al.

2005), northeast Afghanistan (Schurr et al. 2014, Yeats and Madden 2003), and Southeast Afghanistan and Pakistan along the Chaman Fault corridor(Szeliga et al. 2012) .

In this important research and undertaking a large inventory of Afghanistan's historic quakes was compiled. Due to poor infrastructure, poor housing conditions, and substandard building typologies prevalent across the country, Afghanistan remains vulnerable to earthquakes of high magnitude and intensity. In the past two decades (2002-2022), the country has been hit by 4,190 earthquakes of magnitudes 4.0 - 7.5. Two of these earthquakes were major i.e., > 7 Mw while 19 were strong (>6 Mw), and 224 moderate quakes were recorded (USGS 2022a). Cumulatively, 245 earthquakes (moderate to strong), in 20 years, could have caused damages, however, analyses presented in this study indicate that 16 of these tremors caused noticeable losses to the communities across Afghanistan regardless of depth and magnitude. For example, a shallow (depth 8 km), 6.1 Mw in 2002 killed 1,000 and injured 200 in the northern town of Nahrin, and demolished settlements, villages, and towns in the proximity of the epicenter. Similarly, in 2015, a 212 km deep earthquake of Mw 7.5 with an intensity of VII, centered in the Hindukush, killed 399 and injured 2,536 across the region (Ismail and Khattak 2016).

Compiling these events into a catalog is critical for Afghanistan since an updated comprehensive catalog for the country is lacking. Also, it is essential since Afghanistan lacks seismic research institutions, governmental departments with capacity, and institutional memory to keep a repository of earthquake events in one place for future references. Other objectives were:

a) To provide an open access and reliable document to earthquake disaster practitioners.
b) To help guide set earthquake intervention priorities in terms of investments of time, knowledge, and physical resources to identified regions exposed to earthquakes or else

corruption under the garb of seismic interventions might lead to a misallocation of funds, and resources to places which are otherwise aseismic. *A complete catalog of these compiled quakes of may be found in Appendix A.*

In this study, surveys were conducted regarding the perceptions of earthquake risk perception in Kabul, Afghanistan, and Khyber Pakhtunkhwa (KP), Pakistan and revealed meaningful findings:

a) A relatively young population (87% of respondents in Kabul aged 18-50; 79% in KP for the same age group), who were well-educated groups living yet in economically unstable communities and were often concerned about armed violence in their communities due to the ongoing strife exacerbating a disaster situation.

b) Traditionally conservative communities practiced stringent segregation of men and women. For example, male to female ratio in our study in Kabul City was 69:31 and 80:20 in KP constraining any chance of interviewing women for perception studies and disallowing a random sampling method to get diverse responses to perception questions.

c) Communities in Kabul City and KP often held fatalistic attitudes toward earthquakes that was demonstrated in their underestimation of dangers of earthquakes and a strong belief in ‘Allah knows better’ (*Khuda Mefahma*). It is believed that culture and religion heavily influenced their perceptions of seismic risk molded by the teachings of Islam — the faith of the respondents in this study.

The study outcomes provided fundamental guidelines for disaster and risk managers, planners, and urban policymakers to facilitate a reasonable evaluation of the current state of seismic risk in the city. These findings also uncovered gaps in seismic disaster management plans regarding earthquakes through the exclusion of many local stakeholders including DRR practitioners, local communities, local and national policy makers, financial institutions, service institutions, and non-governmental organizations. Further, it was discovered that the existing DRR plans were laden with assumptions (e.g., strategies assumed peaceful and total government control situations all over Afghanistan while the ground reality was different) and had overlooked cultural sensitivities, conflict dimensions, and gender roles.

It was also revealed that survey respondents held strong traditional values and attitudes prevalent in Afghan society and similar societies such as those of Libya (Suwihli and Paradise 2020), Pakistan (Khan et al. 2019), Saudi Arabia (Alshehri et al. 2013), Turkey (Demirkaya 2008), and Morocco (Paradise 2005), often more related to Muslim culture rather than the direct teachings of the Qu‘ran (Aksa 2020).

Regarding earthquake mitigation, respondents repeatedly cited a regular fear of community violence, administrative corruption, and a lack of governmental and community accountability but were never addressed in the survey instruments. Respondents frequently referred to corruption as part of the wider national and local issues including bribery at all levels, bureaucratic and military extortion, nepotism in delegation of services, and privileges granted to tribal and ethnic affiliations in respect to services such as housing, education, health, provision of security, and provision of relief in the aftermath of a disaster. Thus, concentrating attention on these daily issues and away from the discourse around earthquakes and the imminent risk it presents to Kabul City.

Moreover, insecurity and fear pertaining to armed conflict and violence was frequently mentioned as a main concern that redirected attention (and possibly valuable resources) from other worthwhile concerns such as earthquake preparedness and mitigation in Afghanistan. Despite the overwhelming distrust of the government regarding earthquake preparedness by the respondents (75%), this study revealed that a significant percentage (59%) of respondents believed that it was not solely the responsibility of the government to prepare and manage earthquake disasters. Yet, they remained shy to share what could be done or how they could participate or contribute to reducing seismic risk.

In the seismically active regions of Khyber Pakhtunkhwa province of Pakistan, a strong relationship between education and defensive actions during and after the event was noted. Strong correlations (r^2=0.403) were observed between action and education. The more educated survivors of the quake had run away from the falling debris. The freshness of an event is found to spike risk perceptions as well (Burton 1993). 90% of the respondents believed an earthquake was imminent. 71% believed another earthquake would hit the region in 2-5 years. Gender was correlated with perception. For example, in this study, 20% of the surveyed population constituted women and 50% of the interviewed women feared the occurrence of an imminent earthquake in 1-2 years, demonstrating higher perceptions of fear, while men rejected any imminent earthquake in 1-2 years.

Further, these analyses in Khyber Pakhtunkhwa, divulged that a relatively higher perception (90%) of seismic danger was noted than many other communities, although they appeared as unprepared as in other communities in Afghanistan. For example, none of the respondents sought cover during the earthquake indicating a lack of knowledge of *'seeking cover'*. This behavior might have been biased because of the short lag-time between the event and survey – a rare circumstance in perception studies (Burton 1993), and yet the value of this study. It is a rare occasion that individuals can be surveyed with six months of such a strong and dreadful event.

Analyses of seismic risk perception in Afghanistan (Chapter 5), Pakistan (Chapter 6), and the wider the Muslim World (Chapter 7) revealed that the cultural orientations influenced by the teachings of Islamic played a fundamental role in shaping Muslim perception of earthquake hazard. For example, in Al-Marj, Libya ~70% of the respondents avoided predicting *any* earthquake occurrence *anytime*. Similarly, in Agadir, Morocco, ~55% respondents reported no knowledge of earthquakes often reciting the 99th chapter of the Qur'an that addresses earthquakes as signs of Judgment Day. Although residents of Kabul had experienced earthquakes repeatedly, ~51% held that *only* 'Allah knows' when another earthquake might occur thus implying the *unimportance* of seismic research or science in general. Similarly, ~96% of respondents in Al-Marj, Libya believed only 'Allah knows' about any future occurrence of an earthquake. The often-cited fatalistic influences of Islam on its communities was supported in these findings in that Muslim communities tend to have a lesser tendency to prepare for earthquakes due to the singular link between divine retribution and earthquakes in the Qur'an (Paradise 2005). Therefore, a truly objective (quantitative, scientific) approach to understanding their perceptions and knowledge of hazards would not suffice. Hence, an integrative constructivist approach that combined various elements of social, cultural, psychological, and interactions amongst them proved the right method to address this phenomenon.

This dissertation established that active seismicity presents a direct earthquake risk to millions of people in these four countries. A review of damaging earthquakes in the 20th century revealed that the four countries constituted ~28% of the worldwide fatalities while ~17% of the damaging earthquakes were concentrated there. In other words, of the 609,139 fatalities recorded globally, 168,338 fatalities were from these four countries – a staggering number! However, when it came to preparations for an earthquake, residents in these countries seemed reluctant since earthquakes were ‘acts of God’ against which ‘nothing can be done’ and a futile attempt to ‘escape’. For instance, in Kabul ~46% reported no preparedness for an earthquake, while ~27% of the respondents agreed that nothing could be done against Allah’s wrath. Such a lack of hazards awareness and risk preparedness requires a more effective and determined action on the part of communities – from village to nation – to prevent losses and save lives.

8. 1. Recommendations

Studies of perceptions of risk are effective in helping design disaster risk management plans and policies and improve risk communications – an important aspect of the multidisciplinary world of the hazard sciences. Seismic activity has caused substantial losses to the population of Muslim countries several of which are located adjacent to active fault systems and corridors. This study assessed, investigated, examined, and evaluated the existing perception of seismic risk in four Muslim majority countries and helped in suggesting the following recommendations:

1. A seismic slip deficit on the northern section of the Chaman Fault (from 32° to 34°) is only 20-30 km from Kabul and prior research forecasts imminent danger to Kabul and the region. This calls for a detailed study of the fault to a) determine the precise rate of movement locked along this slip deficit, and b) calculate an estimated extent of losses for Kabul City and adjacent towns and villages.
2. Since the slip deficit centered near Kabul presents a significant seismic risk it is imperative to conduct a comprehensive study of the physical, social, and socio-economic vulnerabilities of the city and region. Such a plan and policy design and implementation would potentially reduce damages, deaths, injuries, and losses in the event of a moderate-high earthquake by integrating seismic hazard frequency and magnitude science and

aspects of risk and its consequences (e.g., infrastructure, relief and recovery services, emergency stockpiles).

3. Afghanistan's National Disaster Management Plan (NDMP 2010) was created to identify hazards, and present mitigative recommendations and plans, however, a comprehensive plan on seismic hazard in Afghanistan needs to be created and integrated. This new, comprehensive plan would reflect new scientific findings and risk analyses, in addition to seismic hazard and seismic risk maps for Kabul and its 22 districts.
4. Since Afghanistan has been a theater of widespread conflict and political instability, new seismic hazard and risk studies must include elements of conflict, conflict sensitivities, and related vulnerabilities. Conflict should be an integral part of the project design addressing DRR. If not adapted to the local, regional, and national context, DRR interventions have the potential to cause new, or exacerbate existing conflict.
5. In Afghanistan and Pakistan, most institutions, plans, programs, and projects working on disaster risk reduction (DRR) depend heavily on external funding and serious concerns are continually addressed about long-term funding sustainability. Therefore, these programs should be incorporated and integrated into the national development budget.
6. In Afghanistan and Pakistan, the mantle of DRR education is carried by the increasing numbers of non-profit organizations. Collaboration with these NGOs should be mainstreamed and made part of the larger DRR plans and programs including aspects of that directly address seismic hazard and risk. These more comprehensive initiatives should be included in discussions associated with policies, plans, programs, and projects that promote seismic safety.

7. Effective disaster management identifies relevant stakeholders. Since formal institutions are in their nascent stages (both in Afghanistan and Pakistan), and most are incapable of providing adequate DRR services (crippled by lack of funding, expertise, lack of resources, and relevant policies), it is essential to identify communal organizations and leaderships (e.g., tribal elders *misharan/arbab*) and local councils to integrate them in DRR planning and management.
8. This study revealed that the majority of the population of Afghanistan were young, relatively well-educated, and had internet access. Therefore, to disseminate verified earthquake safety information, the use of internet and social media in the distribution of verified scientific information and practical advice is advised.
9. In an increasingly globalized world where disaster and seismic studies are being conducted, the role of higher educational institutions (e.g., Kabul University, Kabul Polytechnic University, University of Peshawar etc.) is central in compiling and translating and contextualizing educational materials and using applicable channels to disseminate this knowledge to all stakeholders and the public.
10. UNDDR (2022) blamed the increasing frequency and intensity of disasters on a ‘broken perception’ of risk based on “optimism, underestimation and invincibility”. This can lead to policy, finance, and development decisions that exacerbate existing vulnerabilities and place communities in danger. In developing countries, risk creation is outstripping risk reduction. Disasters, economic loss, and the underlying vulnerabilities that drive risk, such as poverty, conflict, and inequality, and increasingly in tandem with collapsing ecosystems. Policies, programs, projects, and initiatives addressing DRR, and seismic risk management should take these forewarnings into account.

In communities that perceive seismic research as sacrilegious fortune-telling, and as, for example, where Agadir continues to develop atop active faults, or where Al-Marj was rebuilt only a few kilometers from the site of the old city (Suwihli and Paradise 2020), these notions prove to be the perfect prescription for deaths, injuries, and damages (Paradise 2006). The probabilistic and predictive nature of science has proven itself to be a valuable tool in seismic research and pre-quake preparation, however it might be our individual and collective decisions based on our ‘broken’ perceptions (UNDRR 2022) that may explain the difference between a prepared and safer community, or a society that flirts with injury, damage, and death.

CHAPTER 9: References

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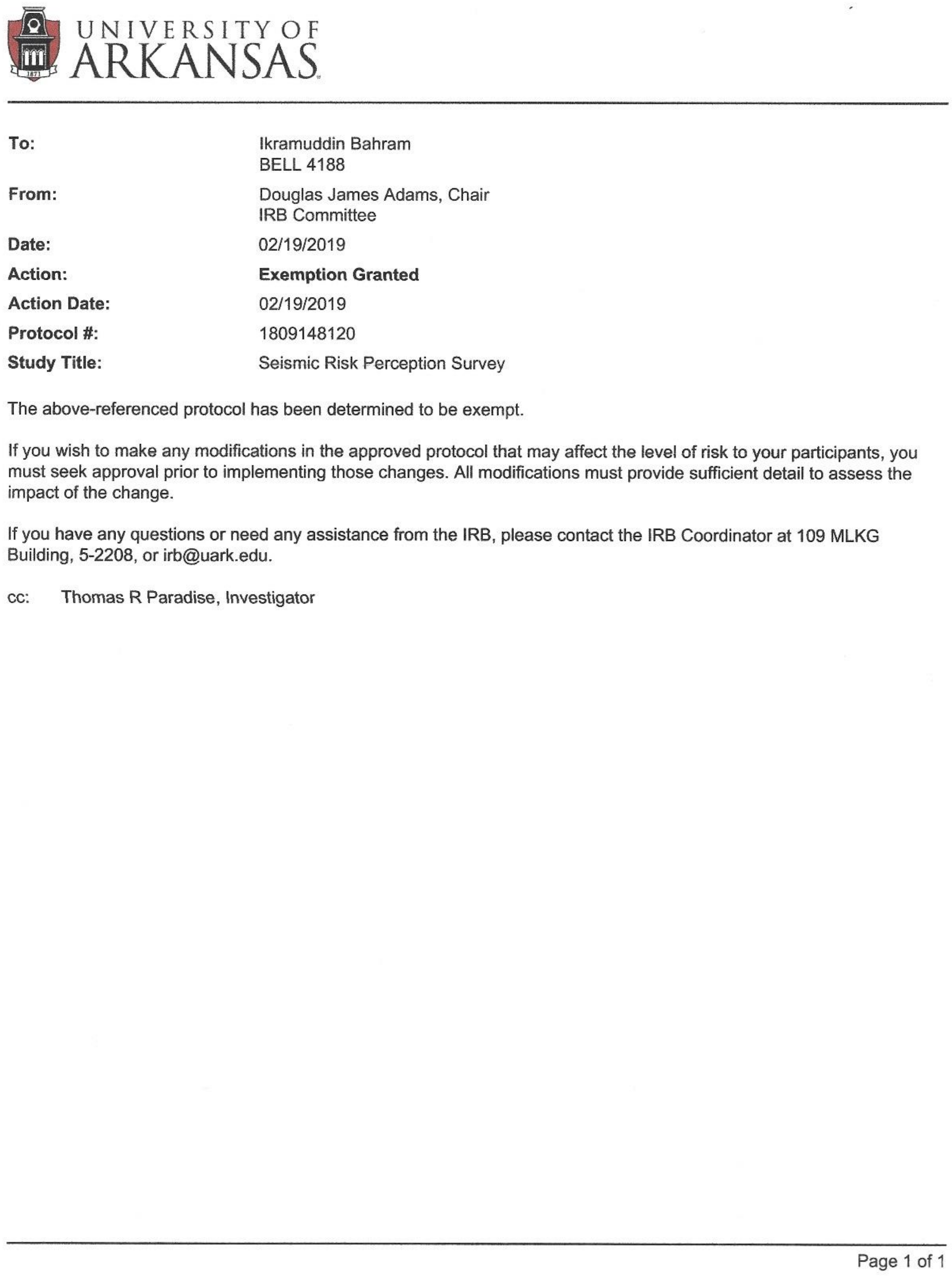
CHAPTER 10: Appendices

Appendix A:	IRB Approval
	Survey Samples [Dari, Pashto, and English]
	Figure of Kabul City survey respondents by province of birth
	Survey Data Matrix
	Cross-tables of Record of Survey Data for Afghanistan, Pakistan, Morocco, and Libya
Appendix B:	Afghanistan Earthquake Catalog (Magnitudes 5 - 8)
	Table of major faults in Afghanistan
	Map of major faults in Afghanistan
	Corruption Perception Index graphs for Afghanistan and Pakistan
Appendix C:	Pictures of Damages from Afghanistan, and Pakistan; Tweets in the aftermath of recent earthquakes in Pakistan.

Appendix A. IRB Approval and Protocol Number



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To:	Ikramuddin Bahram BELL 4188
From:	Douglas James Adams, Chair IRB Committee
Date:	02/19/2019
Action:	**Exemption Granted**
Action Date:	02/19/2019
Protocol #:	1809148120
Study Title:	Seismic Risk Perception Survey

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

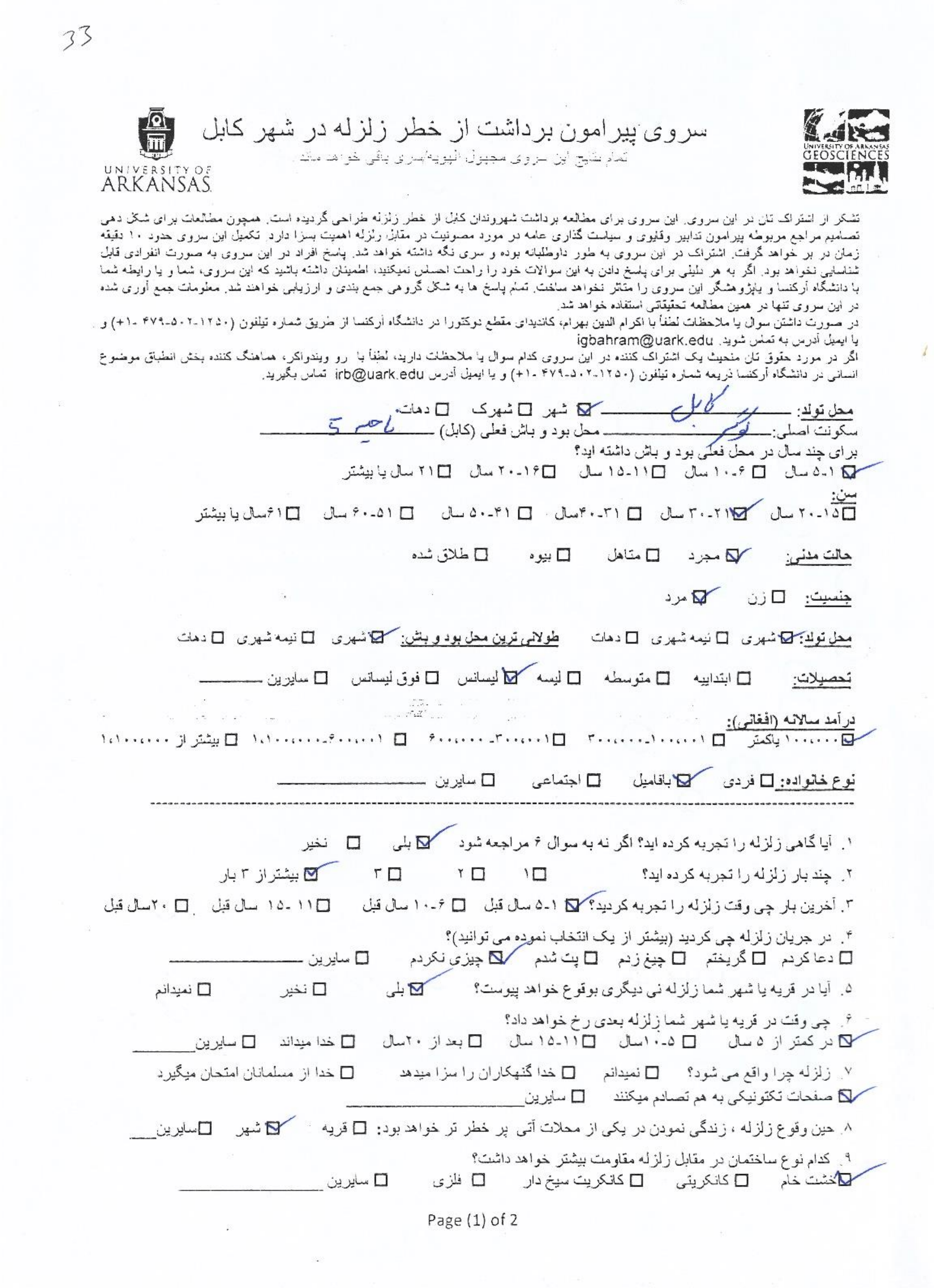
If you wish to make any modifications in the approved protocol that may affect the level of risk to your participants, you must seek approval prior to implementing those changes. All modifications must provide sufficient detail to assess the impact of the change.

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

Page 1 of 1

Survey instruemnt in Dari, Pashto, and English. Responses recorded on the Dari and Pashto iterations in Kabul City, Afghanistan.



33

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سروی پیرامون برداشت از خطر زلزله در شهر کابل

تمام نتایج این سروی مجهول الهویه/سری باقی خواهد ماند

تشکر از اشتراک تان در این سروی. این سروی برای مطالعه برداشت شهروندان کابل از خطر زلزله طراحی گردیده است. همچون مطالعات برای شکل دهی تصامیم مراجع مربوطه پیرامون تدابیر وقایوی و سیاست گذاری عامه در مورد مصونیت در مقابل زلزله اهمیت بسزا دارد. تکمیل این سروی حدود ۱۰ دقیقه زمان در بر خواهد گرفت. اشتراک در این سروی به طور داوطلبانه بوده و سری نگه داشته خواهد شد. پاسخ افراد در این سروی به صورت انفرادی قابل شناسایی نخواهد بود. اگر به هر دلیلی برای پاسخ دادن به این سوالات خود را راحت احساس نمیکنید، اطمینان داشته باشید که این سروی، شما و یا رابطه شما با دانشگاه آرکنسا و پژوهشگر این سروی را متاثر نخواهد ساخت. تمام پاسخ ها به شکل گروهی جمع بندی و ارزیابی خواهند شد. معلومات جمع آوری شده در این سروی تنها در همین مطالعه تحقیقاتی استفاده خواهد شد.

در صورت داشتن سوال یا ملاحظات لطفاً با اکرام الدین بهرام، کاندیدای مقطع دوکتورا در دانشگاه آرکنسا از طریق شماره تیلفون (+۱- ۴۷۹-۵۰۲-۱۲۵۰) و یا ایمیل آدرس به تماس شوید. igbahram@uark.edu

اگر در مورد حقوق تان منحیث یک اشتراک کننده در این سروی کدام سوال یا ملاحظات دارید، لطفاً با رو ویندواکر، هماهنگ کننده بخش انطباق موضوع انسانی در دانشگاه آرکنسا ذریعه شماره تیلفون (+۱- ۴۷۹-۵۰۲-۱۲۵۰) و یا ایمیل آدرس irb@uark.edu تماس بگیرید.

محل تولد: کابل ☑ شهر ☐ شهرک ☐ دهات

سکونت اصلی: لوگر محل بود و باش فعلی (کابل) ناحیه 5

برای چند سال در محل فعلی بود و باش داشته اید؟

☑ ۱-۵ سال ☐ ۶-۱۰ سال ☐ ۱۱-۱۵ سال ☐ ۱۶-۲۰ سال ☐ ۲۱ سال یا بیشتر

سن:

☐ ۱۵-۲۰ سال ☑ ۲۱-۳۰ سال ☐ ۳۱-۴۰سال ☐ ۴۱-۵۰ سال ☐ ۵۱-۶۰ سال ☐ ۶۱سال یا بیشتر

حالت مدنی: ☑ مجرد ☐ متاهل ☐ بیوه ☐ طلاق شده

جنسیت: ☐ زن ☑ مرد

محل تولد: ☑ شهری ☐ نیمه شهری ☐ دهات **طولانی ترین محل بود و باش:** ☑ شهری ☐ نیمه شهری ☐ دهات

تحصیلات: ☐ ابتداییه ☐ متوسطه ☐ لیسه ☑ لیسانس ☐ فوق لیسانس ☐ سایرین ______

درآمد سالانه (افغانی):

☑ ۱۰۰،۰۰۰ یاکمتر ☐ ۱۰۰،۰۰۱-۳۰۰،۰۰۰ ☐ ۳۰۰،۰۰۱-۶۰۰،۰۰۰ ☐ ۶۰۰،۰۰۱-۱،۱۰۰،۰۰۰ ☐ بیشتر از ۱،۱۰۰،۰۰۰

نوع خانواده: ☐ فردی ☑ باقامیل ☐ اجتماعی ☐ سایرین ______

---

۱. آیا گاهی زلزله را تجربه کرده اید؟ اگر نه به سوال ۶ مراجعه شود ☑ بلی ☐ نخیر

۲. چند بار زلزله را تجربه کرده اید؟ ☐ ۱ ☐ ۲ ☐ ۳ ☑ بیشتر از ۳ بار

۳. آخرین بار چی وقت زلزله را تجربه کردید؟ ☑ ۱-۵ سال قبل ☐ ۶-۱۰ سال قبل ☐ ۱۱ -۱۵ سال قبل ☐ ۲۰سال قبل

۴. در جریان زلزله چی کردید (بیشتر از یک انتخاب نموده می توانید)؟

☐ دعا کردم ☐ گریختم ☐ چیغ زدم ☐ پت شدم ☑ چیزی نکردم ☐ سایرین ______

۵. آیا در قریه یا شهر شما زلزله ئی دیگری بوقوع خواهد پیوست؟ ☑ بلی ☐ نخیر ☐ نمیدانم

۶. چی وقت در قریه یا شهر شما زلزله بعدی رخ خواهد داد؟

☑ در کمتر از ۵ سال ☐ ۵-۱۰سال ☐ ۱۱-۱۵ سال ☐ بعد از ۲۰سال ☐ خدا میداند ☐ سایرین ______

۷. زلزله چرا واقع می شود؟ ☐ نمیدانم ☐ خدا گنهکاران را سزا میدهد ☐ خدا از مسلمانان امتحان میگیرد

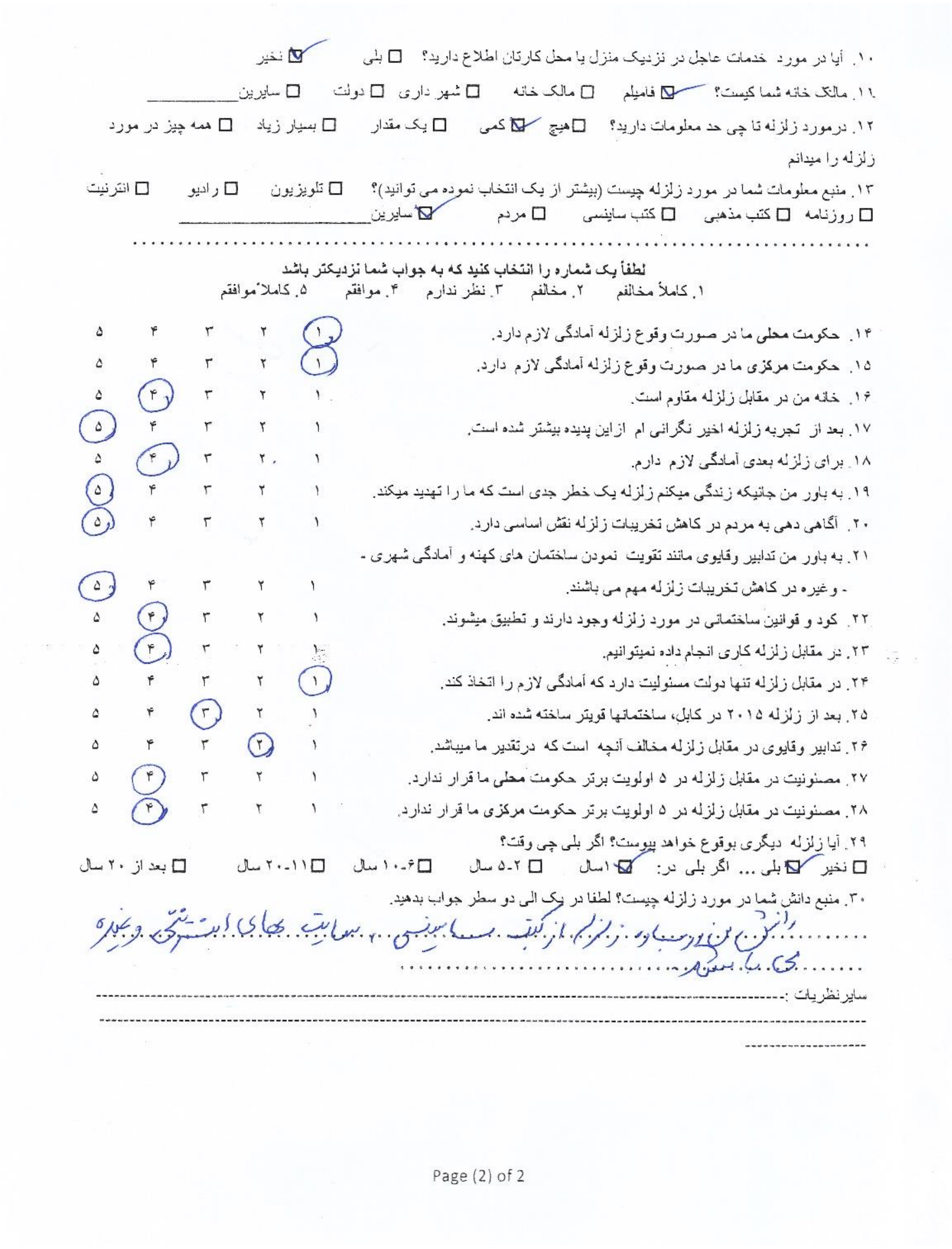
☑ صفحات تکتونیکی به هم تصادم میکنند ☐ سایرین ______

۸. حین وقوع زلزله ، زندگی نمودن در یکی از محلات آتی پر خطر تر خواهد بود: ☐ قریه ☑ شهر ☐ سایرین ___

۹. کدام نوع ساختمان در مقابل زلزله مقاومت بیشتر خواهد داشت؟

☑ خشت خام ☐ کانکریتی ☐ کانکریت سیخ دار ☐ فلزی ☐ سایرین ______

Page (1) of 2



۱۰. آیا در مورد خدمات عاجل در نزدیک منزل یا محل کارتان اطلاع دارید؟ ☐ بلی ☑ نخیر

۱۱. مالک خانه شما کیست؟ ☑ فامیلم ☐ مالک خانه ☐ شهر داری ☐ دولت ☐ سایرین__________

۱۲. درمورد زلزله تا چی حد معلومات دارید؟ ☐هیچ ☑ کمی ☐ یک مقدار ☐ بسیار زیاد ☐ همه چیز در مورد زلزله را میدانم

۱۳. منبع معلومات شما در مورد زلزله چیست (بیشتر از یک انتخاب نموده می توانید)؟ ☐ تلویزیون ☐ رادیو ☐ انترنیت
☐ روزنامه ☐ کتب مذهبی ☐ کتب ساینسی ☐ مردم ☑ سایرین____________________

……

لطفاً یک شماره را انتخاب کنید که به جواب شما نزدیکتر باشد

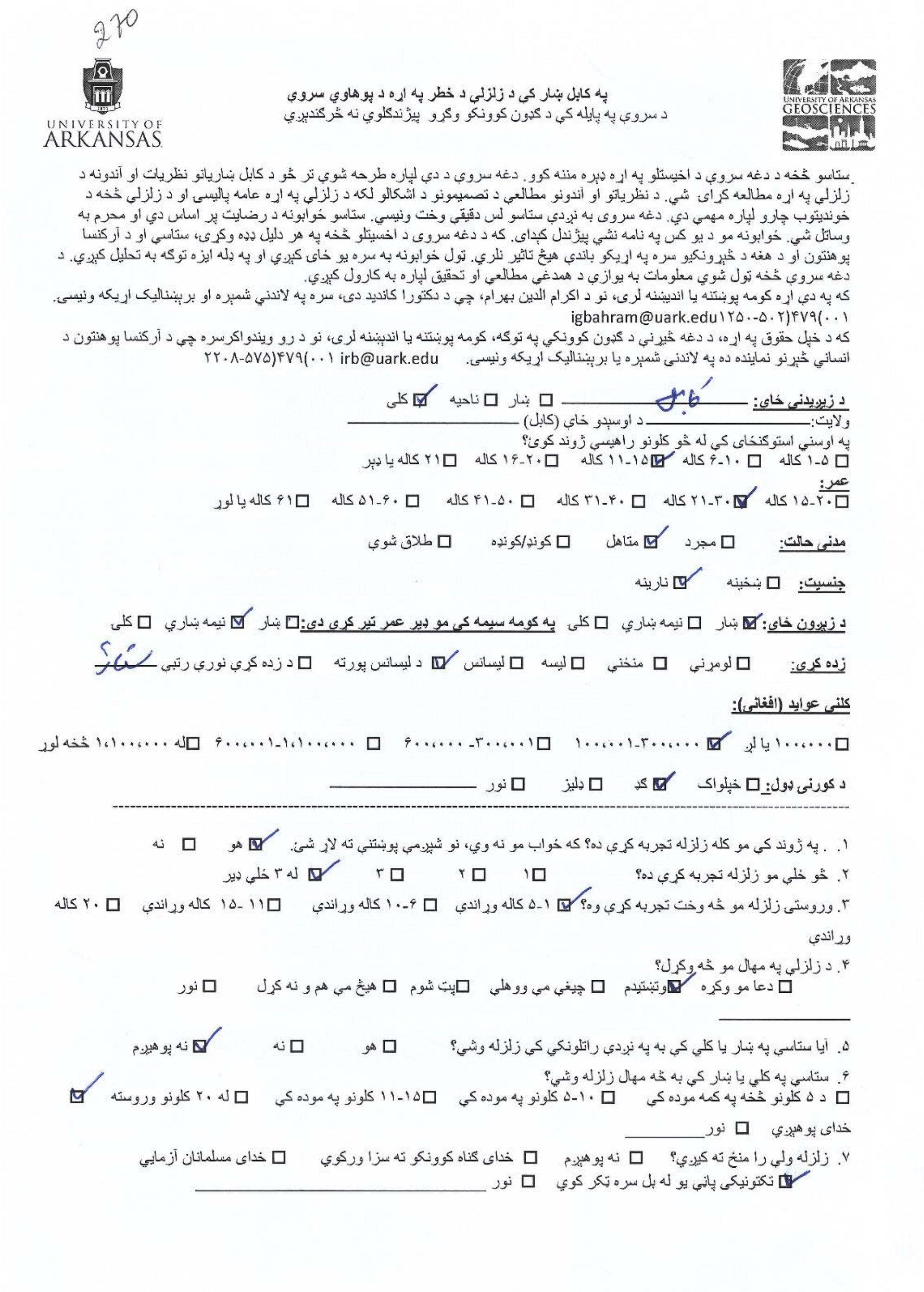
۱. کاملاً مخالفم ۲. مخالفم ۳. نظر ندارم ۴. موافقم ۵. کاملاً موافقم

۱۴. حکومت محلی ما در صورت وقوع زلزله آمادگی لازم دارد.	[✓ ۱]	۲	۳	۴	۵
۱۵. حکومت مرکزی ما در صورت وقوع زلزله آمادگی لازم دارد.	[✓ ۱]	۲	۳	۴	۵
۱۶. خانه من در مقابل زلزله مقاوم است.	۱	۲	۳	[✓ ۴]	۵
۱۷. بعد از تجربه زلزله اخیر نگرانی ام ازاین پدیده بیشتر شده است.	۱	۲	۳	۴	[✓ ۵]
۱۸. برای زلزله بعدی آمادگی لازم دارم.	۱	۲	۳	[✓ ۴]	۵
۱۹. به باور من جائیکه زندگی میکنم زلزله یک خطر جدی است که ما را تهدید میکند.	۱	۲	۳	۴	[✓ ۵]
۲۰. آگاهی دهی به مردم در کاهش تخریبات زلزله نقش اساسی دارد.	۱	۲	۳	۴	[✓ ۵]
۲۱. به باور من تدابیر وقایوی مانند تقویت نمودن ساختمان های کهنه و آمادگی شهری - - وغیره در کاهش تخریبات زلزله مهم می باشند.	۱	۲	۳	۴	[✓ ۵]
۲۲. کود و قوانین ساختمانی در مورد زلزله وجود دارند و تطبیق میشوند.	۱	۲	۳	[✓ ۴]	۵
۲۳. در مقابل زلزله کاری انجام داده نمیتوانیم.	۱	۲	۳	[✓ ۴]	۵
۲۴. در مقابل زلزله تنها دولت مسئولیت دارد که آمادگی لازم را اتخاذ کند.	[✓ ۱]	۲	۳	۴	۵
۲۵. بعد از زلزله ۲۰۱۵ در کابل، ساختمانها قویتر ساخته شده اند.	۱	۲	[✓ ۳]	۴	۵
۲۶. تدابیر وقایوی در مقابل زلزله مخالف آنچه است که درتقدیر ما میباشد.	۱	[✓ ۲]	۳	۴	۵
۲۷. مصئونیت در مقابل زلزله در ۵ اولویت برتر حکومت محلی ما قرار ندارد.	۱	۲	۳	[✓ ۴]	۵
۲۸. مصئونیت در مقابل زلزله در ۵ اولویت برتر حکومت مرکزی ما قرار ندارد.	۱	۲	۳	[✓ ۴]	۵

۲۹. آیا زلزله دیگری بوقوع خواهد پیوست؟ اگر بلی چی وقت؟
☐ نخیر ☑ بلی ... اگر بلی در: ☑ ۱سال ☐ ۲-۵ سال ☐۶-۱۰ سال ☐۱۱-۲۰ سال ☐ بعد از ۲۰ سال

۳۰. منبع دانش شما در مورد زلزله چیست؟ لطفا در یک الی دو سطر جواب بدهید.
دانش من در مورد زلزله از کتب ساینسی، سایت های انترنتی و غیره
می باشد.

سایرنظریات :---



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په کابل ښار کې د زلزلې د خطر په اړه د پوهاوي سروي

د سروې په پایله کې د ګډون کوونکو وګړو پیژندګلوي نه څرګندیږي

ستاسو څخه د دغه سروې د اخیستلو په اړه ډیره مننه کوو. دغه سروې د دې لپاره طرحه شوي تر څو د کابل ښاریانو نظریات او آندونه د زلزلې په اړه مطالعه کړای شي. د نظریاتو او آندونو مطالعې د تصمیمونو د اشکالو لکه د زلزلې په اړه عامه پالیسی او د زلزلې څخه د خوندیتوب چارو لپاره مهمي دي. دغه سروی به نږدې ستاسو لس دقیقې وخت ونیسي. ستاسو ځوابونه د رضایت پر اساس دي او محرم به وساتل شي. ځوابونه مو د یو کس په نامه نشي پیژندل کیدای. که د دغه سروی د اخیستلو څخه په هر دلیل ډډه وکړی، ستاسي او د آرکنسا پوهنتون او د هغه د څیړونکیو سره په اړیکو باندې هیڅ تاثیر نلري. ټول ځوابونه به سره یو ځای کیږي او په ډله ایزه توګه به تحلیل کیږي. د دغه سروې څخه ټول شوي معلومات به یوازې د همدغې مطالعې او تحقیق لپاره به کارول کیږي.

که په دې اړه کومه پوښتنه یا اندیښنه لری، نو د اکرام الدین بهرام، چې د دکتورا کاندید دی، سره په لاندني شمیره او بریښنالیک اړیکه ونیسی.
igbahram@uark.edu۱۲۵۰-۵۰۲)۴۷۹(۰۰۱

که د خپل حقوق په اړه، د دغه څیړنې د ګډون کوونکي په توګه، کومه پوښتنه یا اندیښنه لری، نو د رو ویندواکرسره چې د آرکنسا پوهنتون د انساني څیړنو نماینده ده په لاندنی شمیره یا بریښنالیک اړیکه ونیسی. irb@uark.edu ۲۲۰۸-۵۷۵)۴۷۹(۰۰۱

د زیږیدنې ځای: کابل ☐ ښار ☐ ناحیه ☑ کلی
ولایت:________ د اوسیدو ځای (کابل) ________
په اوسني استوګنځای کې له څو کلونو راهیسې ژوند کوئ؟
☐ ۱-۵ کاله ☐ ۶-۱۰ کاله ☑ ۱۱-۱۵ کاله ☐ ۱۶-۲۰ کاله ☐ ۲۱ کاله یا ډیر

عمر:
☐ ۱۵-۲۰ کاله ☑ ۲۱-۳۰ کاله ☐ ۳۱-۴۰ کاله ☐ ۴۱-۵۰ کاله ☐ ۵۱-۶۰ کاله ☐ ۶۱ کاله یا لوړ

مدنی حالت: ☐ مجرد ☑ متاهل ☐ کونډ/کونډه ☐ طلاق شوي

جنسیت: ☐ ښځینه ☑ نارینه

د زیږون ځای: ☑ ښار ☐ نیمه ښاري ☐ کلی **په کومه سیمه کې مو ډیر عمر تیر کړی دی:** ☐ ښار ☑ نیمه ښاري ☐ کلی

زده کړې: ☐ لومړني ☐ منځني ☐ لیسه ☐ لیسانس ☑ د لیسانس پورته ☐ د زده کړې نورې رتبې ستاژ

کلنی عواید (افغانی):
☐ ۱۰۰،۰۰۰ یا لږ ☑ ۱۰۰،۰۰۱-۳۰۰،۰۰۰ ☐ ۳۰۰،۰۰۱-۶۰۰،۰۰۰ ☐ ۶۰۰،۰۰۱-۱،۱۰۰،۰۰۰ ☐ له ۱،۱۰۰،۰۰۰ څخه لوړ

د کورنی ډول: ☐ خپلواک ☑ ګډ ☐ دلیز ☐ نور ________

---

۱. . په ژوند کې مو کله زلزله تجربه کړې ده؟ که ځواب مو نه وي، نو شپږمې پوښتنې ته لاړ شئ. ☑ هو ☐ نه
۲. څو خلې مو زلزله تجربه کړې ده؟ ☐ ۱ ☐ ۲ ☐ ۳ ☑ له ۳ خلې ډیر
۳. وروستی زلزله مو څه وخت تجربه کړې وه؟ ☑ ۱-۵ کاله وړاندې ☐ ۶-۱۰ کاله وړاندې ☐ ۱۱-۱۵ کاله وړاندې ☐ ۲۰ کاله وړاندې
۴. د زلزلې په مهال مو څه وکړل؟
☐ دعا مو وکړه ☑ وتښتیدم ☐ چیغې مې ووهلې ☐ پټ شوم ☐ هیڅ مې هم و نه کړل ☐ نور
____
۵. آیا ستاسې په ښار یا کلې کې به په نږدې راتلونکې کې زلزله وشي؟ ☐ هو ☐ نه ☑ نه پوهیږم
۶. ستاسې په کلي یا ښار کې به څه مهال زلزله وشي؟
☐ د ۵ کلونو څخه په کمه موده کې ☐ ۵-۱۰ کلونو په موده کې ☐ ۱۱-۱۵ کلونو په موده کې ☐ له ۲۰ کلونو وروسته ☑ خدای پوهیږي ☐ نور________
۷. زلزله ولې را منځ ته کیږي؟ ☐ نه پوهیږم ☐ خدای ګناه کوونکو ته سزا ورکوي ☐ خدای مسلمانان آزمايي
☑ تکتونیکی پانې یو له بل سره ټکر کوي ☐ نور ________

٨. د زلزله په وخت کې په دغه سیمو کې ژوند کول به له خطرونو ډک وي: ☐ کلی ☑ ښار ☐ نور_____________

٩. کوم ډول ودانی د زلزلې په وړاندې ډیر مقاومت لري؟
☑ خامې خښتې ☐ کانکریټ ☐ سیخ لرونکي کانکریټ ☐ فلزی ☐ نور_______________

١٠. آیا په خپل میشت ځای او د کار ځای کې د بیړنیو خدمتونو په اړه معلومات لرئ؟ ☐ هو ☑ نه

١١. ستاسې د کور ښتن څوک دی؟ ☑ زما کورنی ☐ د کور ښتن ☐ ښاروالي ☐ حکومت ☐ نور_________

١٢. د زلزلې په اړه څومره معلومات لرئ؟ ☐ هیڅ ☐ لږ ☑ یو څه معلومات لرم ☐ ډیر معلومات لرم

☐ د زلزلې په اړه په هر څه پوهیږم.

١٣. . د زلزلې په اړه ستاسي د معلوماتو سرچینه کومه ده؟ ☐ تلویزیون ☐ رادیو ☑ انټرنټ ☐ ورځپانه
☐ دیني کتابونه ☐ ساینسي کتابونه ☐ نور خلک ☐ نور______________________

. . . .

مهرباني وکړئ او یوه شمیره په نښه کړئ چې ستاسې د ځواب استازیتوب کوي

١. . په بشپړه توګه مخالف یم ٢. مخالف یم ٣. نظر نلرم ٤. موافق یم ٥. په بشپړه توګه موافق یم

١٤. زمونږ سیمه ایز حکومت د زلزلې را منځ ته کیدو په صورت کې بشپړه چمتو دی. [✓ ١] ٢ ٣ ٤ ٥

١٥ زمونږ مرکزي حکومت د زلزلې را منځ ته کیدو په صورت کې اړیني چمتوالي لري. [✓ ١] ٢ ٣ ٤ ٥

١٦. زما کور د زلزلې په وړاندې مقاومت لري. ١ [✓ ٢] ٣ ٤ ٥

١٧. د وروستني زلزلې وروسته، د زلزلې په اړه مې اندیښنه ډیره شوې ده. ١ ٢ ٣ [✓ ٤] ٥

١٨. د بلې زلزلې لپاره بشپړه چمتو یم. ١ ٢ ٣ [✓ ٤] ٥

١٩. زما په آند په کومه سیمه کې چې ژوند کوم، زلزله یو جدي خطر دی او مونږ ګواښي. ١ ٢ ٣ [✓ ٤] ٥

٢٠. خلکو ته د زلزلې د ورانیو د کمښت په اړه پوهاوی مهم دی. ١ ٢ ٣ ٤ [✓ ٥]

٢١. زما په آند د مخنیوی چارې لکه د زاړو ودانیو ځواکمن کول او ښاري چمتوالی کولای شي چې د زلزلې د ورانیو په کمښت کې مهمه ونډه ولوبوي.
١ ٢ [✓ ٣] ٤ ٥

٢٢. ودانیز کودونه او قوانین شتون لري او پلي کیږي. ١ [✓ ٢] ٣ ٤ ٥

٢٣. د زلزلې په وړاندې هیڅ هم نشو کولای. ١ ٢ [✓ ٣] ٤ ٥

٢٤. د زلزلې په وړاندې یواځې دولت مسؤلیت لري چې چمتوالی ولري. ١ ٢ [✓ ٣] ٤ ٥

٢٥. د ٢٠١٥ کال زلزلې وروسته په کابل کې ودانی ځواکمني جوړې شوې دي. ١ ٢ [✓ ٣] ٤ ٥

٢٦ د زلزلې په وړاندې د مخنیوی هڅې د خدایي تقدیر سره په تضاد کې دي. ١ ٢ ٣ ٤ ٥

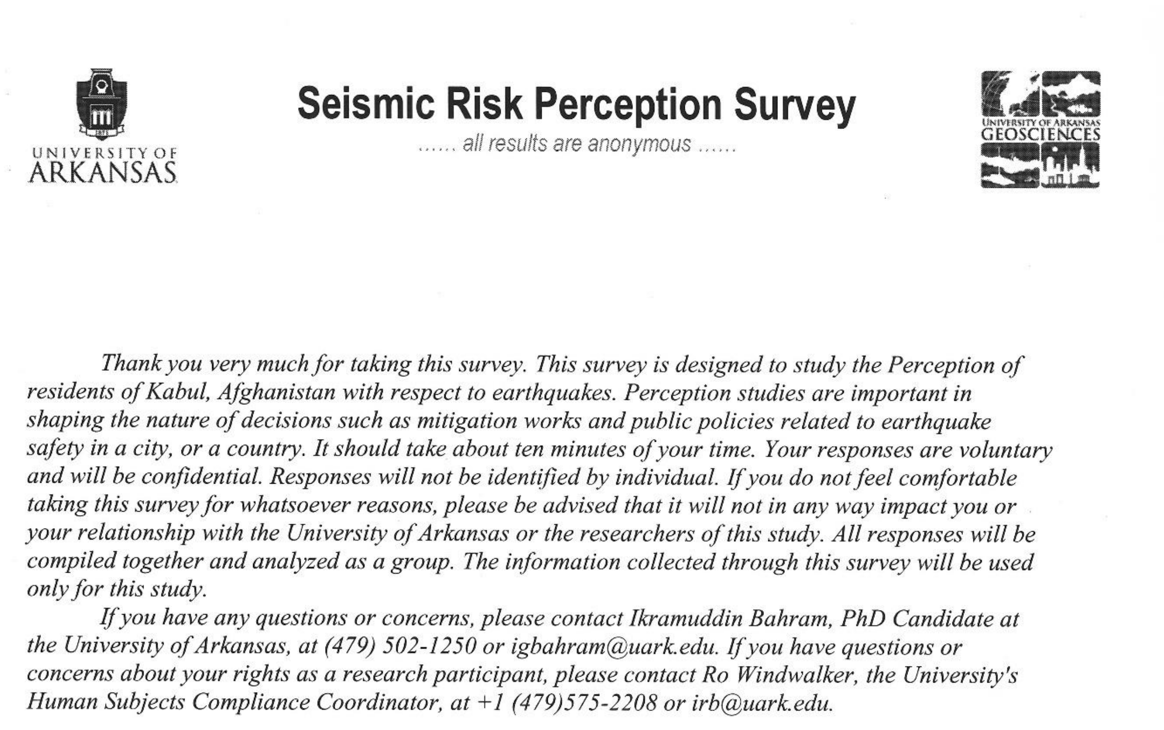
٢٧. . د زلزلې په وړاندې خوندیتوب د سیمه ایز حکومت په پنځه مهمو لومړیتوبونو کې دی. [✓ ١] ٢ ~~٣~~ ٤ ٥

٢٨. د زلزلې په وړاندې خوندیتوب د مرکزي حکومت په پنځه مهمو لومړیتوبونو کې دی. [✓ ١] ٢ ٣ ٤ ٥

٢٩. آیا بله زلزله به رامنځ ته شي؟ که ځواب مو هو وي، نو څه وخت؟
☑ نه ☐ هو.... که ځواب مو هو وي نو: ☐ یو کال ☐ ٥-٢ کاله ☐ ١٠-٦ کاله ☐ ٢٠-١١ کاله
☐ له ٢٠ کلونو وروسته

پورته وړاندوینه مو د کومو معلوماتو او پوهاوي پر بنسټ کړې ده؟
د زلزلې ورځوان لږ ازادي شوی ستم پیښیږي...
....

نور نظرونه :---



Seismic Risk Perception Survey

...... *all results are anonymous* ......

Thank you very much for taking this survey. This survey is designed to study the Perception of residents of Kabul, Afghanistan with respect to earthquakes. Perception studies are important in shaping the nature of decisions such as mitigation works and public policies related to earthquake safety in a city, or a country. It should take about ten minutes of your time. Your responses are voluntary and will be confidential. Responses will not be identified by individual. If you do not feel comfortable taking this survey for whatsoever reasons, please be advised that it will not in any way impact you or your relationship with the University of Arkansas or the researchers of this study. All responses will be compiled together and analyzed as a group. The information collected through this survey will be used only for this study.

If you have any questions or concerns, please contact Ikramuddin Bahram, PhD Candidate at the University of Arkansas, at (479) 502-1250 or igbahram@uark.edu. If you have questions or concerns about your rights as a research participant, please contact Ro Windwalker, the University's Human Subjects Compliance Coordinator, at +1 (479)575-2208 or irb@uark.edu.

UNIVERSITY OF ARKANSAS

Seismic Risk Perception Survey

...... all results are anonymous ......

UNIVERSITY OF ARKANSAS GEOSCIENCES

Town of birth: ______________________ ☐**Village** ☐**Town** ☐**City** ______________

Province: ______________________ **Current neighborhood in Kabul:** ______________

How many years have you lived in the area? ☐1-5 ☐6-10 ☐11-15 ☐16-20 ☐21 or more

Age in years: ☐15-20 ☐21-30 ☐31-40 ☐41-50 ☐51-60 ☐61 or more

Gender: ☐male ☐female **Status:** ☐single ☐married ☐widowed ☐divorced

Birthplace: ☐urban ☐suburban ☐rural **Resided longest:** ☐urban ☐suburban ☐rural

Education: ☐Elementary ☐Middle-High ☐college ☐graduate ☐other______________

Annual Income: ☐≤$1,500 ☐$1,501-4,000 ☐$4,001-8,000 ☐$8,001-15,000 ☐>$15,000

In AFS: ☐≤100,000 ☐100,001-300,000 ☐300,001-600,000 ☐600,001-1100,000 ☐>1100,0000

Household type: ☐Nuclear ☐Joint ☐Communal ☐Other______________________

……

1. Have you ever felt an earthquake? (If **NO,** skip to question 6) ☐Yes ☐No

2. How many times have you felt an earthquake? ☐1 ☐2 ☐3 ☐>4

3. When did you last feel an earthquake? ☐< 5 years ☐5-10 years ☐10-15years ☐>20years

4. What did you do first during the last earthquake?
☐Prayed ☐Ran Away ☐Screamed ☐Sought Cover ☐Did Nothing ☐Other__________

5. Will there be an earthquake in your city/town/village? ☐Yes ☐No ☐I don't know

6. When will there be an earthquake in/around your village/town/city?
☐<5years ☐5-10years ☐10-15years ☐>20years ☐God Knows ☐Other__________

7. Why do earthquakes happen? ☐I don't know ☐Allah punishes the sinful ☐Allah tests the believers
☐Tectonic plates slip alongside each other. ☐Other______________________

8. During an earthquake, it is more dangerous to live in: ☐Village ☐City ☐Other__________

9. What type of building is more resistant to earthquake?
☐Adobe ☐Concrete ☐Re-enforced Concrete ☐Steel ☐Others ______________

10. Are you aware of any emergency services close to your office or your home? ☐Yes ☐No

continued on the reverse ...

11. Who owns your house? ☐My Family ☐Landlord ☐City ☐Government ☐Other________________

12. How much do you personally know about earthquakes? ☐Nothing ☐Little ☐Some ☐Much ☐All

13. From where do you get your information about earthquakes? ☐TV ☐Radio ☐Internet ☐Newspaper
☐Religious books ☐Scientific books ☐Other people ☐Other ______________________

……

Please circle the number that represents your best response to each of the following statements:
1=strongly disagree, 2=disagree, 3=no opinion, 4=agree, 5=strongly agree

14. My local government is prepared for earthquake:	*1*	*2*	*3*	*4*	*5*
15. My national government is prepared for earthquake:	*1*	*2*	*3*	*4*	*5*
16. My house is safe from earthquake (resistant to earthquakes):	*1*	*2*	*3*	*4*	*5*
17. I became afraid after recent earthquakes:	*1*	*2*	*3*	*4*	*5*
18. I am prepared for another earthquake:	*1*	*2*	*3*	*4*	*5*
19. I believe that earthquakes are serious threats where I live:	*1*	*2*	*3*	*4*	*5*
20. Educating people has a vital role in reducing earthquake damage:	*1*	*2*	*3*	*4*	*5*
21. I believe that preventive measures is important in reducing earthquake damages… such as strengthening old buildings, preparing the city, other: ______________________	*1*	*2*	*3*	*4*	*5*
22. Building codes and laws exist, and are implemented:	*1*	*2*	*3*	*4*	*5*
23. We cannot do much about earthquakes:	*1*	*2*	*3*	*4*	*5*
24. It is ONLY the government's responsibility to prepare for earthquakes:	*1*	*2*	*3*	*4*	*5*
25. After the earthquakes in 2015, buildings were built BETTER in Kabul:	*1*	*2*	*3*	*4*	*5*
26. Taking earthquake preventive measures is against divine fate:	*1*	*2*	*3*	*4*	*5*
27. Earthquake safety is NOT in LOCAL government's top 5 priorities:	*1*	*2*	*3*	*4*	*5*
28. Earthquake safety is NOT in NATIONAL government's top 5 priorities:	*1*	*2*	*3*	*4*	*5*

29. Will there be another earthquake and if so, when?
☐NEVER or ☐YES … **if yes:** → ☐1 year ☐1-5 years ☐5-10 years ☐10-20 years ☐>20 years

What guides your knowledge of this? ____

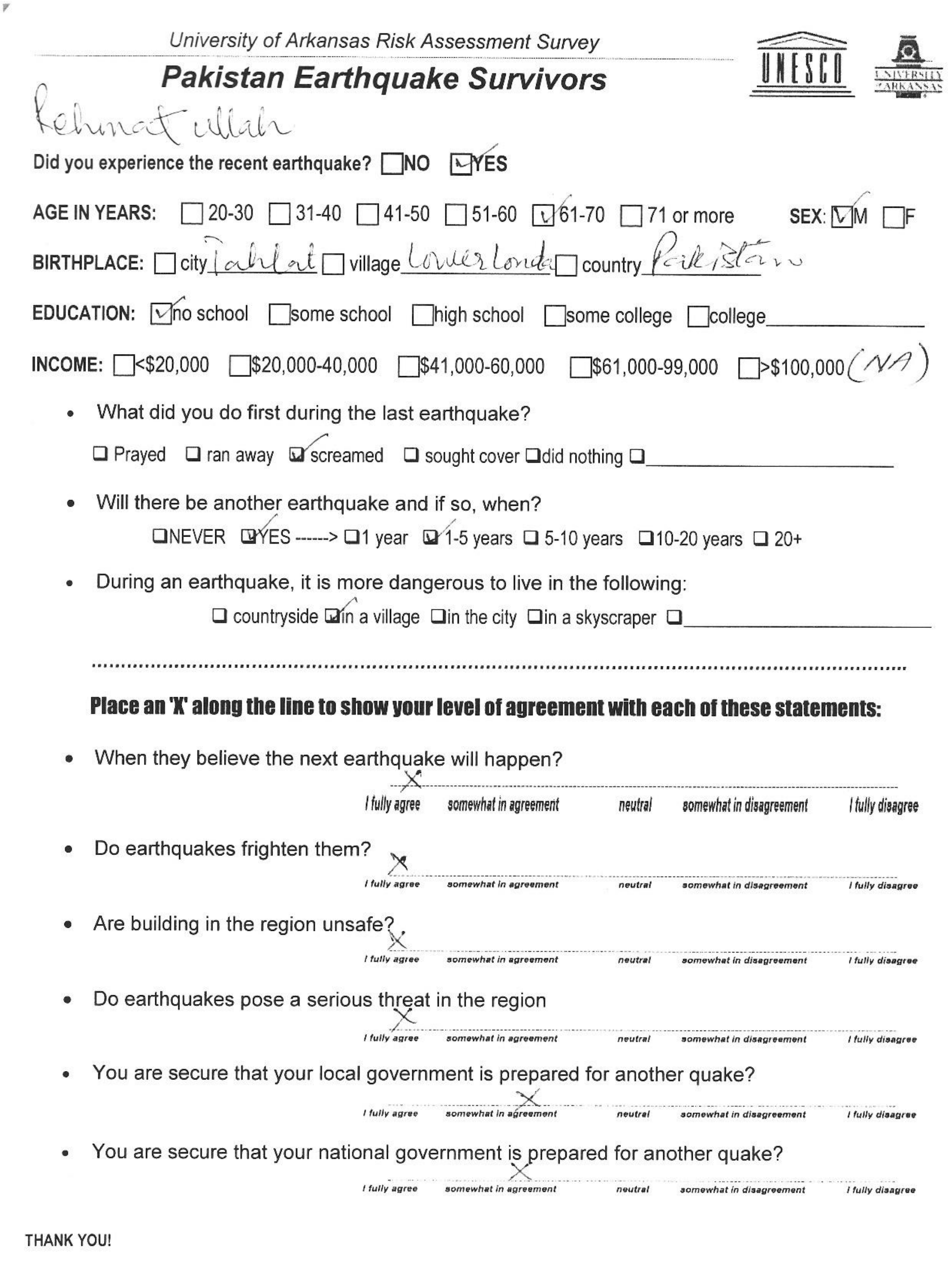
____

……

Comments:

Thank you.

Survey instrument used in KP, Pakistan.



University of Arkansas Risk Assessment Survey

Pakistan Earthquake Survivors

Rehmat ullah

Did you experience the recent earthquake? ☐NO ☑YES

AGE IN YEARS: ☐20-30 ☐31-40 ☐41-50 ☐51-60 ☑61-70 ☐71 or more **SEX:** ☑M ☐F

BIRTHPLACE: ☐city Tahlat ☐village Lower Londa ☐country Pakistan

EDUCATION: ☑no school ☐some school ☐high school ☐some college ☐college______________

INCOME: ☐<$20,000 ☐$20,000-40,000 ☐$41,000-60,000 ☐$61,000-99,000 ☐>$100,000 (NA)

- What did you do first during the last earthquake?

  ☐ Prayed ☐ ran away ☑ screamed ☐ sought cover ☐did nothing ☐______________________

- Will there be another earthquake and if so, when?

  ☐NEVER ☑YES ------> ☐1 year ☑ 1-5 years ☐ 5-10 years ☐10-20 years ☐ 20+

- During an earthquake, it is more dangerous to live in the following:

  ☐ countryside ☑in a village ☐in the city ☐in a skyscraper ☐______________________

……………………………………………………………………………………………………

Place an 'X' along the line to show your level of agreement with each of these statements:

- When they believe the next earthquake will happen?

  [✓ I fully agree] somewhat in agreement neutral somewhat in disagreement I fully disagree

- Do earthquakes frighten them?

  [✓ I fully agree] somewhat in agreement neutral somewhat in disagreement I fully disagree

- Are building in the region unsafe?

  [✓ I fully agree] somewhat in agreement neutral somewhat in disagreement I fully disagree

- Do earthquakes pose a serious threat in the region

  [✓ I fully agree] somewhat in agreement neutral somewhat in disagreement I fully disagree

- You are secure that your local government is prepared for another quake?

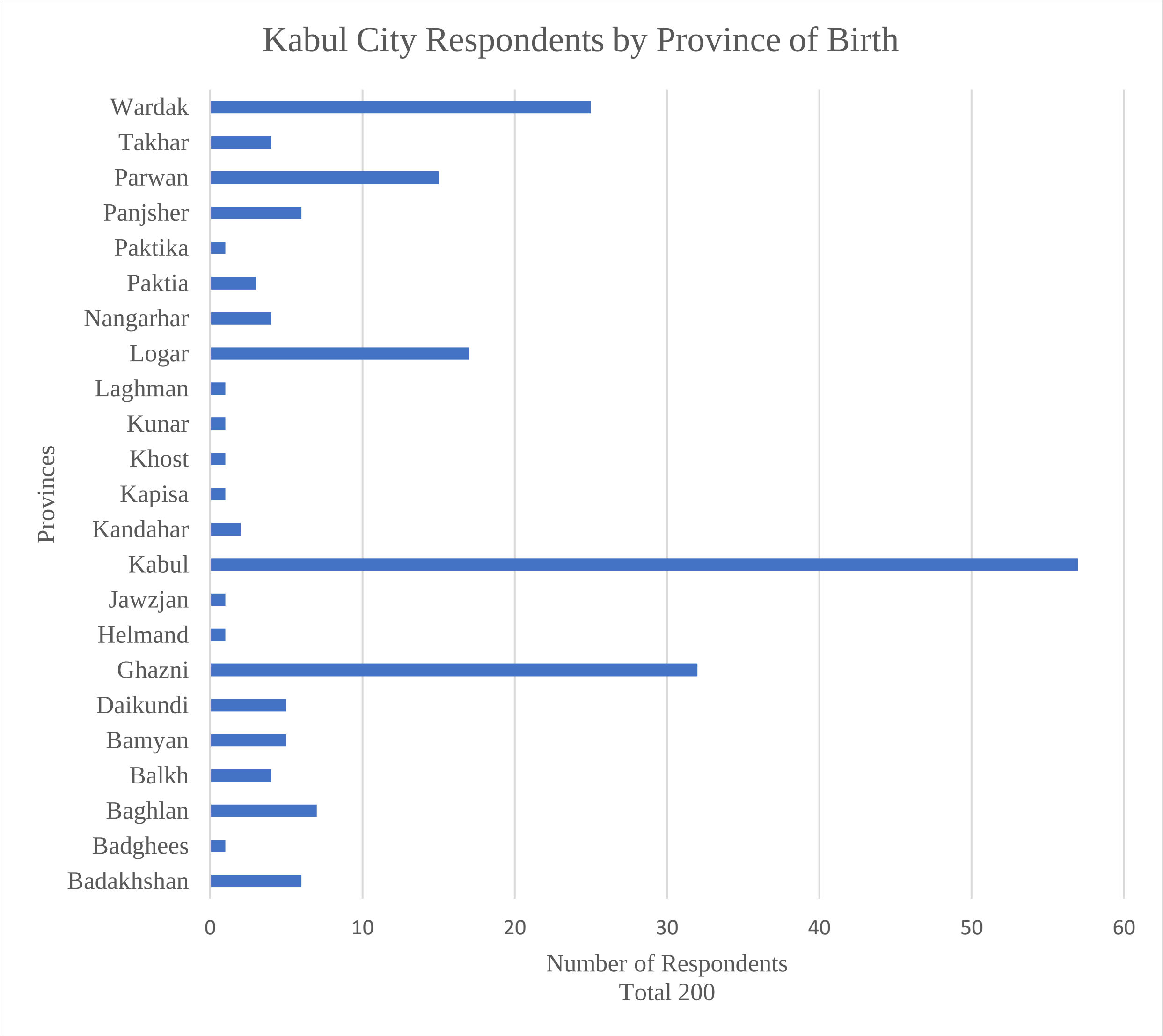
  I fully agree [✓ somewhat in agreement] neutral somewhat in disagreement I fully disagree

- You are secure that your national government is prepared for another quake?

  I fully agree [✓ somewhat in agreement] neutral somewhat in disagreement I fully disagree

THANK YOU!

060

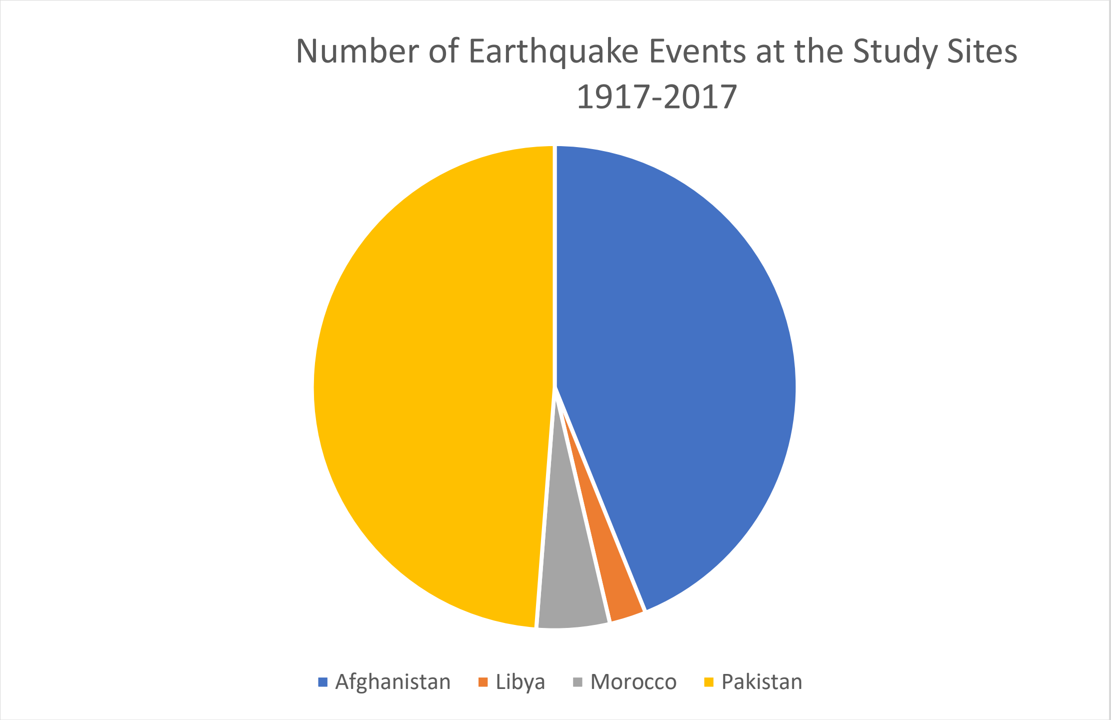


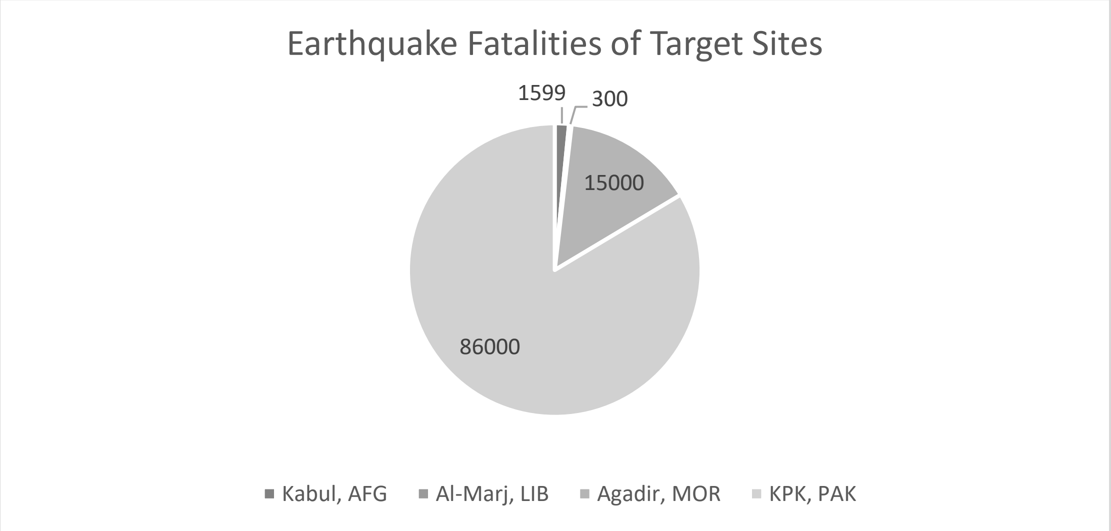
Respondents by province of birth. Kabul witnessed a fast-paced urbanization period between 2001-2021. Millions of Afghans returned from Pakistan and Iran and millions of others moved to Kabul from their provinces for multiple reasons.

Table of responses compared and analyzed from Afghanistan, Pakistan, Libya, and Morocco (Expressed in percentages)

Questions	**Options**	**Agadir, Morocco**	**KPK, Pakistan**	**Al-Marj, Libya**	**Kabul, Afghanistan**
GENDER					
	Male	59	77	51	69
	Female	41	23	49	31
AGE					
	16-20	10	0	27	20
	21-30	45	16	48	54
	31-40	26	42	9	16
	41-50	10	21	8	7
	51-70	7	21	7	4
EDUCATION:					
	None	18	35	0	0
	Primary	25	17	1	4
	Middle-High	26	30	15	15
	College	14	39	81	52
	Graduate	17	7	12	16
	Other	0	0	0	13
ANOTHER QUAKE SOON?					
	Yes	6	94	19	52
	No	12	6	1	3
	I don't know	29	0	69	45
	Allah knows	53	0	11	0
WHEN IS THE NEXT QUAKE?					
	1-5 years		70	2	29
	6-10 years		27	2	6
	11-15 years	18	1		3
	>20 years	13		96	4
	God Knows		2		51
	Others (40-60years)	34			
KNOWLEDGE ABOUT QUAKES?					
	Nothing	55	Na	25	8
	a little	15	Na	46	21
	some	10	Na	24	59
	much	5	Na	5	10
	a lot	15	Na	0	2
EARTHQUAKES FRIGHTEN ME?					
	No	32	2	15	12
	a little	16	0	13	16
	somewhat	6	0	22	23
	a lot	8	0	30	35

	yes a lot!	38	98	19	15
MY HOUSE IS SAFE FROM QUAKES?					
	Yes Very (Strongly Agree)	24	0	7	7
	Yes a bit (Agree)	15	0	33	39
	somewhat (Neutral)	2	0	20	26
	not much (Disagree)	20	7	24	21
	not at all (Strongly Disagree)	39	93	15	8
BELIEVE EARTHQUAKES ARE A SERIOUS THREAT?					
	Yes Very (Strongly Agree)	73	91	23	16
	Yes, a bit (Agree)	8	7	36	29
	somewhat (Neutral)	6	2	15	22
	not much (Disagree)	5	0	11	23
	not at all (Strongly Disagree)	8	0	14	11
THINGS DONE DURING AN EARTHQUAKE:					
	Prayed	Na	16	26	26
	Ran Away	Na	57		44
	Screamed	Na	14	12	6
	Sought Cover	Na	0	7	4
	Did Nothing	Na	12	40	14
	Other	Na		3	2


Number of Earthquake Events at the Study Sites 1917-2017
Afghanistan
Libya
Morocco
Pakistan


Earthquake Fatalities of Target Sites
1599
300
15000
86000
Kabul, AFG
Al-Marj, LIB
Agadir, MOR
KPK, PAK

B. Earthquake Catalog

Catalog of earthquakes (March 1, 2002-March 31, 2022). Following Ambraseys and Bilham (2003). All earthquakes with magnitude ≥ 5, regardless of their consequences, have been presented. While moderate magnitude earthquakes (5.0-5.9) do not cause noticeable damage in the developed world, in Afghanistan, they still cause fatalities in dozens and cause significant structural damage. Therefore, to compile a complete list of significant earthquakes in Afghanistan, earthquakes with magnitudes ≥ 5 have been listed here.

Source USGS (2022b) at https://earthquake.usgs.gov/earthquakes/search/.

No.	***Date***	***Latitude***	***Longitude***	***Depth (km)***	***Mag***	***Mag Type***	***Location***
1	2002-03-03	36.429	70.438	209	6.3	Mb	54 km ESE of Farkhar, Afghanistan
2	2002-03-03	36.502	70.482	225.6	7.4	Mw	51 km SW of Jurm, Afghanistan
3	2002-03-25	36.062	69.315	8	6.1	Mw	16 km E of Nahrin, Afghanistan
4	2002-03-25	35.952	69.237	10	5.1	Mb	Hindukush region, Afghanistan
5	2002-03-25	35.951	69.199	10	5.1	Mw	13 km SSE of Nahrin, Afghanistan
6	2002-03-27	36.023	69.338	10	5.6	Mw	19 km ESE of Nahrin, Afghanistan
7	2002-04-12	35.959	69.417	10	5.9	Mw	28 km ESE of Nahrin, Afghanistan
8	2002-04-12	35.883	69.259	10	5.1	Mw	23 km SSE of Nahrin, Afghanistan
9	2002-07-13	30.797	69.979	33	5.8	Mw	65 km W of Taunsa, Pakistan
10	2002-09-03	36.425	70.722	232.8	5.2	Mw	49 km SSW of Jurm, Afghanistan
11	2002-09-29	36.194	70.094	135.6	5.2	Mw	47 km SSE of Farkhar, Afghanistan
12	2002-10-01	36.38	70.725	149.9	5.2	Mw	54 km S of Jurm, Afghanistan
13	2002-12-25	35.704	69.868	90.8	5.5	Mw	53 km NE of Bazarak, Afghanistan
14	2003-03-29	35.976	70.585	114.1	5.9	Mw	68 km NNW of Parun, Afghanistan
15	2003-04-02	35.973	70.548	110.7	5.2	Mw	70 km NNW of Parun, Afghanistan
16	2003-04-25	36.66	71.555	66.9	5.1	Mw	3 km SE of Ishkashim, Afghanistan
17	2003-07-03	35.476	60.784	40.8	5.2	Mw	29 km NNE of Torbat-e Jam, Iran
18	2003-08-04	29.078	59.745	33	5.6	Mw	93 km SSW of Nosratabad, Iran
19	2003-08-21	29.053	59.773	20.2	5.9	Mw	96 km SSW of Nosratabad, Iran
20	2003-11-21	31.401	59.427	33	5	Mw	163 km S of Birjand, Iran
21	2003-11-25	31.288	70.071	33	5	Mb	59 km E of Zhob, Pakistan
22	2003-11-26	36.85	68.44	33	5.1	Mb	39 km WNW of Kunduz, Afghanistan
23	2004-02-23	37.536	71.898	109.7	5.1	Mw	30 km E of Khorugh, Tajikistan
24	2004-03-12	36.397	70.774	218	5.8	Mw	52 km S of Jurm, Afghanistan
25	2004-04-05	36.512	71.029	187.1	6.6	Mw	Afghanistan-Tajikistan-Pakistan region
26	2004-05-07	36.188	71.199	123.2	5.2	Mw	62 km SSW of Ishkashim, Afghanistan
27	2004-05-13	29.528	68.407	25	5.1	Mw	51 km E of Sibi, Pakistan
28	2004-05-16	36.172	71.531	118.3	5.1	Mw	56 km S of Ishkashim, Afghanistan
29	2004-07-15	35.875	70.579	47.5	5.4	Mw	59 km NNW of Paun, Afghanistan
30	2004-07-18	33.426	69.524	10	5.2	Mw	33 km SE of Gardez, Afghanistan
31	2004-08-10	36.444	70.796	207	6	Mw	46 km S of Jurm, Afghanistan
32	2004-08-13	30.922	69.769	11.6	5.4	Mw	55 km SSE of Zhob, Pakistan

33	2004-10-06	36.446	70.76	206.4	5.3	Mw	46 km S of Jurm, Afghanistan
34	2004-10-01	36.793	71.054	65.1	5	Mw	21 km ESE of Jurm, Afghanistan
35	2005-01-18	35.531	67.965	10	5.3	Mw	63 km SW of Dahnah-ye Ghori, Afghanistan
36	2005-05-02	30.271	67.804	24.3	5.2	Mw	14 km SSE of Ziarat, Pakistan
37	2005-06-20	36.346	71.078	235.7	5.3	Mw	55 km SW of Ishkashim, Afghanistan
38	2005-07-01	36.569	71.32	63.1	5.6	Mw	22 km WSW of Ishkashim, Afghanistan
39	2005-07-16	30.003	69.461	10	5.2	Mw	13 km NNW of Barkhan, Pakistan
40	2005-07-23	36.387	70.718	209.1	5.5	Mw	54 km S of Jurm, Afghanistan
41	2005-08-16	36.466	70.9	202.7	5.3	Mw	44 km S of Jurm, Afghanistan
42	2005-08-26	36.306	71.633	106.2	5	Mw	42 km SSE of Ishkashim, Afghanistan
43	2005-08-27	36.365	70.746	215	5	Mw	56 km S of Jurm, Afghanistan
44	2005-08-31	36.269	69.214	17.6	5	Mw	23 km NNE of Nahrin, Afghanistan
45	2005-10-08	34.621	72.996	10	5.2	Mb	6 km S of Shingli Bala, Pakistan
46	2005-10-18	34.786	72.985	10	5	Mw	11 km N of Shingli Bala, Pakistan
47	2005-10-21	31.961	67.55	10	5	Mw	62 km ESE of Qal?t, Afghanistan
48	2005-12-12	36.357	71.093	224.6	6.5	Mw	53 km SW of Ishkashim, Afghanistan
49	2006-03-21	29.345	68.428	10	5.1	Mw	57 km ESE of Sibi, Pakistan
50	2006-07-29	37.255	68.828	34.2	5.6	Mw	10 km NE of Imam Sahib, Kunduz, Afghanistan
51	2006-07-29	37.13	68.808	10	5.4	Mw	7 km SSE of Imam Sahib, Kunduz, Afghanistan
52	2006-11-29	36.277	70.883	208.6	5	Mb	65 km S of Jurm, Afghanistan
53	2007-01-15	35.317	65.494	10	5	Mw	26 km SSW of Qaleh-ye Shahr, Afghanistan
54	2007-02-11	36.728	72.971	53.8	5.1	Mw	63 km ESE of Khandud, Afghanistan
55	2007-04-03	36.451	70.688	222.1	6.2	Mw	47 km SSW of Jurm, Afghanistan
56	2007-04-28	36.447	70.497	203.9	5	Mb	55 km SSW of Jurm, Afghanistan
57	2007-06-22	37.296	68.903	31.1	5.3	Mw	12 km NNW of Imam Sahib, Afghanistan
58	2007-07-25	36.077	70.364	125.5	5	Mw	71 km SE of Farkhar, Afghanistan
59	2007-08-08	37.093	71.718	117	5.1	Mw	41 km NNE of Ishqoshim, Tajikistan
60	2007-09-09	30.612	69.792	20	5.3	Mw	82 km W of Taunsa, Pakistan
61	2007-10-27	36.449	70.367	214.1	5	Mb	47 km ESE of Farkhar, Afghanistan
62	2007-11-03	36.458	70.862	174.7	5	Mb	45 km S of Jurm, Afghanistan
63	2007-11-12	36.241	71.226	110.1	5	Mb	Afghanistan-Tajikistan-Pakistan region
64	2007-11-25	29.652	69.524	35	5.1	Mw	27 km S of Barkhan, Pakistan
65	2007-11-29	36.422	71.734	113	5.1	Mb	34 km SSE of Ishkashim, Afghanistan
66	2007-12-02	36.591	71.025	245.7	5.2	Mw	34 km SSE of Jurm, Afghanistan
67	2008-01-19	36.428	70.767	204.8	5.2	Mw	48 km S of Jurm, Afghanistan
68	2008-03-09	33.3	59.2	4	5	Mw	47 km S of Ghayen, Iran
69	2008-05-11	36.408	70.748	218.1	5.4	Mw	51 km S of Jurm, Afghanistan
70	2008-06-04	37.347	72.146	224.2	5	Mb	46 km NNW of Khand?d, Afghanistan
71	2008-06-21	36.474	70.234	222.9	5.1	Mb	35 km ESE of Farkhar, Afghanistan

72	2008-07-03	35.5	58.8	10	5.2	Mw	42 km NE of Kashmar, Iran
73	2008-08-12	36.547	71.472	90.7	5	Mw	16 km SSW of Ishkashim, Afghanistan
74	2008-09-01	37.328	68.928	1.6	5.4	Mb	15 km N of Imam Sahib, Afghanistan
75	2008-09-05	36.536	71.291	230.4	5.4	Mw	27 km SW of Ishkashim, Afghanistan
76	2008-09-06	36.487	70.934	191.5	5.8	Mw	42 km SSE of Jurm, Afghanistan
77	2008-09-18	36.491	71.275	219.8	5	Mb	31 km SW of Ishkashim, Afghanistan
78	2008-09-24	36.153	71.253	99.6	5.2	Mw	63 km SSW of Ishkashim, Afghanistan
79	2008-10-05	33.886	69.47	10	6	Mw	35 km SSW of Azrow, Paktia, Afghanistan
80	2008-10-13	36.187	71.001	122.7	5.3	Mw	72 km SW of Ishkashim, Afghanistan
81	2008-10-26	36.49	70.683	210	5.7	Mw	43 km SSW of Jurm, Afghanistan
82	2008-10-28	30.563	67.444	10	5.3	Mw	11 km NW of Alik Ghund, Pakistan
83	2008-10-28	30.639	67.351	15	6.4	Mw	23 km NW of Alik Ghund, Pakistan
84	2008-10-29	30.598	67.455	14	6.4	Mw	13 km NNW of Alik Ghund, Pakistan
85	2008-10-31	30.538	67.442	10	5.1	Mb	9 km NW of Alik Ghund, Pakistan
86	2008-12-09	30.342	67.555	10	5.2	Mw	16 km S of Alik Ghund, Pakistan
87	2008-12-09	30.393	67.448	10	5.3	Mw	12 km SSW of Alik Ghund, Pakistan
88	2008-12-09	30.306	67.64	10	5.2	Mb	11 km SW of Ziarat, Pakistan
89	2008-12-09	30.442	67.404	10	5.7	Mw	12 km WSW of Alik Ghund, Pakistan
90	2008-12-21	35.962	71.407	74.4	5	Mw	74 km NE of Parun, Afghanistan
91	2008-12-29	36.389	71.075	151	5.8	Mw	52 km SW of Ishkashim, Afghanistan
92	2009-01-03	36.419	70.743	204.8	6.6	Mw	50 km S of Jurm, Afghanistan
93	2009-01-04	36.442	70.883	186.7	5.7	Mw	47 km S of Jurm, Afghanistan
94	2009-01-20	35.869	69.932	91.5	5.2	Mb	72 km NNE of Bazarak, Afghanistan
95	2009-03-02	30.518	67.776	10	5	Mb	15 km NNE of Ziarat, Pakistan
96	2009-03-14	30.154	68.474	35.5	5	Mb	9 km W of Duki, Pakistan
97	2009-04-16	34.185	70.076	5.9	5.2	Mw	39 km E of Azrow, Paktia, Afghanistan
98	2009-04-16	34.106	70.056	4	5.1	Mb	38 km ESE of Azrow, Paktia, Afghanistan
99	2009-07-02	37.469	71.782	124.7	5	Mw	20 km E of Khorugh, Tajikistan
100	2009-07-05	36.444	71.081	248.3	5.3	Mw	48 km WSW of Ishkashim, Afghanistan
101	2009-09-19	36.476	70.736	199.9	5.1	Mw	44 km SSW of Jurm, Afghanistan
102	2009-10-15	36.989	71.377	94.1	5	Mb	36 km NW of Ishqoshim, Tajikistan
103	2009-10-22	36.517	70.95	185.9	6.2	Mw	39 km SSE of Jurm, Afghanistan
104	2009-10-25	29.566	63.879	125.3	5.6	Mw	90 km NW of Dalbandin, Pakistan
105	2009-10-29	36.391	70.722	210	6.2	Mw	53 km S of Jurm, Afghanistan
106	2009-10-30	34.181	70.02	30.4	5.1	Mb	12 km E of Kharoti, Nangarhar, Afghanistan
107	2010-01-23	36.525	71.481	93.4	5.1	Mb	18 km SSW of Ishkashim, Afghanistan
108	2010-01-30	36.758	71.309	93	5	Mb	21 km WNW of Ishkashim, Afghanistan
109	2010-02-27	35.94	70.074	99.7	5.7	Mw	72 km SSE of Farkhar, Afghanistan
110	2010-04-01	30.088	69.541	35	5	Mb	21 km N of Barkhan, Pakistan
111	2010-04-18	35.633	67.658	13	5.6	Mw	77 km SSW of Aybak, Afghanistan

112	2010-05-06	33.108	71.328	50.6	5	Mb	21 km E of Karak, Pakistan
113	2010-06-04	36.501	70.17	220.6	5.1	Mw	29 km ESE of Farkhar, Afghanistan
114	2010-07-30	35.221	59.317	19	5.5	Mw	10 km ESE of Torbat-e Heydariyeh, Iran
115	2010-08-24	36.508	71.251	226.1	5	Mw	31 km SW of Ishkashim, Afghanistan
116	2010-09-17	36.443	70.774	220.1	6.3	Mw	47 km S of Jurm, Afghanistan
117	2010-10-06	29.715	69.587	10	5.2	Mb	21 km SSE of Barkhan, Pakistan
118	2010-10-10	33.869	72.887	33.2	5.2	Mb	14 km SSW of Haripur, Pakistan
119	2010-10-28	36.517	71.101	187.7	5.3	Mw	42 km WSW of Ishkashim, Afghanistan
120	2010-11-02	36.411	71.207	99.8	5.1	Mb	42 km SW of Ishkashim, Afghanistan
121	2010-11-10	36.746	70.895	252.5	5.2	Mw	14 km SSE of Jurm, Afghanistan
122	2010-11-15	34.549	70.458	34.1	5.2	Mw	13 km N of Jalalabad, Afghanistan
123	2010-12-09	31.53	70.083	14.1	5.4	Mw	56 km SW of Kulachi, Pakistan
124	2010-12-11	30.424	69.462	28	5	Mw	58 km N of Barkhan, Pakistan
125	2010-12-12	32.344	69.661	53.6	5	Mb	9 km ENE of Wana, Pakistan
126	2011-03-11	36.271	70.553	192.2	5.1	Mb	70 km SSW of Jurm, Afghanistan
127	2011-03-21	36.491	70.927	190.2	5.8	Mw	42 km SSE of Jurm, Afghanistan
128	2011-04-25	36.232	72.175	89.9	5	Mb	74 km SE of Ishqoshim, Tajikistan
129	2011-05-13	36.593	71.012	232.1	5	Mw	34 km SSE of Jurm, Afghanistan
130	2011-05-14	36.409	70.748	207.3	5.9	Mw	51 km S of Jurm, Afghanistan
131	2011-08-26	36.445	70.727	202.4	5.3	Mw	47 km SSW of Jurm, Afghanistan
132	2011-11-07	36.502	71.102	212.1	5.6	Mw	43 km WSW of Ishkashim, Afghanistan
133	2011-11-21	32.2	59.92	14.2	5	Mw	98 km SE of Birjand, Iran
134	2012-01-13	36.009	70.512	100.9	5	Mb	75 km NNW of Parun, Afghanistan
135	2012-01-19	36.288	58.835	8.3	5.1	Mw	9 km NNE of Neysh?b?r, Iran
136	2012-06-11	36.039	69.401	29.1	5.4	Mb	24 km E of Nahrin, Afghanistan
137	2012-06-11	36.023	69.351	16	5.7	Mw	20 km ESE of Nahrin, Afghanistan
138	2012-07-01	34.481	59.927	28	5.1	Mw	82 km WSW of T?yb?d, Iran
139	2012-07-12	36.527	70.906	198	5.7	Mw	38 km S of Jurm, Afghanistan
140	2012-07-19	37.248	71.375	98.4	5.6	Mw	31 km SSW of Khorugh, Tajikistan
141	2012-09-02	33.474	59.897	12	5.1	Mb	71 km ESE of Q?â€™en, Iran
142	2012-09-12	36.697	71.442	192.4	5.1	Mb	8 km W of Ishkashim, Afghanistan
143	2012-09-25	36.277	69.211	30.3	5.2	Mb	24 km NNE of Nahrin, Afghanistan
144	2012-10-01	36.167	69.216	50.2	5.1	Mb	13 km NNE of Nahrin, Afghanistan
145	2012-10-15	35.949	69.683	112.4	5	Mb	51 km ESE of Nahrin, Afghanistan
146	2012-11-19	30.538	67.584	10	5.3	Mb	8 km NE of Alik Ghund, Pakistan
147	2012-12-05	33.506	59.571	14.4	5.8	Mw	43 km SE of Q?â€™en, Iran
148	2012-12-29	35.711	70.599	117.4	5.5	Mw	44 km NW of PÄ• rÅ«n, Afghanistan
149	2013-01-22	36.339	68.847	51.5	5.2	Mb	26 km NNE of Baghl?n, Afghanistan
150	2013-04-04	36.403	71.106	239.5	5.3	Mw	49 km SW of Ishkashim, Afghanistan
151	2013-04-05	36.454	71.457	103.9	5.4	Mb	26 km SSW of Ishkashim, Afghanistan
152	2013-04-24	34.526	70.22	63.8	5.5	Mw	16 km S of Mehtar L?m, Afghanistan

153	2013-07-03	36.534	70.474	215.3	5.2	Mb	48 km SW of Jurm, Afghanistan
154	2013-09-08	36.5088	70.1261	212	5.2	Mw	25 km ESE of Farkhar, Afghanistan
155	2013-10-13	36.4392	70.7061	210	5.3	Mw	48 km SSW of Jurm, Afghanistan
156	2013-12-21	36.5395	71.3868	87.1	5	Mb	20 km SW of Ishkashim, Afghanistan
157	2014-01-14	36.5504	71.5185	107.24	5.1	Mb	14 km S of Ishkashim, Afghanistan
158	2014-03-28	37.2444	71.2425	101.07	5.2	Mb	38 km SW of Khorugh, Tajikistan
159	2014-06-14	36.4544	70.7174	200	5.6	Mw	46 km SSW of Jurm, Afghanistan
160	2014-07-13	36.4088	67.7024	35	5	Mb	32 km S of Khulm, Afghanistan
161	2014-07-19	36.8785	71.0988	83.67	5.2	Mw	23 km E of Jurm, Afghanistan
162	2014-08-31	36.5605	70.9638	200.45	5.2	Mb	35 km SSE of Jurm, Afghanistan
163	2014-09-13	36.0019	70.6992	94.97	5.2	Mw	67 km NNW of Parun, Afghanistan
164	2014-09-27	36.4517	69.8145	29.16	5	Mwr	13 km SSW of Farkhar, Afghanistan
165	2014-11-21	36.5157	71.0089	234.57	5.2	Mb	41 km SSE of Jurm, Afghanistan
166	2014-11-22	36.5225	66.5824	21.63	5.4	Mw	38 km SW of Balkh, Afghanistan
167	2015-05-05	35.321	58.409	8.6	5	Mb	10 km NNW of Kashmar, Iran
168	2015-06-29	36.6802	71.3004	191	5.5	Mw	20 km W of Ishkashim, Afghanistan
169	2015-08-10	36.5326	71.2147	224	5.9	Mw	33 km WSW of Ishkashim, Afghanistan
170	2015-09-09	36.0086	70.4897	107.39	5.4	Mw	76 km NNW of Parun, Afghanistan
171	2015-10-23	29.6377	70.326	11	5.6	Mw	10 km NNW of Dajal, Pakistan
172	2015-10-26	36.459	70.6847	206.94	5.9	Mb	46 km SSW of Jurm, Afghanistan
173	2015-10-26	36.5244	70.3676	231	7.5	Mw	Hindukush region, Afghanistan
174	2015-11-02	32.0869	69.5562	44.73	5	Mb	23 km S of Wana, Pakistan
175	2015-11-22	36.4344	71.4233	102	5.7	Mw	29 km SSW of Ishkashim, Afghanistan
176	2015-12-25	36.4935	71.1263	206	6.3	Mw	42 km WSW of Ishkashim, Afghanistan
177	2016-01-02	36.5426	70.932	189	5.2	Mw	36 km SSE of Jurm, Afghanistan
178	2016-01-08	36.6015	70.9688	223.13	5	Mb	31 km SSE of Jurm, Afghanistan
179	2016-01-12	36.5979	70.9503	239	5.7	Mw	31 km SSE of Jurm, Afghanistan
180	2016-01-23	36.6676	71.3509	94.89	5	Mb	16 km W of Ishkashim, Afghanistan
181	2016-02-21	36.4892	70.8607	174	5.2	Mw	41 km S of Jurm, Afghanistan
182	2016-04-10	36.4725	71.1311	212	6.6	Mw	42 km WSW of Ishkashim, Afghanistan
183	2016-04-24	37.0018	71.4798	114.79	5.1	Mwr	Afghanistan-Tajikistan border region
184	2016-05-13	30.6598	66.4243	10	5.2	Mw	28 km S of Chaman, Pakistan
185	2016-05-13	30.659	66.3878	10	5.5	Mw	29 km SSW of Chaman, Pakistan
186	2016-06-23	36.4695	70.6894	210	5.3	Mw	45 km SSW of Jurm, Afghanistan
187	2016-10-20	36.4437	71.2694	106.95	5.1	Mb	35 km SW of Ishkashim, Afghanistan
188	2016-11-15	36.5242	70.8421	190.95	5.4	Mw	37 km S of Jurm, Afghanistan
189	2016-12-08	36.454	71.1604	87.51	5	Mb	41 km SW of Ishkashim, Afghanistan
190	2017-01-09	36.9069	68.3142	25.83	5.2	Mw	42 km SSE of Shahritus, Tajikistan
191	2017-02-28	37.6873	72.101	127.1	5.2	Mw	53 km ENE of Khorugh, Tajikistan
192	2017-04-05	35.7755	60.4363	13	6.1	Mw	61 km NNW of Torbat-e J?m, Iran
193	2017-04-05	35.7971	60.4318	10	5.1	Mb	63 km NNW of Torbat-e J?m, Iran

194	2017-04-17	36.5405	70.8619	194.44	5.1	Mb	36 km S of Jurm, Afghanistan
195	2017-05-02	35.8339	60.5704	10	5.1	Mb	65 km N of Torbat-e Jam, Iran
196	2017-06-25	36.4357	70.6732	207.15	5.2	Mw	49 km SSW of Jurm, Afghanistan
197	2017-07-19	36.3061	70.92	112.57	5	Mb	62 km S of Jurm, Afghanistan
198	2017-08-25	36.4191	71.3353	110.81	5.1	Mb	34 km SSW of Ishkashim, Afghanistan
199	2017-10-28	36.1991	70.6618	101.46	5.2	Mw	75 km SSW of Jurm, Afghanistan
200	2017-11-07	29.4443	66.4555	17.62	5	Mb	43 km ESE of Nushki, Pakistan
201	2018-01-14	36.4525	70.7313	199.53	5.3	Mw	46 km SSW of Jurm, Afghanistan
202	2018-01-31	36.5261	70.8507	193.73	6.2	Mw	37 km S of Jurm, Afghanistan
203	2018-03-24	36.4652	70.6687	200.25	5	Mb	46 km SSW of Jurm, Afghanistan
204	2018-03-30	36.4561	71.1277	237.94	5	Mw	44 km SW of Ishkashim, Afghanistan
205	2018-04-28	36.3125	71.1715	88.42	5.3	Mw	52 km SW of Ishkashim, Afghanistan
206	2018-05-06	37.3578	71.467	89.53	5.1	Mw	16 km SSW of Khorugh, Tajikistan
207	2018-05-09	33.1351	70.5177	19.35	5.4	Mb	18 km NNW of Bannu, Pakistan
208	2018-05-09	36.9942	71.3822	116	6.2	Mw	36 km NW of Ishqoshim, Tajikistan
209	2018-05-10	36.5631	71.0575	199.4	5	Mw	38 km SSE of Jurm, Afghanistan
210	2018-06-17	30.0772	70.2093	10	5.1	Mw	41 km W of Dera Ghazi Khan, Pakistan
211	2019-02-02	36.4642	70.7006	211.72	5.6	Mw	46 km SSW of Jurm, Afghanistan
212	2019-03-16	29.7206	67.4271	10	5	Mb	18 km SSE of Mach, Pakistan
213	2019-06-12	34.6813	72.8572	12.9	5.2	Mb	11 km W of Shingli Bala, Pakistan
214	2019-08-04	36.6761	71.2747	226.29	5.1	Mw	23 km W of Ishkashim, Afghanistan
215	2019-08-08	36.5272	70.0571	226	5.8	Mw	18 km ESE of Farkhar, Afghanistan
216	2019-08-10	37.1698	71.5345	110.74	5.3	Mw	35 km S of Khorugh, Tajikistan
217	2019-08-16	36.4389	70.693	207.71	5.1	Mw	48 km SSW of Jurm, Afghanistan
218	2019-08-21	36.3898	69.3398	42.93	5	Mb	38 km SSE of Khanabad, Afghanistan
219	2019-10-09	36.5069	70.6409	203.28	5.1	Mw	43 km SSW of Jurm, Afghanistan
220	2019-10-14	36.5287	70.6021	202.56	5	Mw	42 km SSW of Jurm, Afghanistan
221	2019-11-05	36.5503	70.1149	209.88	5.1	Mw	23 km E of Farkhar, Afghanistan
222	2019-11-14	36.4665	71.5096	97.63	5.1	Mb	24 km S of Ishkashim, Afghanistan
223	2019-12-04	36.4769	70.7941	141.79	5	Mb	43 km S of Jurm, Afghanistan
224	2019-12-20	36.5374	70.4555	212	6.1	Mw	49 km SW of Jurm, Afghanistan
225	2020-01-02	34.1326	60.2681	10	5.5	Mw	81 km SW of Taybad, Iran
226	2020-06-16	37.8342	72.2035	127	5.6	Mw	68 km ENE of Khorugh, Tajikistan
227	2020-06-16	36.6712	71.0335	229.31	5	Mb	27 km SE of Jurm, Afghanistan
228	2020-11-14	30.3659	67.435	12.04	5.5	Mw	16 km SSW of Alik Ghund, Pakistan
229	2020-12-30	34.741	72.9466	10	5	Mb	7 km NNW of Shingli Bala, Pakistan
230	2021-01-16	36.4494	70.6979	204	5.5	Mw	47 km SSW of Jurm, Afghanistan
231	2021-01-24	37.1151	71.6199	117.26	5	Mb	41 km S of Khorugh, Tajikistan
232	2021-05-28	36.5239	70.1352	209.8	5	Mb	25 km ESE of Farkhar, Afghanistan
233	2021-06-24	34.9509	69.0848	16.2	5.1	Mw	10 km SW of Charikar, Afghanistan
234	2021-07-20	29.3258	70.0487	10	5.2	Mw	36 km NW of Rajanpur, Pakistan
235	2021-08-15	37.4907	70.1356	8.68	5.2	Mw	40 km ESE of Chubek, Tajikistan

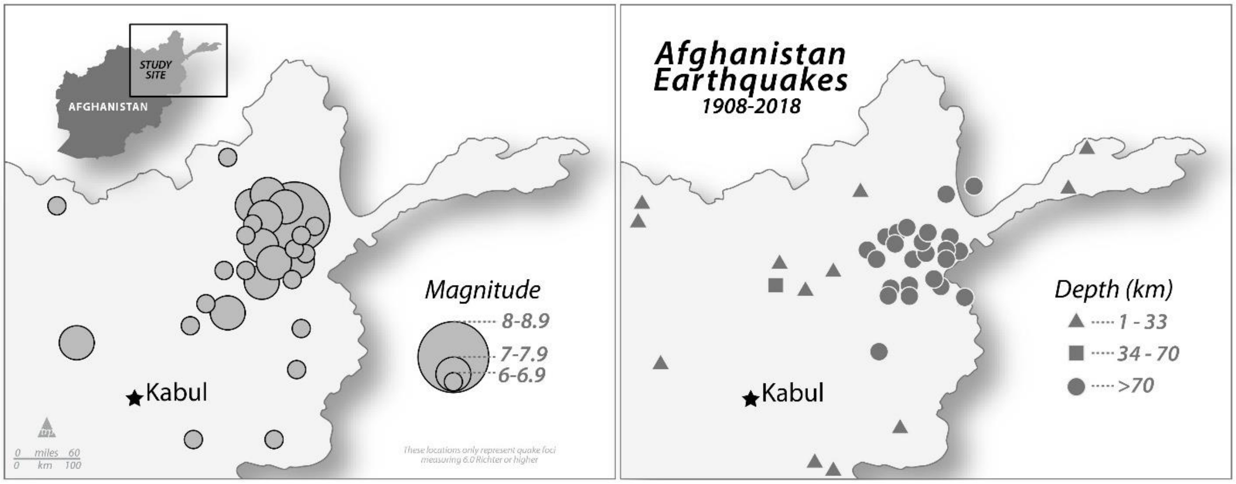
236	2021-09-02	37.6012	70.3436	10	5	Mb	56 km E of Chubek, Tajikistan
237	2021-09-13	37.289	58.8939	10	5.1	Mb	39 km ENE of Quchan, Iran
238	2021-10-05	36.8392	66.6469	10	5.1	Mw	40 km WNW of Mazar-i-Sharif, Afghanistan
239	2021-10-06	30.1933	67.9948	9	5.9	Mw	11 km NNE of Harnai, Pakistan
240	2022-01-01	36.59	71.1783	231.91	5.2	Mw	15 km WNW of Zebak, Afghanistan
241	2022-01-14	36.5418	71.4945	106.99	5.3	Mb	16 km SSW of Ishkashim, Afghanistan
242	2022-01-17	34.9289	63.6208	11.4	5.3	Mw	45 km E of Qala i Naw, Afghanistan
243	2022-01-24	36.0702	69.1575	10	5	Mw	2 km ENE of Nahrin, Afghanistan
244	2022-02-05	36.4307	71.126	212	5.8	Mw	45 km SW of Ishkashim, Afghanistan
245	2022-03-02	35.5426	69.7991	87.59	5.2	Mw	36 km NE of Bazarak, Panjshir, Afghanistan

** Moment-magnitude (MW), broadband body wave (MB), short-period body-wave magnitude (mb), and unknown magnitude type. Magnitude type (abbreviated "MagType"): The type of magnitude corresponding to the preferred magnitude. "W" denotes moment magnitude, "B" denotes broadband body-wave magnitude, "b" denotes body-wave magnitude. After Dewey (2006).*

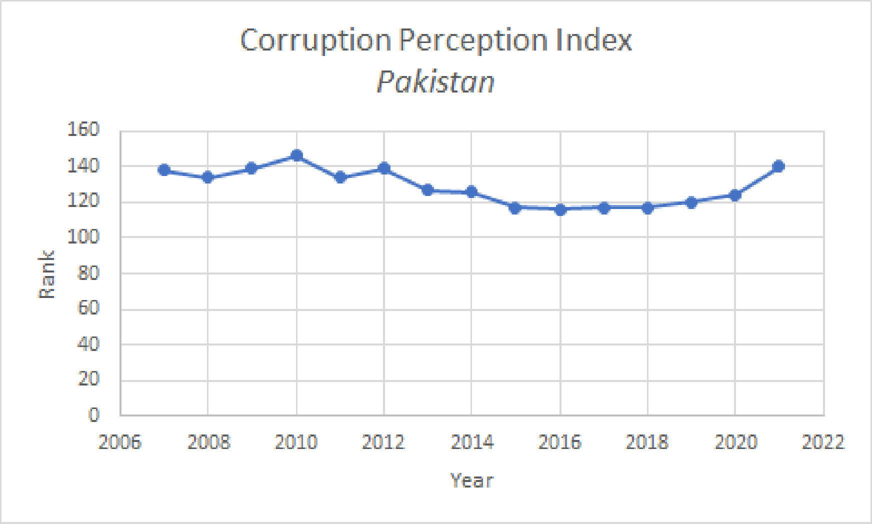
Major fault system of Afghanistan named. Each of these faults is actually multiple shear-zones in the Earth's crust, not a single linear break.

Abbreviation	***Fault System Name***
AM	Alburz-Marmul fault
AN	Andarab fault
BB	Bandi Bayan fault
BT	Bandi Turkistan fault
CB	Central Badakhshan fault
CH	Chaman fault
DM	Dosi Mirzavalan fault
DS	Darfashan fault
DZ	Darwaz fault
GA	Gardez fault
HM	Helmand fault
HR	Harirud fault
HV	Hanjvan fault
KO	Kunar (Konar) fault
KR	Kaj Rud fault
MO	Mokur fault
ON	Onay fault
PJ	Panjshir fault
PM	Paghman fault
QA	Qarghanaw fault
SA	Sarobi fault
SP	Spin Ghar fault

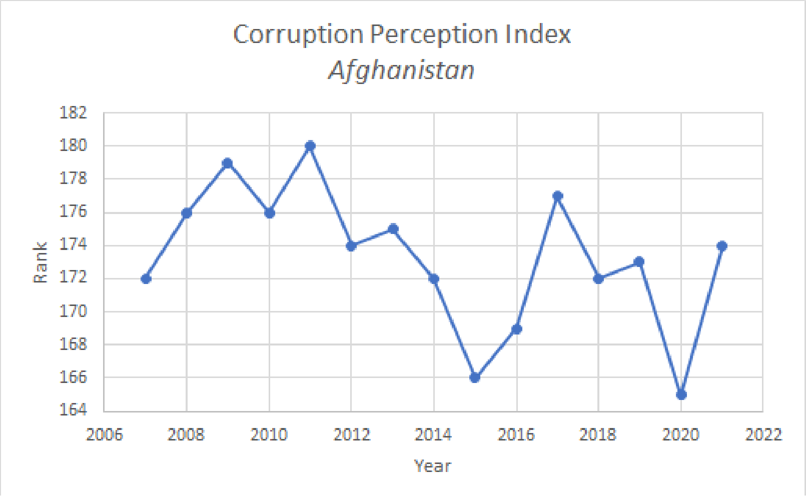
Major faults in Afghanistan. Their names have been abbreviated. Use the above table of abbreviations for this map.



Earthquakes of Afghanistan are concentrated in the northeast of the country. These maps compare depth and magnitude of earthquakes recorded between 1908 and 2018. Data from: USGS 2018



Pakistan struggles with corruption and its ranking has fluctuated between 120-140.



The last two decades were also marked by expansive financial corruption in Afghanistan. Afghanistan has been consistently ranked as one of the most corrupt countries in the world.

Appendix C: Pictures of Damages from Afghanistan, and Pakistan; Tweets in the aftermath of recent earthquakes in Pakistan.

Pictures of survivors of 1998 Takhar earthquake. The first quake hit in February 1998 when the region was going through harsh winter conditions.

Extensive damages to an Afghan village in the eastern province of Nangarhar following 2015 Hindukush earthquake of Mw 7.5.

After a damaging earthquake, these villagers are digging into the debris to save a few wood planks that might have not been damaged. These wood beams are used in roof structures.

Damage to an adobe structure in Badghis, January 2022. Taliban soldier guarding the location.

Damage to the countryside being assessed.

Earthquakes leave people homeless quickly. Afghan building typologies are poor and sustain heavy damages.


UNHCR
The UN Refugee Agency
© UNHCR

The city of Kabul, densely populated, heavily built, and highly exposed to seismicity.

The haphazard development in the past 20 years has led to congested streets, narrow alleys, and crowded markets. All factoring in the risk equation and raising seismic risk for the city.

Over 3 million people were left homeless in the aftermath of Kashmir earthquake. People were housed at makeshift tents donated by UNHCR, and other humanitarian agencies.

Like Afghanistan, Pakistan sustains heavy losses to earthquakes of high magnitude.

Damage to an RC building in the northwestern towns of Pakistan due to the 7.5 magnitude earthquake of 2015 centered in the Hindukush region.

Damages sustained in a moderate magnitude but shallow earthquake in Pakistan in September 2019.

Following are a series of tweets from Pakistani citizens expressing their grief and praying for safety against earthquakes.

SYED ZAIN✍ @Dep_ressed_soul · 7h

ان للہ و انا علیہ راجعون

Hameed Ullah, student of Software Engineering Department 8th Semester at Mirpur University Of Science and Technology (MUST) Mirpur AJK Pakistan Jumped from Hostel upper floor to rescue his life during earth quake has died. May his soul RIP.

#earthquake

ßushra Nasir Ahmed @bushra_2... · 9h

The number of casualties has reached 40 in #Mirpur Azad Kashmir **#earthquake**. More than 700 people have been reported injured and are receiving treatment in DHQ hospital Mirpur AJK. The number is exponentially growing. Wishing immense strength and prayers for the victims.🙏🏻

Mohsin Bilal Khan @MohsinBilal... · 8h

Exclusice CCTV video of Today's **#earthquake** in #Mirupur Azad Ja
Kashmir.
(1/2)

ISRA JATOi 💫🥀
@IsraSaySs

Allah isn't happy with us at all plz recite Durood Shareef as much as u can #earthquake 🙏

إِذَا زُلْزِلَتِ ٱلْأَرْضُ زِلْزَالَهَا ١

When the earth is shaken with its (final) earthquake.

[Al-Quran 99:1]

Comic_ lover😎
@Comiclover16

May Almighty Allah keep us safe💕
#earthquake

When the earth is shaken with its [final] earthquake
[Quran 99:1]

9:22 AM · 9/24/19 · Twitter for Android

8 Retweets **25** Likes

Adnan 💀
@Adnan__02

Every one please recite Surah Zilzal #earthquake

سُورَةُ ٱلزَّلْزَلَةِ

بِسْمِ ٱللَّهِ ٱلرَّحْمَٰنِ ٱلرَّحِيمِ

إِذَا زُلْزِلَتِ ٱلْأَرْضُ زِلْزَالَهَا ① وَأَخْرَجَتِ ٱلْأَرْضُ أَثْقَالَهَا ② وَقَالَ
ٱلْإِنسَٰنُ مَا لَهَا ③ يَوْمَئِذٍ تُحَدِّثُ أَخْبَارَهَا ④ بِأَنَّ رَبَّكَ أَوْحَىٰ لَهَا
⑤ يَوْمَئِذٍ يَصْدُرُ ٱلنَّاسُ أَشْتَاتًا لِّيُرَوْا۟ أَعْمَٰلَهُمْ ⑥ فَمَن يَعْمَلْ
مِثْقَالَ ذَرَّةٍ خَيْرًا يَرَهُۥ ⑦ وَمَن يَعْمَلْ مِثْقَالَ ذَرَّةٍ شَرًّا يَرَهُۥ ⑧

8:01 AM · 9/24/19 · Twitter for iPhone

11 Retweets **56** Likes

فاطمہ
@FatimaahAliH

"Death will find you even if you hide in fortress built up strong and high."
Quran 4:78
May Allah keep everyone safe ✨
#earthquake

بِسْمِ اللّٰهِ الرَّحْمٰنِ الرَّحِيْمِ
اِذَا زُلْزِلَتِ الْاَرْضُ زِلْزَالَهَا ① وَاَخْرَجَتِ الْاَرْضُ اَثْقَالَهَا ②
وَقَالَ الْاِنْسَانُ مَالَهَا ③ يَوْمَئِذٍ تُحَدِّثُ اَخْبَارَهَا ④ بِاَنَّ
رَبَّكَ اَوْحٰى لَهَا ⑤ يَوْمَئِذٍ يَّصْدُرُ النَّاسُ اَشْتَاتًا ۙ لِّيُرَوْا
اَعْمَالَهُمْ ⑥ فَمَنْ يَّعْمَلْ مِثْقَالَ ذَرَّةٍ خَيْرًا يَّرَهٗ ⑦ وَمَنْ
يَّعْمَلْ مِثْقَالَ ذَرَّةٍ شَرًّا يَّرَهٗ ⑧

Safinatun Nijat - Tours
@Nijat110

Imam Ja'far Sadiq ع said:

When fornication becomes widespread earthquakes occur as an upshot.

[Al-Tahdhib, Vol.3, pg,148.
Hadith-318]

#earthquake

Raja Fawad Mehdi
@RajaFawadMehdi

Every one please recite Surah Zilzal
#earthquake

سُورَةُ الزَّلْزَلَةِ

بِسْمِ ٱللَّهِ ٱلرَّحْمَٰنِ ٱلرَّحِيمِ

إِذَا زُلْزِلَتِ ٱلْأَرْضُ زِلْزَالَهَا (١) وَأَخْرَجَتِ ٱلْأَرْضُ أَثْقَالَهَا (٢) وَقَالَ
ٱلْإِنسَٰنُ مَا لَهَا (٣) يَوْمَئِذٖ تُحَدِّثُ أَخْبَارَهَا (٤) بِأَنَّ رَبَّكَ أَوْحَىٰ لَهَا
(٥) يَوْمَئِذٖ يَصْدُرُ ٱلنَّاسُ أَشْتَاتٗا لِّيُرَوْاْ أَعْمَٰلَهُمْ (٦) فَمَن يَعْمَلْ
مِثْقَالَ ذَرَّةٍ خَيْرٗا يَرَهُۥ (٧) وَمَن يَعْمَلْ مِثْقَالَ ذَرَّةٖ شَرّٗا يَرَهُۥ (٨)

7:07 AM · 9/24/19 · Twitter for Android

352 Retweets **1,168** Likes

MAHRUKH🌸 (JOJO & WARDA KA...
@stay_awayyy_

Plz everyone recite Surah Zilzal🙏
#earthquake

سُورَةُ الزَّلۡزَلَةِ

بِسۡمِ ٱللَّهِ ٱلرَّحۡمَٰنِ ٱلرَّحِيمِ

إِذَا زُلۡزِلَتِ ٱلۡأَرۡضُ زِلۡزَالَهَا (١) وَأَخۡرَجَتِ ٱلۡأَرۡضُ أَثۡقَالَهَا (٢) وَقَالَ
ٱلۡإِنسَٰنُ مَا لَهَا (٣) يَوۡمَئِذٖ تُحَدِّثُ أَخۡبَارَهَا (٤) بِأَنَّ رَبَّكَ أَوۡحَىٰ لَهَا
(٥) يَوۡمَئِذٖ يَصۡدُرُ ٱلنَّاسُ أَشۡتَاتٗا لِّيُرَوۡاْ أَعۡمَٰلَهُمۡ (٦) فَمَن يَعۡمَلۡ
مِثۡقَالَ ذَرَّةٍ خَيۡرٗا يَرَهُۥ (٧) وَمَن يَعۡمَلۡ مِثۡقَالَ ذَرَّةٖ شَرّٗا يَرَهُۥ (٨)

6:38 AM · 9/24/19 · Twitter for Android

194 Retweets **766** Likes

Ahmad 🇵🇰
@ahmadnawaz539

May Allah protect us #earthquake

سُورَةُ الزَّلْزَلَةِ

بِسْمِ ٱللَّهِ ٱلرَّحْمَٰنِ ٱلرَّحِيمِ

إِذَا زُلْزِلَتِ ٱلْأَرْضُ زِلْزَالَهَا (١) وَأَخْرَجَتِ ٱلْأَرْضُ أَثْقَالَهَا (٢) وَقَالَ
ٱلْإِنسَٰنُ مَا لَهَا (٣) يَوْمَئِذٍ تُحَدِّثُ أَخْبَارَهَا (٤) بِأَنَّ رَبَّكَ أَوْحَىٰ لَهَا
(٥) يَوْمَئِذٍ يَصْدُرُ ٱلنَّاسُ أَشْتَاتًا لِّيُرَوْا۟ أَعْمَٰلَهُمْ (٦) فَمَن يَعْمَلْ
مِثْقَالَ ذَرَّةٍ خَيْرًا يَرَهُۥ (٧) وَمَن يَعْمَلْ مِثْقَالَ ذَرَّةٍ شَرًّا يَرَهُۥ (٨)

6:37 AM · 9/24/19 · Twitter for Android

10 Retweets **31** Likes

Teacher
@AdeelSays

Massive #earthquake, May Allah keep every one safe.

سُورَةُ الزَّلْزَلَةِ

بِسْمِ اللَّهِ الرَّحْمَٰنِ الرَّحِيمِ

إِذَا زُلْزِلَتِ الْأَرْضُ زِلْزَالَهَا ① وَأَخْرَجَتِ الْأَرْضُ أَثْقَالَهَا ② وَقَالَ
الْإِنسَانُ مَا لَهَا ③ يَوْمَئِذٍ تُحَدِّثُ أَخْبَارَهَا ④ بِأَنَّ رَبَّكَ أَوْحَىٰ لَهَا
⑤ يَوْمَئِذٍ يَصْدُرُ النَّاسُ أَشْتَاتًا لِّيُرَوْا أَعْمَالَهُمْ ⑥ فَمَن يَعْمَلْ
مِثْقَالَ ذَرَّةٍ خَيْرًا يَرَهُ ⑦ وَمَن يَعْمَلْ مِثْقَالَ ذَرَّةٍ شَرًّا يَرَهُ ⑧

6:12 AM · 9/24/19 · Twitter for Android

119 Retweets **470** Likes

Dr. Nabeel Alvi
@RphNabeel

May Allah keep everyone safe. Pls recite Surah Zilzal.

#earthquake

سُورَةُ الزَّلْزَلَةِ

بِسْمِ ٱللَّهِ ٱلرَّحْمَٰنِ ٱلرَّحِيمِ

إِذَا زُلْزِلَتِ ٱلْأَرْضُ زِلْزَالَهَا (١) وَأَخْرَجَتِ ٱلْأَرْضُ أَثْقَالَهَا (٢) وَقَالَ
ٱلْإِنسَٰنُ مَا لَهَا (٣) يَوْمَئِذٍ تُحَدِّثُ أَخْبَارَهَا (٤) بِأَنَّ رَبَّكَ أَوْحَىٰ لَهَا
(٥) يَوْمَئِذٍ يَصْدُرُ ٱلنَّاسُ أَشْتَاتًا لِّيُرَوْا۟ أَعْمَٰلَهُمْ (٦) فَمَن يَعْمَلْ
مِثْقَالَ ذَرَّةٍ خَيْرًا يَرَهُۥ (٧) وَمَن يَعْمَلْ مِثْقَالَ ذَرَّةٍ شَرًّا يَرَهُۥ (٨)

6:06 AM · 9/24/19 · Twitter for Android

Azi Baloch 🇵🇰 🇵🇰
@baloch_azi

May Allah keep every one safe
#earthquake

سُورَةُ الزَّلزَلَةِ

بِسۡمِ ٱللَّهِ ٱلرَّحۡمَٰنِ ٱلرَّحِيمِ

إِذَا زُلۡزِلَتِ ٱلۡأَرۡضُ زِلۡزَالَهَا ١ وَأَخۡرَجَتِ ٱلۡأَرۡضُ أَثۡقَالَهَا ٢ وَقَالَ
ٱلۡإِنسَٰنُ مَا لَهَا ٣ يَوۡمَئِذٖ تُحَدِّثُ أَخۡبَارَهَا ٤ بِأَنَّ رَبَّكَ أَوۡحَىٰ لَهَا
٥ يَوۡمَئِذٖ يَصۡدُرُ ٱلنَّاسُ أَشۡتَاتٗا لِّيُرَوۡاْ أَعۡمَٰلَهُمۡ ٦ فَمَن يَعۡمَلۡ
مِثۡقَالَ ذَرَّةٍ خَيۡرٗا يَرَهُۥ ٧ وَمَن يَعۡمَلۡ مِثۡقَالَ ذَرَّةٖ شَرّٗا يَرَهُۥ ٨

6:25 AM · 9/24/19 · Twitter for Android

11 Retweets **55** Likes

Syed Fahad Jan 🇵🇰 (TEAM IVF)
@imsFj07

May Allah keep everyone safe. Pls recite Surah Zilzal. 🙏

#earthquake

سُورَةُ الزَّلزَلَةِ

بِسۡمِ ٱللَّهِ ٱلرَّحۡمَٰنِ ٱلرَّحِيمِ

إِذَا زُلۡزِلَتِ ٱلۡأَرۡضُ زِلۡزَالَهَا ١ وَأَخۡرَجَتِ ٱلۡأَرۡضُ أَثۡقَالَهَا ٢ وَقَالَ
ٱلۡإِنسَٰنُ مَا لَهَا ٣ يَوۡمَئِذٖ تُحَدِّثُ أَخۡبَارَهَا ٤ بِأَنَّ رَبَّكَ أَوۡحَىٰ لَهَا
٥ يَوۡمَئِذٖ يَصۡدُرُ ٱلنَّاسُ أَشۡتَاتٗا لِّيُرَوۡاْ أَعۡمَٰلَهُمۡ ٦ فَمَن يَعۡمَلۡ
مِثۡقَالَ ذَرَّةٍ خَيۡرٗا يَرَهُۥ ٧ وَمَن يَعۡمَلۡ مِثۡقَالَ ذَرَّةٖ شَرّٗا يَرَهُۥ ٨

6:10 AM · 9/24/19 · Twitter for Android

The Pakistan Times @PakTime... · 14h

May Allah keep everyone safe.
#earthquake

سُورَةُ الزَّلۡزَلَةِ
بِسۡمِ ٱللَّهِ ٱلرَّحۡمَٰنِ ٱلرَّحِيمِ
إِذَا زُلۡزِلَتِ ٱلۡأَرۡضُ زِلۡزَالَهَا ١ وَأَخۡرَجَتِ ٱلۡأَرۡضُ أَثۡقَالَهَا ٢ وَقَالَ
ٱلۡإِنسَٰنُ مَا لَهَا ٣ يَوۡمَئِذٖ تُحَدِّثُ أَخۡبَارَهَا ٤ بِأَنَّ رَبَّكَ أَوۡحَىٰ لَهَا
٥ يَوۡمَئِذٖ يَصۡدُرُ ٱلنَّاسُ أَشۡتَاتٗا لِّيُرَوۡاْ أَعۡمَٰلَهُمۡ ٦ فَمَن يَعۡمَلۡ
مِثۡقَالَ ذَرَّةٍ خَيۡرٗا يَرَهُۥ ٧ وَمَن يَعۡمَلۡ مِثۡقَالَ ذَرَّةٖ شَرّٗا يَرَهُۥ ٨

Mahad786 @says_mahdi · 14h

Share it.
#earthquake jolts in Pubjab side.

سُورَةُ الزَّلۡزَلَةِ
بِسۡمِ ٱللَّهِ ٱلرَّحۡمَٰنِ ٱلرَّحِيمِ
إِذَا زُلۡزِلَتِ ٱلۡأَرۡضُ زِلۡزَالَهَا ١ وَأَخۡرَجَتِ ٱلۡأَرۡضُ أَثۡقَالَهَا ٢ وَقَالَ
مَا لَهَا ٣ يَوۡمَئِذٖ تُحَدِّثُ أَخۡبَارَهَا ٤ بِأَنَّ رَبَّكَ أَوۡحَىٰ لَهَا
يَصۡدُرُ ٱلنَّاسُ أَشۡتَاتٗا لِّيُرَوۡاْ أَعۡمَٰلَهُمۡ ٦ فَمَن يَعۡمَلۡ
مِثۡقَالَ ذَرَّةٍ خَيۡرٗا يَرَهُۥ ٧ وَمَن يَعۡمَلۡ مِثۡقَالَ ذَرَّةٖ شَرّٗا يَرَهُۥ ٨

Akif Khattak 🇵🇰 @iamAkifKhan · 14h

Allah warn us again and again but we are not listening to him. turn to Allah before its too late. Astaghfirullah

#earthquake

Haqeeqat tv @haqeeqattv · 14h

Every one please recite Surah Zilzal. #earthquake

سُورَةُ الزَّلْزَلَةِ

بِسْمِ ٱللَّهِ ٱلرَّحْمَٰنِ ٱلرَّحِيمِ

إِذَا زُلْزِلَتِ ٱلْأَرْضُ زِلْزَالَهَا (١) وَأَخْرَجَتِ ٱلْأَرْضُ أَثْقَالَهَا (٢) وَقَالَ
ٱلْإِنسَٰنُ مَا لَهَا (٣) يَوْمَئِذٍ تُحَدِّثُ أَخْبَارَهَا (٤) بِأَنَّ رَبَّكَ أَوْحَىٰ لَهَا
(٥) يَوْمَئِذٍ يَصْدُرُ ٱلنَّاسُ أَشْتَاتًا لِّيُرَوْا أَعْمَٰلَهُمْ (٦) فَمَن يَعْمَلْ
مِثْقَالَ ذَرَّةٍ خَيْرًا يَرَهُۥ (٧) وَمَن يَعْمَلْ مِثْقَالَ ذَرَّةٍ شَرًّا يَرَهُۥ (٨)

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May ALLAH forgive us and Protect Safe Everyone.