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Better Awareness for Better Natural Hazards Preparedness in Pakistan

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ABSTRACT

Pakistan is highly vulnerable to natural disasters. It faces severe geophysical hazards (earthquakes, landslides, and tsunami) as well climate change reinforced hydro-meteorological hazards (floods, droughts, tropical storms). Poor availability and exploitation of natural resources combined with dense, high and fast growing population and other peculiar politico-socio-economic factors add to Pakistan's vulnerability to disasters caused by these hazards. The knowledge and awareness of impending disasters, their impacts, their mitigation, preparedness and adaptation is lacking among government officials, planers, engineers and general public. This research presents two case studies; one each from the categories of geophysical hazards and hydro-meteorological hazards, where knowledge and awareness is lacking and where improvements in the same can lead to better adaptation and preparedness. The first case study discusses mitigation of seismic hazards to non-engineered buildings through better knowledge of low-cost structural engineering solutions. It is demonstrated that seismic performance of these structures can be improved from life-safety viewpoint by adopting simple low-cost modifications to the existing construction practices. The second study points at lack of awareness among local planning officials of climate change impacts leading to water scarcity and flood hazards at different times. The research demonstrates a lack of institutional capacity in Pakistan that was discovered through primary research conducted for this study. Tit was found there are common themes across the two very different case studies and there are common lessons that can be learnt for hazard preparedness in Pakistan.

1. Introduction – Pakistan's Exposure to Natural Hazards

Economic toll and mortality rate due to natural hazards (earthquakes, floods, hurricanes, storms etc.) is on the rise across the globe due to increased population, urbanization, population density and inhabitation of areas prone to these natural events (UNDP, 2004). Collapse of buildings and houses during earthquakes has been the leading cause of worldwide fatalities in natural disasters during the last 110 years (OFDA/CRED, 2014). Due to increase in awareness and implementation of stringent building design codes and practices, mortality rates due to natural hazards has decreased steadily in the developed countries since the mid twentieth century (Degg, 1992). The situation is however grim when a similar analysis is conducted for the developing and the under-developed countries (Degg, 1992). In fact, more than 92% of the approximately 2.7 million fatalities due to geophysical hazards occurred in the developing countries over the period 1900 to 2012 (OFDA/CRED, 2014). Climate change reinforced water related disasters like floods also impact people of the developing countries much more severely than the people in the developed countries (Stern, 2006). In the following sections two natural disaster related case studies from Pakistan are presented. The two case studies highlight that simple institutional and engineering improvements and awareness can lead to significant reduction in the harm from natural disasters in developing countries like Pakistan.

Pakistan is a country of more than 180 million people with land area of about 800,000 km^2. Pakistan is located at the confluence of Indian, Eurasian and Arabian tectonic plates. The boundary region of these plates is seismically active that gives rise to severe earthquakes at regular time intervals. About 85% of the land area of the country is exposed to seismic risk (OCHA-ROAP, 2007). Similarly, the snow and rain fed rivers of the country cause flooding of the planes and tropical storms and storm surges inundate the coastal regions at regular frequency exposing about 11% of the land area to hydrological hazards (OCHA-ROAP, 2007). According to OFDA/CRED (2014), these natural hazards have caused tremendous economic damage, human fatalities and large scale uprooting of the population in Pakistan over the past century as depicted in Fig. 1. It can be observed that floods are the leading cause for economic damage and displacement of populations, while earthquakes are the leading cause for loss of human lives due to natural disasters in Pakistan.

This research presents two case studies related to natural hazard

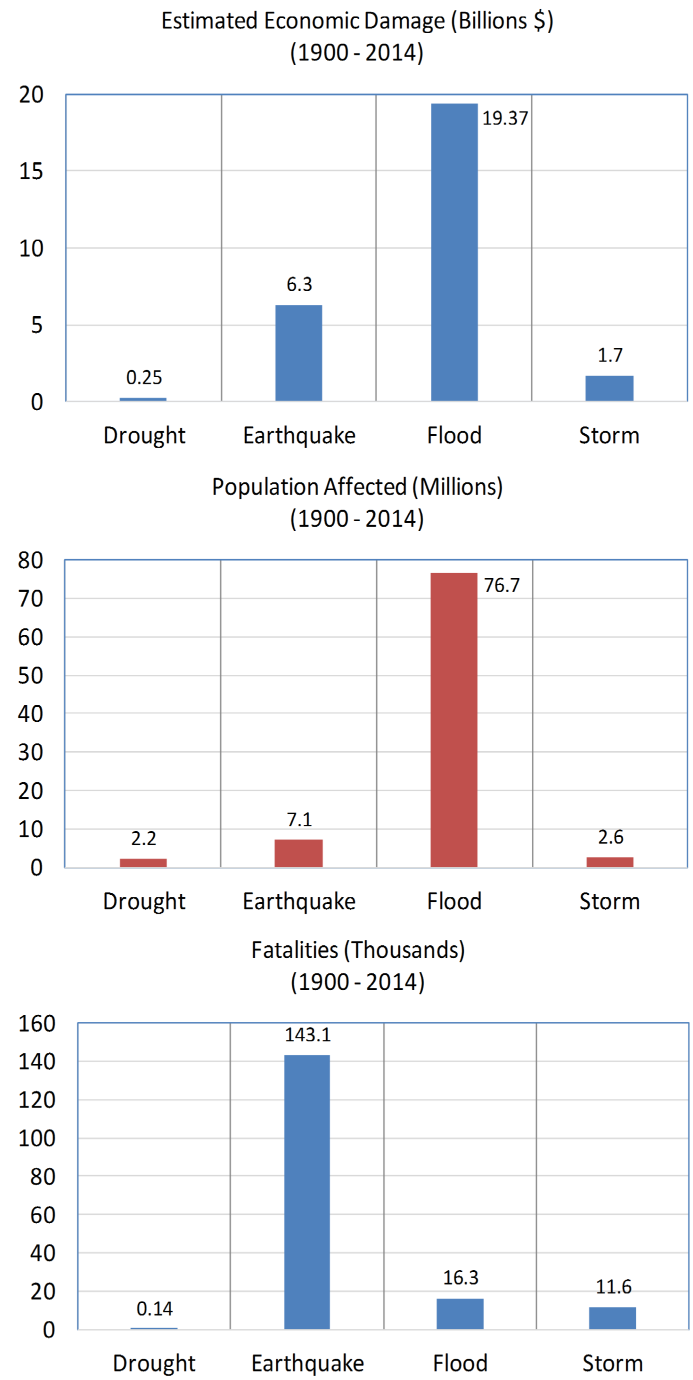

Figure 1: *Cost and impact of disasters caused by natural hazards in Pakistan (1900 – 2014). Source: (OFDA/CRED, 2014)*

preparedness and management in Pakistan. Both studies demonstrate that awareness and understanding of the natural hazards and the knowledge required for disaster management is lacking and that improvements in the same can lead to better adaptation and preparedness.

The first case study discusses mitigation of seismic hazards to non-engineered buildings through better knowledge of low-cost structural engineering solutions. The research is in the context of the tremendous loss of life that resulted in the aftermath of recent earthquakes in Pakistan. It presents an overview of the typical damage observed in non-engineered structures and its most likely causes in the 2005 Hazara-Kashmir earthquake, which claimed more than 80,000 lives. It is demonstrated that seismic performance of these structures can be improved from life-safety viewpoint by adopting simple low-cost modifications to the existing construction practices. Incorporation of these practices in the rebuilding efforts and their continued use in later construction would however require improved awareness of utility and function of such practices.

The second study points at lack of awareness among local planning officials of climate change impacts leading to water scarcity and flood hazards at different times. The study highlights Pakistan's vulnerability to climate change due to large, dense, fast growing population with poor human resources training on one hand and declining, unpredictable and highly vulnerable water resources on the other. It also demonstrates a lack of institutional capacity that was discovered through a survey of 150 local town planning official and a number of interviews with the local environmental experts at various government and semi-government agencies in Pakistan.

2. Case Study 1: Better Knowledge for Improving Seismic Performance of Non-engineered Buildings in Pakistan

The tremendous loss of life that resulted in the aftermath of 2005 Hazara-Kashmir earthquake in Pakistan was mostly due to the collapse of non-engineered and semi-engineered building structures. Such structures are used as houses, schools, primary healthcare centers and government offices. These building are classified structurally into two categories viz. non-engineered and semi-engineered. Non-engineered structures include: adobe, unreinforced masonry (URM) and wood buildings. Semi-engineered buildings are mostly low-rise (up to 3 story) light concrete frame structures or masonry bearing walls with reinforced concrete slabs. This case study presents an overview of the typical damage observed in non-engineered structures and their most likely causes in the said earthquake. It is demonstrated that seismic performance of these structures can be improved from life-safety viewpoint by adopting simple low-cost modifications to the existing construction practices.

2.1 Overview of seismic performance of non-engineered buildings

Houses (single family as well as multi-family residences) comprise more than 80% of the building stock in the world. Single family houses are almost always built without the supervision of a professional engineer or an architect and are more likely to suffer damage during a seismic event.

The traditional materials for house construction are: adobe, natural stone, and masonry (burnt clay bricks, concrete blocks) set in mud/lime/cement-sand mortar, timber and light reinforced concrete frame. The roof of such dwellings consists of wood joists in-filled with thatch or tree branches and plastered with mud, corrugated metal sheets or reinforced concrete slab. Traditional knowledge, past experience and rules of thumb are the only available design guides for construction of these dwellings. The structural components are usually adequate for withstanding the gravity loads but grossly inadequate to withstand the lateral inertia loads imposed by earthquakes. In fact, the collapse of such non-engineered and semi-engineered structures has caused more than 90 per cent of the earthquake fatalities throughout the world (Spence & So, 2009). Structural deficiencies in such structures typically include: (i) inadequate foundations, (ii) lack of connectivity between walls and roof elements, (iii) low out-of-plane strength of walls, (iv) lack of connectivity between walls and (v) lack of local reinforcement around opening.

This case study examines the performance of 'non-engineered' buildings in recent earthquakes and suggests appropriate structural modifications to these structures so that a reasonable level of life-safety can be achieved at a minimal cost.

2.1.1 Adobe Houses

Adobe (sun dried earthen brick) is the most widely used material for house construction in the world. Approximately 30% of the world's population and 50% of the population in developing countries live in earthen dwellings, (Blondet, Garcia, & Brzev, 2003). This type of houses are common in the developing countries of Asia and Americas that are prone to earthquakes, such as Bangladesh, India, Pakistan, Afghanistan, Iran, Turkey, Mexico, Peru, Haiti and Guatemala.

2.1.2 Stone Houses

Houses made of natural stone are prevalent in the hilly areas where the basic building block (i.e. stone) is abundantly available and it is difficult to make adobe bricks due to lack of suitable soil and means of its extraction. Natural, rough cut and dressed stone have been traditionally used depending on the economic affordability of the owner. The stones are laid with clay mortar, lime mortar or cement-sand mortar or stacked dry. The walls can be as thick as 500 mm. The roof is constructed of wood logs, timber joists, light steel beams that are covered with thatch and in-filled with stone, timber tiles or burnt clay bricks. Timber roof trusses, wood planks, corrugated metal sheets and more recently reinforced concrete slabs have also been used. Usually, the roof bears on the stone walls with no positive connection.

This type of construction is found often in buildings of cultural and historical significance in the developed countries, and in developing countries where it represents affordable and cost- effective housing construction. This construction type is present in earthquake-prone regions of the world, such as Mediterranean Europe and North Africa, the Middle East, India, Nepal, Pakistan and other parts of Asia. Seismic performance of stone buildings has been similar to adobe buildings. However, the potential to cause injury or death is more than the adobe houses due to the weight of the stone walls and the heavier roof components.

2.1.3 Unreinforced masonry (URM)

Unreinforced masonry is a relatively superior type of construction and is mostly found in the urban areas. The main load resisting element is the masonry walls which act to cater for the gravity loads as well as the lateral loads. Masonry units are either burnt clay bricks or cement masonry units with varying configurations and sizes. The masonry units are usually laid in cement sand mortar and use of reinforced concrete lintels above openings is also common. In older construction, lintels are of masonry arches as well. The roof or floor structure in this kind of construction is usually heavy in weight consisting of reinforced concrete slab, timber or steel joists with metal deck and concrete topping, or recently, precast concrete planks. This kind of construction can be found in historic structures in the developed as well as developing countries and modern era structures (less than 50 year of age) in developing countries.

Serious loss of life and damage to property has resulted due to the poor performance of these structures because use of this type of construction has been extended beyond single family residences to multi-story offices, schools, hospitals, government buildings, shopping centers etc. due to its perception of a modern and superior construction material. Deficiencies of URM are similar to adobe and stone construction when it comes to resisting seismic loads as the relatively increased compressive strength of the material is of little value in withstanding the seismic shaking.

2.2 Hazara-Kashmir earthquake (2005)

On the 8th of October 2005 at 08:57 local time Hazara-Kashmir earthquake, with magnitude 7.6 on the Richter scale struck the Kashmir and the North Western region of Pakistan. The earthquake affected nearly 30,000 km^2 area, killed more than 75,000 persons, injured more than 110,000 and rendered about 3.5 million people homeless. The direct economic impact of the earthquake was estimated to be about US$ 3 billion.

Buildings in the affected area consisted of non-engineered dwellings and semi-engineered multi-story (2 to 4) reinforced concrete frame buildings with non-seismic design and poor workmanship. Traditional timber frame structures are also present in the affected area and performed relatively better than the masonry construction. The next section is devoted to the suggested improvements to the non-engineered adobe/stone/URM buildings (mostly houses) for improving their life-safety.

2.3 Strengthening techniques for Adobe/stone/URM

The idea of seismic retrofit of non-engineered buildings is that it should avoid incorporation of materials and construction techniques that are alien to the region. Improvements on the existing construction techniques are the best way for implementing a long-lasting and sustainable seismic safety and hazard mitigation initiative.

Upgrading the strength and capacity of a multi-story URM structure is a specific structural engineering task that requires careful evaluation of the load paths and examination of strength of various components. Therefore, in this paper the focus will only be on seismic upgrading of small URM structures which are mostly used for residences or small offices.

Walls are the primary gravity load as well as lateral load resisting elements in these structures. Therefore, the primary focus of most of the strengthening techniques is to enhance the integrity and capacity of the walls, to improve the integrity of the roof with the walls and to ensure that the collapse of walls and roof is prevented to improve life-safety of such structures. Various methods to achieve this purpose are discussed in this section.

i. Connection of wall and roof elements

Secure the roof with the walls to prevent roof collapse and to improve the diaphragm action of the roof. This is achieved by providing a bond beam (or ring beam) at the roof level for new construction and securing the roof elements to the walls by means of connecting angles or plates as depicted in Fig. 2. Roof bond beam serves the dual purpose of connecting the roof to the walls as well as tying the walls together. Chaudhary (2013) has demonstrated that provision of properly connected roof diaphragm can reduce the lateral displacements of such buildings by more than ten times as compared to the structure without properly connected roof diaphragm.

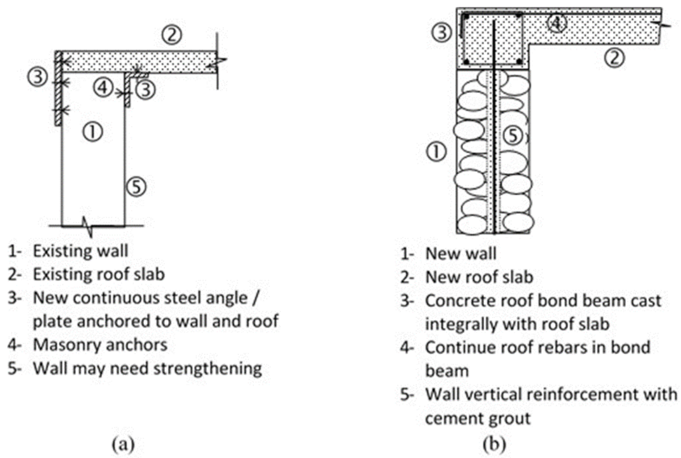

Figure 2: *Improving connectivity of roof with walls. (a) Existing construction, (b) New construction*

ii. Connection of mutually perpendicular walls

The connection between mutually perpendicular walls (specially, corner walls) need to be ensured to enhance building integrity by tying the walls together. The tying is to be done by a material that has good tensile strength and ductility. It includes: (i) wire mesh reinforcing around the corners, (ii) use of reinforced concrete (R/C) corner stitches (L-stitch) and (iii) provision of continuity angles and plates. Refer to Fig. 3 for salient details of the last two techniques.

iii. Strengthening the walls

Walls are the main gravity load as well as lateral load carrying elements in these structures. Therefore, any measure to improve the lateral strength of the walls will have a positive impact on the integrity of the structure. IAEE (2001) and Bhattacharya et al. (2014) have documented several methods to achieve this goal. Some of these methods include: wire mesh reinforcing, steel strip reinforcing, provision of pilasters to reduce the span of wall, Polypropylene (PP) band reinforcing etc. Selection of any of the strengthening methods should take into account the availability of material, local construction practices and availability of the skilled labor to carry out the task.

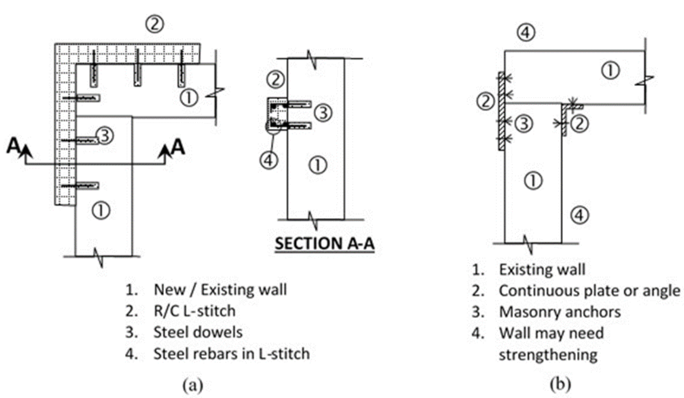

Figure 3: *Improving connection between walls. (a) L-stitch in new construction, (b) Continuity element for existing construction*

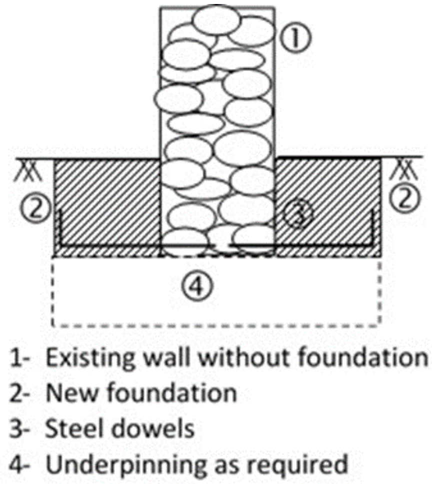

Figure 4: *Detail of foundation strengthening in an existing structure*

iv. Strengthening of foundation

Lack of foundation size and embedment can result in excessive lateral displacements under seismic loads. Failure of the structure can occur even if the walls and roof elements are strong enough and properly tied together. Adequate foundation size is required to safely transmit the gravity and lateral loads to the supporting soil. Fig. 4 depicts a typical detail for enlarging the size and depth of the existing foundation.

The structural details and techniques presented above were recommended for adoption by the Earthquake Reconstruction and Rehabilitation Agency (ERRA) with further instructions for the local craftsmen, owners and government officials to suit the local needs (EERA, 2006). In the nine years following the 2005 Kashmir earthquake, more than 400,000 structures have been built according to these guidelines. It is hoped that the trend of incorporating these simple seismic details in non-engineered houses will get ingrained in the local building traditions and will considerably improve the life safety in the aftermath of a future seismic event.

3. Case Study 2: Climate Change Awareness and adaptation at Local Level in Pakistan

Climate change awareness is an imperative to achieve disaster mitigation in developing countries. According to Lata and Nunn (2012), lack of awareness is a significant barrier to climate change adaptation in developing countries. Raising climate change awareness at the local government level is critical for Pakistan as climate change impacts are exacerbating the number and extent of disasters in this disaster-prone country (Scientific American, 2010). This part of the study assessed the awareness of climate change impacts on various socio -economic indicators among the local planning officials in Punjab, Pakistan. The findings of this study are based on a detailed survey conducted with local planning officials in Pakistan. The survey explores the level of awareness of climate change, its causes and impacts in Pakistan. The findings suggested improvements to the situation through simple structural measures.

Climate change is the most serious global environmental issue of the present time. It is a serious threat to the security and prosperity of the world in the twenty-first century. Increased awareness helps in preparing and implementing climate change adaptation measures, such as adjustments in natural and manmade systems to reduce the likely impacts of climate change. According to a recently published index, Pakistan was ranked 12th on the list of countries most vulnerable to the impacts of climate change (IUCN, 2009). The study presented herein provides an in-depth analysis of the survey conducted with 150 local Union Council officials of Lahore, Capital of Pakistan's Punjab Province. This survey attempts to determine the level of climate change awareness among the local officials.

According to Oxley (2010), increased sense of awareness and interest for disaster risk reduction in Pakistan can help to increase the disaster preparedness through developing and forecasting early warning and evacuation systems. As some of these disasters, like floods and droughts, are related to climate change, it makes good sense to investigate what is known about climate change impacts and adaptation among the leaders and planners of the society. Local planning officials are important stakeholders in Pakistan that has strong influence over physical infrastructure development. Improvements in their level of climate change awareness can lead to better adaptation outcomes.

3.1 Climate Change and Pakistan

One of the significant impacts of climate change on water resources of Pakistan is unpredictable melting of glaciers followed by decreased river flows and groundwater. According to IPCC Fourth Assessment Report (2007), "Glaciers in the Himalaya are receding faster than in any other part of the world and, if the present rate continues, the likelihood of them disappearing by the year 2035 and perhaps sooner is very high if the Earth keeps warming at the current rate". While there has been a disagreement among climate scientists on the 2035 date, the chief of the UN climate change panel has stressed that the devastating impacts of this glacier melting cannot be ignored regardless (SMH 2010).

Most rivers in Pakistan originate from mountains in Kashmir and are mainly fed by water from melting snows. They provide substantial surface-and ground-water resources. About a quarter of the country's land is cultivated using water from these rivers and groundwater (Piracha, 2008). Melting away of glaciers will result in water shortages both for irrigation and for drinking purposes (Piracha & Majeed, 2011). In light of these circumstances it is important to study environmental awareness and adaptation at the local level in Pakistan.

3.2 Climate Change Awareness among Local Officials

Lahore District in the Punjab Province (the most populous and with largest irrigated agricultural lands in Pakistan) was selected for an in-depth analysis for this study. This district is made up of both urban and rural areas. Most provincial head offices, policy makers, and experts are based in Lahore. Some national level organizations (Water and Power Development Authority, National Engineering Services Pakistan) are also located in Lahore City District. Opinion and policies of local officials in Lahore reflect and influence of other districts in Punjab and elsewhere in Pakistan. Lahore City District is administratively divided into 9 towns. These towns are further subdivided into 150 Union Councils.

Punjab Local Government Ordinance (PLGO) 2001 describes the functions and responsibilities of Union Council local officials in detail. One of the functions and responsibilities of Union Council local officials is to collect and maintain statistical information for socio-economic surveys. It is also the responsibility of these officials to consolidate village and neighborhood development needs and prioritize them into union-wide development proposals. Local officials also provide and maintain public sources of drinking water. They also work with other public, private or voluntary organizations, engaged in activities similar to those of the Union councils. It is also the function of local officials to carry out projects of the approved Union Annual Development Plan by contracting out to the private sector. Local officials may seek the support of the Town Municipal Administration or District government for implementation of Annual Development Plan. They also assist the relevant authorities in disasters and natural calamities, and assist in relief activities (PLGO, 2001).

Table 1: *Extent of Climate Change Awareness*

	Responses	Frequency	Percent*	Valid Percent**
	Only heard	33	22.0	46.5
	Know something about it	29	19.3	40.8
	Know a great deal about it	9	6.0	12.7
	Total	71	47.3	100.0
	Not aware of climate change	79	52.7	
Total		150	100.0	

Union Council local officials were selected for a survey because of their grass-root level interaction with the communities. This survey was conducted from Feb. to May 2011 with a standard questionnaire to know the existing level of awareness of climate change impacts and adaptation measures among local officials from each Union Council of Lahore District. The findings from the survey are summarized below.

3.2.1 Overall Climate Change Awareness

Almost half of the surveyed respondents (53%) were not aware of the phenomenon of climate change. Only 71 out of 150 respondents were aware of climate change phenomena. It shows that the level of awareness about climate change among local officials is very low.

Deeper understanding of climate change phenomena is also very low among local government officials in Pakistan (Table 1). Almost half of the local officials who were aware of climate change had only heard about the word climate change. Very few local officials (only 13% of climate aware or about 6% of total number of respondents) knew a great deal about the climate change phenomenon. It shows a very high level of climate change ignorance at local government level in Pakistan.

3.2.2 Awareness of Causes of Climate Change

A very big question in climate change debate is on its origins. Does it result from manmade causes or natural causes? Manmade causes of climate change include increase in greenhouse gases, emissions from automobiles, power plants, factories, etc. Literature shows that 97% of the climate change researchers believe humans are the primary cause of climate change (Anderegg et al., 2010).

In the survey, the local government officials were also asked about the causes of climate change. Overwhelming majority of respondents believed that both natural and manmade causes are responsible for

Table 2: *Perceived Causes of Climate Change*

Responses	Frequency	Percent
Natural cause	5	7.0
Manmade cause	21	29.6
Both natural and manmade cause	44	62.0
Do not know	1	1.4
Total	71	100.0

Table 3: *Consequences of Glacier Melting*

Responses		Frequency	
		N	Percent
Impacts of Glacier Melting	Water scarcity	11	33.3
	Reduced agricultural yield	10	30.3
	Floods	12	36.4
Total		33	100.0%

climate change (see Table 2). Only 21 out of 71 (30 %) local officials responded that climate change was only due to manmade causes. It further indicates lack of knowledge about climate change phenomena among local officials in Punjab.

3.2.3 Consequences of Climate Change

Global climate change impacts range from physical, to social and cultural aspects. Climate change is a big threat to the regions of developing countries because the effects of climate change are not equally distributed all over the world. The large and poor populations of developing countries are likely to be more affected by climate change impacts as compared to rich developed countries (Mertz et al., 2009). As developing countries like Pakistan are already suffering from high poverty levels and scarcity of resources, populations of these areas are more vulnerable to the effects of climate change.

Local official's opinion was sought during the survey about present and future consequences of climate change for Punjab-Pakistan. Most of the respondents believed that water and food security of Punjab-Pakistan is threatened at present and in future as a consequence of climate change. Water, energy and agriculture sectors will be affected the most by climate change impacts in Pakistan (IUCN, 2009). It is estimated that 40% more food will be required by the year 2025 to fulfil the demand of increasing population in Pakistan. This analysis shows consequences of climate change are very serious for Pakistan. While Pakistan will need much more food in future due to fast pace of population growth, the climate change is eroding even its current food production capacity. The local planning officials seemed to have intuitive understanding that the situation is dire.

3.2.4 Awareness about Climate Change Impacts on Water Resources

Compared with the global average of more than 7,000 m3/year/person, water availability in Pakistan at 1,756m3/year/person is very low (Adeel & Piracha, 2004). According to Mirza & Ahmad (2005), even small changes in climate can cause water resources problems in Pakistan. One of the significant impacts of climate change on water resources of Pakistan is unpredictable melting of glaciers followed by decreased river flows. About two fifths (39%) of the respondents were aware of Himalayan Glaciers' melting due to climate change whereas almost the same number of respondents (38%) were unsure about this fact. The World Bank Study 'Pakistan's Water Economy Running Dry' (2006) cited in (Amir, 2009) stated that "Western Himalayan Glaciers will retreat for the next 50 years causing increase in Indus River flows. Then the glacier reservoirs will be empty, resulting in decrease of flows by up to 30% to 40% over the subsequent fifty years".

Melting of seasonal snowfall and rapid glaciers melting has resulted not only in reduction of water resources but also caused flash floods in many areas of Pakistan (Jilani et al., 2007). Pakistan's economy is also affected by glacier melting because it heavily depends on water from glacier melt. A question about impacts of glacier melting was asked from the 33 local officials who were aware of Himalayan Glaciers melting due to climate change. Table 3 shows the multiple responses of 33 local officials about impacts of glacier melting on water resources of Punjab. According to 36% local officials, flooding is the major impact of glacier melting on water resources of Punjab. Other impacts of glacier melting in Punjab are water scarcity and reduced agricultural yield. This analysis shows local officials have little understanding of Himalayan Glaciers melting due to climate change and its impacts on water resources of Punjab.

Flooding is the most damaging and frequent natural disaster in Pakistan (Figure 1). Abbas (2009) reports that 40% population of Pakistan is vulnerable to multiple disasters and this vulnerability is predicted to be increased by increasing climate change impacts. Almost 10% of the Pakistan's population was badly affected by 2010 flooding (Polastro et al., 2011). Although local officials do not have deeper understanding of climate change impacts, three fourth (75%) of them attributed the 2010 flooding in Pakistan to this phenomenon.

4. Conclusions

Natural disasters are causing tremendous loss of life and property with earthquakes being the most serious life safety risk. Loss of life in earthquakes mostly occurs due to collapse of buildings and non-engineered dwellings. Based on the results of an analytical study and evidence of damage to non-engineered construction in the past earthquakes, some structural details are reviewed in the first part of this paper. These cost-effective measures are based on engineering judgment and analytical results, and can improve the life-safety of such structures in earthquakes.

Pakistan is a disaster-prone country and climate change impacts are exacerbating the frequency and extent of disasters. Rapid population growth, poor urban management, and non-implementation of various policies are creating a peculiar situation for the country. Pakistan's resilience to deal with the adverse impacts of natural disasters is also very low because of the country's socio-political instability. Extreme poverty and weak institutional capacity to effectively respondent to the climate change impacts in Pakistan may also increase the vulnerability to natural disasters.

This paper highlights that climate change awareness is at an alarmingly low level in local government setup in Pakistan. Understanding of climate change impacts and its consequences is very low at the lower level of local government setup among Union Council local officials of Punjab. This paper also revealed that local officials are unaware of impacts of Himalayan Glaciers melting due to climate change. Although, a big majority of them believe that 2010 flooding in Pakistan was due to climate change impacts.

5. Recommendations

It is emphasized that the curricula of most civil engineering schools in Pakistan hardly consider any teaching in the subject of non- engineered, traditional constructions which is also one of the reason for lack of improvements in the traditional construction technology to withstand extreme man-made or natural disasters. This situation needs to improve through active participation of the technical and vocational education sector, policy makers, local government officials and home owners.

There is a need to strengthen the institutional setup to prepare and implement natural disaster reduction and climate change adaptation strategies in Pakistan. Some policy recommendations to deal with the issue of climate change by local government in Pakistan are as follows:

- Climate change awareness raising campaigns are needed at local level in Pakistan.
- Local government setup in Pakistan should be strengthened to implement National Climate Change Policy (MCC, 2012).
- Potential climate change adaptation actions are need at local level to reduce the vulnerability of climate change impacts in Punjab.
- Water resources are very sensitive to the impacts of climate change. So water resources adaptation measures should be incorporated in planning and development policies of the government.

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