Report on Post Earthquake Rapid Assessment Northern Pakistan – 8 October 2005

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By

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Preface

On 8 October 2005 an earthquake of magnitude 7.6 on the Richter scale occurred in Northern area of Pakistan and in the border area of Indian Kashmir devastating an area of nearly 30,000 km. The impact zone extended to some areas in Afghanistan too. As per the official reports, around 75,000 people were killed in all the three countries, but the actual figure might be higher than what has been recorded to date.

The earthquake had highest impact in the North Western Frontier Province (NWFP), as well as 5 districts of Jammu and Kashmir partly under Pakistan and partly under the territory of Indian Kashmir. The total devastation caused was much higher than any of the earthquake disasters recorded in the recent history of Pakistan. The destruction to housing and settlements, urban as well as rural, was much higher than ever before. The Asian Disaster Preparedness Center (ADPC) was invited by the Habitat for Humanity International (HFHI) to participate in the rapid assessment mission initiated by HFHI. This mission was undertaken to conduct a study of the direct impact of the event and to identify the issues to be considered in meeting the shelter needs, during the immediate aftermath as well as in the long-term recovery phase.

The Habitat for Humanity International (HFHI) took immediate steps to mobilize a team, which also included a member from ADPC and a member from Asian Institute of Technology (AIT) of Thailand, respectively, to visit affected areas in Pakistan namely Bagh in Azad Kashmir, and Abbottabad, Manserha and Balakot in North Western Frontier Province from 31st October to 4th November 2005.

During the visit, the team analyzed the destructions, especially to buildings and dwellings, gathered information on the types of construction, causes of failure due to the earthquake, potential seismic-resistant interventions during reconstruction phase, and solutions for winter shelter. This report presents the findings on:

⇒ Factors that contributed to high losses, casualties and damages to property
⇒ Possible risk reduction measures to be included in long and short term recovery programs
⇒ Suggestions on the approaches for implementation of reconstruction and rehabilitation programs

These findings, however, would need updating as more information flows in and therefore conducting another detailed assessment before the commencement of the recovery program, is highly recommended. The findings represent the conclusions from most current observations made at present and available to help those involved in formulation of a comprehensive recovery program as well as long and short term approaches for mitigation of impacts of future earthquake disaster events.

The ADPC wishes to place on record its appreciation to HFHI for the opportunity provided to ADPC for participation in the study and wish to thank all the team members namely Barry Mackey, Jack Blanchette, Kathryn Reid, Samantha Rex, Farhan Mall of HFHI, Dan Bavington of ZOR Engineers (PVT) LTD, Dr. Pennung Warnitchai of AIT, The Evangelical Assistance Mission (TEAM) and Mr. N.M.S.I. Arambepola of ADPC, for their inputs and assistance during the study.

Dr. Suvit Yodmani,
Executive Director,
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November 23, 2005

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1. Introduction

According to the seismic zonation of Northern districts of Pakistan, Gilgit, Ghizer, Diamer, Skardu, Ghangche, Chitral, Swat and North Western Frontier Province, are vulnerable to many types of natural disasters including floods, earthquakes, landslides. Several earthquake events have been reported earlier but the earthquake on 8th October was one of the most devastating events recorded in the recent history of Pakistan.

Fig 1- Map of the Northern districts of Pakistan

The area affected by the earthquake of 8th October is located within an active fault zone covering the northern Pakistan and adjacent parts of India as well as Afghanistan. As per the literature, the earthquake of 8th October can be regarded as the direct result of the stress releases in the tectonically active zone of Indian subcontinent moving northward at a rate of about 40 mm/yr (1.6 inches/yr) and colliding with the Eurasian Plate. This ongoing process of collision is also otherwise responsible for creation of highest mountain peaks in the world including the Himalayan, and other associated mountain ranges of Hindukush-Himalayas. The seismic map in Figure 2 shows that the affected area as well the other northern areas of Pakistan are under high earthquakes risk.

2. What happens during an earthquake?

The total energy released by an earthquake is measured by instruments and expressed in Richter scale. The value shown in this scale is the magnitude of the earthquake and in the case of Pakistan it measured to be in the region of 7.6 on the Richter scale. The point on the earth's surface directly above the faulting, where energy release first starts, is called as the epicenter. As shown in Figure 3, the epicenter was most heavily shaken during this earthquake.

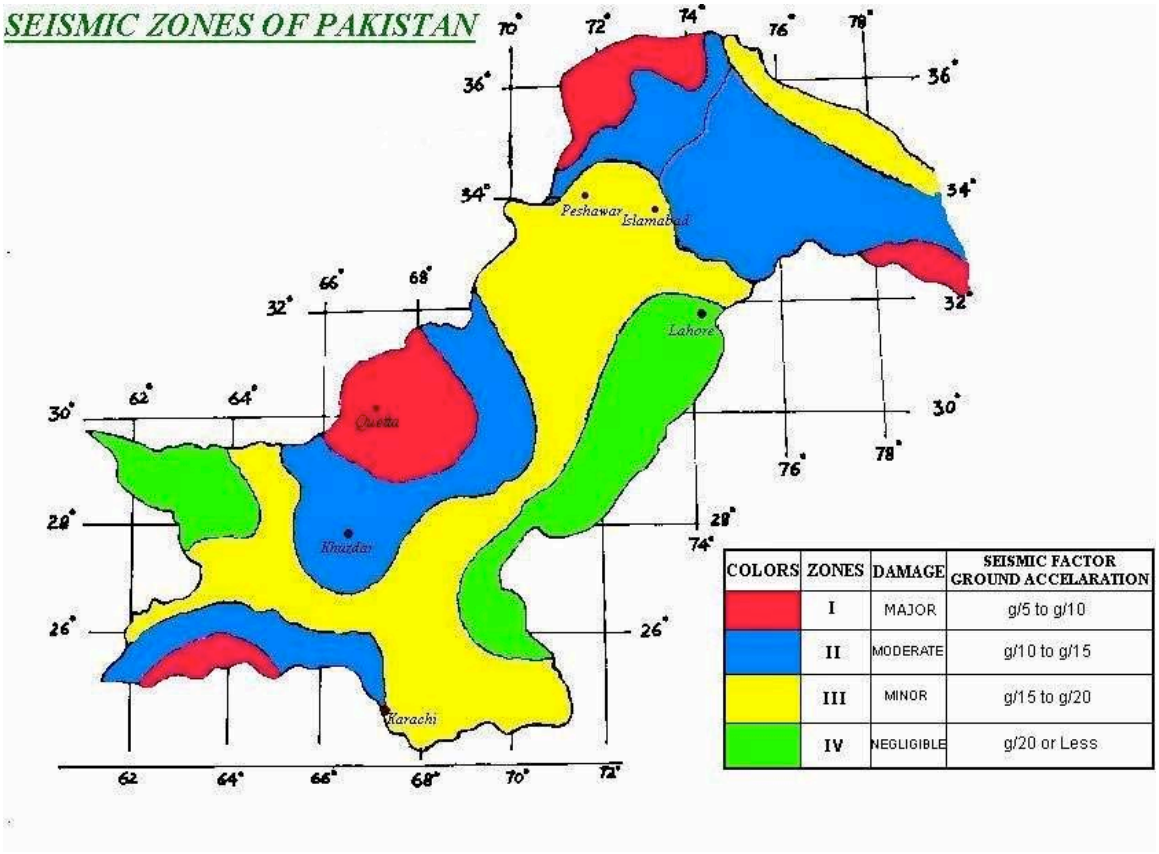


Fig. 2 - Seismic Zones in Pakistan (Source: Meteorological Department, Peshawar)

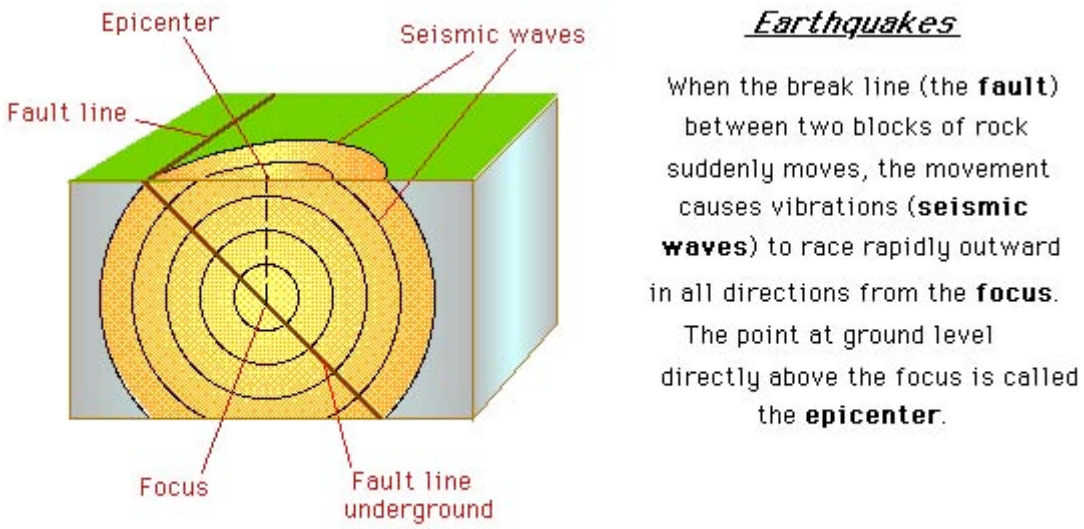


Fig. 3 - Epicenter
(Source: http://cse.ssl.berkeley.edu/lessons/indiv/davis/inprogress/QuakesEng3.html)

The ground failure from an earthquake may be observed in the form of ground rupture along the fault zone and associated impacts such as landslides, subsidence and settlement, and soil liquefaction. Ground rupture can be of different magnitudes. According to the reports of this particular earthquake, the width and length of the rupture zone was about 40km and 100km

respectively. The building directly traversed by such a rupture will collapse or be severely damaged. If the foundation soil consists of uniform loose sand, within a depth of 8 m below the ground surface, and is either saturated by or submerged under water, it may behave like a fluid when shaken by a strong earthquake (Arya, 1987). The effect of such a situation, on a building, will be either sinking or tilting and cracking or collapsing (No evidence has been found in this connection during the field visit and in the reports produced by experts).

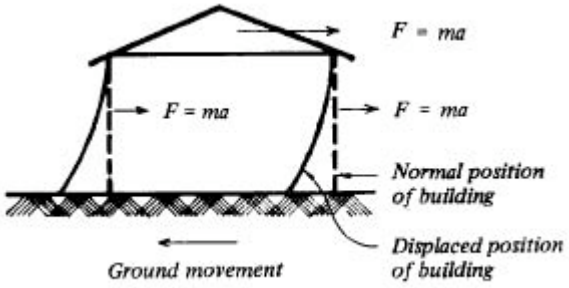


Fig. 4 - Forces applied on a building due to ground movement from an earthquake (Source: Arya, 1987)

Forces applied on a building due to the ground movement from an earthquake, is as a result of the inertia of the mass of the building. Some possible damages that can be caused by an earthquake for different parts of a building are listed in Table 1.

Table 1: Damages that can be caused by an earthquake to different parts of a building

Part of the building	Possible damages
Roof	a. Collapse of the roof due to lack of support from the roof carrying structure b. Dislocation of roof trusses, purling, etc. from the wall c. Displacement and falling down tiles, cracking of roofing sheets (.g. asbestos cement), ceiling sheets d. Falling of parapets, chimneys, baloneys etc.
Walls	a. Fall out of infill walls, Cladding walls and gable ends b. Shattering of random rubble masonry walls, falling of inner and outer layers of the wall away from each other c. Diagonal cracking of wall piers between window and door openings, shearing of columns d. Overturning of boundary walls, free standing partitions e. Gaps in walls due to collapse of portions of the walls f. Horizontal and vertical cracks in walls due to bending of wall normal to its plane g. Fine or wide cracks in walls h. Falling of plaster from ceiling and walls
Foundation	a. Spreading of individual column footings in soft soil b. Foundation soil failure which may result in sinking, tilting and cracking or collapse of buildings

Adapted from Arya (1987)

In addition to the above mentioned damages, buildings can be subjected to some general damage due to an earthquake such as partial collapse of building, complete collapse of staircases (free standing), collapse of old wooden frames due to deterioration of joints, decayed parts etc. and torsion failure of unsymmetrical buildings.

3. Information produced by experts immediately after the event

Following the earthquake US Geological survey issued a **Preliminary Earthquake Report** on the event. Given below is the extract from the report, issued by the U.S. Geological Survey, National Earthquake Information Center - World Data Center for Seismology, Denver:

A major earthquake occurred at 03:50:40 (UTC) on Saturday, October 8, 2005. The magnitude 7.6 events have been located in PAKISTAN (This event has been reviewed by a seismologist).

Magnitude: ***7.6***
Date-Time: *Saturday, October 8, 2005 at 03:50:40 (UTC)=Coordinated Universal Time*
Saturday, October 8, 2005 at 8:50:40 AM *= Local time at epicenter*

Time of Earthquake in other Time Zones
Location: *34.493°N, 73.629°E*
Depth: *26 km (16.2 miles) set by location program*
Region: ***PAKISTAN***
Distances:
105 km (65 miles) NNE of ***ISLAMABAD, Pakistan***
115 km (70 miles) ESE of ***Mingaora, Pakistan***
125 km (75 miles) WNW of ***Srinagar, Kashmir***
165 km (105 miles) SSW of ***Gilgit, Kashmir***

Location Uncertainty: *horizontal +/- 3.6 km (2.2 miles); depth fixed by location program*
Parameters: *Nst=280, Nph=280, Dmin=907.3 km, Rmss=0.79 sec, Gp= 22°,*
M-type=teleseismic moment magnitude (Mw), Version=U
Source: *USGS NEIC (WDCS-D)*
Event ID: *usdyae*
Felt Reports: *More than 79,000 people killed, 65,308 injured and extensive damage in northern Pakistan. The heaviest damage occurred in the Muzaffarabad area, Kashmir where entire villages were destroyed and at Uri where 80 percent of the town was destroyed. At least 32,335 buildings collapsed in Anantnag, Baramula, Jammu and Srinagar, Kashmir. Buildings collapsed in Abbottabad, Gujranwala, Gujarat, Islamabad, Lahore and Rawalpindi, Pakistan. Maximum intensity VIII. Felt (VII) at Topi; (VI) at Islamabad, Peshawar and Rawalpindi; (V) at Faisalabad and Lahore. Felt at Chakwal, Jhang, Sargodha and as far as Quetta. At least 1,360 people killed and 6,266 injured in India. Felt (V) at Chandigarh and New Delhi; (IV) at Delhi and Gurgaon, India. Felt in Gujarat, Haryana, Himachal Pradesh, Madhya Pradesh, Punjab, Rajasthan, Uttaranchal and Uttar Pradesh, India. At least one person killed and some buildings collapsed in Afghanistan. Felt (IV) at Kabul and (III) at Bagrami, Afghanistan. An estimated 4 million people in the area left homeless.*

Landslides and rock falls damaged or destroyed several mountain roads and highways cutting off access to the region for several days. Landslides occurred farther north near the towns of Gilgit and Skardu, Kashmir. Liquefaction and sand blows occurred in the western part of Vale of Kashmir

and near Jammu. Landslides and rock falls also occurred in parts of Himachal Pradesh, India. Seiches were observed in Haryana, Uttar Pradesh and West Bengal, India and many places in Bangladesh.

Earthquakes and active faults in northern Pakistan and adjacent parts of India and Afghanistan are the direct result of the Indian subcontinent moving northward at a rate of about 40 mm/yr (1.6 inches/yr) and colliding with the Eurasian continent. This collision is causing uplift that produces the highest mountain peaks in the world including the Himalayan, the Karakoram, the Pamir and the Hindu Kush ranges. As the Indian plate moves northward, it is being subducted or pushed beneath the Eurasian plate. Much of the compressional motion between these two colliding plates has been and continues to be accommodated by slip on a suite of major thrust faults that are at the Earth's surface in the foothills of the mountains and dip northward beneath the ranges. These include the Main Frontal thrust, the Main Central thrust, the Main boundary thrust, and the Main Mantle thrust. These thrust faults have a sinuous trace as they arc across the foothills in northern India and into northern Pakistan. In detail, the modern active faults are actually a system of faults comprised of a number of individual fault traces. In the rugged mountainous terrain, it is difficult to identify and map all of the individual thrust faults, but the overall tectonic style of the modern deformation is clear in the area of the earthquake; north- and northeast-directed compression is producing thrust faulting. Near the town of Muzaffarabad, about 10 km southwest of the earthquake epicenter, active thrust faults that strike northwest-southeast have deformed and warped Pleistocene alluvial-fan surfaces into anticlinal ridges. The strike and dip direction of these thrust faults is compatible with the style of faulting indicated by the focal mechanism from the nearby M 7.6 earthquake.

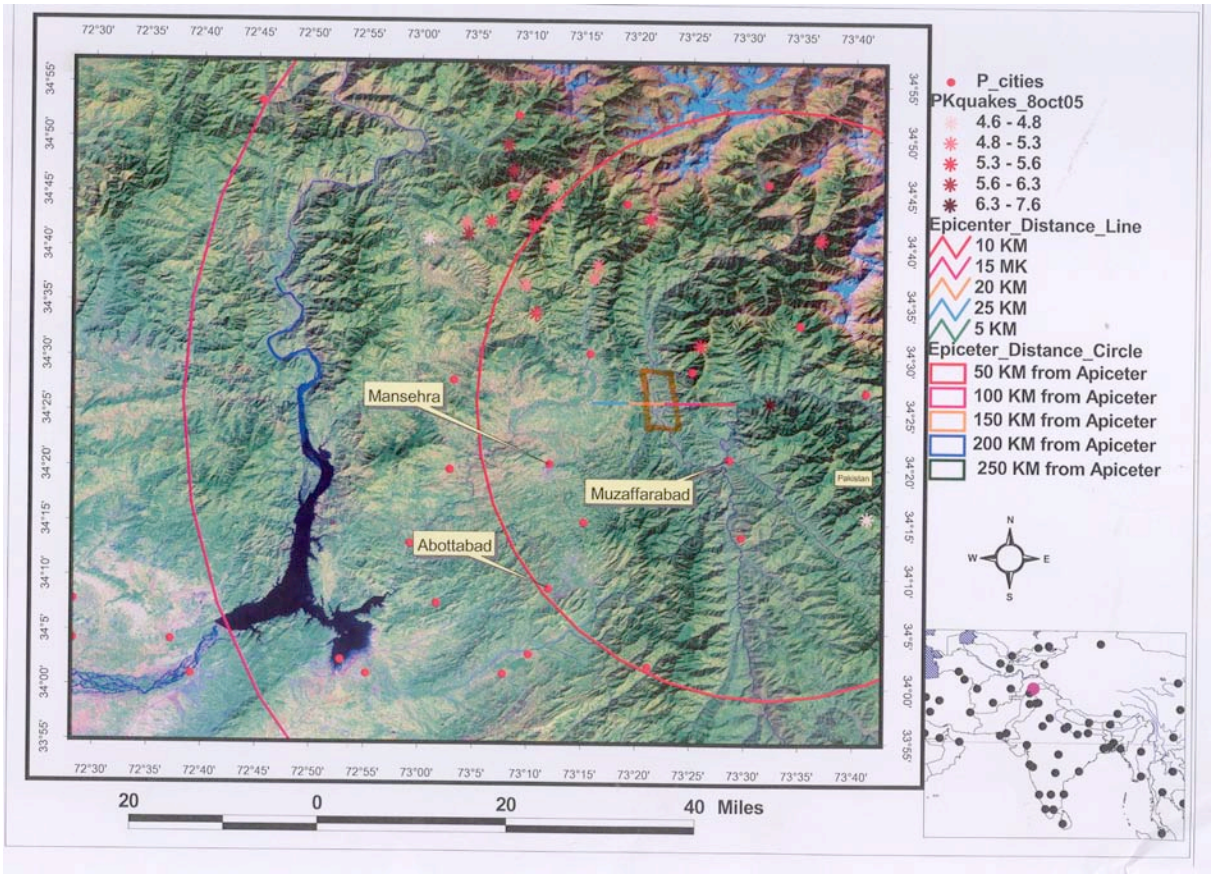


Fig. 5 – Pakistan Earthquake's Epicenter

4. Methodology adopted during the study

For assessment of the impact of the earthquake on northern districts of Pakistan the investigation team looked into three aspects related to damages and destruction caused by earthquake to buildings: (i) Visual observation of direct impacts due to disaster, (ii) Indirect impacts and secondary effects of the event during the immediate post disaster period and; (iii) factors contributing to the high-risk environment. Wherever possible, the victims, relief workers and other government and non-government officials involved in the post disaster activities were interviewed for obtaining necessary information.

5. Caveats

For interpretation of the teams' findings, it is essential to keep two factors in mind. Firstly, given the spread area of the earthquake event and the scope of the rapid assessment, the team was neither able to focus in details on the impact to other sectors nor could they consult with entire range of public and private organizations involved in the operations during the immediate aftermath of the event. Therefore, the team focused on the factors contributing to damages to buildings only, and there might be some gaps in the coverage of the assessment of the particular aspect. Secondly, the data available in the aftermath of the earthquake was preliminary and incomplete and most of the key statistical parameters continue to change daily.

6. Key Findings

This particular event is one of the biggest natural calamities experienced in the recent history of Pakistan, in terms of devastation and magnitude. In terms of direct costs, it is very difficult to estimate the total wealth lost at this stage given the limited information available till date. In particular, detailed survey data of capital and inventory losses in any of the sectors is not yet available. On the basis of the observations made and assumptions the major sectors affected are:

- Housing and human settlements;
- Infrastructure and services;
- Agriculture;
- Health; and
- Education

The earthquake event has had a huge social impact to the general life of all the citizens of Northern Pakistan. The total fatality rate from the event is in the range of 75,000 as per the official figures. The actual figures may be higher since many rural areas, affected by the event, are scattered within a large area and it is difficult to obtain actual population statistics. Also, the actual number in the urban areas, buried under destroyed building mass, will also not be accurately known for a long time. However, the number of deaths, recorded within a day, is considerable as compared to country's natural daily crude death rate. Injury rates are also very high and many of the survivors are traumatized by their ordeal. An estimated number of 3 million people have been left homeless. Around 17,000 children are among the dead as per unconfirmed sources and The Ministry of Education estimates that a very high number of school-aged children are among dead and homeless. Employment losses in the affected areas are estimated to range from 20 percent to nearly 50 percent. Addressing these social costs will impose an added burden on the Government of Pakistan. The highest losses recorded are from the human settlements, commercial and agriculture sectors.

Large number of tents is being used as temporary shelters for Internally Displaced Persons (IDPs), therefore authorities are facing a secondary problem of providing necessary facilities, such as, temporary shelter for a huge number of IDPs in the forthcoming winter season and to look after their welfare, health and sanitation, food and other essential utilities. The resumption of schools in the coming year is likely to be delayed in areas affected by the events due to above reasons.

Table 2: Estimated Cost of Earthquake

Category	US $	US $
Death &Injury Compensation		**205,000,000**
Relief		**1,092,000,000**
Early Recovery		**398,000,000**
Livelihoods: grant portion		*97,000,000*
Livelihoods: non-grant portion	*12,303,500*	
Other sectors	*288,696,500*	
Sub-total		*301,000,000*
Reconstruction		**3,503,000,000**
Short-term reconstruction		*450,000,000*
Long-term reconstruction		*3,053,000,000*
Total		**5,198,000,000**

Source: As reported by UN Agencies Recovery Needs Assessments and ADB/WB Preliminary Damage and needs Assessment, November 2005.

Table 3: Key Impacts of the Earthquake

Indicator	Latest Estimate	Sources
Area affected	30,000 sq km	FRC
Population affected	Between 3.2 million and 3.5 million	FRC
Deaths	73,000	FRC
Injured	79,000	FRC
Houses	400,153 (damaged and destroyed)	ADB/WB
Families affected	500,000 (seven persons per family on average)	UNOCHA
Number of food insecure	2.3 million	WFP/UNICEF
Latrines needed	160,000	UNICEF
Number of school children affected	955,000	UNICEF
Number of women affected (age15-49)	800,000	UNFPA

Source: *Pakistan 2005 Earthquake, Early Recovery Framework (With Preliminary Costs of Proposed Interventions) by United Nations System, Islamabad, Pakistan, November 2005 (http://www.reliefweb.int/rw/rwb.nsf/db900SID/RMOI-6J89V9?OpenDocument)*

6.1 Government Response and International Support

The Government's initial emergency response to the earthquake event under the directive of HE President of Pakistan was satisfactory and rapid action was taken by the army and government authorities to reach and provide relief supplies to remote areas, which are inaccessible or difficult to reach. UN agencies, other international donor agencies, national and international NGOs, CBOs, informal institutions set up by communities and large number of representatives from international

institutions are also attending to the immediate needs of the displaced population and are assisting the government to establish normalcy after the event in meeting the immediate needs of most of the victims.

Few weeks after the event, most of cleaning up operations have been completed to clean up the debris from roads and road network has been re-established. The authorities have rendered a commendable service in all aspects and very good progress has been made so far.




The emergency services and temporary hospitals and shelters

6.2 Heavy devastation caused due to high risk

From the areas visited, maximum damages were observed in the city of Balakot. The ground motion seems to be have been very severe in and around Balakot. Ground rupture has been observed in several areas within the city and in the vicinity on mountain slopes, roads and pavements etc. Also in some areas a slump in the ground along the fracturing was observed.

Devastation at Balakot

The maximum size of the observed openings were about 15-20 cm in width and few meters in length in some places while in some places width of the openings was limited to few centimeters. It can be inferred that Balakot was surely falling within the rupture zone; therefore the intensity of the earthquake impact was very high within the city area. Heavy destruction in the city was mainly due to the high intensity of the earthquake and the buildings and other structures could not withstand the ground acceleration created by the earthquake.

Fissures and openings caused by the earthquake

A number of factors should be considered in future recovery programs in order to integrate measures to mitigate high risk. Therefore, it is important to understand how risk is created. *Risk generally consists of three components: Hazard, Vulnerability and Exposure. Any risk mitigation program should consider mitigating all three components to reduce the total risk in a future event. Obviously, the hazard intensity was the major factor behind causing such devastation in the area, which cannot be controlled or predicted by any means.*

Similarly, the level of exposure also played a role and is the reason why destruction was not uniform in all areas affected. Depending on the distance of the location to epicenter the magnitude of destruction observed, varied. The other major factor was the vulnerability of the various elements (structural, physical, social, economic and environment).

The main vulnerability apparently was created due to the lack of understanding of the nature of hazard and lack of knowledge of preexisting risk due to earthquake hazard. There were no such severe incidents reported in the recent history in the same area and little attempt was made to share experience of similar disaster events that had occurred elsewhere. Such an approach would have helped in building of a strategy to highlight the existing vulnerabilities and to undertake measures in reducing them.

The above-mentioned factors contributed in creating high losses and damages due to earthquake disaster. The scenario reiterates the fact that the disasters are capable of revealing the existing vulnerabilities (its social, economic, physical and environmental dimensions) and should serve as a lesson to all other countries known to be under threat of earthquake hazard.

6.3 Issues related to physical vulnerability reduction

The physical vulnerability was created due to various reasons. Among them are; location of the settlements within the impact zone; low level of structural competence of buildings, lifeline facilities and infrastructure to withstand ground acceleration created by the earthquake; landscape conditions etc.

The type of buildings in the impact zone can be categorized as per the usage such as:

- Commercial building such as shops, office buildings, commercial buildings, etc.
- Dwelling houses
- Government buildings
- Service buildings such as school buildings, hospitals etc.

Commercial buildings:
The commercial buildings were mainly concrete frame structures but still the destruction seemed to be very high in Balakot, medium to high (around 50-60% destruction) in Bagh and to a lesser degree in other cities.

The multi-story buildings can be categorized into:

- UNFRAMED STRUCTURES: those in which the weight of the floors and roof are supported by the bearing walls
- FRAMED STRUCTURES: those that consist of a structural steel or reinforced concrete skeleton made of horizontal beams and vertical columns

In case of some multi-storied buildings, the ground floor, which generally consists of shops with columns and walls, was completely destroyed and sandwiched in between the ground and upper floors. In most of the cases, the ground floor suffered heavily causing total collapse of the building.

In single story buildings (mostly light frame, light wall structures with columns and concrete slab) destruction was much higher. In Balakot it was nearly 90%. Buildings of both kinds, with concrete slab roof or with light corrugated iron sheet roof, suffered equally.

Damage to a building can be classified as two types:
STRUCTURAL: affecting structural (load-bearing) elements and;
NON-STRUCTURAL: affecting non-structural and decorative elements

Structural failures

In some buildings structural defects have been noticed which are related to weak joints, poor workmanship and design shortcomings. This has helped to prove one of the misconceptions that the concrete buildings are stronger. As a general practice most of the buildings in such remote areas are constructed using the general construction practices, without engineering advise and supervision and therefore cannot be considered as engineered buildings. No building codes have been applied strictly, in terms of quality control, as is the case in many developing countries One general practice is incremental expansion of buildings depending on the availability of funding and people tend to leave reinforcement bars unprotected when they construct the ground floor with the expectation of

adding more floors at a later stage. This provides weaker joints in many cases since the waiting time may be longer than few years.








Causes of failure
(Weaker joints, structural failures, poor workmanship etc.)

The team also inspected one of the building sites in Islamabad where one multi-storied building collapsed totally. At the time of inspection the damaged areas had been cleaned up but the onlookers who had seen the building collapse told that the ground vibration continued for a considerable time (nearly about 1 to 2 minutes) and the collapsed building along with other neighbouring buildings started swinging and later gave away while other buildings remained intact. It is pre-mature to make a decision on the failure mechanism but there should be a through investigation into the event rather than reaching conclusions through assumptions.


Multi-storied building collapse

Dwelling houses

The capacity of the dwelling houses to withstand earthquake depends on the structural integrity, workmanship, building quality, compliance to building codes, building material strength and aging of buildings.

Most of the residential buildings destroyed were either non-engineered buildings owner built. The destruction was mainly caused due to the fact that more than 50% of buildings were not constructed in compliance with building code and also ageing factor played a major role in their structural weaknesses.

Majority of the dwelling houses in the rural areas are built using traditional practices. The walls are either stone masonry with clay mortar or are stone packed. In certain cases the walls are adobe construction with clay mortar. The roof is constructed using a single or few layers of timber, covered with grass and clay. This gives better insulation and protects from rain and snow during winter. Some people had misconception that the buildings collapsed due to heavy roof slab but actually they have collapsed under the impact of ground acceleration created by earthquake on the weak walls. In addition to foundation material and walls, configuration of the buildings, which is usually rectangular in shape, and the building direction also play a role. According to the findings one or more factors mentioned above have contributed to collapse of such buildings.








Destruction to rural houses

Majority of houses in urban areas (Balakot, Mansehra, Bagh etc.) are modern buildings like in any other developing country in South Asia. The team observed some of such structures, dwelling houses that were, mostly single story buildings (mostly light frame structure, light wall structures with columns and concrete slab) and some multi-storied buildings that had been partially or totally destroyed. It was found that general defects seen in the commercial buildings were also common to these types of buildings. The cement block buildings with weaker mortar layer suffered most destruction.




Destruction to the modern dwelling houses

Therefore, vulnerability of the constructed houses is caused due to weak walls, overall workmanship, poor design as well as structural defects. It is generally perceived by communities that light roof might be better in terms of saving lives, but if walls are not strong enough then even light roof houses will become death traps.

Light roof does not save lives

Government buildings

The team could not inspect many government buildings. Comments made herein should not be taken as the general reason behind the collapse of such buildings. The buildings might not have been designed to withstand such a high intensity earthquake and that might be the main reason behind their collapse. As per the observations made on a few buildings, vulnerability has been caused due to poor technology used (workmanship and construction material). The government buildings are usually designed and supervised by engineers and have been constructed according to the building codes. The general practice followed by government institutions is to conduct an investigation on the failure pattern, which should be taken as an opportunity for review of building codes. The quality may have suffered also due to the usage of river stones as construction material. The general practice in Bagh, as observed, is to use splitted stones, obtained from river bed, as construction material but because of their rounded surface they provide weaker bond when used with weak cement mortar. These tend to be subject to shear failures easily. The interlocking may provide additional strength, when rough and irregular surfaces are placed against each other during construction, but the methodology adopted in construction in Bagh is not the best option to acquire required strength to withstand very strong earthquake ground accelerations. It would be better to review such traditional practices in future.

Destruction to the government buildings

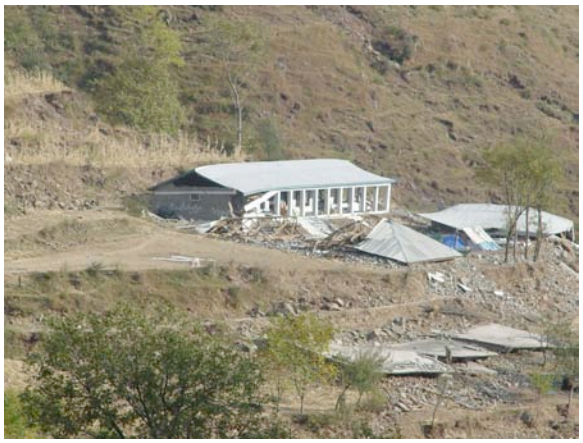
Service buildings such as school buildings, hospitals, mosques etc.
As per the records as many as 8000 school buildings have been destroyed due to the earthquake and around 17,000 school children have died as consequence of the earthquake. Unfortunately the earthquake happened during school hours when children and teachers were inside the buildings, causing massive fatalities. The team did not have an opportunity to see many buildings but had the opportunity to visit Boys High School in Bagh. Most of the school buildings are stone masonry with corrugated tin sheet roof or concrete frame buildings. The stone masonry buildings suffered the most and mostly due to weakness of construction material as they were mainly constructed using rounded river stones after splitting them into two to have a pointed surface as the outer wall.

Diagonal cracking of walls in partially damaged building

Non-structural elements, including electrical appliances, have also suffered a lot of destruction. In contrast to the school buildings, the mosques suffered less damages and the buildings seems to be stronger since most of them are concrete buildings. The team did not have a chance to visit any of the hospitals. Due to large-scale destruction faced by the hospitals as well as due to their insufficient

capacity to accommodate the large number of patients, a few NGOs have set up mobile hospitals in Balakot as well as in other cities.

One of the lessons that can be learned from the heavy damages to service buildings is the need for special design codes and practices for construction of such critical facilities. Though these buildings have to be constructed quickly but the decision on adoption of special construction codes for such buildings have to be made as a priority requirement before the commencement of reconstruction programs.

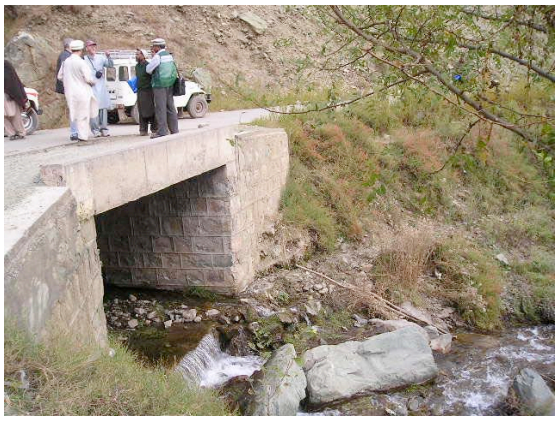



Destruction caused to School buildings and Mosques

Infrastructure

The infrastructure, such as roads and bridges, and lifeline facilities, such as electrical supply lines, water supply lines etc. also suffered heavy damages. The road network was paralyzed due to large-scale landslides and slope destabilization due to the high ground motion. Some of the bridges even suffered minor displacements, in Balakot and Bagh. The roads have been cleaned up as of now but after the winters and during the monsoon season the mass movement can get activated again. The electrical supply was disrupted due to damage to supply lines, transformers etc. Also the water supply was disrupted due to the damage of supply lines.






Photographs of destroyed infrastructure facilities

6.4 Social-economic Vulnerability

The sufferings of the communities affected are associated with their livelihood and income generating activities. The rural population is scattered in a considerable area but are reluctant to leave the area due to the fact that they don't want to leave their animals behind. Their economic activities are mainly associated with living environment and animals. Animal raising and use of animals in agriculture are few income generating options available to communities living in rural mountains. Therefore it is difficult to disconnect them from the living environment since social and cultural factors are directly connected to such living environment. This obviously contributes to

increase their vulnerability. For example, it will be difficult to resettle farming community away from the agricultural area and mountains as it is connected to their livelihood. The community has been living in temporary sheds, semi-permanent houses in the impact zone for centuries and they would like to continue their life in the same way.

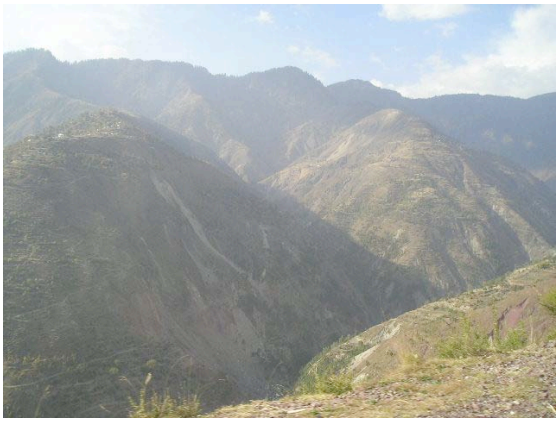
Escalation of socio-economic vulnerability of most of the affected urban families who are dependent on either small family businesses or are self-employed is unavoidable in case of such an event. They loose everything they posses and have to start all over again. The farming community at least has the land, which is their main income source but for the urban community sufferings are higher due to direct damages and long term loss of income avenues. Therefore, the government should consider vulnerability reduction not only through provision of physical means but also through a holistic approach, looking at the livelihood and living environment.

Other noticeable factor is the high number of fatalities recorded amongst school going children. This once again proves that the most vulnerable groups during disasters are children, women and elderly people who generally remain inside the buildings during a disaster. Due to the specific nature of social and cultural practices in Pakistan, the single parent families, widows and children who have lost both their parents will undergo serious difficulties in future. Although it is too early to have the full picture of social and economic vulnerabilities of the affected population, it is obvious that there should be special programs undertaken to address their needs.

Fields and farm animals

6.5 Environmental Dimension in Vulnerability

The impact to environmental resources and bio-diversity by this earthquake are also considerable. Many big landslides occurred in Balakot area. Many roads, in Balakot as well as in Kashmir, were blocked by debris, which will continue to cerate similar problems during as well as after monsoon. River network is also blocked by debris flow, causing contamination of river water.



Landslides caused by the earthquake

In most of other areas the disaster lead to the environment pollution. The cleaning operations were successful in cleaning up of roads and transportation network, but the cities affected, which had become a pile of debris, cleaning up activities have yet to start. Since most of the dead bodies are still buried under the rubble, it will be difficult to commence the cleaning up operations in some of the cities. On the other hand, some of the commercial operations have started in the buildings, which were partially destroyed, for example in Bagh and Mansehra to satisfy the customers before the festival season.

It would be better to undertake measures to recycle the material found everywhere amongst debris, rather than further polluting the rivers and lower areas through filling of cleared debris. People should also be educated and made aware about undertaking environmentally friendly practices during cleaning up operations.

Rubble and destructions

7. Recommendations

The following recommendations can be considered by the authorities:

- General
- Human Settlement
- Infrastructure Development Issues and Other Sectors

General

- The Government's immediate response in coping with the situation during the response phase of the disaster is commendable and efficient. However it is necessary to consider setting up an institution to deal with the full recovery phase. The experience in India after the Gujarat Earthquake and Orissa cyclone, in Japan after Kobe earthquake, in Turkey after the earthquake in Marmara Region will be very valuable and government should seek assistance from the international community to facilitate a process for such experience sharing. ADPC is willing to provide necessary assistance for facilitating the same.
- It is important to consider a multi-hazard environment in designing any program for long-term risk mitigation under the recovery program. It will not be advisable to execute a program based only on an individual event such as the earthquake event, when formulating policies and long term risk reduction measures.
- The natural calamities experienced by the country and resultant economic losses should compel the Government to consider setting up of an appropriate **Specialized Umbrella Agency** to deal with all the aspects of Disaster Risk Management. The institution should have authority, independence and technical competence in decision making towards policy formulation and implementation, research, early warning and in undertaking interventions aimed at mitigation of risk.
- Pakistan also needs to have a set of technical institutions with clearly laid down responsibilities and mandate for carrying out studies or to offer services for mitigating the impact of potential hazards. Traditionally, earthquakes, drought, floods, cyclones, landslides etc. have been considered as potential hazards but the government institutions should have a policy for undertaking proactive approach for risk reduction. Most of the disaster risk management institutions in the world were borne as a result of disaster events, therefore Pakistan government should use the window of opportunity provided by Earthquake of October 8 to promote a culture of safety throughout the country.
- The government should identify above- mentioned technical institutions as soon as possible and provide resources for building their capacity. It is often seen that most of the technical institutions are poorly placed when it comes to early warning, preparedness and mitigation due to lack of equipment, trained cadre etc. They cannot place much emphasis on other priority functions such as research studies and services pertaining to hazardous events since they neither have mandatory provisions to deal with such events nor do they have to provide services. The reliability of information depends on sophistication of systems adopted. Therefore, this event provides good opportunity for the government to obtain international assistance for establishing and building up of the local expertise in hazard related services.

Human Settlement Sector

- Providing winter shelter for around 3 million population displaced and made homeless is one of major immediate challenges faced by the government. Most of the affected families

are living in tents at the moment but new shelter options have to be made available within the next year for the victimized families. However the exact figure has to be established by a team of shelter sector specialists and the solutions have to be made available soon before commencement of winter. The team after inspecting a house provided by PAI, which is made out of steel sheets, inferred that these types of houses seemed to be very cost effective since the material can be reused in permanent houses as roofing material.


The present status of temporary shelters

Other temporary shelter options designed in Bagh

Temporary shelter proposed by PAI

- Determination of the status of affected buildings to be carried out by a qualified set of professionals and damage and loss estimation should be carried out with the status report prepared by them. An inventory and certification of status and estimation of damages should be done as soon as possible and it should be viewed as one of the priority subjects under the recovery program. There are buildings with minor as well as smaller structural damages, which can be easily retrofitted without demolition. But as common people will not have correct understanding about which buildings should be demolished which should be repaired, the inspection teams should be able to provide such advise during the loss estimation process.

Non-Structural defects

- As a general component of the recovery assistance program, the Habitat for Humanity International is planning to have a Disaster Response Program and under the same they are planning to set up Disaster Resource and Training Centers (HDRTC). Such centers will be set up within the areas affected by earthquake event with the aim of training skilled workers, artisans, builders, home owners etc. in appropriate technologies. Under the same program they intend to provide necessary resources to the affected population for building shelters. The purpose of the program is to develop the capacity of local builders. The program may include local and international NGOs who will be involved in reconstruction and training programs. It might be better if they could be provided with type plans, and design and construction methodologies for usage of locally available construction material.

- Some of those affected by the earthquake have already begun to reconstruct their homes. They are planning to use the remaining and recovered material from destroyed houses and may use the traditional know-how in construction. While this should be encouraged, safer designs should also be incorporated into their building practices. It would be better if authorities or NGOs involved in recovery assistance could help them in better construction. Steps such as, strengthening walls of traditional houses by usage of cement mortar, light reinforcement using locally available bamboo as well as steel reinforcement should be taken which would not cause extra burden to the local house owners. However bulk of the construction is expected to take place after the winter season and it might be better if other institutions also take similar steps like Habitat for Humanity International to improve the quality standards of construction during recovery phase.


Reconstruction efforts

- The team has a number of findings on the contributory factors for high risk. The physical vulnerability is one of the main components considered under the human settlement studies during the rapid assessment. Factors such as structural competence of buildings and structures, location, direction of buildings, configuration, structural integrity, workmanship, building quality, compliance to building codes, building material strength, aging of buildings etc. contribute to creating a high-risk scenario. The above factors should be considered in the design phase of the recovery program. The team recommends that the recovery programs should include a component on training and capacity building on construction in disaster prone areas to benefit construction professionals, property developers, artisans and other significant actors involved in the recovery phase. They should have a basic knowledge on earthquake occurrence and how buildings can be made stronger to resist earthquake generated ground accelerations. It should be made part of the training of technical hands, government officers and professional staff involved in recovery programs.

- The Government is considering major policy decisions on the future developments within the impact zone. The team feels that it is necessary to initiate a dialogue among all the professionals and other stakeholders, including communities living within the impact zone, to aid the implementation of sustainable set of policies.

- At present, the authority for granting approval for any type of construction lies with the local government institutions including construction in hazard prone areas. However, during disasters the entire responsibility is placed under the central government institutions. Therefore, it is advisable at this stage to redefine the authorities and responsibilities of different governmental institutions. It is recommended that local governments should be given a larger role in control of development within disaster prone areas and should be assigned a managerial role for disaster events within the authority area under the guidance of the federal government.

- The government must strengthen the enforcement of building codes throughout the country. Stiffer penalties and an effective building supervision and licensing system are urgently needed to ensure better structural performance of buildings in hazardous events.

Infrastructure Development Issues and Other Sectors

- Before embarking on a major reconstruction program, it is recommended that a comprehensive risk assessment be carried out to determine the feasibility of reconstruction on the existing sites and find out the extent to which relocation will be needed. This should be the basis for all the sectors with suffered large-scale impacts.

- The recovery program should be formulated with considerations to all the sectors and stakeholders including the communities. It will not be advisable to take standalone sector-based decisions without consultation and cross-reference of related issues. A more advisable approach is to have one comprehensive recovery program managed by a single institution, with sub-components, being managed by other sector - based institutions.

- Emphasis should be placed on common infrastructure facilities within the recovery program. In order to establish normalcy, it is imperative to rehabilitate the present facilities at their present locations as an interim measure. However, the recovery program should take in to consideration the long-term development program of the impacted area.

Message from ADPC

ADPC is willing to help the Government of Pakistan in aspects mentioned above for making communities safer for the sustainable development of Pakistan in future and consider it as its obligation and privilege.