Chapter 5

Hazard-specific Preparedness

Floods

Pakistan has faced several flood disasters since its independence in 1947. This led to development of strategies and institutions dedicated to flood-disaster preparedness. Whereas the rescue and evacuation operations remained in the control of the Pakistan Army, institutions such as the Federal Flood Commission, WAPDA, and the Flood Forecast Division developed strategies for mitigation and preparedness.

The existing flood management strategies in practice are outlined below.

Structural measures

a. Construction of embankments
b. Construction of spurs and battery of spurs
c. Construction of dykes, gabion walls, and flood walls
d. Construction of dispersion and diversion structures
e. Channelling of flood waters
f. Construction of delay action dams
g. Construction of bypass structures

Non-structural measures

Improved flood forecasting systems through the following.

a. An effective system of data collection and dissemination
b. Collection of real-time rainfall and river flow data
c. Prediction of weather by radar
d. A modern system of transmitting flood forecasts
e. An improved early flood-warning system:
    i) giving early flood warnings based on effective flood forecasts, and
    ii) reliable interaction between all flood-control and relief agencies
f. Timely warning and evacuation arrangements by provincial relief departments and district administrations

Flood protection plans and works

As shown in Table (4), several flood protection plans have been adopted since 1977, of which two plans, each of 10 years covering the period until 1998, have already been implemented. A master feasibility study of hill torrents was also completed in 1998. A comprehensive Flood Protection Plan is in process; while a new 10-year Comprehensive Flood Protection Plan is now finalised and is in the implementation phase from 2006 to 2015. In total, ~ 6000 km of embankment works have been completed with the construction of over 1,300 spurs (Table 4). At the moment more than 170 spurs and embankments are being constructed at vulnerable points. Pakistan has made a reasonable investment in flood-protection works (Table 5). Significant progress has been made in the early flood-warning system in recent years (Table 6).

Table 4: A brief list of flood protection plans adopted and executed in Pakistan

Plan	Period of completion	No. of flood protection schemes completed	Investment cost (Rs in million)
National Flood Protection Plan PHASE-I, 1977 to 1987 (NFPP-I)	1988	350	1,767
National Flood Protection Plan PHASE-II, 1988 to 1998 (NFPP-II)	1998		7,576
• Normal annual development programme	1998	170	2,541
• Flood/rain damage restoration project	1988	2,065	2,300 (+US$ 200m)
• Flood protection sector Project-I	1998	257	4,860 (+US$ 131m)
• Flood/rain damage restoration project	1992-1994	1,980	6,659 (+193m)
Master feasibility studies for harnessing of flood flows of hill torrents of Pakistan	1998		24,950
National Flood Protection Plan/ Comprehensive Flood Management Plan	To be completed by 2012		25,965
Perspective Five Year Plan for Flood Control, Development and Management (2005-06 to 2009-10)	2009-2010		14,500

Table 5: Summary of federal investment in flood protection works, 1977-6/2005

Name of Province/Federal Line Agency	Investment (Rs in million)	Percentage of total investment
Punjab	4,456	44.3%
Sindh	3,576	35.6%
NWFP	1043	10.4%
Baluchistan	750	7.5%
FATA	120	1.2%
Northern Areas (NA)	81	0.8%
Azad Jammu & Kashmir	29	0.3%
Total	**10,056**	**100%**

Table 6: Existing flood forecasting facilities, Pakistan Meteorological Department	
1.	Preparation of rainfall-runoff models for upper catchments of the rivers Jhelum, Chenab, Ravi, and Sutlej and their tributary hill torrents and 'nullah'; these also included the tributary rivers and hill torrents and 'nullah' of the River Indus from Mandori to Taunsa
2.	Preparation of river flow models for the rivers Jhelum, Ravi and Sutlej. A model of Taunsa Guddu reaches of the Indus River was also prepared
3.	Combining of all the rainfall and river flow models under one user friendly computer package FEWS-Pakistan (Flood Early Warning System-Pakistan) for easy use by PMD (NFFB) and other relevant organisations
4.	Installation of 10-CM QPM weather radar at PMD, Lahore to provide reliable quantitative precipitation forecasts (QPF)
5.	Procurement and installation of 69 high frequency (HF) radio sets
6.	Procurement of a Meteorburst telecommunication (MBC) system for transmission of data to the National Flood Forecasting Bureau (NFFB) on a real-time basis
7.	Bathymetric surveys for the rivers Jhelum, Chenab, Ravi, and Sutlej and of the Indus River between Mithan Kot and downstream from Kotri (up to about 180 km downstream from Kotri); carrying out of discharge measurements at all locations of interest on the River Indus system (barrages and bridges across rivers) for defining and improving rating curves – also carried out by Innovation and Science Research Investments (ISRIP) (WAPDA)
8.	Preparation of a flood-warning manual which provides information on the different processes and steps involved in preparing flood forecasts and warnings and the dissemination of flood warnings to the relevant agencies and general public
9.	Establishment of a National Flood Forecasting Bureau under the auspices of PMD, Lahore

Activities in flood season

Flood season in Pakistan lasts from July to October. All the flood forecasting and warning agencies and data collection departments start functioning from June 15th every year and continue their rainfall and river flow data collection and flood-forecasting activities up to October 15th. During this period effective interaction and communication between various flood related provincial and federal departments and agencies are maintained on a round-the-clock basis in order to counter any eventuality due to rain or floods.

Summary of flood disaster management

Pakistan's strategy for flood preparedness revolves around structural measures for flood containment. These include construction of embankments; spurs; dykes, gabion walls, or flood walls; dispersion or diversion structures; delay action dams; bypass structures; and channelling of floodwaters. In this context, over 5,600 km of embankments have been constructed along major rivers and their tributaries along with more than 600 spurs to protect these embankments.

Development of a warning system is the second major focus of the flood disaster management policy in Pakistan. Following the devastating flood of 1992, a comprehensive programme for flood forecasting and warning capabilities was introduced with the help of Asian Development Bank under the auspices of the Federal

Flood Commission. The Indus Flood Forecasting System (IFFS) involved installation of weather radars, an HF radio system for communication, development of training and user manuals, and preparation of computer simulation models.

These mitigation measures are supplemented with an apparently well-drilled policy of disaster response. Based on the early warning system, army engineers are deployed at points of potential embankment breaches or spill-overs. These engineers are equipped with equipment and material to control the breaches to the extent possible. Army personnel are deployed in potentially dangerous areas to carry out rescue activities wherever required. Provincial relief, food, health, and law and order agencies are coordinated into a comprehensive relief effort.

Earthquakes

Despite the fact that Pakistan has suffered many earthquakes in the past 100 years, the impression was that earthquakes were infrequent, caused only local damage in remote parts of the country, and were not a major threat to urban society, in general, and major cities in particular. Disaster management for earthquakes, therefore, remained virtually negligible. No disaster plan specific to earthquake hazards was formulated. Even common mitigation strategies such as seismic hazard zonation and seismic resistant building codes were treated only casually and arbitrarily.

Status of seismic hazard zonation

Over the years, geological studies by the Geological Survey of Pakistan and supplemented by academia produced a reasonable understanding of the geodynamics of Pakistan. Several regional geological and tectonic maps of Pakistan were published by authors, such as Bakar and Jackson (1964), Kazmi and Rana (1982), Tahirkheli and Jan (1979), Searle and Khan (1996), and Tahirkheli (1996), which provide a sound database for seismogenic fault structures for inclusion in seismic hazard estimation. Further, the Geological Survey of Pakistan has 100% coverage of the country in terms of geological and tectonic maps on a scale of 1:250,000 and 75% coverage on a scale of 1:50,000, and these are valuable assets as they provide a sound geological database for estimation of seismic hazards.

Pakistan has a network of seismic stations, operated and maintained by the Pakistan Meteorological Department (PMD). Additionally, a network around Tarbela Dam has been operated by WAPDA since the early seventies. Pakistan Atomic Energy Commission has another nationwide network of seismic stations which was established in 1975. It has 24 short period and broad band seismometers to record a whole frequency spectrum generated by local, regional, and teleseismic events. Data from these seismic stations and those available from international networks yield a comprehensive catalogue of instrumental data.

The historical data for earthquakes occurring prior to the instrumental phase is based on research carried out by international scientists such as Oldham (1893), Quittmeyer et al. (1979), and Amraseys and Bilham (2003). There is a lot of scope for improvement as Pakistan completely lacks paleoseimicity data and, together with the scarcity of historical data, this places constraints on assessment of recurrence intervals associated with various seismogenic fault structures.

Despite data limitations, efforts have been made to construct preliminary seismic hazard zonation maps such as those drawn by the Pakistan Meteorological Department, Geological Survey of Pakistan, and the National Engineering Services Pakistan (NEPAK).

Building code 1986

The only possible mitigation against earthquakes is building structures that are earthquake resistant. Buildings can be constructed in such a way that they do not collapse on the occupants during an earthquake.

Pakistan developed a building code in 1986 based on a seismic hazard zonation map prepared jointly by the Geological Survey of Pakistan and NESPAK (Farah and Adhami 1986). A re-evaluation took place in 2000 as there was some discrepancy between the estimations of the 1986 map and the estimations of the United States Geological Survey Department. A Seismic Committee was established by the Association of Consulting Engineers and it proposed that Islamabad and Karachi should be assigned upper-moderate seismic hazard potentials (Zone 2b) (there were 7 zones in all).

Building code 2007: seismic provisions

The earthquake of 2005 invalidated the existing seismic hazard zonation maps of Pakistan that had assigned the entire region moderate seismic hazard potential status in 1986. The Government of Pakistan (Ministry of Housing and Works) assigned NESPAK to re-evaluate the seismic hazard map and include seismic provisions in the Building Code to be reviewed and approved by the Pakistan Engineering Council. The code has been prepared by NESPAK and has been reviewed by several sub-committees constituted by the Pakistan Engineering Council, including scientists in the fields of geology and geophysics.

There are now five seismic hazard zones (Table 7).

Table 7: Seismic zones of Pakistan

Seismic zone	Peak horizontal ground acceleration
1	0.05-0.08g
2A	0.08-0.16g
2B	0.16-0.24
3	0.24-0.32
4	>0.32g

According to this seismic zonation, much of the Himalayan region in the north, the Suleiman Range and Chaman Fault Zone region in the mid west, Makran coast in the southwest, and Thar-SE Sindh coastal area in the southeast have been assigned zones 3 and 4, implying a moderate to high seismic hazard risk. Based on this zonation, the new building code provides guidelines for seismic provisions – including site considerations, soils and foundations, structural design requirements, structural tests and inspections, reinforced concrete, structural steel, masonry, architectural elements, and mechanical systems.

Rescue and response to earthquakes

Pakistan does not have a specifically designed preparedness plan for earthquakes. Pakistan Meteorological Department is the earthquake monitoring agency and is responsible for reporting the various parameters of the earthquake such as time of occurrence, location of the epicentre in terms of longitude and latitude, and magnitude. These parameters determine the enormity of the disaster, pinpointing the area or the region affected and extent of damage expected. This information is conveyed to the National Crisis Management Cell, Interior Ministry, which is supposed to be the first to respond, followed by Federal and Provincial Emergency Relief Cells, and all the relevant federal and provincial ministries, divisions, and departments such as health, food, communications, and the police.

In practice, it is the community affected by the disaster which makes the first response. This is followed by the army. Non-government organisations, local and international, are next to step in, including volunteers from the public. Pakistan has a long way to go to attain an advanced degree of preparedness for earthquake disasters. Micro-zonation is the next step, but will take years to complete. Detailed slope stability analysis will need to be incorporated into rural and urban planning in future. Existing buildings need thorough structural inspection and retrofitting by qualified engineers or technicians.

Landslides

Pakistan has large tracts of mountainous terrain, and often it has extreme relief. Almost all the northern areas of Pakistan – Diamer, Gilgit, Hunza, Nagar, Ghizer, and Baltistan – are part of the Karakoram and are characterised by extreme altitudes with very steep slopes. Parts of the Northwest Frontier Province – Hazara Division, Kohistan, Chitral, Swat, and Dir – have equally high mountains with steep unstable slopes. Part of Punjab province (Murree Area) and much of Pakistani Kashmir are in the Higher or Lesser Himalayas and slope stability is a major issue. The mountains in the tribal belt as well those as in Baluchistan have moderately high landslide vulnerability.

Despite these facts, there is no preparedness plan for landslide disasters. As and when the landslide takes place, communities have to make the first response on their own.