PAKISTAN: *FLOOD MANAGEMENT - RIVER CHENAB FROM MARALA TO KHANKI*

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Abstract. Detailed information is provided on the approach and experience in flood management in that country in general and in the Chenab River area, with particular emphasis on flood forecasting activities being carried out. Of particular interest is the comprehensive description on flood management and mitigation measures and on the functions and responsibilities of the various flood related government organizations. Some brief information is also provided on the involvement of flood-affected communities in planning and flood management activities

1. Location

The Chenab is one of the largest rivers of the Indus basin, being a major tributary of the Indus river in Pakistan; its source lies in Himachal Pradesh, India. The Chenab enters Pakistan just upstream of the rim station Marala. The total catchment area upstream of Marala is nearly 28,000 km^2. The distance from the Marala Barrage to the confluence point with the Indus river at Mithankot is 598 km.

The case study area comprises the river stretch between Marala Barrage to Khanki Headworks. The total area is 1120 km2. The length of the river is 56 Km and the width varies from 700 to 1400 m, whereas the flood plain is about ten times as wide as the river. In this stretch a number of small tributaries, covering a drainage area of 3,437 km^2, flow into the Chenab. Marala Barrage is the rim station at the Chenab and is of paramount importance in all water regulation matters. Khanki Headworks is the oldest barrage on the Chenab, completed in 1892. Both barrages play a vital role to manage the surpluses and deficiencies of surface water. The population in the study area is approximately 453,000 and the annual population growth rate is 2.1%.

The pilot area mostly comprises agricultural land. Over the past 30 years, the area under cultivation has decreased due to industrialization, urbanization and increase in the salinity of irrigated land. The area under change is outside the riverbanks, and there have been no encroachments and narrowing or modification of the river channel. Although this area lies in the river flood plain in cases of exceptionally high floods, embankments protect it. Breaching sections have been defined so as to reduce the pressure on the protection bank of this area when floods occur.

2. Nature of floods

Floods in Chenab result from heavy rainfall in the upper drainage basin, which falls under the most active monsoon belt from the Arabian Sea and Bay of Bengal. The snowmelt contributions are on the average 40% of the total flow in July, when the peak melt rates are attained. Hence, it synchronizes with the early monsoon in July, but not with the peak values occurring in August and September. During the monsoon, the tributaries flowing into the Chenab River can aggravate the floods. The historical extreme events in the study area were recorded in 1988, 1995, 1996, 1997 and 1998. To have an idea of the losses and damages, during the flood of 1998 in the “tehsils” of Wazirabad, Gujrat and Sialkot 1,243 villages and some 460,000 persons, over an area of 2,555 km2, were affected.

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3. Flood management and mitigation strategies

During its early years, Pakistan experienced severe floods in 1955 and 1956 in the Indus Basin Rivers. These floods, however, did not initiate a national drive for flood protection, as the land-use at that time was not so flood-prone. Economic growth and population pressure continued building up when the disastrous floods of 1973 and 1976 occurred. Both these resulted in heavy losses to life and property and disrupted the nation's major communication links, and proved to be the driving force for national policy-makers to set up a federal agency for managing the flood problem.

The *Federal Flood Commission (FFC)* was created in January 1977. According to its mandate, in 1978 a *National Flood Protection Plan* (NFPP-1978) was prepared, the main thrusts of which were to: (i) reduce flood losses; (ii) give priority to flood protection to areas of greatest economic risk; (iii) provide protection to areas outside of flood plains, i.e. cities and vital infrastructure; and (iv) improvement in existing flood protection/flood control facilities. The first phase of the *Flood Protection Sector Project (FPSP I)* was also initiated, with assistance of the Asian development Bank (ADB).

Following severe 1992 floods a comprehensive programme for strengthening and increasing the scope of flood forecasting and warning capability of the *FPSP I* was approved in 1994. It included the procurement and installation of an S-Band weather radar, functional since 1997, and the preparation of a flood warning manual. The latter extensively describes the flood categories, which can be expected, and flood-wave routing down-stream to avoid flooding in the vulnerable populated areas and avoid damages to the structures. The working methodology has been developed in conjunction with the reservoir management authorities.

Since then the *FPSP-II* is in process, under which one S-Band Radar is planned to be installed at Mangla and another at Sialkot, expected to be functional by 2005. It includes a series of mayor studies, some of which are already completed, with the aim to providing (i) a flood forecasting system that will allow full utilization of the flood forecasting capabilities offered by the equipment to be installed under the FPSP; and (ii) a decision support system for improved flood management.

A classification of flood limits (*High, Very High, Exceptionally High*) has been established for each river to indicate the river/channel flow conditions with respect to embankments/spill-over scenario, alertness and watch to be maintained by the river management authority and for population awareness. This classification is used in formulation of flood management plans in terms of river/barrage/dam. These classification/limits are associated with different stepwise actions and responsibilities/flood management activities of field staff in that area.

On receipt of a significant forecast, which is issued for high and above flood levels, the following actions are taken for flood management: (i) relief authorities start preparing relief oriented action; (ii) rescue authorities prepare for any evacuation; (iii) district authorities/community members (public representatives) are informed to prepare the public accordingly for shifting of the population to safe areas as per flood fighting plan of the District, and Government ministries, etc. activate their resources. In case of exceptionally high flood the breaching section is activated on predetermined sites to reduce the pressure and to divert the floodwaters to least populated areas.

Flood affected communities are involved in the formulation of flood management plans in the following manner: (i) the local representative of the community is associated in each and every activity planned or executed in that area; (ii) at district, sub-district and at provincial level, the government has assigned each minister a district for flood management. The minister is the head of the elected representative of that district; he co-ordinates the flood management activities will all the government functionaries.

As regards specifically the Chenab study area, each district authority and the Irrigation Department have prepared structural measure plans. The districts of Sialkot and Gujrat have their own flood fighting plans, in which construction of flood dykes, levees to confine flows, and by-pass flood ways to divert flows have been worked out. Since there is no dam/reservoir in this area to store the floodwaters (the two existing barrages only serve to regulate the flow to the link canals for irrigation purposes), the floodwaters are therefore only used for groundwater recharge and as a soil conditioner for the agricultural land to improve land fertility. The water use management system is in place particularly for irrigation purposes; it has a detailed layout of canals and link canals to the irrigated areas, the operation of which becomes important during exceptionally high flooding.

Among the non-structural (flood-forecasting) measures, an important part is the timely collection of data of river gauges and other relevant details. The river Chenab above the rim station Marala flows through a rugged and hilly terrain and there are no major dam or headworks above Marala. Therefore, flood management in the study area requires the following two main inputs: QPM (quantitative precipitation measurements) covering the Indian part of the Chenab basin and Indian discharge data. In addition, precipitation is measured hourly and three hourly and water levels confirmed through visual observation taken at river sites gauges. The six hourly discharge data is received at the *Flood Forecasting Division (FFD)* through police wireless radio sets, and in case of any significant situation hourly or half-hourly data can be received at FFD. This data is used as input for the flood forecast model, flood records and water resource management for integrated flood management of the river basin.

4. Institutions responsible for flood management

The flood management process in Pakistan is multi-functional involving a number of different Government organizations. The *Federal Flood Commission (FFC)* plays a major role in remodeling the flood mitigation policy in Pakistan and is responsible for implementing the FPSP I and II, with ADB assistance. It is the coordinating body at the Federal Government level with all the provinces and technical agencies.

The *Flood Forecasting Division (FFD)* of the *Pakistan Meteorological Department (PMD)* plays a pivotal role in the entire flood mitigation process. Hydrometeorological data from the various national and international sources is processed to prepare flood forecasts and warnings to be disseminated outwards to various national organizations.

The major flood related functions of the *Provincial Irrigation and Drainage Authority (PIDA*) include: (i) flow measurement at the specific sites at rivers, canals and mullahs; and (ii) planning, design construction and maintenance of flood protection works. The *Water and Power Development Authority (WAPDA)* is involved in the management of dams and its major functions are the collection of: (i) rainfall data from telemetric rain gauge stations; (ii) to provide the hydrometric flood data at rim stations and barrages.

The *Provincial Relief organizations* are charged with the responsibility of disaster preparedness, emergency response, and post-disaster activities pertaining to all disasters, including floods. The *Pakistan Army* flood-related functions encompass all the rescue and relief operations during and after floods. Provincial governments provide all the support and equipment (boats, life jackets, vehicles, tents etc.).

The *Commissioner for Indus Waters (CIW)* is a regulatory body to get river flow and rim data from India. An *Emergency Relief Cell (ERC)* has been established under the cabinet division and is controlled by the Cabinet Secretary. Main functions include: (i) planning and assessment of relief requirements of major disasters; (ii) stock pilling of basic necessities needed during emergency.

District flood fighting plans also includes the involvement of the flood-affected communities. The breaching section and decision requires the involvement of elected representatives of the public.

During and post-flood situation the elected representatives of the community of the flood affected areas are involved in relief and rehabilitation and in shifting the public to pre-designated safety shelters, arrangement of food distribution, provision of emergency health facilities and settlement, rehabilitation and distribution of relief goods. Each province has its own setup to reach to community through elected representatives, minister and town/district public elected representatives.

5. Policy

The national water policy is under formulation. At present the first priority is to utilize the available water in equitable and judicious manner to encourage the migrated agrarian population to settle evenly within the Indus basin. An institutionalized planning exercise was carried out in the form of five-year plans, which were implemented from 1955 onwards. These five-year plans focused on the extension of irrigation facilities to new areas and to improve the irrigation control and distribution in existing areas.

6. Main lessons learnt

- To have a better coordination and a quick flow of information, representatives of various users of flood mitigation agencies have been positioned in the premises of the Flood Forecasting building, so that in case of any flood situation a better liaison can be made.

- During the years 1988 and 1992, which were important flood years, although forecasts were issued, their impact was lost since they could not be received in time by the reservoir management authorities. This situation required amendments in the existing procedure and at present a more pro-active method has been adopted rather than the previous passive approach. This has now greatly contributed to timely forecast issuance and its receipt by the user agencies and its quick response.

- To further increase coordination and integrated effort at a broader level the FFC organizes pre-and post flood meetings every year at national level, as a follow up action to review the lapses and shortcomings during each previous flood season. This helps in further fine-tuning of the existing network and coordination system.

- A Manual (official document) has been prepared, listing the role of each and every organization and details of action to be taken for an integrated flood forecasting and management