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Peak-Flood Inundation Map of the Western Peshawar Plain (Peshawar, Charsada, Nowshera Districts): Implications for Flood Disaster Preparedness Plans

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Flood Inundation Map (FIM) is one of the most essential prerequisites for any flood management plan. FIMs provide information on the spatial extent and depth of flood waters in a given area. Since these provide spatial distribution of floods in an event, they clearly define which cities, towns, villages, roadways, streets, buildings, airports, etc., are likely to be impacted by floodwaters. They serve two purposes. In pre-event settings, they form the basis of preparedness plans through structural and non structural measures. For instance, if a town or important infrastructure is located within the flood zone, structures like embankments, spurs, gabions, water diversion channels, draining channels etc can be built to avoid flooding from the water source. Likewise, the inhabitants at such locations may be made aware of the flood hazards and may be drilled through well coordinated evacuation/rescue plans. In the event of flooding, the same maps make basis for organizing warning, rescue, response and relief operations.

Pakistan has been subject to flood hazards on regular basis throughout its history. Flood management has been a focus since 1970s when floods caused extensive damages along the major river courses in Punjab and Sindh. However, entire emphasis has been on structural measures involving construction of embankments, spurs and bunds, and that too, mostly in the Punjab and Sindh plains. Pakistan ignored development of flood inundation maps, which are crucial not only for preparedness against flood hazards but are also most important tool for rescue/response phase during flooding. The result is that in 2010 when floods of unprecedented volumes hit Pakistan, it was not clear which population centres and infrastructures (especially roads) were most endangered and which routes be used to conduct rescue and response operation.

Using Peshawar, Charsadda and Nowshera districts in western Peshawar basin as a case study, a peak flood inundation map has been prepared based on peak flooding conditions as witnessed in end July-early August 2010. A two-fold methodology has been adopted. Firstly we have conducted a field survey delineating the extent of flooding on either sides of the rivers draining into the western Peshawar basin. Height of flood levels have additionally been measured at several points within the flooded areas. For a regional overview of the peak flood inundation, we have used an August 4, 2010 satellite image taken by the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) on NASA's Terra satellite. The combined dataset thus acquired was superimposed on the 0.6-2.5 m resolution satellite images of the Peshawar Plain freely available on Google Earth. Further we superimposed 15-30 meter resolution DEM based on ASTER onto the dataset in ArcGIS, to find the spatial distribution of topography in the studied region.

The resulting FIM for the western Peshawar basin is the first attempt on flood zoning in the western Peshawar basin. Major results from this study include:

1. Western Peshawar basin is endangered by both riverine as well as flash floods. The riverine floods are caused by high discharge in seven rivers. The major rivers of Swat and Kabul as they enter Peshawar basin are divided into distributaries, which include Jindai and Khiali (Swat River), Sardaryab, Naguman and Shah Alam (Kabul). Other notable rivers include Kalapani from north of Mardan and Bara from south of Peshawar. Except for Kalapani and Jindai rivers, rest of these distributary rivers converge into main Kabul River within an area of 5 km^2 immediately upstream the Kabul River bridge on M1 Motorway. Bara River joins the Kabul River immediately past the M1 Kabul River Bridge while Jindai and Kalapani join the Kabul River further downstream near Nowshera. Therefore within a stretch of about 15 km between M1 Kabul Bridge and Nowshera, Kabul River is primarily a confluence area for 7 major river courses, which not only makes this region most vulnerable to flood hazards, but is supplier of an influx of flood water for Nowshera city and district.
2. During the 2010 peak floods, the outward inundation by these 7 rivers flooded a total area of >300 km^2, 10 times more compared to the area of their normal river course.
3. A stretch of 8 km wide area between Shah Alam River in the southwest and the Jindai River in the northeast on either side of the M1 Motorway was most heavily flooded. It is highly likely that the M1 Motorway in this stretch blocked the normal flow in rivers and associated distributaries, resulting in widespread inundation in the Charsadda district. The Jindai River Bridge with a span of ~70 m, far less than the span of the floodway in the Jindai River (i.e., 120 m), definitely contributed to ponding along the northern embankment of the motorway. Motorway drains for at least three streams occurring between the Kabul and the Jindai bridges are too narrow for peak flood conditions. A redesigning of the Jindai bridge and drains in this 8 km stretch of the M1 Motorway is crucial for controlling future flood hazards in the Charsadda district.
4. The FIM produced based on peak flood conditions in 2010 should form basis for future development projects in the western Peshawar Basins to avoid losses through future flood disasters in this region.