AN APPRAISAL OF 2011 – RAIN / FLOOD DAMAGES IN SINDH

By

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ABSTRACT

In Pakistan unprecedented torrential monsoon rains in 2011 caused severe damages to human settlements and cropped area in Sindh, eastern Balochistan and southeastern Punjab due to inadequate surface/sub-surface drainage system of the affected areas. Particularly, in Sindh province, the inundation was further supplemented by the over topping of Left Bank Outfall Drainage (LBOD) and other drains at various locations due to extra ordinary discharge above the design capacity experienced in those drains. The floods caused considerable damage to human life and other public infrastructure. According to Pakistan Meteorological Department, 2011-Monsoon rainfall, over province of Sindh, was 271% above normal, which was the heaviest, recorded during the period 1961–2011

The 2011-rains / floods affected an area of about 6.166 million acres, affecting 33983 villages, claiming about 484 lives, damaging 1287193 houses (684,725 partially and 602,468 fully), inundating cropped area of about 2.317 million acres and disturbing population of about 9.186 millions. The post rains / flood damages assessment report-2011 indicates that around Rs. 14.714 billion would be required for restoration/improvement of Irrigation Drainage and Flood Control Structures in Sindh province. Deferred maintenance of LBOD and other drainage systems considerably reduced the discharge capability of LBOD system and other drains which resulted in over topping of LBOD and other drains at various locations due to over-design discharge experienced in those drains during 2011 Rains / Floods.

The paper discusses in detail the causes of 2011 Rain / Flood damages in Sindh province and recommends suitable measures to avoid the same in future.

1. INTRODUCTION

Inundations due to floods have the potential to cause fatalities, displacement of people, and damage to property and environment and thus severely compromise economic development. Flooding accounts for 40% of all the natural hazards worldwide and half of all the deaths caused by natural disasters (e.g. Ohl and Tapsell 2000; Jonkman and Vrijling 2008).

Floods are natural phenomena which cannot be prevented; nevertheless, some human activities contribute to an increase in the likelihood and adverse impacts of flood events (European Parliament, Council 2007). First, the reduction of the natural water retention by inappropriate land use and river management (e.g. continuous embankments) increases the scale and the frequency of floods. Recent analyses investigated such effects on flood hazard (see, e.g. Fohrer et al. 2001; Wooldridge et al. 2001; Brath et al. 2003 ; Camorani et al. 2006). Second, there has been an increasing vulnerability of flood-prone areas because of the growing number of people and economic assets located in flood risk zones (flood-prone areas are traditional zones of special importance as they offer favourable conditions for human settlements and economic development). Finally, flood risk, that may be defined as the product of probability of flood and associated damage (i.e. the damage expectation, Merz et al. 2007), increases with economic development given that potential damage increases.

Resistance strategies of flood risk management are based on the construction of levees may be (Vis et al. 2003). The design of levees and other water-retaining structures is usually based on an acceptable probability of overtopping and the portion of risk that remains is called residual risk (van Manen and Brinkhu is 2005). Residual flood risk behind levees is largely unaccounted. Levees are usually characterised by a uniform safety level (e.g. return period equal to 200 years). It implies that condition is undesirable (e.g., in case of same time, and, therefore, the evolution of the flood event is

1. Federal Flood Commission, Ministry of Water and Power, PAKISTAN.

Stream flows above the design discharge may cause flooding anywhere and even at several locations at the time and, therefore, the evolution of the flood event is unpredictable. It is obvious that this unpredictable. It is obvious that this exceptional events a large area must be evacuated as all areas adjacent to the river theoretically have the same probability of flooding). The so-called resilience strategy is a different approach to flood risk management. The concept of resilience originates from ecology (e.g. Holling 1973) and was introduced, in the context of flood risk management, by De Bruijn and Klijn (2001). The idea behind the resilience approach is living with floods instead of fighting floods. In this approach, flooding is allowed in certain areas, whereas the impact of flooding is minimised through policies of land-use planning and management (e.g. Vis et al. 2003).

Since its creation, Pakistan has faced severe floods in 1950, 1956, 1957, 1973, 1976, 1978, 1988, 1992, worst flooding of 2010 and now in 2011 rain-caused flooding in Sindh Province. These floods of various magnitudes from 1922 to 2011 affected the river basins in Punjab and Sindh. In Khyber Pakhtunkhwa (KPK), Balochistan, FATA, Gilgit-Baltistan, Azad Jammu and Kashmir and some areas of Punjab also, flood damages are caused mainly due to flash floods in secondary and tertiary rivers including hill torrents. In recent years, vulnerabilities of large cities to flooding have increased. During the Monsoon Season-2011, the country, particularly Sindh province has experienced worst urban flooding due to improper drainage system to cope with heavy rains.

The unprecedented flood of 2010 was the worst ever in the history of the country in which about 1985 people lost their lives, 1,608,184 houses were destroyed, 17,553 villages were reportedly damaged / destroyed and a total area of 160,000 Sq. km was affected. The 2011-rains / floods affected an area of about 6.166 million acres (23 Districts in Sindh, 4 in Punjab and 1 in AJK), affecting 33982 villages, claiming about 488 live, damaging 1287192 houses (684,724 partially and 602,468 fully) and cropped area of about 2.317 million acres and population of about 9.186 million has been affected.

2. FLOOD PROTECTION and WATER SECTOR INFRASTRUCTURE OF PAKISTAN

Five main rivers, namely, the Indus, Jhelum, Chenab, Ravi and Sutlej flow through the country's plains. The Indus (including the Kabul, Swat and Panjkora tributaries) Jhelum and Chenab are known as the **western rivers**, and the Ravi, Beas, and Sutlej known as the **eastern rivers**. Supplemented by a number of secondary rivers and streams, these rivers supply water to the entire Indus Basin Irrigation System. The rivers have their origin in the higher altitudes and derive their flows mainly from snowmelt and monsoon rains. The catchment area of Indus is most unique in the sense that it contains seven (7) of the world's highest-ranking peaks, after Mount Everest. These include K-2 (28,253 ft), Nanga Parbat (26,660 ft), Rakaposhi (25,552 ft) etc. Likewise, barring the polar areas, seven (7) glaciers situated in the Indus catchment, namely Siachin, Hispar, Biafo, Batura, Baltoro, Barpu and Hopper are amongst the largest in the world.

The Irrigation System of Pakistan is the largest integrated irrigation network in the world, serving 42 million acres of contiguous cultivated land. The system is fed by the waters of the Indus River and its tributaries. The irrigation network of Pakistan mainly comprises of 3 major reservoirs, 19 Barrages, 12 inter-river link canals, 45 independent irrigation canal commands and 143 large dams of height 15 meters and above.

The major storage reservoirs include Tarbela (existing Live Storage Capacity = 6.625 MAF against original 9.70 MAF), Chashma (existing Live Storage Capacity = 0.263 MAF against original 0.70 MAF) on River Indus and Mangla (existing Live Storage Capacity = 5.066 MAF against original 5.30 MAF) on River Jhelum. The total length of main canals/ distributaries and minors is about 64,000 KM. Watercourses comprise another 1,621,000 Kilometers. The schematic diagram of Indus Basin Irrigation System is shown in Figure -1.

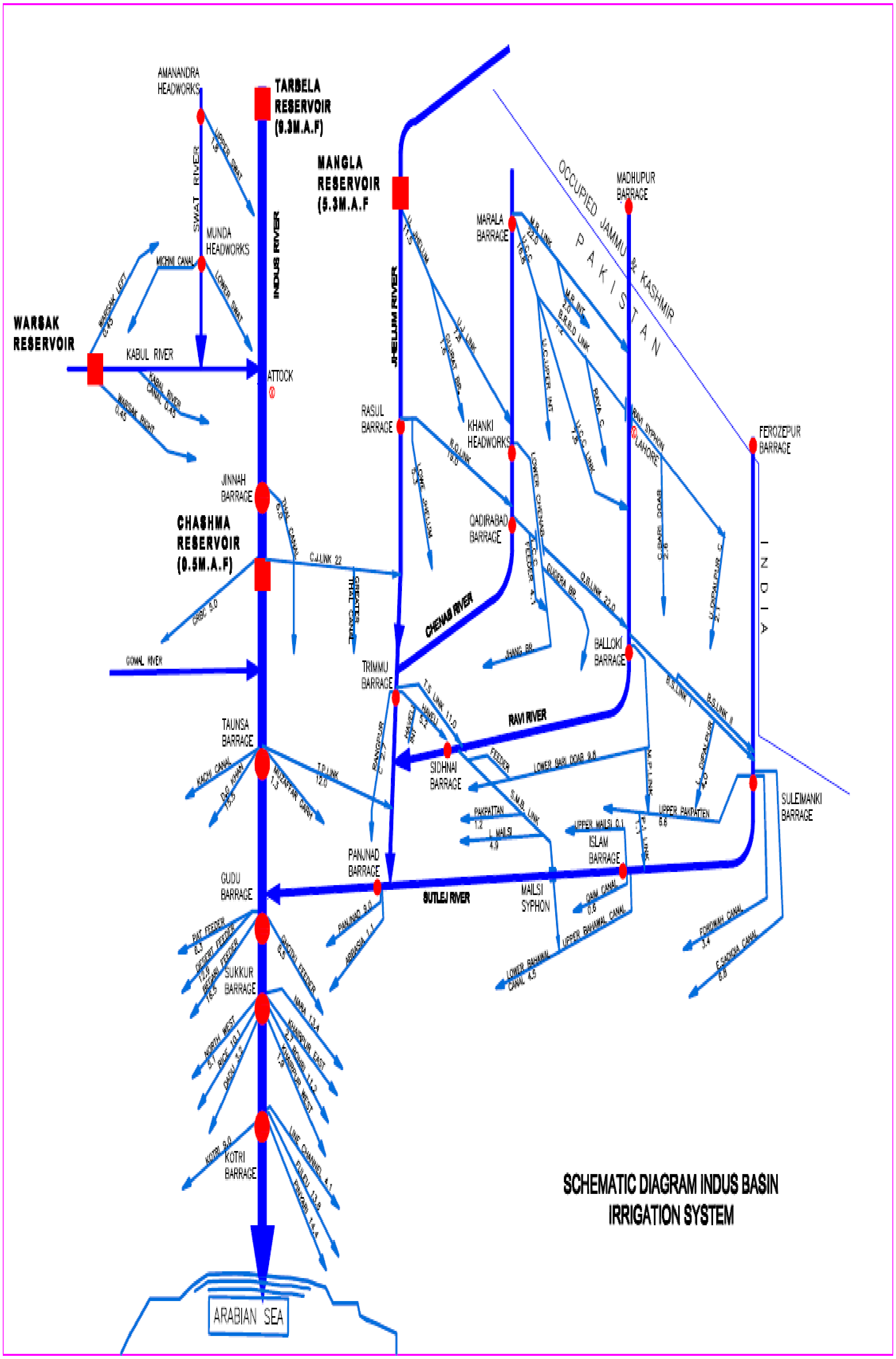

Figure 1: Schematic Diagram of Indus Basin Irrigation System

Diversion of river waters into off taking canals is made through barrages, which are gated diversion weirs. The main canals in turn deliver water to branch canals, distributaries and minors. The watercourses get their share of water through outlets in the irrigation channels. Distribution of water from a watercourse is effected through a time-schedule called "warabandi".

Average annual surface water availability is 142 MAF whereas the annual canal withdrawal is 104 MAF. Water availability at farm gate is 106 MAF comprising 62 MAF of surface water and 44 MAF of groundwater. Supplemented by an annual groundwater withdrawal of some 44 MAF, the average depth of water available at the farm gate is 3.07 feet per acre. Approximately 3 million individual farms with an average size of about 12 acres benefit from this system. Indus River System Authority (IRSA), created in consequence of 1991 Water Accord between the provinces, makes the inter-provincial water allocations.

The existing flood management strategy includes flow regulation by two reservoirs and barrages, flood forecasting, early warning, evacuation, protection of critical infrastructure, and urban and rural areas by flood embankments and spurs etc along the rivers. The Provincial Irrigation Departments (PIDs) maintain about 6,808 km of flood protection embankments and over 1410 main spurs along the rivers. Province-wise break up of existing flood protection infrastructure is given in Table-1.

Table 1: Existing Flood Protection Facilities in Pakistan

Name of Province	Embankments (KM)	Spurs (No)
Punjab	3,332	496
Sindh	2,422	46
Khyber Pakhtunkhwa	352	186
Balochistan	697	682
Gilgit-Baltistan	4,622	-
Total	**6,808**	**1,410**

3. FLOODS IN PAKISTAN

The major cause of floods in Pakistan is heavy concentrated rainfall, mostly in the river catchments and sometimes outside the rivers e.g. 2011 floods in Sindh, which sometimes augmented by snowmelt flows, generally result into floods in rivers during the monsoon season. Occasionally, monsoon currents originating in the Bay of Bengal and resultant depressions often result in heavy downpour in the Himalayan foothills additionally affected by the weather systems from the Arabian Sea (Seasonal Low) and from the Mediterranean Sea (Westerly Wave) cause destructive floods in either or all of the main rivers of the Indus System. However, in some cases exceptionally high floods have occasionally been caused by the formation of temporary natural dams due to land sliding or glacial movement and their subsequent collapse. There are large seasonal variations in almost all the river discharges, which further aggravate the river course and morphology.

The major rivers cause flood losses by inundation of areas along their banks, by damaging irrigation and communication facilities across or adjacent to the rivers, and by erosion of land along the riverbanks. In the upper part of the Indus Basin System, floodwater spilling over the riverbanks generally returns to the river. However, in the lower part of Indus River (Sindh Province), which is primarily flowing at a higher elevation than adjoining lands, the spill flows do not return to the river. This phenomenon largely extends the period of inundation resulting in even greater damages. Although flood protection by embankments have been provided along almost the entire length in the Sindh Province and at many locations in the upper areas, the bund breaches can still occur. Such breaches often cause greater damage than would have occurred without the bunds because of their unexpected nature and intensification of land use following the provision of flood protection.

Over the years, the river beds have silted up and the existing discharge capacity of some important structures (Barrages and Rail / Road Bridges) on Rivers Indus, Chenab and Ravi has reduced which is the major reason of flooding. The exceptionally high floods thus result in afflux on the upstream side, which sometimes results in breaches in the flood embankments. Some times, the flood embankments have to be deliberately breached at pre-selected locations to save the main barrage structures and other vital settlements and installations.

The encroachment of village abadies in riverine areas has also increased the quantum of flood damages and losses to humans and livestock. As there is no proper regulatory frame work in the country regarding the settlement in riverine areas, most of the poor people have constructed their shelters along the vulnerable river banks and become victims to devastating floods. Some people are making use of the most of these areas for business purposes through promoting agriculture and cattle Ghats / dairies. All such activities are extending beyond the safe limits of riverine areas to achieve more economic benefits but in fact these activities are posing a great threat of unprecedented and unruly flood; the losses due to which may be in hundred multiples of such small scale economic profit. The river catchments and flood plains are to be kept as prohibited area for the riverine community especially during the flood season.

Nineteen major floods in 61 years (almost one major flood event every 3 years) are one of the main challenges to economic development. Overall, around 10,640 people lost their lives and the country suffered a cumulative financial loss of US$ 30 billion. Some 161,357 villages were reportedly damaged/ destroyed and a total area of 592,099 Sq. km was affected due to the nineteen major flood events. Among these extreme flood events, 2010 flood was the most destructive flood in Pakistan, which significantly added to these figures (Table-2).

Table 2: Historical Flood Damages in Pakistan

Year	**Direct losses (US$ million)**		**Lost lives (No)**	**Affected villages (No)**	**Flooded area (Sq-km)**
	@ 1US$= PKR 40	**@ 1US$=PKR 86**			
1950	227	488.05	2190	10000	17920
1955	176	378.4	679	6945	20480
1956	148	318.2	160	11609	74406
1957	140	301	83	4498	16003
1959	109	234.35	88	3902	10424
1973	2,388	5134.2	474	9719	41472
1975	318	683.7	126	8628	34931
1976	1,621	3485.15	425	18390	81920
1977	157	337.55	848	2185	4657
1978	1,036	2227.4	393	9199	30597
1981	139	298.85	82	2071	4191
1983	63	135.45	39	643	1882
1984	35	75.25	42	251	1093
1988	399	857.85	508	100	6144
1992	1,400	3010	1008	13208	38758
1994	392	842.8	431	1622	5568
1995	175	376.25	591	6852	16686
2010	-	10000	1985	17553	160000
2011	-	171.09*	488	33982	24967
Total	**8923**	**29355.54**	**10640**	**161357**	**592099**

*As received from PID Sindh. PID, Balochistan is reportedly compiling the damage reports, which will take some time. Damage details by rest of the Provinces / Federally Administrated Areas have not been reported, as no serious floods were experienced during monsoon season-2011.

4. FLOODS / RAINS-2011 IN SINDH

Unprecedented torrential monsoon rains caused severe damages to abadies and cropped area in Sindh, eastern Balochistan and southeastern Punjab due to inadequate surface/sub-surface drainage system of the affected areas. Particularly, in Sindh province, the flood situation was further supplemented by the over topping of LBOD and other drains at various locations due to extra ordinary discharge above the design capacity experienced in those drains. The floods caused considerable damage to human life and other public and private infrastructure. The flooding followed the previous year's historic 2010-floods, which devastated the entire country. Unprecedented torrential monsoon rains caused severe flooding in 16 districts of Sindh province. The entire Sindh Province, particularly southeastern parts of the province i.e. District Badin, Tharparkar, Hyderabad, Mirpurkhas, Tandu Muhammad Khan, Tandu Allahyar, Shaheed Benazirabad, Thatta, Umerkot, Noshero Feroze, Matiari etc., besides Districts Dadu, Larkana, Kambar-Shahdadkot, Khairpur Ghotki, Sanghar, Shikarpur, Jacobabad, Jamshoro, including southern Punjab and northeastern parts of Balochistan experienced extensive monsoon rains in the second and last week of August and 1st and 2nd week of September 2011. The District Kasur, Pakpattan, Vehari, Bahawalnager were also affected due to release of surplus flood flows in Sutlej River by India.

The 2011-rains / floods affected an area of about 6.166 million acres (23 Districts in Sindh, 4 in Punjab and 1 in AJK), affecting 33982 villages, claiming about 488 live, damaging 1287192 houses (684,724 partially and 602,468 fully) and cropped area of about 2.317 million acres and population of about 9.186 million has been affected.

The main cause of rain / flood damages occurred to abadies and cropped area was unprecedented rains in the areas, besides inadequate surface / sub-surface drainage system of the cities / towns, which was further supplemented by the over topping of LBOD and other drains at various locations due to over design discharge experienced in those drains.

4.1 Official Seasonal Monsoon Rainfall Forecast, 2011

Pakistan Meteorological Department predicted **Normal** monsoon rains during the period from July to September 2011. The official prediction of seasonal monsoon rainfall by Pakistan Meteorological Department, issued on 13th June, 2011, is reproduced hereunder :

> "*Pakistan Summer Monsoon rainfall is invariably affected by the global, regional and local climatic conditions prevailing prior to the season. Analysis of their combined effect indicates that total amount of rainfall averaged over Pakistan during monsoon season (July – September) 2011 will remain 10% below normal.*
>
> *However, there are chances of about 10% above normal rainfall in northern half of Pakistan including Punjab, Khyber Pakhtunkhwa provinces and Kashmir.*
>
> *At occasions, the interaction of easterly and westerly systems may result in heavy downpour causing localized urban/flash flooding.*
>
> *This outlook is prepared at 80% confidence interval and meant for the planning purpose. The area weighted normal rainfall of Pakistan for monsoon season is 137.5 mm."*

4.2 Hydro-Meteorological Causes of 2011-Rains/ Floods

In the month of July, 2011, the country received below normal monsoon rains; however, in August and September, above normal monsoon rains started. A strong weather system entered in the areas of Sindh from the Indian states of Rajasthan and Gujarat in August, 2011 and gained strength with the passage of time and caused heavy downpours. The four weeks of continuous rain created an unprecedented flood situation in Sindh.

Sindh province was severly affected. The unprecedented monsoon rains from August 10th to September 2nd 2011 caused major losses to life, crops, houses, infrastructure, etc. The highest ever recorded monsoon rains in Sindh displaced many people besides destroying crops in the area. The District Badin in Sindh province received record breaking rainfall of 615.3 millimeters during the monsoon spell breaking earlier recorded 121 millimeters in Badin in 1936. The area of Mithi also received record rainfall of 1,290 millimeters during the spell, where maximum rainfall was recorded 114 millimeters in Mithi in 2004.

The first monsoon spell hit southern parts of Sindh on 10th August, 2011. It produced record breaking widespread torrential rainfall resulting in floods in District Badin. The second spell hit the areas on 30th August, 2011 and lasted until 2nd September, 2011. In the month of September, 2011, four more consecutive spells of monsoon rainfall devastated southern parts of the province. The first spell of September hit already inundated parts of the province on 2nd September. Thereafter, the second spell hit on 5th September, the third on 9th September, and the fourth on 12th September, 2011. The four spells of monsoon produced even more devastating torrential rains in the already affected areas of Sindh. The heavy rainfalls recorded in Sindh province in the months of August and September 2011 based on data from the Pakistan Meteorological Department are given in Table-3.

Table-3: Torrential rainfall recorded in August and September, 2011 in Sindh

City	Rainfall (mm) in August, 2011	Rainfall (mm) in September, 2011	Total Rainfall (mm)
Mithi	530*	760*	1290*
Mirpur Khas	263.1*	603*	866.1*
Nawabshah	275.2*	353.2*	628.4*
Badin	331.2*	284.1	615.3*
Chhor	276	268	544*
Dadu	134.1	348.1	482.2*
Padidan	251.2	172	423.2*
Hyderabad	162.2	244.2	406.4
Karachi	61.2	212.2	273.3

* Indicates new record.

The heaviest rainfall spells recorded in Sindh province in the months of August and September 2011 based on data from the Pakistan Meteorological Department are given in Table-4 below :

Table-4: **Heaviest Rainfall spells recorded in Sindh Province during 2011**

City	Rainfall (mm)	Monsoon Spell
Mithi	760	1st to 14th September*
Mirpur Khas	603	1st to 14th September
Padidan	356	30th August to 4th September*
Nawabshah	353.2	1st to 14th September
Dadu	348.1	1st to 14th September
Badin	302.1	10th to 14th August*
Chhor	268	1st to 14th September
Hyderabad	244.2	1st to 14th September
Karachi	212.2	1st to 14th September

- 1 to 14 September 2011, four consecutive spells of monsoon rains.
- 1 to 14 August 2011, first spell of monsoon rains in Sindh.
- 30 August to 4 September, second spell of monsoon rains in Sindh.

4.3 Overall Assessment of 2011-Monsoon Seaso

According to Pakistan Meteorological Department, 2011-Monsoon rainfall, over province of Sindh, was 271 % above normal, which was the heaviest, recorded during the period 1961–2011.

No significant flood situation was experienced in the major rivers during 2011-Monsoon season. The maximum discharge experienced by River Indus was at Chashma i.e. 3,56,500 cusecs (on 28.7.2011), which is a Low Flood stage. River Jhelum experienced a maximum discharge of 87,800 cusecs (on 8.9.2011) at Mangla, River Chenab 1,37,600 cusecs (12.8.2011) at Marala and River Ravi 72,100 cusecs (15.8.2011) at Balloki respectively.

A comparison of Historic Maximum Flood Peaks Vs 2011-Flood Maximum Flood Peaks is given in Table-5 below.

Table-5: Historic Maximum vs 2011 Maximum Peak Discharges

River	Barrages/ Head-works/ Bridges	Designed Capacity	Historic Maximum Peak (cusecs)		Maximum-2011 Peak (cusecs)		
			Flood	Date	Flood	Date	Flood Category
Indus	Tarbela	15,00,000	8,33,000	30-7-10	2,72,200	28-6-11	Low Flood
	Kalabagh	9,50,000	9,50,000	14-7-42	2,93,900	26-7-11	Low Flood
	Chashma	9,50,000	10,36,673	01-8-10	3,56,500	28-7-11	Low Flood
	Taunsa	11,00,000	9,59,991	02-8-10	2,49,200	31-8-11	Normal
	Guddu	12,00,000	11,99,672	15-8-76	2,72,300	4-9-11	Low Flood
	Sukkur	15,00,000*	11,66,574	15-8-76	2,60,800	6-9-11	Low Flood
	Kotri	8,75,000	9,81,000	14-8-56	2,61,400	14-9-11	Low Flood
Jhelum	Mangla	10,60,000	9,33,000	10-9-92	1,41,300	16-9-11	Medium Flood
	Rasul	8,50,000	9,32,000	10-9-92	1,05,800	17-9-11	Low Flood
Kabul	Warsak	5,40,000	1,52,710	30-7-10	70,300	28-8-11	Medium Flood
	Nowshera	-	2,49,100^	10-8-10	72,000	12-8-11	Medium Flood
Chenab	Marala	11,00,000	11,00,000	26-8-57	1,50,400	16-9-11	Medium Flood
	Khanki	8,00,000	10,85,000	1957	1,71,400	17-9-11	Medium Flood
	Qadirabad	8,07,000	9,48,530	11-9-92	1,71,400	17-9-11	Medium Flood
	Trimmu	6,45,000	9,43,225	8-7-59	1,32,900	20-9-11	Normal
	Panjnad	7,00,000	8,02,516	17-8-73	1,51,300	24-9-11	Low Flood
Ravi	Balloki	2,25,000	3,89,845	28-9-88	72,100	15-8-11	Medium Flood
	Sidhnai	1,50,000	3,30,210	2-10-88	30,000	18-8-11	Low Flood
Sutlej	Sulemanki	3,25,000	5,97,000	8-10-55	82,000	29-8-11	Medium Flood
	Islam	3,00,000	4,93,000	1955	49,600	3-9-11	Normal

* Existing design capacity as reported by PID, Sindh is 9,00,000 cusecs.

^ The gauges were submerged at this discharge, it is estimated that a flood of more than 4,50,000 cusecs passed through this point.

4.4 Country-Wide Losses/Damages Due to 2011 Rains / Floods

The 2011-rains / floods affected an area of about 6.166 million acres (23 Districts in Sindh, 4 in Punjab and 1 in AJK), affecting 33983 villages, claiming about 484 lives, damaging 1287193 houses (684,725 partially and 602,468 fully) and cropped area of about 2.317 million acres and population of about 9.186 million has been affected. Province wise detail of losses / damages is given in Table-6. District-wise detail of flood damages caused due to 2011 Rains/Floods in Sindh Province is also given in Table-7.

Table 6: Country-Wide Losses/Damages Due to Rain/Flood 2011

Pro-vince	Villages Affected	Persons Affected	Area Affected (Acres)	Cropped Area Affected (Acres)	Houses Damaged		Persons Died	Persons Injured	Cattle Heads Perished	Camps Established	Persons in Relief Camps
					Partially	Fully					
Punjab	**32**	**6196**	**39312**	**31277**	**Nil**	**830**	**3**	**17**	**Nil**	**12**	**34**
Sindh	**33933**	**9178811**	**6126548**	**2285547**	**684187**	**601317**	**466**	**756**	**116557**	**756**	**240648**
Khyber Pakhtun-khwa	**Nil**	**Nil**	**Nil**	**Nil**	**Nil**	**Nil**	**Nil**	**Nil**	**Nil**	**Nil**	**Nil**
Balo-chistan	**Nil**	**Nil**	**Nil**	**Nil**	**Nil**	**Nil**	**Nil**	**Nil**	**Nil**	**Nil**	**Nil**
FATA	**15**	**671**	**439**	**310**	**534**	**300**	**3**	**Nil**	**1209**	**Nil**	**Nil**
Gilgit-Baltistan	**Nil**	**Nil**	**Nil**	**Nil**	**Nil**	**Nil**	**Nil**	**Nil**	**Nil**	**Nil**	**Nil**
AJ and K	**3**	**170**	**4**	**Nil**	**4**	**21**	**12**	**Nil**	**Nil**	**1**	**90**
G. Total	**33983**	**9185848**	**6166303**	**2317134**	**684725**	**602468**	**484**	**773**	**117766**	**769**	**240772**

Source: Provincial/Concerned Disaster Management Authority

Table 7: Losses/Damages in Sindh Province Due to Rain/Flood 2011

District	Villages Affected	Persons Affected	Area Affected (Acres)	Cropped Area Affected (Acres)	Houses Damaged		Persons Died	Persons Injured	Cattle Heads Perished	Relief Camps Established	Persons in Relief Camps
					Partially	Fully					
Badin	6395	1021301	984805	375,718	172155	210407	73	10	10060	8	4988
Dadu	1454	325000	187811	97,248	12610	4952	19	51	161		
Ghotki	1361	172067	258661	68,679	23891	7739	11	19	1		
Hyderabad	681	377992	113333	26227	13219	7405	17	27	32	1	3200
Jacobabad	1	335	600	3594	1688		2	1			
Jamshoro	614	97350	30,086	39,133	32962	10988	12	9	83	21	8275
Kamber	543	145030	150600	4192	7177	262	6	15	219		
Kashmore	105	12610	29280	14532	750	870	4	3	4		
Khairpur		927953	388638	182891	7138	4291	9	65	327	52	1212
Larkana	408	54355	12793	5396	5079	715	6	1	92		
Matiari	415	109629	160970	83739	23801	9002	25	28	1101	34	16528
Mirpur Khas	3178	705151	819833	171522	30627	87483	60	230	12280	8	622
N' Feroze	437	671499	698434	73660	21300	10155	26	50	512		
Sanghar	5182	1237432	927201	356473	88,722	125206	39	93	19040	560	127444
Sh. Benazir Abad	4104	900000		290000			39	82	22646		
Shikarpur	7	75	2500	20218		30	3	4	28		
Sukkur				26803			1				
T. Allahyar	1609	569829	369685	81645	64132	6031	3	5	197	40	13871
T.M Khan	2835	585411	390997	78038	47582	25353	17	24	187		
Tharparker	2284	907179	51782	12647	96896	81460	28	9	30623	5	20316
Thatta	629	177758	198111	164889	11257		18	15	131	2	809
Umerkot	1691	180,851	350428	108303	23198	8966	23	7	18824	19	42574
Karachi		4			3	2	25	8	9	6	809
G. TOTAL	**33933**	**9178811**	**6126548**	**2285547**	**684187**	**601317**	**466**	**756**	**116557**	**756**	**240648**

Source: Sindh Provincial Disaster Management Authority

4.5 2011-Rains/Flood Damages Need Assessment

The post rains / flood damages need assessment report-2011 as received from PID Sindh indicates that around Rs. 14.714 billion would be required for restoration/improvement of Irrigation Drainage and Flood Control Structures. Detailed breakup is given in Table-8 below.

Table-8: 2011-Rains / Flood Damages Need Assessment for Sindh Province

Sr. No.	Name of Region / Circle	Cost (Rs. Million)
i.	Sukkur Barrage Left Bank Region (Rohri Canal Circle)	1805.170
ii.	Sukkur Barrage Right Bank Region	679.717
iii.	Kotri Barrage Region	1919.870
iv.	Development Region in Sindh	941.800
v.	Sindh Irrigation and Drainage Authority	9323.680
vi.	Small Dams Organization in Sindh	43.500
	Total	**14713.737**

5. CONCLUSIONS AND RECOMMENDATIONS

During 2011 Rains/Floods, village abadies and cropped area were inundated mostly due to extensive rains in the rain/flood affected areas and inadequate surface/sub-surface drainage system in the main cities/towns, besides their locations in the depressions/ low lying areas. Deferred maintenance of LBOD and other drainage systems considerably reduced the discharge capability of LBOD system and other drains which resulted in over topping of LBOD and other drains at various locations due to over-design discharge experienced in those drains during 2011 Rains / Floods.

Future strategies recommended in wake of 2011-Rains / Floods are as follows:

a) Proper survey of all rain/flood areas should be carried out in order to identify flood risk areas i.e. cities, towns and villages, industrial areas etc and proper drainage system of all main cities/towns should be designed so as to avoid such urban flood situation in future.

b) New settlements / abadies should not be allowed to settle in future in low lying area/depressions. For the existing abadies proper protective measures based upon detailed investigations / surveys may be adopted.

c) Proper pumping system should be installed for the existing urban areas, where gravity drainage is ineffective.

d) In view of the changing climate, floods have now become a common phenomenon in the country, therefore, flood management plans need to be formulated at district level clearly indicating the safe high grounds marked for immediate evacuation during the disaster and for establishment of flood relief camps. These plans must be well prepared and shared with all concerned organizations.

e) The close coordination of major stakeholder departments / institutions needs to be improved for efficient relief operations during the flood disaster.

f) The discharge capacity of LBOD and other drains needs to be enhanced keeping in mind the unprecedented rains / floods experienced during monsoon season-2011.

g) The issue of urban flooding caused due to poor drainage needs to be seriously dealt by district level authorities in collaboration with their concerned irrigation departments.

h) Loss of life and property can be minimized if appropriate disaster response plans, supported by reasonably accurate and reliable forecasts, are put in place and are well rehearsed. Hence, Pakistan Meteorological Department needs to be well-equipped to give wholesome forecast indicating intensity and made responsible to issue early warning to all concerned departments. Although flood warning was issued, but its intensity was not known.

i) Urban flood management needs to deal clearly with the surface runoff disposal. Urban flood plans must manage storm water quantity and other engineering aspects of drainage in order to drain out storm-water as fast as possible away from the city/town with minimum damage potential.

j) Rehabilitation/ reconstruction works of 2010-Flood Damages need to be completed on urgent basis for upgrading the flood protection facilities/bunds that will ensure foolproof protection from future floods.

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