

Impact Forecasting

Pakistan Flood Event Recap Report

August 31, 2010

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Introduction

The 2010 Pakistan floods began in July after persistent heavy monsoonal rains inundated nearly every section of the country. As of late August, at least 1,645 people were killed, over 2,479 were injured and hundreds more were listed as missing after the catastrophic floods covered an estimated 62,000 square miles (160,000 square kilometers) of land – nearly one-fifth of the Pakistan’s entire landmass. Extensive damage occurred to homes, structures, the transportation infrastructure, telecommunications and the agricultural sector. The hardest-hit provinces were Khyber Pakhtunkhwa, Punjab, Sindh and Balochistan. Pakistan’s National Disaster Management Authority (NDMA) estimated that over 17.6 million people were affected by the floods, which was more than those impacted by the 2004 Indian Ocean tsunami, the 2005 Kashmir earthquake and the 2010 Haiti earthquake combined.



Flooding in the city of Multan in Punjab Province (Source: United Nations)

Meteorological Recap

The floods in Pakistan were the result of persistent monsoonal rains that brought record rainfall totals to many regions of the country not typically susceptible to significant rainfall. The following sections will help describe what exactly a monsoon is, what a normal monsoon season in Pakistan entails and also provide insight to the current meteorological setup that led to the massive flooding situation.

What is a Monsoon?

A monsoon is described as a shift in wind direction that causes excessive rainfall in many parts of the world including Asia, North America, South America and Africa. Shifts in global wind patterns are generally considered to be the primary mechanism behind the development of a monsoon. During non-monsoonal months, winds normally blow from land to ocean, which makes the air dry. During certain months of the year, the wind pattern shifts and begins to blow from the ocean to land, making the air moist. This moist ocean air is what causes monsoonal rains over many countries.

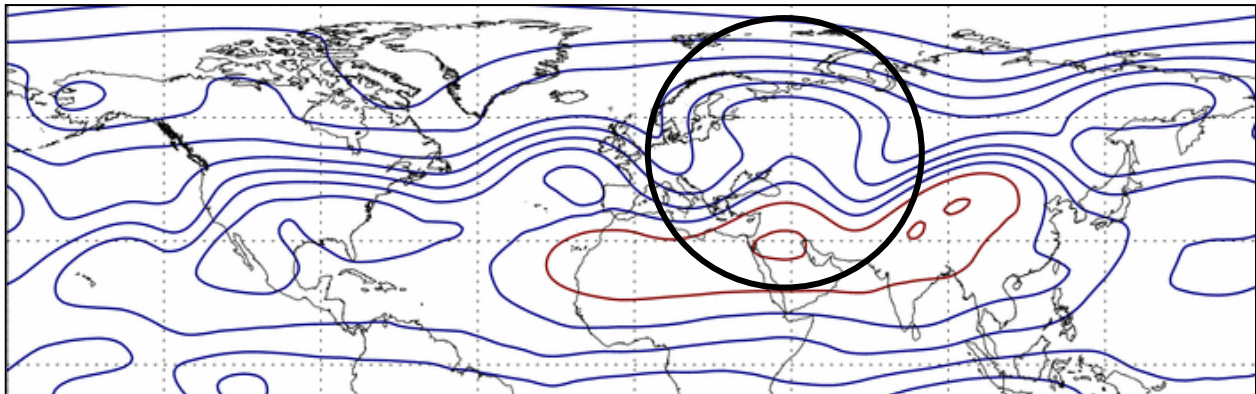
A Normal Monsoon Season in Pakistan

In Pakistan, the Southwest Monsoon season normally occurs between the months of June and September. The Thar Desert and adjoining areas of the northern and central Indian subcontinent (Pakistan, India and Bangladesh) heats up considerably during the hot summers. This heat causes an area of low pressure to develop over this region of the Indian subcontinent. As the low develops, moist winds from the Indian Ocean rush into the region and are then drawn towards the Himalayan Mountains, where they act like a wall to block winds from passing into Central Asia. This pattern forces air to rise and allows storm clouds to develop and cross parts of Pakistan and India. Throughout the months of June, July, August and September, this pattern repeats itself.

July-August 2010 Pakistan Meteorological Setup

The meteorological setup in Pakistan during July and August of 2010 was rather unique. Atmospheric conditions stretching from Western Europe to Southeast Asia caused unusual weather throughout all of these areas – including the extreme heat and wildfires in Russia, the ongoing catastrophic flooding and landslides in China and severe weather and flood events in central and northern Europe.

In early July, a strong ridge of high pressure began to develop near the Ural Mountains in Russia. This ridge became stationary and established a blocking pattern (known as an ‘omega block’ in the meteorological community due to its shape (see figure below)) across nearly all of western Russia. As the ridge remained stationary for nearly two consecutive months, persistent rains fell across much of Pakistan and also in parts of Afghanistan and Indian-held Kashmir beginning at the end of July. With an abnormally active jet stream riding around the periphery of the omega block into western Pakistan, copious amounts of hot and moist air created what some meteorologists called a ‘supercharged monsoon,’ as this unstable atmosphere led to a highly unusual pattern of heavy rainfall.



Upper level atmospheric map from late July and early August showing an ‘omega block’ in western Russia (Source: University of Reading – Department of Meteorology)

The rapid development of a La Niña cycle in the Pacific Ocean (typically resulting in a heavier-than-normal monsoon season in South Asia) also played a role in helping create a rarely-seen atmospheric setup that led to the flooding disaster in Pakistan. Up until mid-July, many farmers and regional government officials were concerned that a subdued start to the monsoon season would lead to water shortages. See Appendix A for a comparison of observed rainfall between July 1st and August 30th for selected cities in Pakistan and the typical average amount for each location.

Extent and Magnitude of Flooding

The flood event became the most extensive in this region since 1929, with 71 of the country’s 122 districts sustaining flood damage. This also became Pakistan’s most significant flood event in its recorded history since becoming a nation in 1947. According to reports, flooding encompassed an estimated 62,000 square miles (160,000 square kilometers) of Pakistan’s 340,000 square miles (803,000 square kilometers). This equates to nearly one-fifth of the country’s entire landmass, or roughly the size of the state of Florida in the United States. A 1,600-kilometer (1,000-mile) swath of damage along the Indus River alone was estimated to possibly cut Pakistan’s economic growth by 2.5 percentage points this year. See Appendix C for a map from the United Nations Office for the Coordination of Humanitarian Affairs (OCHA) that shows a breakdown of fatalities, injuries, damaged homes and the affected population.

Home and Infrastructural Effects

Substantial damage from the floods was prevalent in nearly every section of Pakistan. The most significant home damage was reported in Khyber Pakhtunkhwa, Punjab, Sindh and Balochistan provinces along the Swat and Indus rivers and their respective valleys. A reported 10,860 separate villages were completely inundated by floodwaters after points along the Swat and Indus rivers swelled to more than 10 to 20 times their normal heights. During monsoon season, the rivers sometimes reach one kilometer (0.62 miles) in width, though several spots along the Indus River were measured at 32 kilometers (20 miles) – or 35 times wider than normal. See Appendix D for satellite photos of the Indus River before and during the flood event. Throughout flooded areas of Pakistan, water heights of over 5.5 meters (18 feet) forced residents to escape to their roofs in hopes to be rescued.

According to Pakistan's National Disaster Management Authority (NDMA), at least 1.24 million homes were damaged or destroyed. International aid groups have noted that that number may continue to rise as further assessments are made. At least six million people were listed as homeless, with 17.6 million being affected. Statistics from the United Nations noted that the floods had also destroyed over 5,674 schools and 200 hospitals and health facilities. Topography and location of population played a major role in the high number of damaged domiciles and structures. Much of Pakistan is embedded within a mountainous terrain, and as the torrential rains fell, significant amounts of water ran downhill and tore through populated hillsides before reaching rivers and tributaries. Initial property damage estimates from the government were listed at PKR87 billion (USD1 billion), with that figure expected to rise.



Flooding in Punjab Province (Source: United Nations)

The widespread scope of the flooding also caused tremendous damage to the transportation infrastructure. In Khyber Pakhtunkhwa, the provincial information-minister reported that the transportation infrastructure was already severely impacted by ongoing civil unrest, and that the floods had only worsened the situation. Thousands of roads were either submerged or had been washed away, which made ground travel to many affected towns and villages throughout the country virtually impossible. Hundreds of bridges were destroyed, including one along the Karakoram Highway that connects Pakistan with China. At one point during the event in the town of Sukkur in Sindh Province, hundreds of meters (yards) of water were prevalent on both sides of the Indus National Highway.

The electrical and telecommunications infrastructures of Pakistan was also severely affected by the floods, damaging well over 10,000 transmission lines, transformers, base station controllers, base transceiver stations, feeders and power stations. According to the Pakistan Electric Power Company (PEPCO), millions of residents lost electricity and millions more had lost access to clean drinking water. The Pakistani government estimated total sustained infrastructure damage losses (including roads, bridges, electricity and telecommunications) at over PKR869 billion (USD10 billion).

Agricultural Effects

According to Pakistani government officials, the floods caused catastrophic damage to the agricultural infrastructure. Published reports from the Food and Agriculture Organization (FAO) of the United Nations indicated that floodwaters submerged approximately 6.9 million hectares (17 million acres) of cropland across Pakistan's most fertile grounds in Punjab, Khyber Pakhtunkhwa and Sindh provinces. This equates to nearly 16 percent of all cultivable land in Pakistan. Some of the country's primary crops include cotton, sugarcane, rice, pulses, tobacco, fruits, vegetables and animal fodder, as farming is the country's most important source of food and also a primary economic mainstay.

According to Pakistan's Ministry of Food, Agriculture and Livestock as of late August, economic losses due to crop damage included PKR52 billion (USD600 million) to over 80,000 hectares (198,000 acres) of sugarcane, PKR21.3 billion (USD247 million) of rice, PKR22.4 billion (USD259 million) of maize, PKR17.3 billion (USD200 million) of wheat stock after damaging over 667,000 tonnes and PKR45 billion (USD518 million) to fruits, fodder and vegetables. Farmers noted that seed for next year's crop season was washed away and that many in the farming community could lose up to two years worth of income. In addition, the FAO believes that if September wheat planting is missed due to water-logging, the impact could last for up to two years. Those areas that grow rice and maize are not expected to be able to harvest their first crop until autumn of next year.



Millions of hectares (acres) of cropland were submerged by the floods (Source: United Nations)

The textile industry was particularly affected, as over two million bales of cotton (20 percent of the crop) were washed away over 280,000 hectares (691,000 acres) as of August 30th. The economic damages from the lost cotton was estimated at PKR80 billion (USD925 million). Pakistan's textile industry accounts for 60 percent of the country's exports. Reports indicated that over 200,000 livestock had died, while the rest of the remaining livestock were facing a shortage of feed and fodder critical for survival. In Punjab Province alone, losses from the livestock casualties were PKR9.2 billion (USD106 million). There is a danger that 427,000 additional animals will die as a result of starvation and disease.

Based on official statistics, 23 percent of Pakistan's economy is dependent on agriculture and at least 44 percent of the work force is employed in agriculture-related work. A drop in the agricultural production was expected to have a fairly negative impact on the projected 2010 GDP growth. While it is too early to assess the total loss in the agricultural sector (arising from damages to standing crop, grain and seed stockpiles, livestock, poultry, fruits, agricultural infrastructure, etc.), an estimate from the Ministry of Food, Agriculture and Livestock noted that floods may have damaged crops valued at up to PKR433 billion (USD5 billion).

Historical Significance of Event

This is the most significant flooding event in Pakistan since June 1977, when at least 10,354 people were killed and over 1.2 million people were affected. Pakistan's largest natural disaster in terms of fatalities occurred on October 5th, 2005, when a magnitude-7.6 earthquake struck near the city of Muzaffarabad, Pakistan in Kashmir and left more than 78,000 people dead. See Appendix B for comprehensive lists of historical Pakistani natural disaster events by fatalities and the number affected.

Insured Loss Potential

At this time, there are no available insured loss estimates for this event. The vast majority of the losses (including damage to homes, roads, bridges, agricultural infrastructure, etc.) are not insured for flood. Those residential properties that do have insurance have very little, which would indicate that insured losses will likely be significantly lower than the total economic loss. As of yet, there have not been any reports of any major insured commercial, manufacturing or other industrial facility having been impacted. However, the fully insured KAPCO Power Plant (1,200 MW) at Kot Addu in Punjab Province was halted because of rising waters on August 5th, but was able to re-open after surrounding floodwaters subsided.

As of late August, the only losses that appear to be of significance to the insurance industry are the agricultural losses. Given the large damage to standing crops (at least 6.9 million hectares (17 million acres) of cropland are reported to be inundated), there is a potential for insured agricultural losses.

Several insurers in Pakistan offer crop insurance, usually with claims payments triggered by the declaration of a particular area as a 'calamity' by the Government and also the subsequent recording of the calamity in the official government gazette. The ability to declare a calamity is legislated in the National Calamities Prevention and Relief Act of 1958, which stated that in each province "whenever the province or part thereof is affected or threatened by flood, famine, locust or any other pest, hailstorm, fire, epidemic or any other calamity which, in the opinion of the government warrants action under this Act, government may, by notification, declare the whole or part of the Province, as the case may be, calamity affected."

The declaration is based on an official assessment of the state of the crop and the severity of the weather event. The declaration of a calamity is usually made when there is a likelihood of a famine or severe hardship due to a significant reduction in the amount of crop produced in the district. This typically means that a calamity is generally only declared when the crop yield is less than is half of the normal historical yield for the district. This requirement is also revealed in the government's normal calamity declaration procedures.

As of mid-August, the Loyyah, Mianwali, DG Khan districts in Punjab and the DI Khan District in Khyber Pakhtunkhwa have been declared as calamity areas by the government. The respective provincial governments have also declared the entire area of Khyber Pakhtunkhwa and Sindh to be calamity areas, though these declarations have not been ratified by the national government.

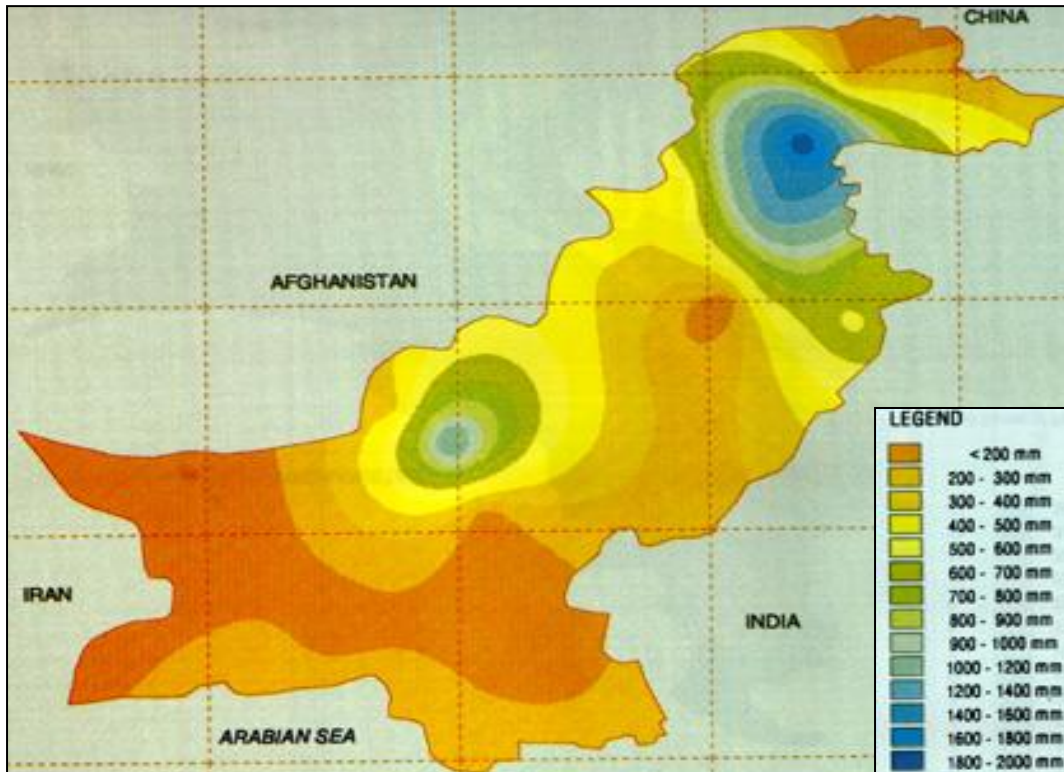
Total economic loss estimates have varied widely between the Pakistani government, international aid groups and media outlets. Some of the various estimates have ranged between PKR1.3-3.7 trillion (USD15-43 billion), though based on some of the official statements from the United Nations and the Pakistani government a final economic loss closer to PKR1.73 trillion (USD20 billion) seems plausible.

Appendix A

Comparison of Rainfall Totals: 2010 vs. Mean Average

Province/Region	Total Rainfall (millimeters)	Normal Avg. (millimeters)	% Avg.
Punjab Province			
Faisalabad	468	201.7	232%
Gilgit Baltistan / Azad Kashmir			
Bunji	130	40.3	323%
Chilas	96	31.0	310%
Gilgit	112	33.2	337%
Gupis	108	37.8	286%
Skardu	57	25.4	224%
Khyber Pakhtunkhwa Province			
Cherat	618	189.8	326%
Chitral	96	12.1	793%
D.I.Khan	523	122.2	428%
Drosh	154	42.1	366%
Parachinar	505	196.8	257%
Peshawar	535	118.7	451%
Saidu Sharif	757	278.5	272%
Sindh Province			
Jacobabad	182	78.2	233%
Karachi Airport	258	126.2	204%
Padidan	164	81.0	202%
Balochistan Province			
Sibbi	149	74.4	200%
Zhob	234	110.8	211%

*Note: Total rainfall data is from selected locations between July 1, 2010 and August 30, 2010
(Source: Pakistan Meteorological Department)



Annual average rainfall totals in Pakistan (Source: United Nations Environment Program)

Appendix B

Lists of Historical Natural Disaster Events in Pakistan

Disaster Type	Date	Death Toll
Earthquake	October 8, 2005	78,000
Earthquake	May 31, 1935	60,000
Flood	June 1977	10,354
Wind storm	December 15, 1965	10,000
Earthquake	December 28, 1974	5,300
Earthquake/Tsunami	November 27, 1945	4,000
Flood	1950	2,900
Flood	July & August 2010	1,645
Flood	September 1992	1,334
Flood	March 3, 1998	1,000

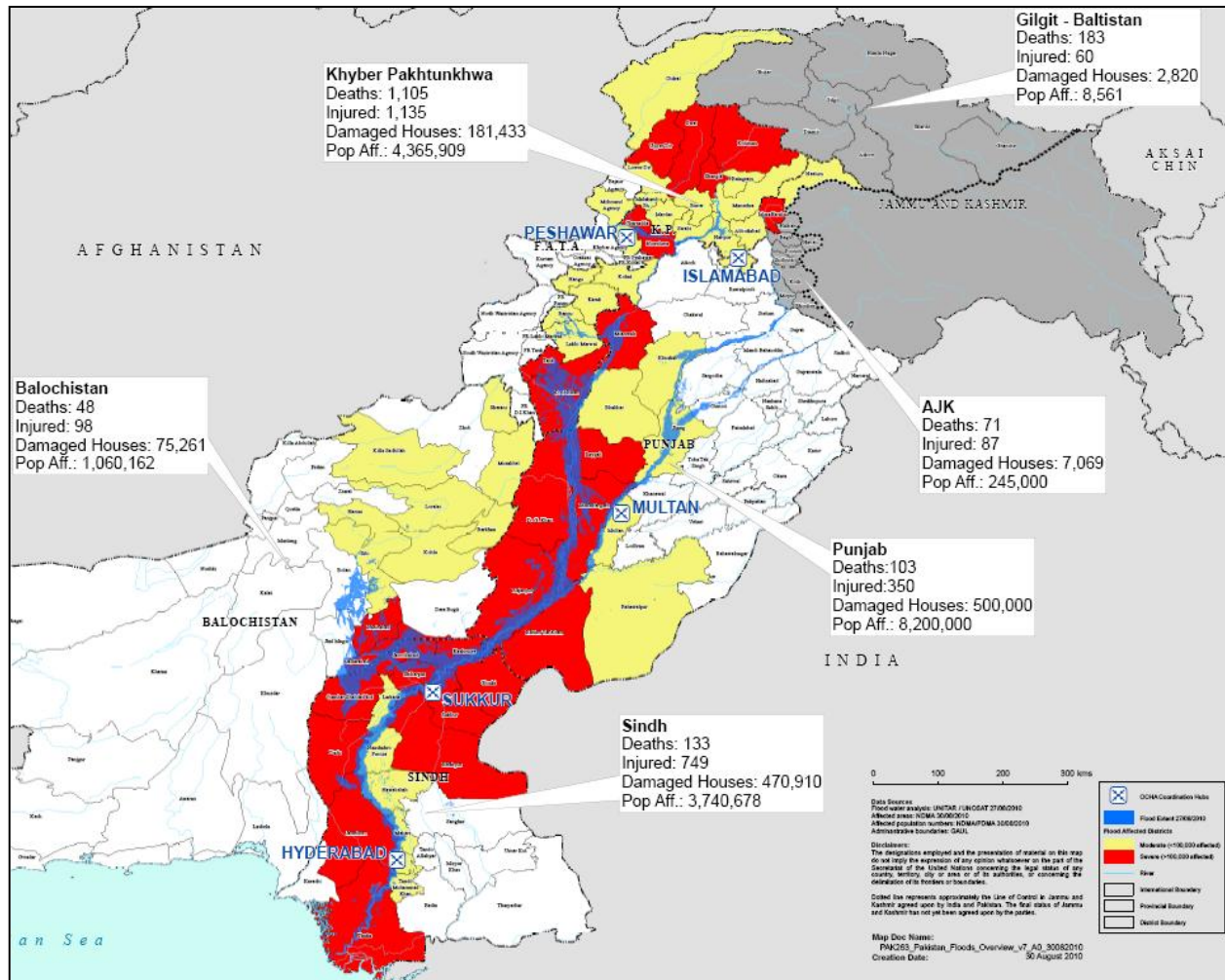
Disaster Type	Date	Total Number Affected
Flood	July & August 2010	17,600,000
Flood	September 1992	12,324,024
Flood	August 9, 1992	6,184,418
Flood	August 2, 1976	5,566,000
Flood	August 1973	4,800,000
Flood	July 1978	2,246,000
Drought	Late 1999 - March 2000	2,200,000
Flood	July 22, 1995	1,255,000
Flood	August 24, 1996	1,186,131
Flood	June 1977	1,022,000

Disaster Type	Date	Economic losses (USD millions)
Flood	July & August 2010	15,000-43,000
Earthquake	October 8, 2005	5,200
Wind storm	2007	1,620
Flood	August 9, 1992	1,000
Flood	August 1973	662
Flood	August 2, 1976	505
Flood	2007	327
Drought	Late 1999 – March 2000	247
Flood	2001	246
Flood	2008	103

*Note that Pakistan did not become a nation until 1947, so the listed natural disaster events prior to this time occurred in the region where Pakistan now occupies

Appendix C

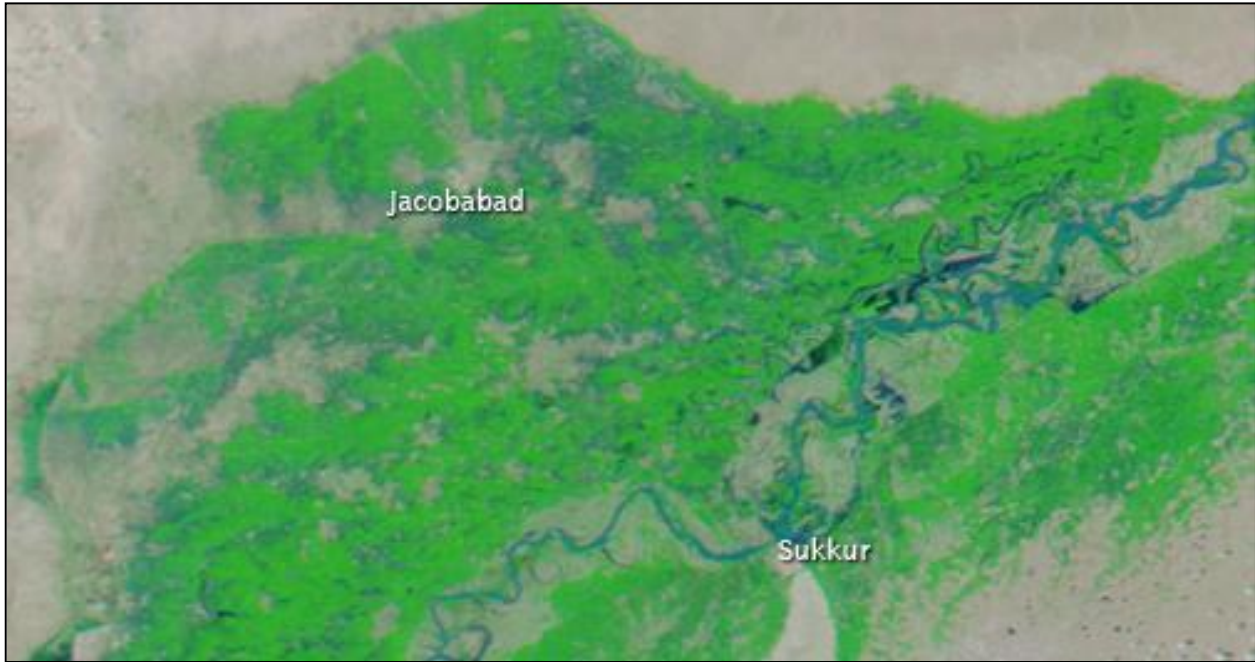
Map of Affected Provinces/Regions in Pakistan



Number of deaths, injuries, damaged homes and affected population by province and region as of August 30, 2010
 Source: United Nations Office for the Coordination of Humanitarian Affairs (OCHA)

Appendix D

Satellite Photos of Indus River Before and After the Flood Event



Satellite image of the Indus River on August 18, 2009 (Source: NASA)



Satellite image of the Indus River on August 17, 2010 (Source: NASA)

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