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Some Catastrophic Events during the Summer Monsoon Season 2010, in Asia

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During the summer monsoon season 2010, Pakistan, India and China experienced excessive rainfall in many regions causing extensive floods, putting pressure on the dams and provoking mud- and landslides in different parts of the region. This short note likes to highlight some of the major natural catastrophes that occurred during 2010 monsoon. The most severe and far reaching catastrophe, no doubt, is the mega flood in Pakistan. Besides looking into some causes and effects of this flood, the note will also focus on the flash flood that occurred in Leh in Ladakh, India and the mudslides that devastated in Zhugqu region in China.

The Monsoon Flood of Pakistan July-August 2010

On 29th July 2010, the newspapers reported that due to rains the water level in the river Swat was rising. However, one day later the world came to know that Pakistan was reeling under severe floods especially in Shangla and Swat districts of the Khyber Pakhtunkhwa province and in Pakistan occupied Kashmir. Within one day, 440 people had lost their life and 400,000 people rendered homeless. The floods had also destroyed much of the infrastructure, which made the rescue work not only difficult but virtually impossible. Subsequent reports began calling it the worst ever flood in eighty years, though it was only the beginning of a much greater tragedy to come (*www. faz.net... 30-7-10*). In the following days, the number of death count rose steeply to 1500, 476 death count alone in the Swat valley, and the number of displaced people to three million (www.faz.net ...4-8-10). By this time the flood had also reached Punjab and on the 9th of August the flood started advancing towards Sindh. It is estimated that nearly one fifth of the land of Pakistan suffered under the inundation. The Indus, at some parts has become as wide as 25 km, a fact which can be easily seen on aerial photographs. The height and velocity of the flood continue to exert a lot of pressure on the banks of the Indus and the system of barrages, especially the Sukkur Barrage, and there is a constant threat that the river embankments may have to be opened to save the barrage, and divert the floods to save the settlements further downstream.

About four weeks after the beginning of the flood it was estimated that 17.2 million people have been affected by the flood, 1.2 million homes destroyed or damaged and 1800 to 2000 people dead (news. uk.mns.com...24-08-2010). The human and economic consequences of this catastrophe are far reaching and very difficult to assess. People need timely shelter, food and health care to prevent the number of death rising. Though saving the people from starvation and diseases is the first priority of the vast relief effort, it is equally important to restart the agricultural operations, the backbone of Pakistan's economy, as soon as possible.

Fig. 1: Areas severely affected by the month long flood July/August 2010 in Pakistan

By the end of August 2010, the flood is still advancing, though in some areas in northern Pakistan the waters have started receding, in the south the flood threat continues especially in Sindh. The flood is a natural catastrophe which developed extremely fast as can be seen in the case of the Swat valley, a tributary of the Kabul river which in turn joins the Indus near Attock. There was hardly any time lag between the rainfall and the inundation, taking the inhabitants of the fertile but steep Swat valley by surprise and making their escape from the flood difficult if not impossible.

In order to understand the relationship between the rainfall and the flood we looked at the daily rainfall data of Pakistan for July and August 2010 that led to the flood and could recognise certain clusters of heavy rainfall. Three rainfall clusters of three to five days were recognised, a pre-flood cluster, the main cluster leading to the flood and the first cluster after the onset of the flood. In the Swat and Kabul valleys, the area from where the flood was first reported, the heavy rainfall was restricted to a period of three days from 28th to 30th of July (see table). The table shows also other

Table 1: Three Rainfall Clusters related to the Mega Flood in Pakistan in 2010

Region of Pakistan	**Pre-flood cluster 20th to 22nd July 2010**	**Main flood cluster 28th to 30th July 2010**	**First cluster after the onset of the flood 3rd-5th August 2010**
Swat and Kabul river basins (Khyber Pakhtunkhwa province)	Absent Except Peshawar 67 mm	Very heavy rainfall i.e. Risalpur 401mm Saidu Sharif 334 mm Peshawar A/P 333 mm Lower Dir 263mm	Absent Except Saidu Sharif 39 mm (4-8-10)
Upper Indus valley incl. Himalayan region	Moderate to heavy rainfall Kotli 141 mm Muzaffarabad 197 mm Garhi Dopatta 155 mm Murree 106 mm Kamra 160 mm	Very heavy rainfall Kotli 223 mm Muzaffarabad 288 mm Garhi Dopatta 346 mm	Absent or lower rainfall Kotli 37 mm Muzaffarabad 37 mm Garhi Dopatta 63 mm
Central Indus valley	Heavy in the northern part , decreasing towards the south Mianwali 281 mm Bannu152 mm Bakkar 96 mm D. G. Khan 46 mm Exception R. Y. Khan 222 mm	Rainfall lower or absent Mianwali 59 mm Bannu 93 mm Bakkar 59 mm	Absent or lower rainfall, heavier towards the south Mianwalli 48 mm Bannu 27 mm Bakkar 76 mm D. G. Khan 137 mm R.Y.Khan 128 mm Khanpur 137 mm
Punjab river basins	North heavy rainfall Lahore A/P 236 mm Jhelum 120 mm Sialkot Cantt. 253 mm South rainfall decreasing or absent Jhang 67 mm	North decreasing or absent Jhelum 114 mm Sialkot Cantt. 73 mm South rainfall increasing Jhang 205 mm Multan 221 mm	Absent or moderate Jhelum 36 mm Jhang 45 mm Except Sialkot Cannt. 124 mm
Sindh	Absent	Absent	Few stations Larkana 131 mm (5-8-10) Jacobabad 50 mm

characteristics of the rainfall pattern. In the Upper Indus valley and the Himalayan region further east, the heavy rainfall event of 28th to 30th was preceded by a high to moderate rainfall clustered around 20th to 22nd July, thus the heavy rainfall was spread over a greater period of time. In the Central Indus valley, the pre-flood period showed heavier rainfall in the north while the south registered heavier rainfall after the onset

Table 2: Some Places with Higher than Normal Rainfall in August 2010

	Place	Rainfall (in mm) August 2010	Rainfall (in mm) Normals Month of August
NW Pakistan	Dir	292	156.0
	Parachinar	260	97.4
	Peshawar	133	72.6
	Saidu Sharif	286	125.9
Central Pakistan	D. I. Khan	376	61.7
	Faisalabad	224	84.7
	Multan	157	36.4
	Khanpur	277	17.4
Sind	Badin	163	92.5
	Larkana	203	31.1
	Hyderabad	81	63.0

Source: Daily rainfall data: http://www.pakmet.com.pk/FFD/indes_files/rainjuly. htm and rainaug.htm

of the flood, during the event from 3rd to 5th August. While the Indus flood moved towards the south, the rainfall intensity also moved towards the south, thus reinforcing the flood danger. Regional variations between the northern and southern part can also be recognised in different parts of the Punjab river basins, the northern part registering very heavy rain even before the flood. The opposite is the case in the lower courses of the Punjab rivers. Sind registered rain only after the onset of the flood. It may be noticed that the rainfall totals for the month of August 2010 are, in a number of places, much above the normals for that month (see table). This higher rainfall helped the flood to continue to persist for such a long time.

If a large catastrophic flood occurs scientists look for explanations. In 2010 they were not only puzzled by the floods in Pakistan and China, but also by the long heat wave in Russia which drove the temperature to above 38°C for a number of days and caused the never ending chain of forest fires. Scientists have related these rare weather phenomena to an unusual behaviour of the jet stream which usually moves at high speed form east to west at high altitudes around the globe, but was found to be in a more stationary position since the middle of July. A blocked jet stream holds the weather system in place. In the case of Pakistan, the cool moist air held within a loop of the jet stream and the arrival of southwest monsoon coincided with disastrous consequences of flooding and destruction (S. Titz). Other reasons given for the flood are global warming, or the overburdened irrigation system. In the case of a flood of this magnitude the state of a canal or an embankment becomes insignificant, they could not have stopped the flood, however, to rebuild the Indus

Table 3: Rainfall charaterstics - Leh

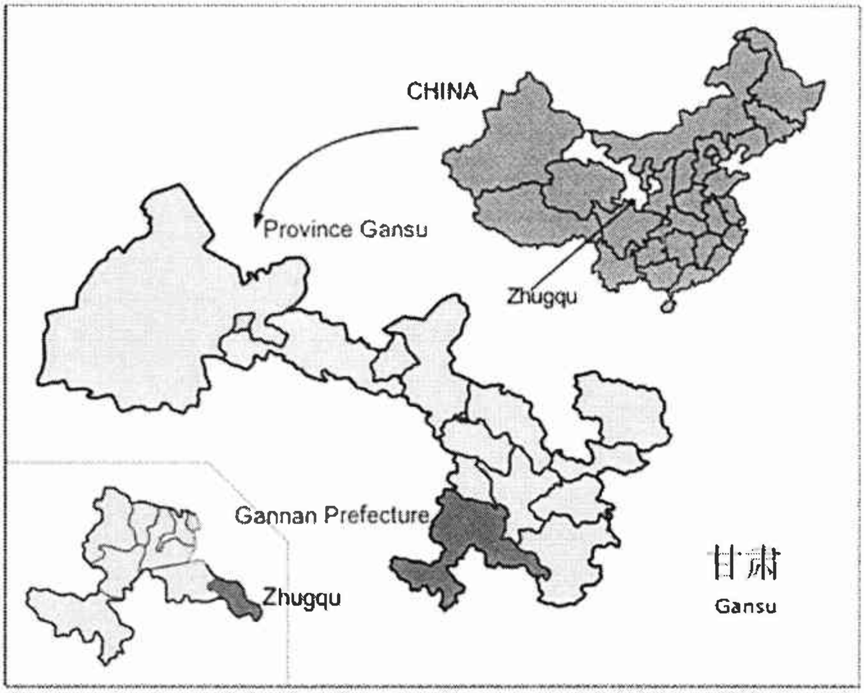
Months	Mean monthly rainfall in mm	Number of Rainy days	Rainfall of the Wettest month in mm	Heaviest rainfall in one day in mm	Date of heaviest rainfall
January	9.5	1.3	41.4	24.4	28-01-1983
February	8.1	1.1	42.2	16.8	25-02-1903
March	11.0	1.3	40.0	16.0	02-03-1930
April	9.1	1.0	42.6	22.1	14-04-1896
May	9.0	1.1	68.6	22.4	14-05-1955
June	3.5	0.4	28.7	19.6	30-06-1955
July	15.2	2.1	75.4	23.6	28-07-1882
August	15.4	1.9	111.5	51.3	22-08-1933
September	9.0	1.2	68.6	25.9	19-09-1893
October	7.5	0.4	88.4	39.1	05-10-1955
November	3.6	0.5	16.7	16.2	04-11-1959
December	4.6	0.7	35.3	15.2	23-12-1944
Total	102.0				

Source: IMD, Leh, Observation period1951-1980

protection system and to desilt the canals will be one of the herculean tasks before Pakistan after the land has dried up.

The Flash Flood in Leh –Leh (27,513 population 2001), the major town of Ladakh, is situated on the right bank of the Indus river at the foot of the Ladakh mountain chain. Settlements in the neighbourhood like Spitu (3200 m) are usually close to the Indus, Leh (height 3505 m), however, is situated on the alluvial fan of a little broader tributary valley a few km away from the river. This site seems to have provided the town, in this arid region, with surface or ground water from the valleys above.

On the 6th of August 2010, Leh experienced, between 01.30 and 02.00 hours IST, a heavy cloudburst leading to a flash flood. The fast developing mud streams on the steep and unstable slopes developed a great velocity and hit the town and some five neighbouring villages with great destructive force, buried houses and people under metre thick cover of debris. This major mud stream damaged major installations, like the hospital and the polytechnic college, and inundated other areas, including the airport. Some 167 people lost their lives, 400 were still missing including 28 soldiers of a camp site, and over 300 injured (by 11th of August). The road, air and communication lines were disrupted. The location of Leh on an alluvial fan of a slightly broader valley - in many respects an advantageous settlement site - may have proved to be a drawback in the case of the flash flood. The water masses coming down the tributary valley were provided with enough slope, distance, momentum and



Location of Zhugqu County, based on file created by Wikimedia Commons, 22 September 2007, author: Croquant

material to turn into the destructive mudflow that destroyed part of Leh, especially parts of old Leh. Villages which suffered severe destruction are Shabu and Choglamsarin located on a right side tributary valley south of Leh, and Phyang on a tributary valley north of Leh, where the destroyed camp of the Army Service Corps was situated, further Nimroo north of Leh near the Indus river. (http://ibnlive.incom.news/dozens-killed-in-leh-cloudburst-flash-floods/).

A cloudburst is believed having rainfall in the order of 100 mm an hour or more. In over 135 years – the weather station was established in 1873 - such a heavy rainfall was never recorded in Leh (see table 3), the heaviest was 51.3 mm on 22nd of August 1933. It is regretted that the amount and the duration of rainfall received during the cloudburst of 6th of August 2010 were not recorded by the IMD. The IMD speaks of a localised event as the nearby meteorological observatory of the Indian Air Force reported 12.8 mm of rainfall during the 24 hours starting from 5.30 hrs. on the 5th to 5.30 hrs. on 6th August 2010 (*http://climatalk.in.*2010/08/the-science-of-cloudburst-in-leh/). It may be noted that this rare and highly localised event was able to produce floods, landslides and to change the quite Indus into a turbulent swift flowing river in spate.

The Mudflow in Zhugqu (also written Zhougqu) – Zhugqu (latitude 33.78° N and longitude 104.36°E) is a medium town

(134,000 persons in 2010) in western China. Zhugqu County is one of the 58 counties of Gansu (Kansu) province and forms part of the Gannan Prefecture which constitutes the south-eastern part of Gansu and is a Tibetan Autonomous Prefecture with one third ethnic Tibetan population. Zhugqu County represents a mountainous dissected terrain which forms the eastern margin of the Qiongtai Shan. Linked by a bridge, Zhughu town (height 1374 m) spans over an irregular hilly area on both banks of the Bailong river. Joined by some tributary the major part of the settlement is located on the left bank (see DigitalGlobe satellite image collected August 10, 2010, Zhugqu, China Mudslide). Downstream from Zhugqu, the Bailong adopts a south-easterly course and joins the Yangtze river basin unlike most rivers of Gansu province who join the Huang Ho.

Around midnight on 8th August 2010, three villages and Zhugqu were struck by an enormous mudslide that swept through the tributary valley, tearing apart multi-storey houses on its way, dislodging them, tossing them around and burying most of them with its inhabitants under huge mass of mud and debris and finally dumping part of the mud and debris into the Bailong blocking the river. This in turn led to severe flooding of some parts of the town. The enormity of this disaster can be seen by the sheer size of the mudslide, five km length and half km width, (asianews.) but more so by the great loss of life of 1144 people, besides the injured and the large number of missing people coupled with the loss of property.

The final cause of the mudslide was the excessive rainfall before 8th August 2010, a rainfall which continued even after the 8th of August producing minor slides in nearby areas. However, it must be also explained that the area besides being seismic is very prone to mudslides. Since 1823 eleven devastating mudslides have been registered in the area. The reasons lie in the relief and the management of the landscape. The natural relief is very steep which can be easily recognised on the above mentioned satellite image by the serpentine, hair pin bend roads on the surrounding hills, including the winding roads of the township on the right bank of the river. Some of the slopes appear forested but most of them seem to be cut into numerous small terraces, yellow coloured and barren at the moment. This leads us to some of the observations Chinese scientists related to the disaster (Wang Zicheng, AsiaNews). Between 1950 and 1990 the Chinese Government tried to convert the mountain slopes into cropland, hence the terracing. The Gansu province remains short in food and for this purpose 1226,000 ha of forests have been converted into 7.300 ha of farmland, mainly terrace cultivation, making the region more susceptible to erosion. The second observation regards the building of a large number of hydroelectric dams (more than 156 dams) along nearly every local river destabilising the environment. Another group of geologists feel that large scale road and railway construction near Zhugqu linking Lanzhou in the north to Chengdu in the south may have increased the risk of soil erosion.

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