Name of Publisher: BRIGHT EDUCATION RESEARCH SOLUTIONS

Area of Publication: Business, Management and Accounting (miscellaneous)

Let's Start!

Journal of Management & Social Science

ISSN Online: 3006-4848
ISSN Print: 3006-483X

https://rjmss.com/index.php/7/about

RECOGNIZED IN "Y" CATEGORY BY HEC

[Socio-Economic and Environmental Impacts of Flood 2010 in Lower Dir District and Mitigation Measures]

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Review Type: Double Blind Peer Review

Journal of Management & Social Science
VOL-2, ISSUE-2, 2025

ABSTRACT

The catastrophic flood of 2010 in District Lower Dir, Khyber Pakhtunkhwa, Pakistan, was a major natural disaster that caused widespread devastation. This study investigates the flood's underlying origins, repercussions, and recovery efforts. The research cites numerous aspects that contributed to the disaster, including record monsoon rainfall, deforestation, and inadequate water management infrastructure. The flood devastated agricultural, infrastructure, and local livelihoods, displacing hundreds of people and causing a significant economic collapse. The study utilizes qualitative and quantitative analysis to emphasize the immediate and long-term environmental and socioeconomic implications on Lower Dir's population. It also evaluates the efficiency of recovery efforts implemented by the government and non-governmental organizations in returning to normalcy. The study makes proposals for strengthening flood resilience through greater disaster planning, community-based risk management, and sustainable development practices to reduce future hazards. The results of study also help researchers, policy makers and managers for practical applications to mitigate floods in future.

Keywords: Floods, Natural Disaster, Deforestation, Socio-Economic Impacts, Displacement, Disaster Planning, Non-Governmental Organizations (NGOs), Community – based risk management.

Introduction

The devastating disaster of flood 2010 in the district Lower Dir, located in the Pakhtunkhwa province of Khyber, Pakistan, was the worst disaster in the recent history of this area. The underlying area, represented by its uneven terrain and river valleys, is not protected against heavy rains that have caused widespread flooding in the area (Mahmood & Ullah, 2016; Qasim et al., 2016). This flood was caused by a huge storm that hit a large part of Pakistan and caused a huge human and financial disaster. The basic reason of the 2010 flood was the severe rainfall of the storm, which was generally above normal levels and caused Panjkora River and its tributaries to overflow (Ahmad & Afzal, 2021). The topography of Lower Dir district, with its unstable slopes and restricted vegetation due to deforestation, favors rapid flooding and the disruption of floodplains. Human activities, including cutting down trees and a lack of land management, have worsened the situation by reducing the country's ability to mitigate moderate floods (Rahman et al., 2014).

Lower Dir District has steep slopes and valleys, which can lead to rapid runoff during heavy rainfall or snowmelt. The Panjkora River and its tributaries flow through the district, and these rivers can swell and overflow their banks during periods of high water. The monsoon season (July-September) always consists of severe rainfall in the region, increasing the risk of floods. Floods in Lower Dir District are often associated with the broader patterns of flooding in the region caused by heavy monsoon rains and the overflow of rivers.

The 2010 floods highlighted the need to improve flood preparedness and resilience in the country. Regional adaptation programs have been established to identify potential flood hazards and set boundaries in disaster response (Asian Development

Bank & GoP, 2010) These services should provide the network with the necessary information and tools to minimize the effects of floods.

The impact of the flood on Lower Dir was profound and devastating. The loss of life was great; many residents lost their lives, and hundreds more were forced to flee their homes (National Disaster Management Authority (NDMA, 2010). The floods damaged infrastructure, including roads, bridges, schools, and health services, disrupting essential services and relief efforts (United Nations Office for Coordination of Humanitarian Affairs (OCHA, 2010, 2022). The agricultural sector, which is an important part of the district's economy, suffered great damage when the agricultural land was flooded and destroyed the crops, causing great economic problems for the affected communities (FAO, 2020). After the disaster, the government of Pakistan in collaboration with international organizations and non-governmental organizations (NGOs), did a lot of relief and recovery. These efforts include disaster relief projects, creating helpful guidelines, and rebuilding damaged infrastructure (World Alliance of Red Cross and Red Sickle Society Social Orders (IFRC, 2013). A long-term recovery strategy has been put in place to increase the flood platform and relief measures, for example, by supporting flood prevention, expanding early warning systems, and improving the economy of the main actors (Karki, 2011).

This study seeks to offer a comprehensive account of the catastrophic, 2010 floods in the Lower Dir region, focusing on their causes, impacts, and the subsequent recovery efforts. By examining the contributing factors behind the disaster and evaluating the response measures taken, the research intends to inform the development of future disaster risk reduction strategies and the implementation of effective measures in flood-prone areas. This study aims to provide a comprehensive analysis of the flood of 2010 in the district Lower Dir, focusing on its causes, its effects, and the recovery process. This research is significant for several reasons. Firstly, it provides a detailed case study of one of the most severe flood events in Pakistan's recent history and contributing to the broader field of disaster risk reduction (DRR). Secondly, the findings from this study can inform policy and practice, helping local and national authorities to make ready for and respond to similar events in the future. Finally, the study highlights the importance of sustainable land management and infrastructure resilience, offering practical recommendations for reducing the risk of future floods in the Lower Dir District and other vulnerable regions.

Research Methodology

Selection of Study Area

Lower Dir District is located in the Khyber Pakhtunkhwa province of Pakistan, an area known for its mountainous terrain and river valleys. The region's topography, while picturesque, also makes it particularly susceptible to flooding. The 2010 monsoon season brought extraordinary rainfall that exceeded historical averages, overwhelming the region's rivers and drainage systems (Ahmad & Afzal, 2021). The Pakistan Meteorological Department recorded rainfall levels that far surpassed normal patterns, contributing to the rapid inundation of large areas (Asian Development Bank & GoP, 2010).

The socio-economic context of Lower Dir District further exacerbated the impacts of the flood. The region is mainly agricultural, with a maximum portion of the population

depending on farming for their livelihoods. The flood destroyed crops, washed away fertile soil, and left vast tracts of land waterlogged, severely disrupting the local economy (FAO, 2020). Additionally, human activities such as deforestation and unregulated land use have significantly altered the natural landscape, reducing its capacity to absorb heavy rainfall and increasing the risk of soil erosion and landslides (Rahman et al., 2014).

The disaster management response to the 2010 flood highlighted both strengths and weaknesses in the existing framework. The National Disaster Management Authority (NDMA) and other governmental and non-governmental organizations mobilized swiftly to provide emergency relief, including food, shelter, and medical care (NDMA, 2010). However, challenges in coordination, resource allocation, and access to affected areas hampered the effectiveness of these efforts (IFRC, 2013). Long-term rehabilitation efforts focused on restoring infrastructure and rebuilding livelihoods, but the process was slow and fraught with difficulties.

Despite the immediate and visible impacts of the flood, there remains a need for comprehensive research to fully understand the complex interplay of factors that contributed to the disaster and to develop effective strategies for future resilience. This research intends to fill this gap by examining the environmental, socio-economic, and institutional dimensions of the 2010 flood in the Lower Dir District. By analyzing the causes, impacts, and responses to the flood, this research seeks to identify key lessons and recommend actionable strategies for improving disaster preparedness and reducing vulnerability to future floods.

Research Design

The research design employs a mixed-methods approach, combining qualitative and quantitative techniques to investigate the 2010 flood in the Lower Dir District.

Sampling Design

A random sampling approach was used to choose a sample of 200 households from Lower Dir's flood-prone areas. Moreover, Key Informants were also interviewed, having firsthand knowledge of the flood event and response efforts, ensuring a range of perspectives from various stakeholders.

To determine the sample size using the Arkin & Colton (1963) formula, we use the formula for calculating the required sample size in a finite population. The formula is given below:

$$n = \frac{NZ^2 \times P \times (1 - P)}{Ne^2 + \{Z^2 \times P \times (1 - P)\}}$$

Where:

$\boldsymbol{n}$ = Sample size

$\boldsymbol{N}$ = Total households in Lower Dir District = 150,000

$\boldsymbol{Z}$ = Level of Confidence (95%)

$\boldsymbol{P}$ = Degree of variability (50%)

$\boldsymbol{e}$ = Margin of error (6%)

Results and Discussion

Geography of the Area under Study

Panjkora river basin is located at a distance of 180 Kms from Islamabad towards the

North-West of the country. The whole of the valley from Chakdara to Lawari Pass spreads from 35° 04′ to 35° 46′ N-latitude and 71° 32′ to 72° 22′ E-longitude (Mahmood, 2019). With a total area of 3699 $km^{2,}$ whereas Lower Dir the specific part of the valley which is under study is located between 34° 22′ and 35° 50′ N-latitude 71° 02′ to 72° 32′ E-longitude. It is surrounded from the North by Upper Dir, from the East by District Swat, from the West by Afghanistan, and in the South West by District Bajawar and in the South by Malakand. It has an outlet of Panjkora River. The total area of Lower Dir is 1583 km^2 surrounded by mountains except the South-East portion (KPITB, n.d.)

River Panjkora flows right in the middle of Dir valley having several contributory streams from the Hindu Kush Mountain with a total length of 220 kms. Panjkora consists of two words "Panj" and "Kora" which means five water channels. The river is an amalgamation of five main streams (locally named as khwar) i.e. Kohistan stream, Gwaldai stream, Sherengal stream, Dir River / Gol and Barawal stream. The River Panjkora is also fed by several other streams. River Panjkora is surrounded by steep mountains of Hindu Kush with peaks ranging to 5,000 meters and beyond. These peaks are covered by substantial amount of snow, which melts in warm weather especially in monsoon and causes floods (Khattak et al., 2012).

In Lower Dir the river basin opens up with good fertile floodplain on either side of the river which is irrigated by narrow channels from Panjkora. The presence of the main communication artery right on the river bank has also attracted nearly all the trade centers and market in the flood prone zone (Mahmood et al., 2019).

Main tributaries of the Panjkora River are as under: -

- Dir Gol/ Dir River. This tributary, originates from the mountainous areas of Upper Dir.
- Kohistan Khwar/ Stream. It originates from Kumrat Valley, in Upper Dir.
- Gwaldai Khwar/Stream. It is another stream contributing to the Panjkora River.
- Usherai Khwar/ Stream. Another important stream that starts from the Usherai valley.
- Barawal Khwar / Stream. This tributary emanates from the Barawal in Upper Dir.
- Dara Utala Khwar/Stream. Another important tributary that joins the river Panjkora.
- Konhaye Stream. This tributary starts from Maidan area in Lower Dir. It is a seasonal stream (nullah) that contributes to the Panjkora River, particularly during the monsoon and snowmelt periods.

Analysis of Metrological Data

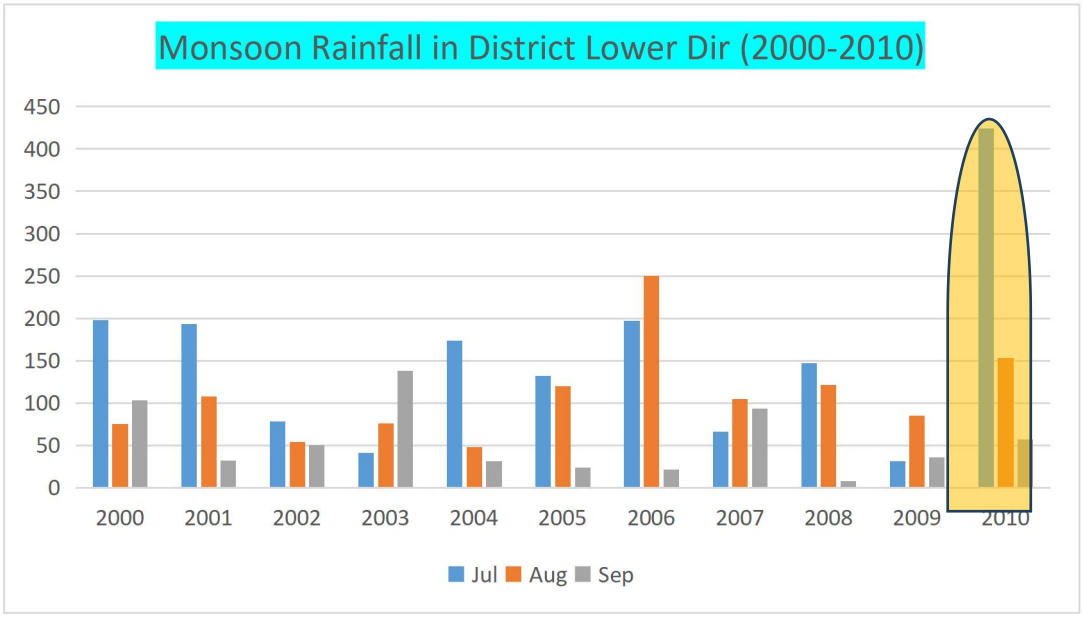
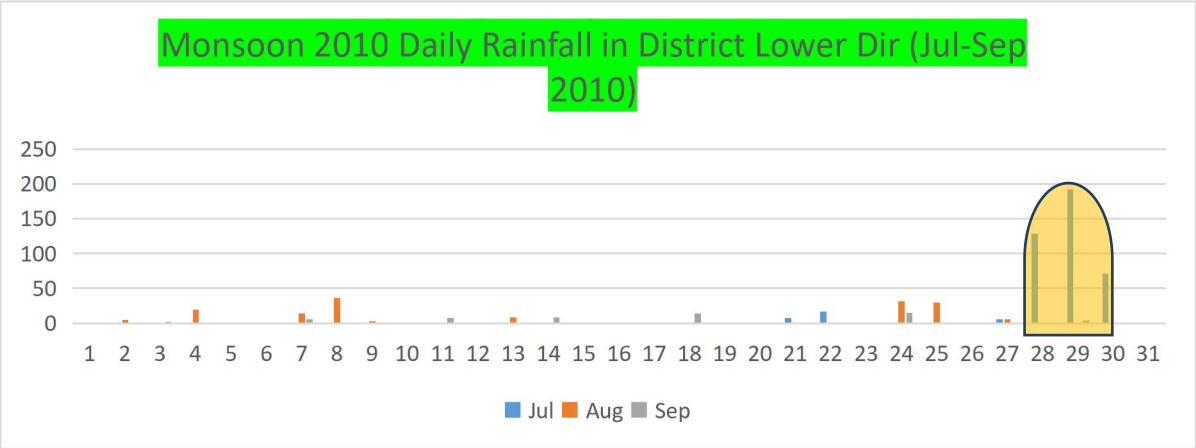


Figure 3 Monsoon Precipitation In Lower Dir From 2000-2010.
Source Regional Met Office Peshawar

For analysis of rainfall data, Metrological Centre at Peshawar was approached for provision of both monthly and daily weather data of District Dir from 2000 to 2010. Precipitation data of monsoon seasons (Jul- Sep) of last ten years (2000 to 2010) was compared for analysis purposes. The comparison clearly showed that Lower Dir had extraordinary downpour from July to August in 2010, ranging from 153 mm to 424 mm.



Furthermore, the monsoon of 2010 from July to August which received maximum downpour was again scrutinized for the purpose of daily precipitation in Lower Dir. The daily precipitation data in Figure 4.5 clearly indicates that on 28, 29 and 30 Jul 2010, 128 mm, 192 mm and 71 mm downpour per day were observed respectively. This unparallel rainfall in short period of time coupled with excessive glaciers' melting in the upper zone of Dir valley tremendously intensified the flood in lower basin.

Impact of Flood 2010 on the Study Area (Lower Dir)

Extraordinary precipitation in combination with heavy snowmelt in the Hindu Kush ranges is the main reasons for these unmatched catastrophic floods. The heights around Panjkora Basin during the winters of 2010 were covered with severe snow in the last eight decades. In July 2010, a combination of snowmelt, excessive precipitation, and rising temperatures triggered the most disastrous flood in the known history of the Panjkora valley. The flood peaked between July 28th and 29th, submerging areas never previously affected. Fast-flowing waters, due to the river's steep gradient, carried heavy rocks, sediments, and large tree logs from nearby forests. This intensified the destruction, washing away crops, causing casualties, and destroying key infrastructure like bridges (Khattak et al., 2012).

The 2010 flood in the Panjkora river has inflicted enormous damage on infrastructures and agriculture, changing the region's landscape. A total of 19 Bridges (Nine major and Nine suspension bridges), as well as roads, have been destroyed and flushed away, disrupting the region's transportation and communication system.

Figure 1 British - Era Bridge of Chakdara, Built in 1902 used for Light Traffic After Flood. Source Flickr

The destroyed bridges included Chakdara, Balambat, Japani pull, Sherpalam, Khall, Ashari Gat, Khazana Bypass, Khadegzai and Zolam. Locals were using old routes to continue their daily lives and businesses due to road closures. (BBC, 2010). The floods had severely impacted the districts of Lower Dir. The crucial bridges connecting Chitral, Swat, as well as the tribal area of Bajaur Agency through Lower Dir partially collapsed, disrupting traffic and communication in these areas. The Pakistan Army had temporarily restored traffic flow by repairing a nearby British - era bridge, built in 1902. However, only light vehicles were allowed to cross, and heavy traffic, including cargo trucks, was prohibited due to safety concerns.

To cross the river, especially in areas where bridges have been destroyed. Locals were also using makeshift Chairlifts, Known as "Zango". While these chairlifts were not safe, they were the only means of crossing the river for many residents. The floods have caused widespread destruction, including:

Figure 2 Locals were using Makeshift Chairlifts, Known as "Zango". Source Flickr

Immediate Recovery Efforts

Rescue and Relief Operations

During 2010 floods in the Dir region of Khyber Pakhtunkhwa, the Pakistan Armed Forces played a significant part in emergency response and relief operations alongside civil administration. The Pakistan Army expeditiously deployed troops throughout the affected area to carry out quick response rescue missions, evacuating stranded peoples from immersed and inaccessible areas, especially in the mountainous region of Lower Dir. Army engineers functioned day and night to reinstate affected roads and bridges that were ravaged by the floods, reestablishing fundamental approach routes for aid delivery. Relief camps were raised to provide shelter for displaced and flood-stricken populations, and critical supplies such as food, clean water, tents, and medical aid were distributed efficiently. The Pakistan Air Force aided by airlifting relief materials and supplies and handling medical evacuations, while the Pakistan Navy, through Operation *Madad,* provided added support in logistics and rescue efforts. (GOP, 2022)

Health Sector Interventions

People in flood-affected areas were administered first aid and medical treatment by the World Health Organization (WHO) and other Non-Governmental Organizations (NGOs) who were either associated with it or working independently. This incorporated the provision of tons of medicines and pharmaceuticals, establishment of more than 6 centers to deal with water borne diseases such as diarrheal diseases, and sanitation and immunization campaigns for children against polio and measles.

Compensation

The Khyber Pakhtunkhwa government announced compensation for both material and human losses after floods 2010. Rs. 15.75 million were immediately distributed amongst families of dead and injured via respective Deputy Commissioners (DCs). The government introduced the Watan Card Scheme, distributing cash assistance to approximately 1.5 million households to support their recovery. However, the amount of Rs 20,000/- per household was found inadequate to cope with the recovery. (Moonsoon Ctgy Plan KP – 2012)

Long-Term Recovery Efforts

Infrastructure Rehabilitation

Efforts were made to fix important infrastructure, like roads and water supply systems. However, problems continued, such as the failure to restore tube wells damaged during the floods because of a lack of funds, leaving many residents without safe drinking water.

Policy and Institutional Strengthening

Pakistan's National Disaster Management Act of 2010 was enacted by the Parliament providing legal back to National Disaster Management Authority (NDMA) and Provincial Disaster Management Commissions in response to the tragedy. To improve the nation's preparedness and reaction to future disasters, these groups were tasked with developing plans and policies for disaster management (NDMA Pakistan, 2011).

Afforestation Efforts

Deforestation being one of the root causes of flood 2010 coupled with environmental issues that were revealed by the 2010 floods which prompted the launch of the Billion Tree Tsunami initiative in Khyber Pakhtunkhwa in 2014. To sustain the ecological balance, this project aimed at restoring forest cover by relying on native species; areas in Dir benefited from the tree planting initiatives. The successful project helped in achieving satisfactory results (Dawn News, 2017).

Disaster Risk Management (DRM) Legal Framework

One important piece of legislation created to handle disaster risk management in the country was the Pakistan National Disaster Management Ordinance, 2006. Following the devastating 2005 Kashmir, Northern Khyber Pakhtunkhwa earthquake, it went into effect. Being reactive in nature, there were a number of obstacles to overcome during the 2010 flood, which reduced its efficacy. Some of the shortcomings of this Ordinance include: -

- Centralization of Authority.
- Lack of Enforcement Mechanisms.
- Overlapping Roles and Institutional Duplication.

Keeping above in view, to improve the nation's disaster management system, Pakistan's National Disaster Management Act, 2010 (NDMA Act) superseded the National Disaster Management Ordinance, 2006. The act, which established a permanent legal framework, was passed by Parliament rather than as a Presidential Ordinance. Additionally, this act created the National Disaster Response Force (NDRF) for specialized disaster response and the National Institute of Disaster Management (NIDM) for training and research (Ali & Iqbal, 2021). Key cardinals include:

- Establishment of National Disaster Fund
- Penal provisions
- Decentralization down to district level
- Flexible for updates

Role of NGOs

In order to provide emergency relief, non-governmental organizations such as the Sarhad Rural Support Programme (SRSP), International Rescue Committee (IRC), Save the Children, Islamic Relief, and Pakistani Red Crescent Society moved swiftly and distributed food, temporary shelters, and non-food items like clothing, blankets, and cooking

utensils (SRSP, 2010). The development of temporary learning centers, the distribution of books and stationery, and the rehabilitation of schools were all made possible by Save the Children (FAO, 2020; Save the Children Pakistan, 2010).

Restoration of Water Supply and Sanitization

Dir's water systems were heavily damaged. NGOs intervened by:

- Repairing water schemes and rehabilitating hand pumps.
- Constructing temporary latrines to prevent disease outbreaks.
- Conducting hygiene promotion campaigns in affected villages (IRC, 2010).

Health Sector

Due to the prevailing high risk of diseases originating from poor sanitation and displacement, NGOs assisted by:

- Médecins Sans Frontières (MSF) and Save the Children set up mobile health clinics in isolated regions of Dir.
- To prevent cholera, typhoid, and other watery illnesses, NGOs conducted immunization campaigns.
- Because women and children are particularly vulnerable, maternal and child health services were given priority (Save the Children Pakistan, 2010).

Environmental Impacts

Damage to Freshwater Habitats

Panjkora river and tributaries underwent significant change. Fish and other aquatic animals' habitats were destroyed as a result of the swift-moving waters scouring streambeds and banks. Large amounts of manure and fertilizer runoff from agriculture also found their way into waterways. The Panjkora being mountainous river, was reportedly "completely washed" of its natural flow, bringing tons of silt and debris downstream, according to observers (Ahmadul, 2023). Man-made fishponds and hatcheries were frequently devastated by floodwaters; in the upper KP districts, thousands of local trout and carp hatcheries were reported to have been destroyed. Numerous freshwater creatures were killed by this severe disruption, and rivers became much murkier and more contaminated.

Soil Sedimentation and Nutrient Loss

Water channels and flood plains were covered by huge sediments ranges from one to five meters in height. Recessing waters also left behind contaminated sediments from trash and sewage, which lowered the quality of soil (documents.worldbank.org). Although some sediment deposition may later "nourish the soil" by supplying nutrients, the immediate aftermath was dominated by the buildup of tons of pollutants and silt.

Wildlife Habitat Loss

Numerous huge beasts and birds were reported to have drowned or been displaced. For instance, the floodwaters carried away numerous pheasants, domesticated and small animals (tribune.com.pk, 2012, ibid). Numerous domesticated animals died, and entire herds of livestock drowned. Breeding habitats were lost for riparian species. Important migratory bird and amphibian refuges, wetlands and riverbanks, were destroyed or submerged, endangering the biological diversity of such ecosystems.

Methods and Materials to determine the Impact of Devastation

This study takes into account various variables to scrutinize the impact of flooding across

different sectors, including agriculture—specifically damage to standing crops, farming land, and fruit orchards, damage to communication arteries and destruction of commercial properties such as shop markets and sale items. Though the secondary source provided the bulk of the data for this research work but conversely a ground assessment in the form of a survey was also conducted to collect firsthand information on the understudy area. During these visits, local residents were interviewed to assess flood-related damage and the fundamental factors that aggravated their severity. Additionally, structured interviews were conducted with officials from key governmental departments. These interviews aimed to get authentic data regarding damages, and evaluate institutional responses to flood hazards, mitigation efforts, and long-term strategies for flood risk reduction.

Furthermore, a wide-ranging literature review was undertaken to examine global and regional perspectives on flood hazards, as well as historical flood events. This review incorporated peer-reviewed journal articles from sources.

Loss Assessment

The estimation of economic losses was based on an assessment of physical damage and unit prices. This method applied to almost all kinds of damage. The losses sustained by communication infrastructure—such as roads, bridges, electric poles, towers, and other physical structures—were determined using cost effect/ data provided by contractors and builders, considering both initial construction expenses and the estimated costs for reconstruction in 2010/ 11. To confirm accuracy, these figures were cross verified with data from the Communication and Works (C&W) Department to resolve any differences.

For market-related damages, losses were calculated by assessing the structural costs of shops in alignment with local trends and evaluating the value of damaged goods based on 2010/ 11 market prices. Likewise, losses related to cultivated land were determined using prevailing land prices at that time, while crop losses were projected by analyzing production capability in term of acre and the corresponding per-ton market prices of 2010 of specific crops. Production capacity figures were obtained from the Agriculture Department and farmer estimates. Furthermore, orchard owners were also consulted regarding the value of their orchards and annual yields to facilitate an accurate assessment of losses in this sector.

Focus of the Study

The 2010 flood severely impacted the Lower Dir region, particularly along the course of the Panjkora River. However, the level of damage varied across different sectors and places. For the purpose of concrete and focus analysis this study has been confined to the seven most severely damaged union councils of Lower Dir which include: Timergara, Balambat, Koto, Monjai, Rabat, Khall and Shalfalam. Despite the widespread flooding, relatively lower levels of devastation to residential structures and less human casualties occurred as most of the built-up areas in the under-study area are situated on higher ground towards mountains away from Panjkora. The primary disruption was caused to cultivated land, standing crops, fruit orchards and communication arteries (Khattak, Rahman, and Haq 2012) The provincial government has declared a flood emergency in District Dir to facilitate relief efforts and assessments.

Losses in Agriculture Domain

Floodplains of Panjkora valley serve as the most lucrative areas for cultivation purposes. However, the river Panjkora and its contributing streams which support farming also pose a constant threat, as periodic flooding results in substantial damage to agricultural land and crops. The Panjkora River basin is extensively used for cultivation, with a variety of crops and vegetables being cultivated. To sustain agriculture, local communities have constructed narrow irrigation channels and small protection walls/ bunds. 2010 floods have inundated nearly all cultivated land along the course of River Panjkora and filled the water channels with sediments, leading to widespread devastation. A significant portion of the floodplain has been completely eroded, while sediment deposits have accumulated on the remaining narrow strips of land. In the affected union councils, approximately 75,500 kannals of irrigated land (locally called it Shulgara) and 693 kannals of rain-fed land (locally called lalma) were entirely washed away, resulting in an estimated financial loss of 15,029.8 million rupees (Khattak et al., 2012) (see Table 1).

Table No 1: Damage to Cultivated Lands with Estimated Loss

Union Council	Damaged Area (In Kannals)		Anticipated loss
	Irrigated Land	Non-Irrigated Land	(In Millions)
Timergara	2375	437	904
Balambat	1130	0	2249.6
Koto	6210	13	4978
Munjahai	3701	0	2456
Rabat	4227	243	1869
Khall	2484	0	1987.2
Shalfalam	1173	0	586
Total	21300	693	15029.8

Source: AC Relief Lower Dir, field survey and Khatak et al 2012.

Table No 2: Destruction To Crops And Estimated Loss

Union Council	Damage to Crops (tonnes)	Paddy (tonnes)	Maize (tonnes)	Estimated loss (Rs. million)
Timergara	227	226	-	33.5
Balambat	592.8	431	161.5	16.7
Koto	1245.2	1242	3.2	97.67
Munjai	616.3	600	16.3	17
Rabat	172.5	120.5	52	11
Khall	549.1	258	290.6	16.7
Shalfalam	197.9	173.5	24.4	2.04
Total	3600.8	3051	548	194.61

Source: AC Relief Timergara, ground survey and Khatak et al 2012.

Traditionally, local farmers had been constructing embankments and retaining walls to protect their agricultural land. However, these protective measures were neither cost-effective nor structurally resilient. Ultimately, the protective measures proved inadequate against the severe flooding and were completely destroyed. In addition to cultivated land, the inundation also damaged a large quantity of paddies and other crops

(Table No.2). Approximately 3600 tons of crops were swept away having cost effect of Rs 194.6 million rupees. Rice paddy was the most affected one with an estimated loss of 3051tons.

Losses of Trees and Orchards

The locals usually plant trees on the riverbanks and on the outer edges of the fields. In some cases, these trees (generally, poplar trees) are planted on a large scale in the open fields as well for commercial, fuel and construction purposes.

Table No 3: Losses of Trees and Fruit Orchards

Union Council	Orange Orchards (kannals)	number of Trees	Appraised loss (Million)
Timergara	0	255	0.55
Balambat	10	215	1.5
Koto	0	165	0.50
Munjai	569	705	86.05
Rabat	23	221	5.5
Khall	30	470	5.3
Shalfalam	0	305	0.5
Total	632	2336	100

Source: AC Relief Timergara, ground survey and Khatak et al 2012.

Likewise, citrus fruits are extensively cultivated in general area Rabat, Odigram and Munjai which are famous throughout in Pakistan. Almost all the orange gardens and other vegetation in the valley had been washed away. A total of 2336 kannals of citrus orchards and 632 other trees have been swept away with a total loss of Rs. 100 million (Table No. 3).

Human Casualties and Damage to Built-up Areas

As discussed before, only the agriculturists generally deal with floodplains for cultivation and farming purposes, whereas the built-up areas and settlements are on the higher ground located away from the river. Hence, few human casualties and less damage to build up areas had occurred during the flood 2010. Whereas those houses constructed in flood prone areas had suffered damage. In this regards Union Council Khall is the most affected one as far as human casualties, damages to houses and vehicles are concerned.

Table No 4: Data of Damaged Houses and Automobiles

Union Council	Number of Damaged Houses		Appraised loss	Number of damaged Automobiles	Death toll	Injuries
	Partly	Completely	Rs. (Million)			
Timergara	8	13	16	8	1	11
Balambat	6	4	5	4	2	9
Koto	0	0	0	0	0	0
Munjahai	0	0	0	0	0	0
Rabat	0	0	0	0	0	4
Khall	10	15	19	6	4	7
Shalfalam	0	0	0	0	0	0
Total	24	32	40	18	7	31

Sources: AC Relief Timergara, ground survey and Khatak et al 2012.

31 individuals were injured and 7 people lost their lives in the under-study area (Table No.4). Union Council Khall is at the top as far as human casualties are concerned. Majority of the casualties occurred while catching timber log in the flood including 4 members from the same family.

Damages to Communication Infrastructure

The floods of 2010 resulted in the destruction of all suspension bridges in Lower Dir district, along with several Reinforced Cement Concrete (RCC) bridges as well. The floodwater rose significantly, sinking some bridges entirely while eroding approaches and segments of others. In total, nine suspension bridges and nine RCC bridges were demolished in Lower Dir, whereas only three RCC bridges were destroyed in the six under study union councils only (refer to Table 5).

According to the Communication and Works (C&W) Department, the estimated financial loss from this damage amounted to approximately Rs. 272 million. One noteworthy exception was the Reinforced Cement Concrete Bridge in Union Council Khall, commonly called as Japani Pul, which withstood the flood despite being immersed for an extended period. However, the roads leading to both ends of the bridge were completely washed away. The population of villages situated on the right side of Panjkora relies heavily on Khall Bazaar for essential goods and services.

Table No 5: Damage To Communication Infrastructure

Union Council	Category of bridges		Type of damages		Appraised Loss	Highways	Appraised Loss
	Hanging	RCC	Completely	Partly	Rs Million	(km)	Rs Million
Timergara	1	0	1	0	15	21	8
Balambat	0	2	2	0	120	8	1
Koto	1	0	1	0	15	0	0
Munjahai	1	0	0	0	15	0	0
Rabat	1	0	1	0	15	0	0
Khall	3	1	3	1	60	32	4
Shalfalam	2	0	2	0	30	2	1
Total	9	3	10	1	272	63	14

Source: AC Relief Lower Dir, field survey and Khatak et al 2012.

Consequently, the destruction of all connecting bridges left these communities isolated for almost four weeks. Following the reduction of floodwaters, local residents took the initiative to reconnect Japani Pul to the roadway by filling the eroded areas, making it accessible for pedestrians only. Later, they reconstructed the bridge approaches, restoring vehicular access as well. At that time, this bridge served as the primary transportation link for villages on the right bank, as all other suspension bridges remained unusable.

Moreover, the floodwaters damaged approximately 63 kilometers of roads within these six union councils under study, having the cost effect of Rs. 14 million (Table No. 5) and causing prolonged disruption to transportation networks.

Damage to Commercial Property

As already mentioned, that trade centers and markets are situated along the riverbanks,

four markets were entirely washed away by the floods, while several others sustained partial damage. In total, 287 shops within these six union councils were damaged, 223 were totally smashed, and resulting in an appraised value of Rs. 226.5 million (refer to Table No.6). The Union Council (UC) Khall experienced the most severe market devastation, where 221 shops were either damaged or destroyed, incurring losses amounting to Rs. 166.3 million. Notably, the primary market in UC Khall, which span over both sides of the river, was heavily impacted. The market towards the main town of Khall was fully erased, whereas the market on the left-side suffered approximately 62% structural damage (Figure 3). Additionally, the floods led to the destruction of 26 kanals of commercial land, contributing to an estimated loss of Rs. 36 million.

Figure 3 : Shops Destroyed Be The Recent Flood Photograph Taken In December, 2010

Table No 6: Damage To Commercial Property

Union Council	Destruction of shops		Type of damage	Estimated loss	Commercial land damaged	Estimated loss
	Total number	Partly	Completely	Rs Million	(Kanals)	RS. Million
Timergara	28	3	2	29	16	24
Balambat	39	12	27	31.2	4	4.2
Koto	0	0	0	0	0	0
Munjahai	0	0	0	0	0	0
Rabat	0	0	0	0	0	0
Khall	221	51	170	166.3	5	5.1
Shalfalam	1	0	1	.5	2	2.2
Total	289	66	223	227	27	36

Source: DOR, AC Relief Timergara, ground survey and Khatak et al 2012.

Conclusions and Recommendations

The primary cause of the flood 2010 in Lower Dir was the intense monsoon rainfall, combined with snowmelt in the Hindu Kush ranges due to high temperature, which significantly amplified the water level in Panjkora and its tributaries. Resultantly, the streams discharged unprecedented water into the main river escalating the flood's intensity, inundations and overflow of water in the lower part of the basin. Likewise, the steepness of mountainous terrain also contributed towards the volume and velocity of flood to carry along substantial loads of wooden logs, rocks and sediments, which amplified the destructive impact. Besides these natural causes, human factors including deforestation, mismanagement of the agricultural land along the riverbank, unchecked urbanization and establishment of commercial centers (markets) right on the river bank, also played a vital role in up surging the severity of damages.

Considering the geographical layout of Panjkora basin, history of floods in the area, natural causes, human factors and findings of research work, the following recommendations are proffered to mitigate the damages of floods and assist the general populace to protect themselves in any such eventuality in future: -

- Waterways have been narrowed again at places after flood 2010 due to unplanned urbanization and encroachments. Detailed surveys and assessment of flood risks zones be carried out for future development all along river Panjkora and its tributaries. There are no rules and regulations in Dir to control and monitor the new construction on the bank of the river Panjkora. It is the responsibility of the government to introduce and implement regulations to stop all types of domestic and commercial construction in flood prone zones and remove the existing encroachments.
- The execution procedures of disaster management plans require to be continuously reworked in order to sustain future flood. No plan is viable unless executed as per the desired road map. Deputy Commissioner Lower Dir, being head of the DDMA should proactively lead in all phases of disaster management with special focus and emphasis on community-based disaster risk management.
- Afforestation drive should be aggressively followed both during spring and monsoon season especially in the upper zone of Pankora valley. This drive must incorporate local communities, schools and colleges. This will increase the land's ability to absorb rainwater and decrease the surface runoff.
- No water reservoir is constructed in Dir valley. Construction of small water reservoirs be thoroughly planned and constructed in the upper zone of Dir valley for irrigation, controlling and regulating the flood water and to avoid sudden flooding.
- As already highlighted that the connectivity of District Lower Dir to the lower parts of the Pakistan is dependent on a single bridge at Chakdara over river Swat. The destruction of this bridge can cause the isolation and disconnection of Dir from rest of the country as happened during flood 2010. To overcome this vulnerability, an alternative road from Batkhela via Tauda China, Katan, Doshkhela and Bandagai and be planned/ constructed to be utilized as alternative in case of similar eventuality. Similarly Upper Dir and Chitral are connected to Lower Dir via a single road from Timergara which runs all along the right bank of river Panjkora. Since less space is available on the right side hence, prone to disruption by flood. While on the right side the valley is open and away from the

river by .5 to 1.5 km thus, an alternative road can be easily planned.

- Generally, no one pays any heed to generalized warnings as per our national psyche. However, with technological development accurate weather forecast and exact location of likely flood areas can be ascertained easily which, can serve as early warning for specific hazardous zones. On receipt of early warning for specific areas and communities DDMAs must start practical application of contingency plans with the help and close liaison of PDMA.
- The response of PDMA and DDMA during flood 2010 was reactive in nature as far as implementation of their Contingency Plans was concerned. There is a dire need for change of organizational culture and rescue and relief plans of PDMA and DDMA. DDMA must complete its groundwork and disaster management arrangement well beforehand and in case of any anticipation of an emergency it should automatically come into play as proactive approach.
- The success of any disaster and risk management plan entirely depends upon the level of awareness and preparation of communities. The robust societies can only be prepared if the communities are taken into confidence during preparation and execution of plans. The aim of community-based disaster risk reduction (CBDRR) can only be achieved through an awareness program. DC Lower Dir should form and supervise committees comprising representatives of communities, NGOs and volunteer workers. The suggestions given by these committees should form part of all phases of disaster management.

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