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*Full Length Research Paper*

# Human response to hydro-meteorological disasters: A case study of the 2010 flash floods in Pakistan

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**Pakistan is one of the most natural disaster-prone countries in the world and during July-August 2010 the worst ever flood in its history occurred. It may take months if not years for the people to recover from the devastating impact. Natural disasters often result in great losses, both in terms of materials and people's lives. Vulnerability to natural disasters combined with socio-economic vulnerability of the people pose a great challenge to the government machinery. Disasters are exacerbated where there is inadequate government support for emergency situations. These situations are complicated because the breakdown of the government structure makes assistance or intervention difficult. This type of emergency is usually associated with the problems of displaced people during times of civil conflict or with people in need caught in areas of conflict. The actual disaster results in substantial damage to the population in terms of loss of life and property. This direct result can be termed the 'first disaster'. Another wave of damage triggered by a chain of cause-and-effect events relating to the first disaster results in indirect damage to people remote from the original disaster. For example, the people cannot repay their loans, resulting in losses to money lenders. Such events can also result in higher incidences of problems relating to health (heart attacks, strokes), emotional responses (suicides) and crime (homicides). This is called the 'second disaster' and can be in greater magnitude than the 'first disaster'. Appropriate rehabilitation and care of the victims in first disaster can break the chain of events leading to the second disaster. This paper summarizes the important and new developments in disaster situations, particularly for the higher flood risk zones, in an endeavour to mitigate the impact of the 'second disaster'.**

**Key words:** Disaster, flash floods, hydro-meteorology, Pakistan, strategies

## INTRODUCTION

Floods are an almost permanent feature of Pakistan. The main reason that floods are a serious problem in the nation relates to its topography (Dales, 1965; Snelgrove, 1967; Ward, 1978). The Indus, Kabul and Swat are three hazard prone rivers, and due to the topographical features interact with the climatic and ecological conditions, resulting in floods occurring in Pakistan annually. However, when floods exceed normal flooding level (Taylor, 1965), they can have serious impacts. Severe flooding occurred in Pakistan in 1973, 1992, 2006 and 2010. However, the floods of 2010 broke all previous records in relation to the level of impact. The most recent estimates place the number of people directly affected by the floods in 2010 as 20,356,550; it is anticipated that this number will rise. Assessments to establish the degree to which affected populations are in need of immediate humanitarian assistance continue. The official death toll is 1,802 (Table 1), with a further 2,994 people injured. Over 1,910,439 houses have been reported as being damaged or destroyed (SMDC, 2010b).

Pakistan is one of the most natural disaster-prone countries in the World (Ahmad, 1990). Natural disasters often result in great losses, in terms of both human life and property. As a result of their unique geo-climatic conditions (Abbasi, 1965), four provinces, Azad Jammu and Kashmir and Gilgit Baltistan are vulnerable to geo-climatic disasters. Over 40% of the land area is vulnerable to earthquakes, 6% to cyclone, 60% to floods

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**Table 1.** Provincial and national loss of life, injury and property loss in the 2010 Pakistan floods (Source: SAARC, 2010): Disaster Management Centre, New Delhi.

| Province | Deaths | Injured | Houses damaged/ destroyed | Total affected districts | Population affected | Cropped areas (ha) | Cattle Head |
|---|---|---|---|---|---|---|---|
| Baluchistan | 48 | 98 | 75261 | 12 | 700000 | 255237 | 55501 |
| Khyber-Pakhtoonkhwa | 1156 | 1198 | 200799 | 24 | 3800000 | 205347 | 52750 |
| Punjab | 110 | 350 | 509814 | 11 | 8200000 | 692847 | 4193 |
| Sindh | 234 | 1201 | 1114629 | 17 | 7356550 | 1097057 | 263670 |
| Azad Jammu and Kashmir | 71 | 87 | 7106 | 7 | 200000 | 30820 | 288 |
| Gilgit-Baltistan | 183 | 60 | 2830 | 7 | 100000 | 3635 | 4669 |
| Total | 1802 | 2994 | 1910439 | 78 | 20356550 | 2284943 | 325570 |

and 25% of the Barani land or rain fed is vulnerable to drought (Ghauri, 1963; Gazdar, 1987).

The losses in lives and property in the extreme floods of 2010 in Pakistan have been incalculable. Disasters like this annihilate the gains achieved in decades of development in the affected area. Repeated disasters threaten sustainable development in Pakistan and destroy the human efforts and investment, and place new demands for reconstruction and rehabilitation. The losses are further compounded in countries like Pakistan because most of the property of the people, particularly in the rural areas, is uninsured (Westcoat and Jacobs, 1993).

The unique geo-environmental setting of the Northern Himalayas, *viz.* the intense rainfall, weak geological formations, accelerated rates of erosion followed by silting and meandering of rivers and very high seismicity makes this area one of the most disaster prone regions in the country (Ahmad and Abbasi, 1960; Karpov and Ross, 1964; Ahmad, 1996). Considering the comparative inaccessibility, the North area demands special attention to minimize the loss of lives and impacts on the communities, as well as to ensure sustainable development. Vulnerability to natural disasters in this region, combined with socio-economic vulnerability of the people, poses a great challenge to the government infrastructure.

## RESEARCH DESIGN AND METHODS

The intention of this paper was the exact determination of major and new developments, particularly in the higher flood risk zones, which are future proofed against uncertainty and be integrated with national policies for sustainable development and allow for modifications to be made in response to changing circumstances and be sufficiently flexible at local level to cope with different socio-economic and geo-physical conditions (Gazdar, 1987; Baker et al., 1988). The development of policies, strategies and plans to combat the risks associated with natural disasters should be based on a comprehensive risk assessment (Leopold et al., 1964; Beven, 1989). Mapping of at risk areas from natural disasters are valuable information and communication tools. They can be used for a wide variety of purposes ranging from floodplain delineation, zoning and landuse planning to presentation of information at public meetings (Cannon et al., 1994). The linkages between disaster management at national and local socio-economic development processes are most often ignored, resulting in re-creation of risks in already flood prone communities.

## FLOOD HYDRO-METEOROLOGY

Flood hydro-climatology encompasses long-period climatic variations as well as short-period hydro meteorological events (Russel, 1942; Naqvi, 1959; Pithawalla, 1978) it provides a climatic framework such as flood geomorphology with the relatively short time scales of gauged flood records, knowledge of the types of circulation features that currently generate at a given station (Strahler, 1957). Hydro-climatology is essential for understanding the interactions between the atmosphere and hydrosphere. The cross-discipline of flood hydro-climatology is an approach to studying hydrologic events within their climatological context by focusing on atmospheric inputs to flooding (Pithawalla, 1943, 1948; Woltemade, 1994). Hydro-climatology can be equally applied to the analysis of short-period events, such as those in an annual or partial duration flood series, by examining how these events vary temporally and spatially in response to longer term climatic variations (Pithawalla, 1943; Leopold et al., 1964). Flood hydro-climatology analyses floods as real-world physical events occurring within the context of time-varying climatic conditions (Strahler, 1957) and within a spatial framework of local and regional networks of changing atmospheric circulation patterns (Baker et al., 1988).

## DISASTERS IN PAKISTAN

Pakistan has been confronted by a series of natural disasters in the recent past; for example the, 2005 earthquake, the Hunza landslide and the 2010 floods. Table 1 provides data on the damages by the 2010 floods. These disasters have different characteristics but all resulted in huge loss of life and damage to property. Coincidentally, Pakistan is also facing the problems such as terrorism and political uncertainty; both of these have a serious impact on the government and its institutional capacity (Allen, 1994).

After the severe earthquake of 2005, the Government of Pakistan established an authority for disaster management the National Disaster Management Authority (NDMA). However, due to lack of technical knowledge and manpower, the authority failed to play its role effectively in coping with the disaster. Consequently, there is an urgent need to build the capacity of the government and lay down clearly its bylaws and mandate (Sardar, 2010b). The NDMA has considered its role is only to regulate - this is a totally wrong perception. The role of similar organizations around the world is to regulate, coordinate, develop systems and train technical manpower for disaster management.

## Disaster management in Pakistan

Disaster management is multidimensional field and requires technical knowledge. Military personnel cannot manage disasters; their expertise is designed for defense and maintaining law and order. The only role the military can play in disaster management is that they can respond to the post-disaster phase for rescue, relief and recovery. Disaster management, not only keeps them away from their primary task, but also places an extra burden on the armed forces, in spite of the fact that they perform an excellent and efficient role in all national calamities. On other hand, it also indicate weakness in NDMA (Sardar, 2010b), which is responsible for providing technical assistance to other government agencies during the disaster. Lack of technical knowledge and skills in disasters results in very high loss of life and property damage (Allen, 1994).

## Disaster response system in Pakistan

Due to the frequent occurrence of disasters induced by natural hazards, the NDMA has been given the responsibility and mandate for coordinating national disaster management efforts across all agencies. This newly born authority has not yet developed a system across the country to handle disasters at national level. Training and capacity building of the officials dealing with emergencies would be an important instrument of disaster reduction and recovery (Goudie, 1986). While natural hazards cannot be controlled, the vulnerability to these hazards can be reduced by planned mitigation and preparedness of sustained measures towards reducing the vulnerability of the community to disasters; the NDMA has failed to perform this designated role properly (Sardar, 2010b).

## Importance of disaster management

Taking into consideration the value of development gains which are wiped out through disasters, as well as the huge quantum of funds required for post-disaster relief and rehabilitation, any investment in disaster mitigation will yield a higher rate of return than any other development project (UNESCAP and UNISDR, 2010). Also, considering the developmental gains which are wiped out because of disasters, all development schemes/projects will need to incorporate disaster assessment and vulnerability reduction as critical components in order that the development process be sustainable (Cannon et al., 1994). Therefore, a paradigm shift has now taken place with the change in focus from reactive to proactive *i.e.* from relief to prevention and mitigation of disasters (Sardar, 2010a).

## Impacts of 2010 flash flooding in Gilgit and Khohistan

In Gilgit and Khohistan, many houses and bridges were destroyed in the 2010 flash flooding, particularly as a result of the debris in the turbulent. The debris consisted of mainly of timber logs, tree branches and uprooted trees of different sizes. The mass of debris was created by destabilization on the sloping areas of the sub-soil layer and vegetation. Mountainous watershed systems in Northern Pakistan collectively transport water to rivers leading to downstream areas (Ahmad, 1958; United Nations, 1960).

## 2010 flood in urban areas of Noshera

Noshera and other urban areas of Punjab and Sindh located in the floodplain of the Swat and the Indus Rivers were severely damaged by floodwater associated with heavy rain (Ahmad, 1997). The urban area is located in the catchment. In Noshera city debris flow and flooding caused damage and losses to shops, commercial centers and house-hold items such as furniture and electronic items. Transportation systems, water supply, sewerage and drainage systems were also subjected to severe destruction or failure in functioning.

## Consequences of poor disaster management

The 2005 earthquake was an instantaneous disaster; all the damage was natural and one cannot criticize the government or any authority because there was no opportunity to minimize the loss of life and property in that event. In contrast, there was a slow onset to disaster in the 2010 flood in relation to the loss of life and property. In that situation the NDMA and the Government of Pakistan failed to minimize the losses. There were no prior hazard assessments or risk calculations or implementation of early warning systems. Political differences between federal and provincial governments exacerbated the disastrous results of the flood in 2010 (Sardar, 2010a).

The Government of Pakistan and the International community failed to manage, or at least poorly managed the 2010 flood disaster, resulting in the dire consequences for Pakistan and the rest of the world (SMDC, 2010a). An assessment of the amount of damage and the magnitude and spread of this disaster clearly indicates that there is an immediate need for serious steps to be taken by the Government, the UN and donor countries (UNISDR, 2009) to manage this type of disaster differently to the 2010 situation. Situations like the 2010 floods create second (follow-on) disaster which later becomes more complex affecting not only Pakistan, but other regions of the world (SMDC, 2010b).

## Rapid assessment during the flood

The purpose of assessment during a flood is mainly to have a factual basis for emergency response and relief coordination. Emphasis of actions during this phase are based on avoiding loss of life, minimizing misery and suffering of the affected population and for avoiding knock-on effects (Whittlesey, 1945). Flood assessment during this phase is also the basis for deciding which levels of administration are to be invoked for the response, *i.e.* to assess whether local or regional emergency response forces are in a position to contain the situation, *or* if assistance from the national level is necessary (Sardar, 2010a). It also provides indicators for international emergency relief agencies about the possibility of response from the international community. Assessment at this stage needs to be made in a very short time and include locally available assets. This type of assessment is usually made under very disturbing circumstances. Based on the emphasis for action, essential information for the emergency response at this stage should include:

The number of people killed, displaced or affected by flooding (including specified needs for the humanitarian response). Assets that have been flooded (inundation map), search and rescue and evacuation requirements. Number of people and assets at risk of being further flooded (hazard or risk map), based on the status of flood defenses and needs for further evacuations. Status of lifelines (evacuation/access roads, hospitals, electricity grid, water and food supply), hospitals and shelters. Current and expected river water levels at various locations as well as weather conditions. The focus of assessment during this phase is on emergency response rather than loss assessment. The current Tool does not include a detailed discussion on this topic (White, 1964; Sardar, 2010a).

## Geographic information system

Geographic Information System (GIS) is being utilized increasingly for hazard and vulnerability mapping and analysis, as well as for the application of disaster or risk management measures (Aronoff, 1995). GIS provide a computer-based information and manipulation system useful in support of low forecasting and emergency response. Information from a variety of sources and scales can be combined as a series of layers, provided that the information can be identified in terms of the common denominator of location. For example, information on vegetative cover can be combined with soils and land slope information to estimate infiltration rates for forecasting purposes. Similarly layers of utility, landuse, floodplain delineation and structural information can help in the development and updating of emergency response plans. An accurate representation of the basin topography is an important asset in flood forecasting, emergency action and mitigation. A digital elevation model (DEM) *or* digital terrain model (DTM) for the basin should be developed as part of any GIS (Kennedy, 2002). Technologies exist that enable the construction of a "seamless best available" DEM. In other words the DEM is constructed from whatever topographic information is available. Parts of the basin or certain features may be very accurate while others may be quite basic (Aronoff, 1995).

The DEM can be improved over time. The development of inexpensive global position indicators has made GIS information easier to obtain. For example, data network sites, buildings or physical features can now be easily located with precision and at low cost. Landuse, vegetative cover or soils information is also easier to assemble. Mapping of ‘at risk’ areas from natural disasters provides valuable information and communication tools (Zaheer, 1995). They can be used for a wide variety of purposes ranging from floodplain delineation, zoning and landuse planning to presentation of information at public meetings. Zoning maps, however, are static and may require updating over time as changes occur (Kennedy, 2002). For static information, such as the delineation of the flood-prone area, frequent updating is not required, and maps are a useful reference tool for a wide variety of users.

For mapping vulnerability and risks, the most useful data is of moderate and medium resolution, which can be used to monitor and estimate damages. Many countries in the region can receive data directly from the polar orbit MODIS Terra and Aqua satellites or get their data and value added products from relevant websites (UNESCAP and UNISDR, 2010).

## GIS and other computer-based information

GIS allow for a wide range of presentational material to be easily generated and tailored to the target audience (Wong, 1963). Three dimensional displays zoom and scan, and rotational techniques can be combined with other informational material such as pictures, overheads or slides. As an example, a GIS flood inundation map can be generated based on hydraulic model derived information (Abbas et al., 2009). The map can be conveyed to residents in the flood plain and is useful for depicting the probable impact of the approaching flood.

## Disaster risk reduction and climate change adaptation

Adaptation to climate change is closely linked with reduction of disaster risks, particularly those related to hydro-meteorological hazards. Assessments require, however, large amounts of data on climate – on rainfall, tropical storms, temperature, sea surface temperature, sea level rise and the frequency - and intensity of events. These need to be considered along with other data on water resources, agriculture, the environment and ecosystems. These data and analysis can then feed into climate-smart disaster risk reduction programmes (UNISDR, 2009).

Climatic data are mainly provided by national meteorological and hydrological departments and relevant sub-regional, regional and global networks – using many of the same systems or capacities that are used for disaster risk reduction. These include those for early warnings, weather forecasting, storm monitoring, flood management, coastal zone management and land use planning (UNESCAP and UNISDR, 2010).

## Public awareness

The process of informing the general population increases the levels of awareness about risks and how people can act to reduce their exposure to hazards (White, 1964). This is particularly important for public officials in fulfilling their responsibilities to save lives and property in the event of a disaster. Public awareness activities foster changes in behaviour leading towards a culture of risk reduction (Sardar, 2010a). This involves public information, dissemination, education, radio or television broadcasts, use of printed media, as well as the establishment of information centres and networks and community and participation action. Practical application of this public-awareness could involve:

1) Family communication plan for flood victims;
2) Family communications;
3) Money, Insurance and vital records;
4) Utility shut-off and safety;
5) Open all doors and windows of house;
6) Select highest place;
7) Stay in groups (women, children's and elders in center young's in surroundings);
8) Unleashed animals;
9) Keep drinking water in plastic Grecians;
10) Tie all housekeeping goods with rope.

Sweeping floodwaters spared nothing and human life was no exception in the 2010 floods. The health problems of the flood-affected areas consisted in the prevention and/or the treatment of the following diseases:

1) Cholera;
2) Malaria;
3) Bowel diseases like dysentery and diarrhea;
4) Pneumonia and other respiratory diseases.

Even when the flood receded, all the water did not subside, and stood for days together in many low-lying areas. These places and other soft-marshy grounds tended to become the breeding places of different disease-carrying organisms. The government not only provided relief to flood evacuees and flood affected villages but also took measures for the prevention of cholera. The incidence of malaria was very high in the flood affected villages and the position was made worse by relapses (Ahmad, 1997). The spread of bowel diseases like dysentery, diarrhea and respiratory diseases was also reported.

It was estimated that more than 75% of the population in the flood- affected villages had suffered from one disease or another and at least one member of every family was bed-ridden. This situation gives some idea of the number of working days lost to the nation and its adverse effects on the economy of the country.

## Psycho-social aspects of flood victims

There was a phenomenal increase in the incidence of psychiatric disorders in the flood affected population. The common problems include:

1) Acute stress disorder;
2) Post traumatic stress disorder;
3) Anxiety disorders;
4) Depression;
5) Alcohol and drug abuse.

Despite faults in human cognition of risk, the probability of risk-mitigating adjustment increases as a positive function of risk perception through the mediating effect that perceived risk has on the variables of image of damage and perceived benefits of such adjustment (Zaidi, 1989). The image of damage is what social units think will happen to themselves, possessions and community were an environmental extreme to occur; it has a positive effect on both perceived benefits of risk-mitigation policy and on risk-mitigation adjustment. The more potential damage is imputed on the basis of risk, the more likely a social unit will adjust to that risk. Perceived benefits, positively affect the probability of risk-mitigating adjustment to the extent that anticipated benefits are worth the costs of policy implementation (Sardar, 2010a).

### Gender impacts

Gender relations in flood disaster deserve special attention because they are a reflection on gender relations in society which in Asia and the Pacific are often very imbalanced, preventing women from gaining the benefits of development and making their full contribution. Women have been stereotyped as housewives, secondary earners or mothers. Although gender issues are fairly well researched and debated, women are still largely marginalized in issues, such as, literacy, land ownership and access to credit (UNISDR, 2009). Accordingly, in dealing with flood disaster and the risks arising from climate change, the women have different capacities to reduce risk and adapt and come up in political decision-making and legal rights (UNDP, 2010).

## DEVELOPMENT OF POLICIES, STRATEGIES AND PLANS

The development of policies, strategies and plans to combat the risks associated with natural disasters should be based on a comprehensive risk assessment (Zaidi, 1975). This requires an integrated approach whereby a wide range of mitigation measures should be considered. For example, mitigation activities such as mapping of hazardous land (that is, floodplain mapping plus landslide and mudslide-prone areas) should be designed so that considerations of other disaster types lead to sounder overall landuse plans. In essence, there would be very little purpose in moving people and goods from one risk zone to another, especially if the other hazard is equally or more apt to occur under the prevailing conditions such as torrential rain. Within this overall process, full consideration needs to be given to the social, environmental and economic impacts of policy and programme development (White, 1961) and provides guidance on aspects of flood hazards that need to be considered within the overall planning process. The aspects contained herein are meant to complement other materials in this guide, such as the development of a flow forecasting and warning system, which are important tools within the range of options to be considered (Sardar, 2010a). Basin wide planning for reduction of flood losses must be considered, *i.e.* using the basin as the basic planning unit. It is absolutely essential to have knowledge of water uses, diversions, storage and management practices in all parts of the basin, as well as the antecedent, present, and forecasted meteorological and hydrological conditions.

## RECOMMENDATIONS

The challenge for Flood Preparedness Planning (FPP) is the under-lying capacities of the national, provincial and district authorities as well as the lack of resources to undertake implementation of the priority activities. In most cases, local resources and capacities are often overlooked, thus relying too much upon external assistance (Sardar, 2010a). The linkages between disaster management at national and local socio-economic development processes are most often ignored, resulting in re-creation of risks in already flood prone communities. For a successful flood preparedness planning, it is imperative to learn from the experiences and best practices for greater collaboration and information sharing to enhance the synergy and to extend the resource base for more effective implementation of flood preparedness programmes. It is also important to establish and integrate FPP within the overall developmental plan for securing resources for better implementation (Sardar, 2010b).

## Conclusions

The flood problem is becoming increasingly acute and is exhibiting the dangerous tendency to become more or less permanent. The general optimism regarding the food position of Pakistan, witnessed at the time of Independence, drawing its full justification from the historical fact that this sub-continent, had enjoyed the reputation of being called the "granary of India", did not endure long. Since 1953, Pakistan has been struggling hard to feed its population from its own food resources, without any marked success. Among the host of reasons responsible for bringing about near reversal of the once secure food position, floods coming with tenacious regularity is the primary one. Large amounts of precious foreign exchange worth tens of millions of rupees have been spent every year on import of food stuff, which in its economic implication is an entirely non-productive expenditure. It is suggested that the recommendations raised in this report be given serious consideration to address the planning for natural disasters (particularly floods), the emergency response to natural disasters and the relevant issue of food security for Pakistan.

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