Commentary

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Evolution of flood management policies of Pakistan and causes of flooding in year 2010

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Abstract

The problem of floods in Pakistan dates back to the year of independence, 1947, when first massive flood inflicted havoc in upper Pakistan. We have divided flood management policy of the region into three time periods; British colonial rule that managed surface water through construction of canals; pre-Indus basin development that achieved a breakthrough in the form of Indus water treaty; and it was during post-Indus basin development phase, in 1973, that federal flood commission and proper flood management policies were devised. However, poor implementation has made these policies ineffective in terms of risk assessment and hazard management. As a case study we discussed the flood of 2010. It was a flash flood in north but inefficient and docile management plans turned it in to a riverine flood as the rainwater receded along the lengths of River Indus, in southern areas. Despite all the obstacles, these huge rainwaters can become a source of much needed energy (electricity) if adequate measures are taken. We conclude that the policies regarding flood management within the country must be revisited, and communication gaps between Pakistani and Indian water commissions must be plugged to avoid such future disasters.

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Introduction

This work is fourth installment of a bigger, collaborative project to evaluate the causes behind floods in Pakistan, risk assessment in advance and hazard management to lessen its effects on the victims. In previous installments, we have tried to unearth the causes behind sudden shifts in rainfall pattern of monsoon using run based control charts (Arslan et al., 2013a, Arslan et al., 2013b). However, as it is a well-known fact that disasters do not cause effects; the effects are what we call a disaster (Dombrowsky, 1995). Hence, disaster is the effect of an event that brings vulnerability, destruction and in turn socio-economic changes in a particular area. Therefore, it is important to understand the causes and effects of a disaster. Natural disasters arouse as a result of abrupt changes in state of natural forces combined with inadequate social systems (Susman et al., 1983, White et al., 1986). The impact of a disaster can differ according to its intensity and area it covers. Policy management of natural disasters must address the three fundamental elements of the system; risk, exposure, and vulnerability (Kotlyakov et al., 1988). Risk is the probability of physical destruction an event can cause. Exposure is the extent of influence of a disaster in terms of lives and economic loss, and vulnerability refers to the circumstances which render a society or individual being susceptible to the damage (Chambers, 1989, Swift, 1989).

Pakistan is blessed with vast resources of water in the form of Indus River and associate tributaries extending from East to West through the length of the country. However, poor management of water resources and lack of effective policy making have led to catastrophic flash or fluvial floods causing huge losses of lives and property in nearby areas. Traditionally, policy management and hazard-related studies have concentrated on the physical events caused by natural disasters. For analytical analysis of flooding in Pakistan, we have divided flood-management policy into three different time periods, i.e. Pre-partition phase period or British colonial rule (1750 up to 1947), pre-Indus basin development phase (1947-1973) known as period of limited risk management, and post-Indus basin development phase (from 1973 to date), also known as period of recent developments.

Historically, various factors have contributed to flooding and re-

sultant hazards, including poor policy implementation, and discrimination towards least developed areas and underprivileged sections of society. Usually, there had always been little execution of theoretical studies in flood hazards research. Main aim of this article is to evaluate the historical evolution of flood management policy in Pakistan with emphasis on identification of key lapses and loopholes in its implementation over the years. As a case study, we will try to explore the causes behind policy failure resulting in heavy losses during flooding of 2010.

British Colonial Rule (1859-1947)

In British colonial rule, canal system was built in the Basin of Indus River. The central objective of this policy was distribution of surface water for irrigation purpose. The first initiative in this regard was the construction of Upper Bari Doab Canal in 1859. Upper Bari Doab, a tributary of river Ravi, was the first canal in Punjab (Merrey, 1986). Later on, Rechna Bari Doab, Jech Doab, Sindh Sagar Doab, Bist Doab, and Lower Bari Doab were also built to distribute water in the region. In 1873, the Canal and Drainage Act was implemented which included flood water management system in the Indus Basin. According to the Part VIII, section (a) of the act; stoppage or diminution of percolation of water or floods should be done beforehand to avoid losses (Mustafa, 2001). The canal system was expanded to include more than 150 canals till 1947 (Biswas, 1992). Furthermore, they constructed a network of linear and ring levees around cities, known as "bunds" to avoid destruction. They also built repairing mechanisms for natural "bunds" and levees including, barrages for primary protection to cities during floods (Weil, 2006).

Pre-Indus Basin Treaty Phase (1947-1973)

The period was limited to lesser flood management with risk acceptance as the system was only relying upon the practicalities developed by Britain colonial government for early flood management policy. A few additional flood prevention measures were taken such as development of embankments, studs, spurs, and other flood-forecasting measures. Provincial governments initiated projects to build these structures (Baig, 2008). However, the planning proved inadequate as huge destructions ensued in three subsequent floods in years 1950, 1956, and 1957 (Aziz and Tanaka, 2011).

Meanwhile, signing of Indus Water Treaty (IWT) happened as a major breakthrough for water distribution between Pakistan and India. Indus Basin Development Program (IBDP) covered construction of canals and reservoirs following Indus Waters Treaty in 1960 (Michel, 1967). The IDBP was part of a mega flood management program with economic support from The World Bank. Inter-provincial water distribution plans were formulated and the levee system (bunds) of flood management was also given enhancement. Dissemination of water resources was further improved in Indus Basin by devising gravity and down streaming distribution systems (Khan and Khan, 2008).

Indus Waters Treaty (IWT)

Indus is the longest river of the region with total catchment area over 944,472 km^2, out of which 553,415 km resides in Pakistan (MOE, 2003). The river has an annual flow of 173 km^3. In 1960, Indus water treaty was signed between Field Marshal Ayub Khan and Prime Minister, Jawaharlal Nehru for distribution of water resources (Gulhati and Iliff, 1973). Pakistan obtained exclusive rights of three western tributaries, Indus, Jehlum and Chenab and India retained rights of three eastern tributaries, Ravi, Beas and Sutluj. Furthemrore, World Bank provided substantial aid to both countries to construct water storage reservoirs and conveyance facilities. The treaty guaranteed ten years of uninterrupted water supply to both the countries.

From 1960 to 19968, the focus of IWT was to distribute the water resources for irrigation purpose and little attention was given to flood hazard management (Biswas, 1992). However, since 1968, emphasis was diverted to flood protection measures with the construction of two dams and one reservoir in Pakistan. Mangla Dam was built in 1967 on River Jhelum; Tarbela Dam in the late l970s on River Indus; and Chashma Reservoir in 1971 on River Indus (Mustafa, 2001). However, due to wars, civil unrest, and political instability, Pakistan could not build further dams while India met the target of within defined period of time. In spite of the restrictions in IWT, India often releases excess water into both the eastern and western tributaries resulting in floods in Pakistan (Alam, 1998).

Flood Forecasting

After recurrent floods during 1950s, a flood forecasting policy was formulated with the help of flood computation system. The policy gave special emphasis on devising a system to predict any situation that can lead to flood. Flood forecasting and warning systems were initialized by creating observatories at Lahore and Sialkot (Kliot et al., 2001). The computation center was established in the Regional Meteorological Center, Lahore. The Center also sought to coordinate federal and provincial government agencies responsible for flood control.

Post-Indus Basin Development Phase (1970 to date)

During pre-Indus basin development phase, policy makers could not assemble technological resources to devise management programs on a basin-wide scale (Mustafa, 1998). However, catastrophic flood of 1973 signposted need of a comprehensive and practicable flood management system. Resultantly, United Nations Development Program (UNDP) and Meteorological Organization (WMO) initiated a combined project for "River improvement and Flood Forecasting/ Warning System" in 1975 (Hewitt, 1983). The attempt towards management was further strengthened when a Federal Flood Commission came in to being in 1977. Under this commission, first country-wide National Flood Protection Plan (NFPP) was devised in 1978. This plan not only laid foundations of flood forecasting and warning tools but also materialized the programs for management of reservoirs, and reinforcement of levees and bunds in emergency situations. Furthermore, with only minor amendments, the plan has served as a reference point for future policy makers (Alam, 1998). The NFPP was implemented in three phases of ten-years each i.e. NFPP-1, NFPP-2, and NFPP-3. In the first phase (1978 to 1987); 350 flood protection schemes were implemented in all over the countries (Shaikh, 2008). In the

first phase (1978 to 1987); 350 flood protection schemes were implemented in all over the countries (Shaikh, 2008). A total of 427 schemes were completed in second phase (1988 to 1997) under two mega projects; Flood Protection Sector Project-I or FPSP-I (257 schemes) and National Annual Development Plan-1 or NADP -I (170 scemes). While, the third phase (1998 to 2007) included 463 schemes were completed with three mega projects; FPSP-II (101 schemes), NADP-II (362 schemes), and development of a flood forecasting and warning system at Lai Nullah, Rawalpindi/ Islamabad (Tariq and van de Giesen, 2012).

The plan also highlighted three policy priorities; up gradation and modernization of hydrological and meteorological data assessment systems in the country. Installation of RADAR system at Sialkot and satellite controlled readout system in Lahore to monitor water levels in river catchments coming from India. Establishment of flood forecasting module and river flow system under the patronage of Water and Power Development Authority (WAPDA), Pakistan Meteorology Department (PakMet) and the Provincial Irrigation Departments (PIDs). Authorities were responsible for issuing rainfall and water depth data to Weather Forecasting Stations (Ul Haq, 1998).

In spite of these policy guidelines and management plans, major floods have devastated the country in years; 1975, 1976, 1978, 1988, 1992, and 2010 (Mustafa, 2001). Due to these catastrophes government has once again given momentum to flood management measures. Hence, a 4th National Flood Protection Plan or NFPP-IV (2008 to 2017) is underway in order to improve upon and extend the earlier plans. In coming pages we have tried to unearth the causes of these unfortunate calamities including floods of 2010 a case study.

Causes of Floods from 1970-2000

The Kalabagh Dam Dispute

Dispute of the Kalabagh dam construction between two provinces, Sindh and Khyber Pakhtunkhwa, has always been remained a major cause of flooding in Pakistan. According to the Sindh opposition and local stakeholders, water flow stoppage due to dam's construction will initiate inter-provincial crisis leading to the scarcity of water. Approximately, 80% of the groundwater of Sindh is saline and this stoppage could compromise the farmland's irrigation. Furthermore, water stoppage may increase the inland intruding of the Arabian Sea. In addition, livelihoods of hundreds of thousands of Sindhi fishermen depends on the ecology of Indus Delta that may be jeopardized because of reduced fresh water flows to the delta. On the other hand, Khyber Pakhtunkhwa is concerned to have potential flooding in their rich farmlands by the creation of lake behind the dam (Mustafa, 2010; Mustafa et al., 2013).

Flooding of Year 2010: A Case Study

According to normal monsoon phenomena, the absorbed solar radiations heat up the landmasses during pre-monsoon period (Fig. 1), which in turn cause increase in temperature and decrease in pressure of the aerial atmosphere. Resultantly, the air masses rises up which later replaces with cold breeze coming from the Indian Ocean. This cold breeze brings moisture from the ocean and starts moving towards Himalaya unless they collapse and cause summer rains in Indo-Pak.

During Monsoon period of 2010, halting of jet stream result in more water recharge from Arabian Sea in northern Pakistan (Lau and Kim, 2012). Furthermore, this delay in the subtropical jet stream was linked to the fuel recharge for approximately more than a month (Hong, Hsu et al., 2011, □□□, 2011). Afterwards, a huge collapse in the precipitation after recovery of jet stream resulted into intense rainfall and flash flooding in northern areas. In Azad Jammu and Kashmir (AJ & K), and Punjab, more than 250 mm rain fell over a 36-hour period and lack of proper management plan resulted into riverine flooding in southern Pakistan. Fig. 2 represents rainfall in all provinces of Pakistan (Arslan et al., 2013, Arslan et al., 2013).

In addition to frozen jet stream theory, flooding of 2010 was not only a cause of natural disaster but was also aggravated by policy failure of higher ruling hierarchy. Violation of Indus-water treaty by the Indian water authorities multiplied the already precarious situation and resulted into riverine flooding in southern Pakistan. According to Article IV (3) (c) of IWT, India was not supposed to increase the catchment area and release all the water into western rivers.

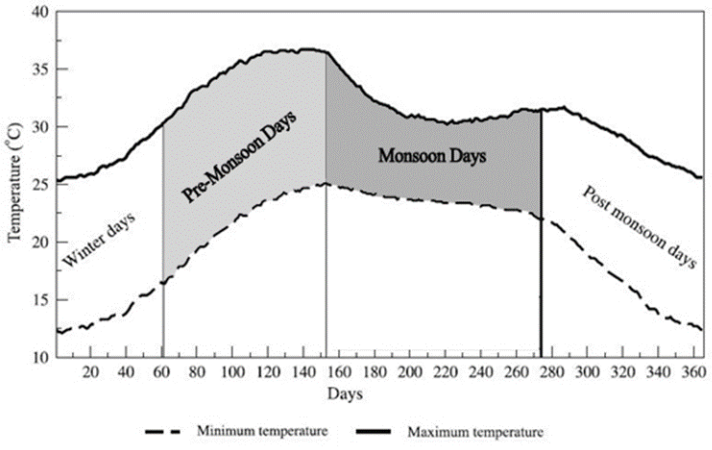


Figure 1: Graphical representation of early monsoon season and heating of landmass in the subcontinent.

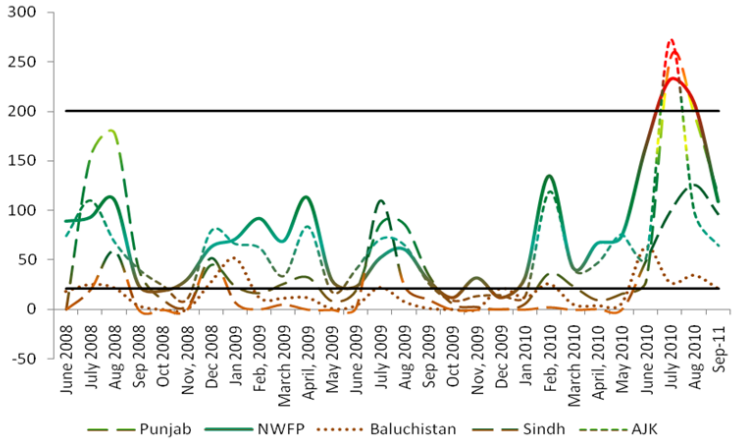


Fig. 2: Rainfall data of all of the provinces for 900 days showing high rainfall in July 2010. Published with the consent of Arslan et al., (2013).

According to irrigation department of the Pakistan, India was responsible for flooding along the banks of River Chenab as a big amount of water was released at Jammu Tawi that caused flood along the river-sides (PakMet). According to flood management authority, the flow of huge floodwater mounting at 210,000 cusecs caused inundation in the nearby villages and agricultural lands (Khan, 2011). As many as, 5 villages near Sialkot, 13 villages between Head Khanki and Rasool Nagar, and 1 village near Kala Shadian were run over by this floodwater. Moreover, India also released, approximately, 18,000 cusecs of water into River Ravi near Narowal and Sialkot districts which forced flood forecasting department to issue early warning to 168 villages along the river bank. Meteorology Department at the time stated that India had also released water in River Sutlej from Ferozewala Headwork without prior intimation. As water accumulated and began to recede in the river Indus , it crossed the threshold level causing major destructions even in Jacobabad which was not even along the normal rout/ waterway (Smith, 2013).

By early August, synergistic effect of intense monsoon rainfall and high water level in western tributaries transformed the landscape of Pakistan. The intense water pushed the banks of rivers even farther, inundating at least 28 major cities and hundreds of small towns and villages in Punjab and Sindh (Fig. 5). Furthermore, by mid-August, more than 1,700 people were killed and thousands were rendered homeless. In total more than 14 million people were affected with both primary and secondary effects of floods according to report of United Nations Office for the Coordination of Humanitarian Affairs (OCHA) (Initiative, 2011).

As the water receded in the rivers with the flow of gravity, water level multiplied and reached highest at Panjnad, where all tributaries combine to form a big channel (Smith, 2013). This high water level took over the protective structure and turned into a riverine flood causing catastrophic destruction in Districts Sukhur and Jacobabad.

Furthermore, by mid-August, more than 1,700 people were killed and thousands were rendered homeless. In total more than 14 million people were affected with both primary and secondary effects of floods according to the report of United Nations Office for the Coordination of Humanitarian Affairs (OCHA) (Initiative, 2011). At the start of September, flood wave reached as far as the city of Jacobabad, 70 km away from the normal rout of River Indus. River

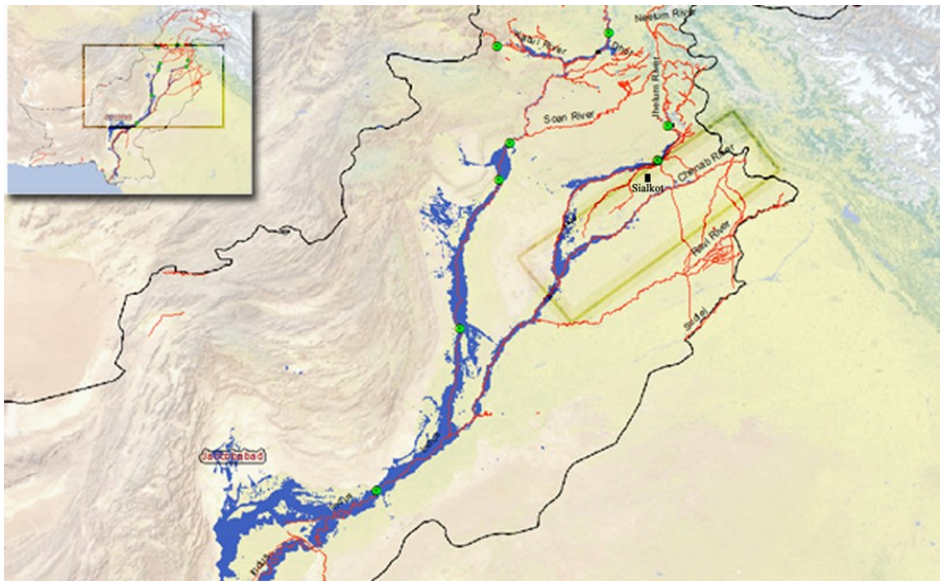


Figure 3: Violation of IWT and release of water in River Chenab, Ravi and Satluj by India.

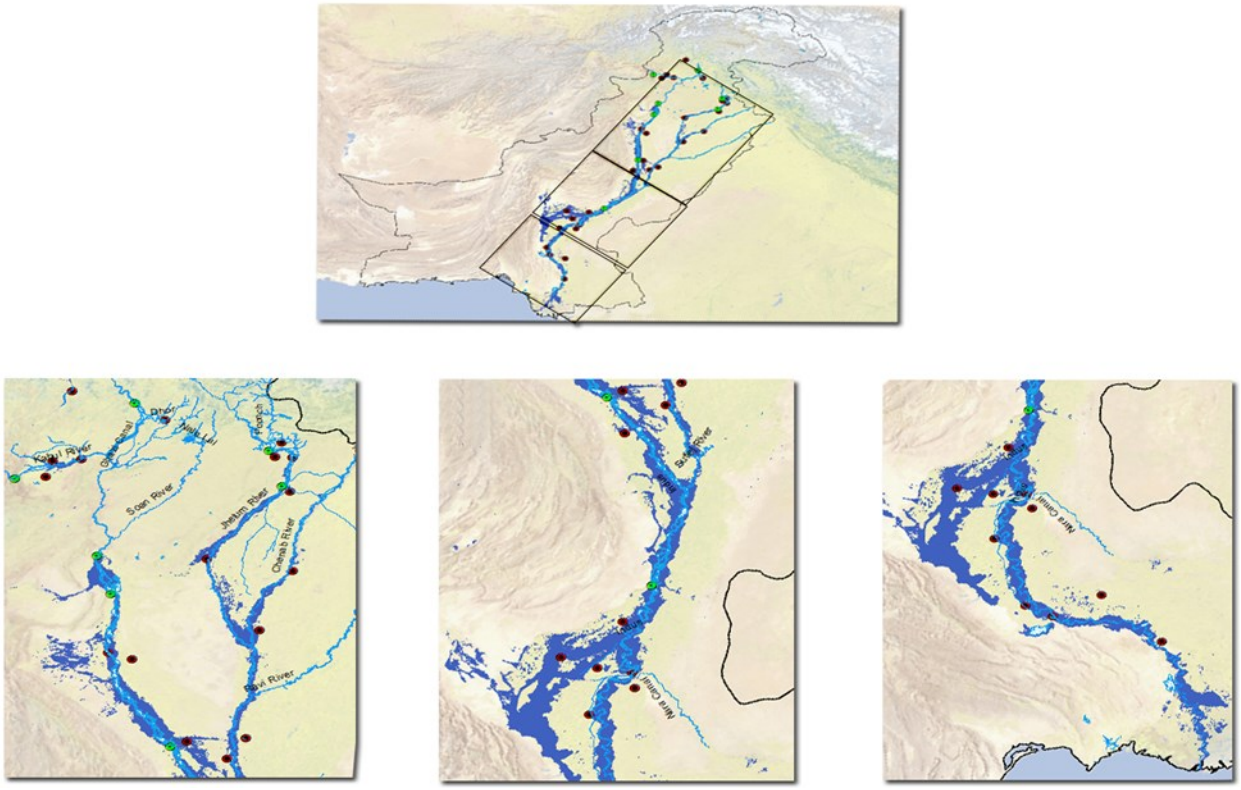


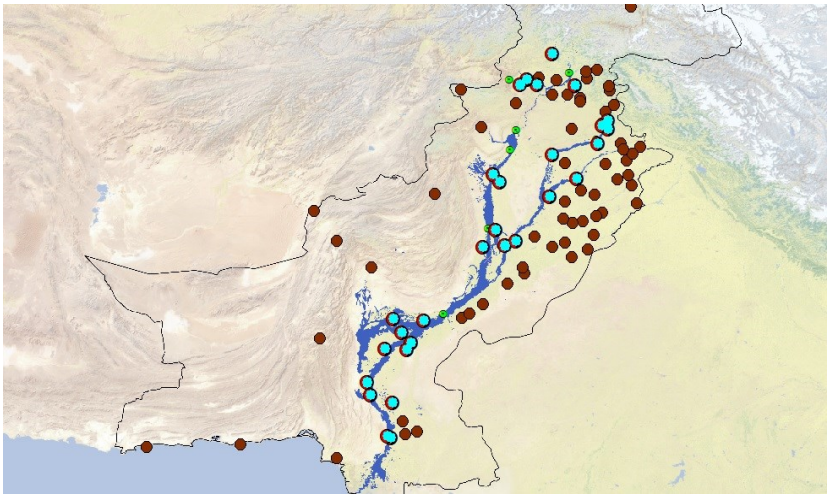
Figure 4: Flow of flood water (dark blue polygons) along the length of Indus River with the maximum allowable limit (light blue polygons); (a) water coming from upper Indus and its tributaries, (b) all the tributaries merging at Panjnad to make a bigger channel of the river, (c) destruction in Jacobabad.

was completely filled and merged in the braided streams of Sukkur and Jacobabad. Pools of water also appeared in the east of Sibi, on the other side of the river. This flood wave traveled down the River, and reached Sukkur, increasing the magnitude of impact on a daily basis (Fig. 4). The inundation is described in the maps given below created using geographic information system (GIS).

Hereby, water flow entered to the city instead of moving southward along the channel. Water level was so high that it exceeded the bearing capacity of the river and resulted in total inundation of floodplain areas (Fig. 3 & 4). Furthermore, overlay analysis illustrates that, approximately, 28 cities (big circles) located on floodplain areas of the river banks were heavily affected (Fig. 5).

The scenario of flooding do not stop with this worst experience of 2010. According to a report of UNICEF, approximately, 5.5 million people were affected due to flooding in monsoon period of 2011. And again in 2012, more than 5 million people were affected by floods and around 270,000 people were housed in relief camps.

Figure 5: Water inundation and destruction on floodplain areas of Indus River



Conclusions

Flooding have been an ever-present danger in Pakistan. As it is said that if you lag behind the events you are bound to fail. Lack of effective policy making, combined with docile implementation and minimal rehabilitation have caused havocs over the years to the people lying down the ways of the mighty Indus River. It is as clear as sun that the political will behind policy implementation have not been as strong as it should be. Hence, insufficient water reservoirs and scarce hydro power units have given rise to not only floods but also a never ending energy crisis. In Pakistan, the existing approach for flood management policies incorporates both structural and non-structural measures, however, their inter-linkage and combined efficiency still need to be optimized. Siltation in existing dams and reservoirs with no proper maintenance has further reduced the water bearing capacity which result into flooding every year. The management of flooding requires comprehensive understanding of the flooding patterns especially the physiographic, hydrologic, climatic, demographic, and socio-economic factors.

Installation of big water reservoirs is now inevitable, in order to devise any effective water management policy. As construction of big dams takes time, small dams and hydropower plants must be planned and built quickly within a given time frame to absorb some of the pressure from existing overburdened reservoirs. Furthermore, construction of water channels and small reservoirs along the length of River Indus would can also help mitigate flooding in this particular area. As offered in Helsinki Rules an efficient flood water distribution plan in potential vulnerable areas can also be a viable option. It has become necessary now to resolve controversies over dams, and improve the existing channels of communication to exchange flood forecasting modules between India and Pakistan.

Conflict of Interest

The author declare no conflict of interest.

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