ORIGINAL PAPER

Floods: impacts on livelihood, economic status and poverty in the north-west region of Pakistan

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Abstract

Climate change-induced floods have diversified effects on the physical and economic system of the dwelling societies. These effects mainly hit agricultural livelihood and livestock ending up in poverty. These irreversible damages are associated with high magnitude and frequency of floods, which are common in the South Asian countries. Similarly, Pakistan was hit hard by 2010 floods which were biggest in history as affecting over 20 million people and causing loss of over US$ 10.85 billion. The devastations were extended to rural poor communities of north-western part of Malakand division in Khyber-Pakhtunkhwa province of Pakistan, which were studied in this research on deploying 500 questionnaires at household level. It was to evaluate the extend of damages to livelihood and economic status of locality. Furthermore, this study tried to analyse the rise in poverty level, compared to the situation before inundating event of 2010. The results of cross-tabulation and logistic regressions confirmed that 1% increase in floods led to 0.44%, 0.31% decrease in livelihood and economic status, respectively. It was also found 1% increase in flooding ended up in 1.947% increase in the poverty level at household level. Further, the loss of livelihood resulted in the economic losses due to damages to crops and livestock and caused rise in poverty. The poverty syndrome was coupled with loss of savings and borrowing of funds that further ruined the economic situation of the locality. Conclusively, the flooding was declared to have posed adverse impacts on sustainable livelihood provision and rise in poverty in the area as not yet addressed through any institutional/governmental intervention.

Keywords Climate change · Flood · Vulnerability · Livelihood · Poverty · Sustainability · Pakistan

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1 Introduction

Climate change is becoming a scared reality of the present times (McCarthy et al. 2001). The adverse impacts of climate change that societies experience in the recent present are also foreshadowing of the futuristic climatic hazards (Parmesan and Yohe 2003). The adverse impacts of floods are diversified over, though not limited to, physical and ecological system change that are mostly life-threatening and irreversible (Gregory et al. 2004). The adversities of flooding are mainly affecting the vulnerable societies, dwelling in the developing regions of the world. These societies usually lack resources that make them highly vulnerable to climatic hazards. At the societal level, rural agriculture and its associated livelihood remain the most exposed sector. Losses to livelihood patterns are associated with damage to the cultivable land and forthwith the dependent agricultural production (McCusker and Carr 2006). Accordingly, the livelihood patterns of the rural communities are largely at the mercy of climate-induced disasters, e.g., flooding. So, the sudden drastic changes in the normal climatic patterns, followed by high magnitude and frequency of changes in the natural environment, are frequently resulting in flooding hazards and damage to earning opportunities in the rural regions (Shifeng et al. 2011). These hazards transform themselves into a great threat to human and associated assets. More alarmingly, such threats are getting ever greater in their occurrence and scope due to increase in the river water flow—a reality getting out of control (Khan 2003). This uncontrolled overflowing water commits large-scale direct losses to limited rural economies and poor societies (Dilley et al. 2005). Thus, flooding of any type, i.e., seasonal (heavy rains during the rainy season) as well as flash flooding (as of unpredictable heavy rains), is declared as the most lethal form of natural hazards. They undoubtedly have mega destructive power to sweep away the farmable land and livestock; the means of living and survival of the poor communities, thus mega damages to economic system status and rise in poverty.

1.1 Impacts on Livelihood[1] (agricultural production and livestock rearing)

The major threat of floods is linked to losses of crops and fodder in the rural agricultural sector. The agricultural production remains as stake as the floodwater, at its first instance, target fertile land in the low lying regions and damaging the standing crops (McCusker and Carr 2006; Chau et al. 2013). The damages to rural communities, in general, and rural livelihood patters, in particular, are linked with vulnerability. This rural vulnerability is the susceptibility or exposure of getting affected from natural hazards or flooding that varies over time and geographical space (Dow 1992; Cutter 2001).

This vulnerability of getting affected from flooding events is extended to bio-physical (e.g., elevation and proximity), social vulnerability (e.g., perception and experience) that increases hazards' potential in any locality (Cutter 1996; Cutter et al. 2003) and vulnerability associated with geographical perspective; poor locality and degraded living conditions that make people and places prone to flooding (Anderson et al. 2015). All in all, the chances of getting affected from flooding are associated with socioeconomic conditions of the community in any geographical region (Cutter et al. 2000).

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[1] Livelihood or means of living here defines only agricultural activities that determine the living and survival gained by the individuals/households in the rural areas.

Similarly, the vulnerably of the societies and regions put the assets on stake. The crops and vegetables that are an important source of rural subsistence life and livelihood remain at the mercy of floating water (Yaro 2004), whereas major threat of these agricultural products is found in the lower catchments of rivers and streams. It is because, rise in water level in the rivers and streams immediately leads to spilling-over of water into agricultural land. It damages the agricultural products, e.g., maize, wheat, rise, vegetables etc. It not only causes food insecurity but also loss of means of living. Such damages are worse in the river catchments as such areas require relatively longer time to dry (Pioneer 2013; Chau et al. 2013). The reality of standing water in the agricultural fields further deteriorates the situation as it ends up in waterlogging and delays in harvesting and transport of the harvested crops to market due to destruction to road network. The damages due to flooding are extended to livestock with often high intensity and scale.

1.2 Impacts on economic status and poverty

Rural economic system is associated with income generation form agricultural production and livestock rearing. These are also the dominant livelihood strategies for the rural poor, as being the main (sometimes the only source) of earning and saving—a quantifiable parameter of economic status (Armah et al. 2010). Thus, their vulnerability to flooding makes the rural poor households and thereupon the individuals to undergo shocks of deterioration. It is because the threats to the livelihood strategies end up in income reduction (Ligon and Schechter 2003). Accordingly, the destruction as of drowning and loss to livelihood damages the whole local economic system. It further hampers the purchasing power. Thus, declaring the dwellings in the floodplains is economically vulnerable (GoQ 2011).

1.3 Institutional/government support

There are extended and diversified damages due to flooding call for an active role of the public institutions to react against the disaster events. The action needs to be consolidated and effective to mitigate the impacts (MacManus and Caruson 2006). Therefore, an operational role of government institution should be spread into several streams and responsibilities to be performed at all different levels, e.g., planning–evaluation, characterized under broader theme of disaster risk management policies and plans (Collins and Kapucu 2008). It is, however, unfortunate that post-flooding reports confirm absence of all such interventions from the responsible government bodies. As a consequence, limited community response rests as the main (sometimes the only) juncture to mitigate adversities of flooding.

The absence of government reactive and proactive response, coupled with limited capacity of the rural poor community to cope with disasters, results in ever increasing natural disasters, knocking at the doors steps of South Asian nations. The region is home of the one-fifth of world's population (Krausmann and Mushtaq 2008; Memon 2012; Hirabayashi et al. 2013). This region with huge population bulk in its basket is also highly vulnerable to flooding disasters. The geographical location of South Asia, i.e., laying at mid-latitudes, steers to consistent flood-related shocks. These shocks are affecting humans in the form of injuries, deaths, and diseases, couple with destruction to physical assets (houses, fodder storage rooms, etc.) and livelihood assets (agricultural production and livestock); the means of rural living and survival (Shrestha and Takara 2008). This alarming situation further leads to deterioration of the economic status and rise in poverty amongst already poor

communities. As a result, the economic aspects of the poor locality is on stake (WB 2007; Mirza and Ahmad 2005; Memon 2012).

1.4 Problem statement

Like other South Asian countries, Pakistan is no exclusion; it has long history of recurrent of disastrous floods (Khan 2003). Over and above, Pakistan is amongst those topmost flood-prone zones where intensity and frequency of floods events are rising (Hirabayashi et al. 2013). The floods of July 28, 2010, were declared the biggest flooding in the history of Pakistan, since 1900, where the locality suffered heavily firstly, in terms of economic losses. This flooding was reported the most disastrous flooding, dangerous than the combination of five giant disasters of the last decade, i.e., Indian Tsunami (December 2004), Katrina USA (August 2005), Earthquake in Pakistan (October 2005), Nargis Cyclone Myanmar (May 2008), and Haiti Earthquake (January 2010) in terms of with causalities, geographical destruction and associated losses (NDMA 2011). According to some estimates, the 2010 catastrophic event inundated 2.1 million ha. of standing crops and loss of 400,000 animals (UN 2011; Webster et al. 2011; Atta-ur-Rahman 2010). At the national level, Khyber Pakhtunkhwa (KP) province and at the provincial level north-western parts suffered predominantly (Rehman et al. 2016). Malakand division was in the top suffering of in the north-western parts that is mainly due to its topographical conditions and geographical location (laying on the banks of Swat and Kabul rivers' basin). Therefore, this region was marked highly vulnerable to flooding events (PMD 2012; Cook et al. 2013). This vulnerability and frequent spells of floods declared the region a flood-prone area (Azam et al. 2012) smashed by heavy monsoon rainfalls during July–September, every year (Inam et al. 2007). Although the average annual precipitation in the region had varied from 125 mm (lower plains) to 500 mm (upstream region) (Khan et al. 2009) that though remained normal precipitation trend, it has sharply changed to more increased and intense rainfalls in 2010. Thus, severe anomalies triggered by climate change including frequent spells of rain raised the water level in the rivers (e.g., Swat and Kabul rivers). This sudden disastrous flooding events caused unprecedented havoc and destruction to livelihood patterns in the study area.

1.4.1 Loss of agricultural livelihood and livestock

The 2010 flooding, at the first instance, effected rural agriculture production. The damages to agriculture sector in the region remain high as in the past population continuously encroached towards the river banks for agricultural practices. It has reduced carrying capacity of the rivers and increased the risk of floods in 2010. The gushing water overflowed the natural embankments and cross the arid land thus demolishing the standing crops, thereby affecting dominant economic activity in the region that contributed to approx. 38% in provincial GDP. It further provided employment to 44% of the local population, here forth affecting livelihood patterns (Khan 2013). The loss of agriculture, livestock, and fisheries—the backbone of rural economy, suffered US$ 5 billion losses. The flooding disaster hit crops, seed, feed storage room and the harvested crops. Along with, major recipient of damages was the standing crops (89% of the total damage), amongst which loss of 2.1 million ha. to standing winter (or Kharif) crops and waste of 1 million tons of food and seed stocks in the region. These losses were coupled with indirect damages in the form of land
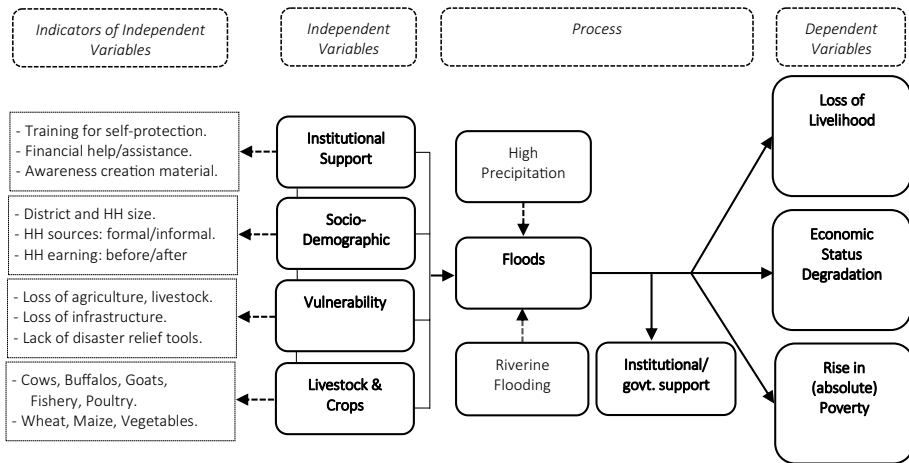
Fig. 1 Conceptual Framework

degradation and halting of farming for months due to standing water in the field, causing food insecurity.

Furthermore, the flooding of 2010 also affected livestock (11% of the total damage). An ample quantity of livestock (both grazing animals and poultry) was washed away and exterminated in the study region. These damages multiplied as flooding hit fisheries—destruction to fishponds and (public and private) hatcheries (GoKP 2011).

1.4.2 Rural economic deprivation and rise in poverty

As of 2010 floods rural economy of Malakand suffered in the shadow of 50% of the total damage to agricultural sector. The agricultural output fell between 2 and 2.5 million tons, dragging the rural economy into a disastrous condition to sustain and feed the local population. The overall damage to rural economy was estimated at approx. US$. 5.42 billion. The economic depreciation further increased due to (approx. US$ 4.8 billion) losses to livestock sector. It is coupled with floods' devastation to ginning units, rice husking mills, and other physical infrastructures, like houses, storage room, and roads, thereby badly affecting the rural economy and causing rise in commodity (GoKP 2011). It has greatly contributed in rising poverty level of the poor and vulnerable community of the region. The earning opportunities were lost, income level dropped, and limited savings could not sustain for longer period to cope up with the aftermaths of flooding as no external help was available.

This research study thus aimed to analyse the self-reported adverse effects of 2010 floods on livelihood, economic status and poverty (at once) in Malakand Division in KP province. The independent variables studied were floods, institutional support, socio-demographic, vulnerability, livestock and crop production (Fig. 1), that were reported to have great effects (Sadia et al. 2016), but not studied intensively on the said parameters.

The questions this research study tried to answer were:

1. Did flooding affect the livelihood of local vulnerable population?
2. Did flooding result in degradation of economic status and rise in poverty?
3. Did institutional/governmental support provide to help the affected locality?

Table 1 Rural population and population density—district-wise statistics. *Source*: 6th Population Census Report 2017

District	Area (Sq. Km)	Rural population	Rural population density (per Sq. km)
Chitral	14,850	288,067	19.3
Swat	5337	1,083,734	203
Malakand	952	409,112	430
Dir	5282	1,226,271	232
Buner	1865	506,048	275
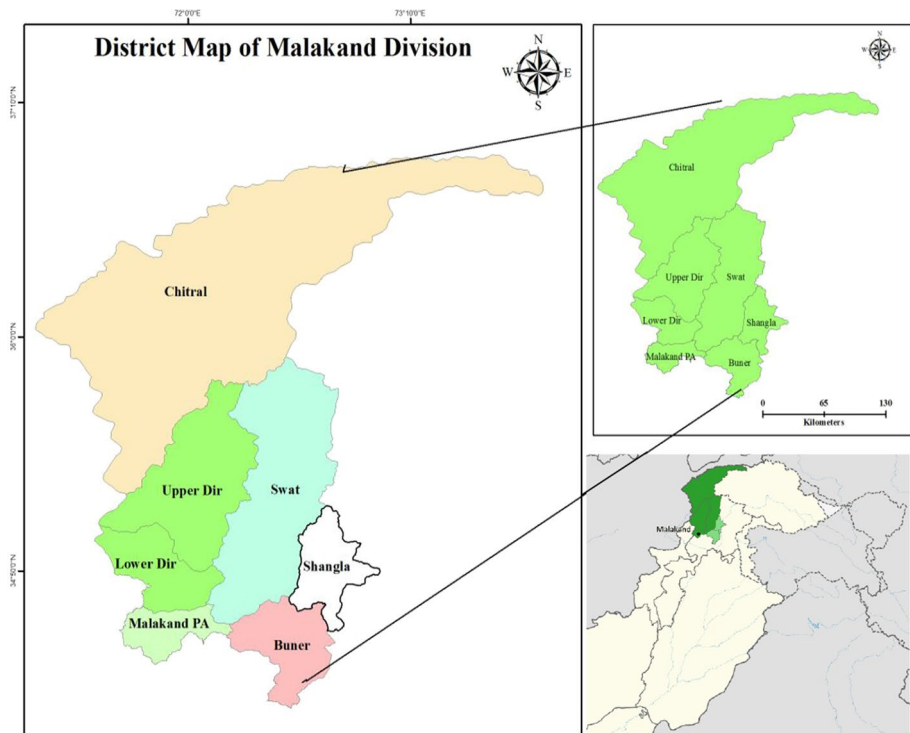
Fig. 2 Malakand Division (North of KP Province

2 Methods and materials

2.1 Study area and survey methods

Malakand Division lies in the northwestern region of Khyber Pakhtunkhwa (KP) province, Pakistan at 35° 30′ 0″ N, 72° 0′ 0″ E. Malakad division is comprised of seven districts, yet this study has targeted five districts namely Chitral, Lower Dir, Upper Dir, Malakand, and Swat (Table 1 and Fig. 2). The selected districts are situated around the river Swat, and Kabul and their tributaries. These selected districts are situated in the riverine zone that makes them more prone to overflowing and flooding events. This vulnerability resulted

Table 2 Sampling of HH. *Source:* 6th Population Census Report 2017

District	Total HHs	Vulnerable HHs*	Target HHs
Chitral	61,619	124	99
Swat	274,620	128	102
Malakand	91,414	125	100
Dir	275,566	130	104
Buner	94,095	119	95

*Based on pilot survey by the author

in adverse effects of 2010 floods on farmable land, loss to agricultural production, loss to agricultural livelihood, loss to economic capital and (rise in) poverty.

Primary data were collected at the household (HH) level with the help of close-ended questionnaires, and field survey was extended over three month's duration (February–April 2018). Before finalizing the study instrument, pilot survey was conducted from (randomly selected) 20 HHs to check the understandability and reliability of the questionnaire. Upon making the necessary changes, the questionnaire was finalized and deployed for data collection from most affected villages, i.e., 3-Chitral, 7-Swat, 4-Malakand, 11-Dir, and 5-Buner, thus targeting 26 villages in five districts and deploying (in total) 500 (male = 481 and female = 19[2]) questionnaires at HH level. The sample size was approx. 100 respondents from the 'vulnerable HHs' per district (Table 2). Due to non-existence of data on HHs residing close to water channels, the said vulnerable HHs were counted during the pre-testing of the survey instrument (i.e., questionnaire) and in consultation with the local focal persons of areas which were inaccessible. Therefore, based on that survey the sample size was selected with confidence level of 95% and ± 5% margin of error, as accepted and deployed in social-science research (Yamane 1967; Cochran 1963). This high confidence level and low margin of error ensured generalization of the study's results to 'vulnerable HHs' in the adjacent districts, nearby provinces and other geographical areas, where HHs remain vulnerable due to their positioning in the line of the water channel and have greater chances of getting affected from flooding.

Cluster sampling (clusters were based on HHs very close to water channels) was deployed within the selected (most effected) villages in each district. It was followed by simple random sampling in each cluster to ensure participation of HHs without any biasness and partiality, required for reliable generalization of the results. The questionnaire was mainly based on yes/no questions, followed by the extent of damages (in %), types (maize, wheat, rise etc.) and degree of crop production (increased/decreased in %). The demographic profile of the sample is shown (Table 3).

2.2 Estimation of variables and statistical modelling

For analysis, the standardized logistic coefficients were projected. This gives the most reliable estimates of the direct and indirect effects of any particular phenomenon (MacKinnon et al. 2007). This model also helps in modelling the 'risk processes such as risk awareness,

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[2] This relatively low representation of the female was due to the fact that only 19 females appeared to be at home at the time of data collection so considered as HH representatives, which otherwise were males in 481 cases. However, they posed no effect on overall results as no gender segregated results were presented.

Table 3 Demographic analysis of respondents. *Source*: Author's calculation using survey data

Category	Frequency	Percentage
Gender		
Male	481	96
Female	19	4
Age		
15–25	32	6
26–35	88	18
36–45	157	31
> 45	223	45
Education		
Primary	217	43
Secondary	234	47
Tertiary	49	10
Earning Before 2010 Flood		
< 15,000	11	3
16,000–35,000	19	18
36,000–55,000	249	50
> 55,000	149	29
Earning After 2010 Flood		
< 15,000	96	19
16,000–35,000	274	55
36,000–55,000	90	18
> 55,000	40	8

risk identification, monitoring and reporting, planning and mitigation' in the social-sciences research (Bayaga 2010). Also, this model has an additive advantage to find out the relationship between instructive (predictor) and response in the risk and impacts' assessment research (Hedeker 2003; Crane et al. 2006; Kleinbaum et al. 2002). Thus, the validity of using the standardized logistic regression coefficients was behind the fact that this technique makes it implicit to gauge the likelihood that 'one standard deviation changes in the central incessant variable' attributes to 'one standard deviation changes in the predictor'. So, 1% increase in floods is synonym of any slight change to normal water flow in the river, streams, etc., that increases the likelihood of potential damage to livelihood, degrade economic status and rise in poverty of the residents. It is compared to local normal circumstances in the area before flooding event occurs. This technique is deployed in flood-related researches where the relative change is observed, compared to any change (measured as % change) in the regular rainwater and river water flow. The change in water flow can also be referred to water flow a day before or national base flood standard or even 100-year floods (not referring to a flood that arises one time every 100 years), as a standard (FIFMTF 1992; Pielke 1999). This standard helps to study the minimum affects or damage due to flooding (taking 1% as a standard to compare with) on the dependent variables in the flood-prone communities, which otherwise cannot be measured without any set standard (Lord 2011). In this sense, the analyses were divided into three different ways or on three dependent variables: firstly the livelihood, secondly economic status and thirdly capture the poverty level, for every 1% increase in flooding, prior to 2010 conditions. The effects of

this increase are gauged as percentage effect on the physical meaning or selected indicators of all the three dependent variables (see: Sects. 2.3.1 and 2.3.2). It was followed by estimations to find a correlation between all the predictors.

The functional form of analysis was finalized as:un

Livelihood = *f* (flood, institutional support, socio-demographic characteristics, vulnerability of household, livestock, crops).
Economic Status = *f* (flood index, institutional support, socio-demographic characteristics, vulnerability of household, livestock, crops).
Poverty = *f* (flood, institutional support, socio-demographic characteristics, vulnerability of household, livestock, crops).

The indexes were constructed each for independent variables, thereby developing three separate models/equations. It was done to explain and predict the climate change (here, flood induced) vulnerability, which is drew on Value–Belief–Norm (VBN) theory of Stern et al. (1999) that helps to capture predictors of components, i.e., vulnerability, institutional support and assets (e.g., crop and livestock) and flood, as done in this research. The independent variables remained the same throughout the study, but the dependent variables were changed in all in the three equations according to research questions to find the relationship.

The final form of the equations is estimated as follows:

$$\text{Livelihood} = \alpha_0 + \alpha_1 \text{Flood} + \alpha_2 \text{Institutional support} + \alpha_3 \text{Socio} - \text{demographic characteristics}$$
$$+ \alpha_4 \text{vulnerability of the household} + \alpha_5 \text{livestock} + \alpha_6 \text{crops} + \mu_i$$
$$(1)$$

$$\text{Economic Status} = \alpha_0 + \alpha_1 \text{Flood} + \alpha_2 \text{Institutional support} + \alpha_3 \text{Socio demographic characteristics}$$
$$+ \alpha_4 \text{vulnerability of the household} + \alpha_5 \text{livestock} + \alpha_6 \text{crops} + \mu_i$$
$$(2)$$

$$\text{Poverty} = \alpha_0 + \alpha_1 \text{Flood index} + \alpha_2 \text{Institutional support} + \alpha_3 \text{Socio demographic characteristics}$$
$$+ \alpha_4 \text{vulnerability of the household} + \alpha_5 \text{livestock} + \alpha_6 \text{crops} + \mu_i$$
$$(3)$$

Here, μ_i is the random disturbance term.

2.3 Construction of variables

2.3.1 Dependent variables

The construction of dependent variables; livelihood index, economic index, and poverty in Eqs. 1–3 was done by developing indexes based on several associated questions, with no reversed responses. The answers of the respondents were added and then dived into two cut-off points, i.e., values less than and equal to average were consigned '0' and values greater than mean were denoted as '1'. The physical meaning of the dependent variables is:

1. *Livelihood index* The minimum livelihood (0) of HH means: loss of farmable land, decreased crop production, loss of livestock and non-availability of other employment opportunities, whereas for maximum livelihood (1) it is vice versa.

2. *Economic index* The minimum/low economic status (0) of HH means: decreased earning and exhaustion of savings and rise in absolute poverty, whereas for maximum economic index (1) it is vice versa.

3. *Poverty index* The minimum/low-level poverty (0) of HH means: decreased earning, loss of house, loss of fodder and machinery and loss of feed storage rooms, whereas for maximum poverty index (1) it is vice versa.

2.3.2 Independent variables

The indexes were constructed for independent variables: flood, socio-demographic characteristics, institutional support, vulnerability, livestock, and crops. These indexes were developed on recording different questions on the selected variables. The responses from the field survey were added and divided into two cut points '0' and '1'.

The physical meaning of the independent variables is:

1. *Flood* Less effected from 2010 flooding (0) of HH means: house and property were less prone to rise in the water level of nearby rivers, streams, canals, lakes, reservoirs or other watercourses within 1/4 of a mile of the property. Also, time and level of water standing in the area cause further damages, whereas for large/more effected (1) it is vice versa.

2. *Socio-demographics* Less demographic (0) means: vulnerable age group (i.e., children and old age people), large household size (means more dependent), major source of earning of the household dependent on agriculture and livestock and low level of education level of the HH members to cope up with adverse effects of floods, whereas for large socio-demographic (1) it is vice versa.

3. *Vulnerable households* Less vulnerable (0) means: less exposure to flooding and low risk of damage to HHs' assets, whereas for large socio-demographic (1) it is vice versa along with underlying causes of high vulnerability due to floods.

4. *Institutional support* Less institutional support (0) means: low inst./government response in emergency situation through financial help, provision of food, fertilizers, seeds, machinery and equipment, training regarding crop production and animal husbandry after floods, a platform for collective knowledge/experiences sharing for disaster preparedness and risk reduction, whereas for large institutional support (1) it is vice versa.

5. *Livestock* The minimum livestock (0) means: minimum quantity of livestock assets of HHs, e.g., cows, buffalos, goats, poultry and fish-farms and maximum effect of flooding on these assets as well as fodder storage and supply, whereas for maximum livestock (1) it is vice versa.

6. *Crops* Less crops (0) means: decreased production of, e.g., wheat, maize, rice, vegetables and fruits due to damage to fertile land and damage/non-availability of fertilizers, manure, green and dry fodder, and farming assets, whereas for more crops (1) it is vice versa.

Similarly, the constructive and descriptive statistics of all the selected variables were completed for all the answers taken from the field survey. The responses of the HHs through primary survey were estimated, and results were projected by frequencies with percentages for all the selected dependent and independent variables (Table 4).

Table 4 Construction of variables. *Source*: Author's calculation using survey data

Variable	Category	
Livelihood	Minimum (0)	Maximum (1)
	≤17.5	>17.5
Frequency	313	187
Percentage	63%	37%
Eco. status	Low status (0)	High status (1)
	≤14.5	>14.5
Frequency	140	360
Percentage	28%	72%
Poverty	Low level (0)	High level (1)
	≤10.5	>10.5
Frequency	159	341
Percentage	32	68
Flood	Less affected (0)	Large/more affected (1)
	≤10	>10
Frequency	18	482
Percentage	4%	96%
Social demographic	Less demographic (0)	Large demographic (1)
Characteristics	≤11.5	>11.5
Frequency	131	369
Percentage	26%	74%
Vulnerable household	Less vulnerable (0)	Large vulnerable (1)
	≤16.5	>16.5
Frequency	68	432
Percentage	14%	86%
Institutional support	Less support (0)	Large support (1)
	≤13.5	>13.5
Frequency	466	32
Percentage	93%	7%
Livestock	Minimum (0)	Maximum (1)
	≤7.5	>7.5
Frequency	166	334
Percentage	33%	67%
Crops	Less (0)	More (1)
	≤16.5	>16.5
Frequency	124	376
Percentage	25%	75%

2.4 Survey reliability

Reliability check was done to see the internal consistency of the measurement, i.e., how closely the items in a group or section were related to each other. Cronbach alpha served for the desired measurement by calculating the number of items and the mean inter-item correlation amongst the variables. Its values were between '0' and '1', where the higher value of Cronbach alpha represented higher internal consistency, yet values greater than 0.6 considered as acceptable in social-sciences research. The Cronbach alpha value for all the

Table 5 Cronbach's Alpha reliability. *Source:* Author's analysis using survey data

Variable	Cronbach's alpha	Variable	Cronbach's alpha
Livelihoods	0.831	Vulnerability of the HHs	0.719
Economic status	0.717	Livestock of HH	0.685
Poverty	0.730	Crops of HH	0.799
Flood	0.755	Institutional support to HH	0.691
Socio-economic characteristics	0.815		

Table 6 Livelihood and flood. *Source:* Author's analysis using survey data

Livelihood	Flood		
	Probability of less affected (0)	Probability of more affected (1)	
Minimum livelihood (0)	12	301	
	(66.67%)	(62.45%)	
Maximum livelihood (1)	6	181	
	(33.33%)	(37.55%)	
Total	18	482	500
	(100%)	(100%)	(100%)

Pearson chi^2(1) = 9.1225 P value = 0.001

selected variables confirms higher internal consistency, as shown from the study's results (Table 5). Also, Chi-square test deployed to calculate the correlation between dependent and independent variables.

3 Results and discussion

3.1 Livelihood

The study's results confirmed correlation of flood with livelihood, economic status, livestock and crops, poverty and institutional support, interchangeably. It was demonstrated that out of total (500) respondents, 482 respondents confirmed floods hit locals' livelihood, whereas 18 respondents negated such happening. Furthermore, out of major category (482 HHs) 62.45% of the HHs confirmed that min. livelihood opportunities have more chances of getting affected by flooding, while the probability of getting affected remained relatively as low as around 37.55% with max. livelihood in this flood-prone area. Likewise, the probability of getting affected by flooding events remained also high as up to 66.67% with min. livelihood, compared to 33.33% of the respondents in the category of less probability of getting affected by flooding. Thus, the correlation between floods and livelihood was established on the existing relationship between (adverse effects) of floods and livelihood, rejecting the null hypothesis of no correlation between the said variables. It confirmed that floods remained more dangerous for the community having min. livelihood and thereby acceptance of alternative hypothesis (H$_1$) at 1% sig. level and Chi-square test

Table 7 Vulnerability of the HHs and livelihood. *Source:* Author's analysis using survey data

Livelihood	Vulnerability		
	Less vulnerability (0)	More vulnerability (1)	
Minimum livelihood (0)	52 (76.47%)	261 (60.42%)	
Maximum livelihood (1)	16 (23.53%)	171 (39.58%)	
Total	68 (100%)	432 (100%)	500 (100%)

Pearson chi^2(1) = 15.4675 *P* value = 0.001

value confirmed a strong association between the said variables (Table 6). This trend is also reported from other societies (i.e., the Okavango Delta system) where annual variability and extreme floods caused hostile impacts on rural livelihoods (Motsholapheko et al. 2011). Another study also confirmed that floods relentlessly squeeze the livelihood patterns and household income of the affected communities (Asgary et al. 2012).

The findings of the study further explored the relationship between livelihood and vulnerability of the HH, and a strong association was found between the two variables. Out of total 500 households, total of 52 HHs with min. livelihood was found 76.47% less vulnerable, compared to 16 HHs with max. livelihood was declared as 23.53% more vulnerable in this flood-prone area. On the other side, the HHs with min. livelihood remained 261 HHs with 60.42% more vulnerability than 171 with max. livelihood opportunities and 39.58% vulnerability of getting affected by the adverse effects of flooding (Table 7).

Thus, to conclude that households with min. livelihood was more vulnerable than the HHs with max. livelihood in the investigated area. This trend is also reported from other studies also that floods disrupt cultivable land, particularly in the floodplains. Floods also destroy physical infrastructure, including the water channels that further cause extended disruptions and curtail transport systems thereby causing food insecurity—contributing collectively in increasing vulnerability of the rural communities (Meyer and Bendsen 2003; Magole and Thapelo; 2005; Malala 2009).

To determine the correlation between livelihood-institutional/governmental support, the Chi-square test showed 10% significant level of correlation amongst the selected variables. It is established from the results that 34 HHs against 466 HHs/respondents confirmed probability of less supported by the institutional/government, out of which 53.13% confirmed less probability to receive the said support. It was followed by 46.88% of the HHs having less chances of getting such support although having max. livelihood opportunities available. On the other side, 63.30% of HHs (with the response numbers 295/500 HHs) are found to have more chances of external support, against 36.70% HHs having probability of large/more institutional/govt. support with max. livelihood. Conclusively, it was to found that the greater number of the HHs with min. livelihood—more is the probability of getting larger institutional/govt. support and vice versa (Table 8).

3.2 Economic status

The results further demonstrated the co-relation of economic status with flooding. The study found a strong association between the said variables (*p* value showed significance at

Table 8 Livelihood and Institutional support. *Source:* Author's analysis using survey data

Livelihood	Institutional support		
	Probability of less support (0)	Probability of more support (1)	
Minimum livelihood (0)	19 (53.13%)	295 (63.30%)	
Maximum livelihood (1)	15 (46.88%)	171 (36.70%)	
Total	34 (100%)	466 (100%)	500 (100%)

Pearson chi^2(1) = 3.495 *P* value = 0.081

Table 9 Economic status and flood. *Source:* Author's analysis using survey data

Economic status	Flood		
	Probability of less affect (0)	Probability of large/more Affect (1)	
Low status (0)	2 (11%)	138 (71%)	
High status (1)	16 (89%)	344 (29%)	
Total	18 (100%)	482 (100%)	500 100%)

Pearson chi^2(1) = 2.6418 *P* value = 0.004

1% level). It was found that (in total) 482 HHs reported that had large probability of getting affected, out of which 71% (in this category) were reported of having low economic status. Contrary, in total, 18 HHs confirmed less probability of getting affected, out which 89% confirmed of getting less affected due to high economic status. It was therefore concluded that low economic status leads to having a larger probability of getting affected, whereas higher economic status assured relatively less probability of getting damaged by flooding (Table 9).

The results further demonstrated co-relation of economic status with flooding and strong association between the said variables was found as *p* value showed significance at 1% level. It is established that low economic status concluded to larger probability of getting affected, whereas higher economic status can assure relatively less probability of getting harmed, by flooding. Hence, floods are found more dangerous and can have more economic cost for those who have low economic status.

The results further demonstrated a strong association between economic status and vulnerability of the households. It was established that 20 households with low economic and less vulnerable were 29%, whereas the HHs with same (i.e., less) vulnerability found were 120, i.e., 71% in this category. On the other hand, 78% of the HHs were found more vulnerable having low economic status, compared to 48 HHs with high economic status and 22% more vulnerability of getting affected by flooding. Thus, households with low economic status were more vulnerable to the adverse effects of flooding than the houses with high economic status in this study area (Table 10). The existing literature also confirms that the occurrence of disaster (at any point time) is

Table 10 Vulnerability of the household and economic status. *Source:* Author's analysis using survey data

Economic status	Vulnerability		
	Less vulnerability (0)	More vulnerability (1)	
Low status (0)	20 (29%)	312 (78%)	
High status (1)	120 (71%)	48 (22%)	
Total	140 (100%)	360 (100%)	500 (100%)

Pearson chi^2(1) = 3.050 *P* value = 0.003

Table 11 Economic status and Institutional/govt. Support. *Source*: Author's calculation using survey data

Economic status	Institutional/govt. support		
	Probability of less support (0)	Probability of more support (1)	
Low status (0)	34 (69.04%)	47 (27.12%)	
High status (1)	106 (31.33%)	313 (73.19%)	
Total	140 (100%)	360 (100%)	500 (100%)

Pearson chi^2(1) = 9.3746 *P* value = 0.009

strongly linked to physical as well as the socio-economic vulnerabilities present in any region, where the said vulnerabilities reinforce the extend and damage associated with any natural disaster (Blaikie et al. 2005).

Further, the Chi-square test was performed and correlation was observed between economic status and institutional/governmental supports at 1% significant level. It was observed that total 34 HHs with a low economic status have a probability of 69.04% to receive less institutional/governmental support, compared to 47 HHs with the probability of 27.12% chances of getting more institutional/governmental support at HH level. Contrawise, The 106 HHs with high economic status were found to have 31.33% less chances, whereas 313 HHs with 73.19% likelihood of getting large institutional/government support (Table 11), thus declaring that HHs with high economic status have a large probability of getting the said support and vice versa in the flood-prone area. In addition, the results found a correlation between economic status and livestock at HH level, *p* values at 1% significant level—null hypothesis of no correlation rejected. It was observed that 21 (12.65%) HHs with low economic status also have minimum livestock, compared to 145 (35.63%) HHs with the same status but having maximum livestock, in the flood-prone area. Conversely, 119 (87.35%) HHs with high economic status have minimum livestock, compared to 215 (64.37%) HHs with same economic status but maximum livestock (Table 12). To conclude, the HHs with high economic status have maximum livestock and vice versa, in the survey area.

Table 12 Economic status and livestock of the household. *Source*: Author's calculation using survey data

Economic status	Livestock		
	Minimum livestock (0)	Maximum livestock (1)	
Low status (0)	21 (12.65%)	145 (35.63%)	
High status (1)	119 (87.35%)	215 (64.37%)	
Total	140 (100%)	360 (100%)	500 (100%)

Pearson chi^2(1) = 29.0418 *P* value = 0.000

Table 13 Poverty and flood. *Source*: Author's calculation using survey data

Poverty	Floods		
	Less affected (0)	Large/more affected (1)	
Low level (0)	2 (88.89%)	157 (32.57%)	
High level (1)	16 (11.11%)	325 (67.43%)	
Total	18 (100%)	482 (100%)	500 (100%)

Pearson chi^2(1) = 3.6852 *P* value = 0.045

3.3 Poverty

The results (*p* values) further confirmed rejection of null hypothesis at 5% significance level, as strong correlation was found between the variables 'poverty' and 'flood'. It was proven that out of (total) 500 of HHs, only 2 HHs with low poverty level were 88.89% less probable of getting affected by the floods. It is contrary to 16 HHs with (comparatively) higher poverty level ended up in 11.11% chances of getting affected from the flooding events. Also, 157 HHs with the low poverty level were recorded to be in a situation where they have 32.57% chances of getting affected from floods. Lastly, 325 HHs were found to have 67.43% large probability affected by floods (Table 13). Thus, floods were more dangerous for those having (comparatively) higher level of poverty in the area.

Also, the strong association between poverty and vulnerability of the household at 10% significance level rejected the null hypothesis. It was established that out of 500 HHs, 62 households with low poverty level and less vulnerability were 91%, compared to only 9% HHs with same level of vulnerably but residing in high poverty. Contrawise, the study found 18 HHs residing in low level of poverty and 4% chances of getting more affected. However, 414 households were found with high poverty level and 96% more vulnerable to get affected from flooding events, thus to establish that households with high poverty level were more/large vulnerable to get adversely affected from the flooding of 2010 (Table 14). Here again, the above results are confirmed by other studies like Ahmed et al. (2009) that extreme spells of climate influence poverty as by affecting

Table 14 Vulnerability of the household and poverty. *Source: Author's analysis using survey data*

Poverty	Vulnerability		
	Less vulnerability (0)	Large vulnerability (1)	
Low level (0)	62 (91%)	18 (4%)	
High level (1)	6 (9%)	414 (96%)	
Total	68 (100%)	432 (100%)	500 (100%)

Pearson chi^2(1) = 2.7882 *P* value = 0.091

Table 15 Poverty and institutional support. *Source: Author's analysis using survey data*

Economic status	Institutional/govt. support		
	Less support (0)	Probability of more support (1)	
Low level (0)	34 (3%)	84 (70%)	
High level (1)	359 (97%)	23 (30%)	
Total	393 (100%)	107 (100%)	500 (100%)

Pearson chi^2(1) = 2.1402 *P* value = 0.0644

agricultural productivity for which the food prices staple. It no doubt increases the no of vulnerable households below the poverty line.

Similarly, the study showed that 34 HHs (with low level of poverty) found to have 3% probability to receive less institutional/govt. support, compared to 84 HH with the same low poverty status but 70% more chances of getting the desired support. Also, 359 HHs with high poverty status were noticed to have 97% probability of getting less institutional/govt. help and support. In this category, total 23 HHs with a higher level of poverty were noticed to get 30% more support from the institutional/govt. (Table 15). It was thus established that HHs with a high level of poverty get less institutional/govt. support than those living in comparatively better poverty/economic status in this flood-prone area.

The negative sign of institutional/govt. support (either no or late response) to restore livelihoods thereupon improves economic status, and poverty reduction at HH level remains alarming, which is then met through localized ways like, borrowing, selling assets, etc., that further expedite the poverty increase pattern.

The reactive response of the national governments is found encouraging to local affected communities as they do respond to emergency needs. The global public institutions support to recover local losses and assist through tangible means in building safety nets (Botzen and Bergh 2009). Such support is desired and needed as it helps to minimize livelihood and economic losses and help in controlling rising poverty amongst the rural poor communities (Colten et al. 2008; Osbahr et al. 2010) that unfortunately remains unavailable in the study region in the aftermaths of disastrous flooding event.

Poverty	Crops of household		
	Probability of less impact (0)	Probability of large impact (1)	
Low level (0)	6 (24.79%)	118 (77%)	
High level (1)	358 (75.14%)	18 (23%)	
Total	364 (100%)	136 (100%)	500 (100%)

Table 16 Poverty and crops of household. *Source*: Author's calculation using survey data

Pearson chi^2(1) = 4.981 *P* value = 0.0005

Correspondingly, the correlation between crops and poverty at HH level was noticed at 1% significant level. A correlation between crops and poverty level of household presented at 1% significant level (Table 16). It is observed that 6 household's crops those have a low level of poverty were less almost 25%, while 118 household's crops were large around 77% in the study area. It is found that total 358 HHs with less crops and high poverty level were about 75% while only 18 HHs with large crop were approximately 23%. In conclusion, results show that households with a high poverty level have fewer crops in the flood-prone area.

Likelihood ratio (LR chi^2) presented suitability of the equations (as its value is greater than two), whereas prob > chi^2 represented (overall) statistically significance of the equations. The results of odd ratio and *z* values for independent variables revealed that floods were negatively and significantly related to livelihood and economic status, whereas positively and significantly to the poverty level of the HHs, confirming that floods were dangerous for livelihood (i.e., loss of means of living), economic status (i.e., fewer resources to overcome the losses and increase in HHs vulnerability) and poverty level of the peoples in the selected five districts of Malakand division.

3.4 Discussion

The study results have confirmed that 1% increase in floods leads to 0.44%, 0.31% decrease in the livelihood, economic status, while 1.947% increase in the poverty level of the household. Such impacts of floods on livelihood in the rural surroundings are behind the reason that the locality is mainly dependent on agriculture. Crop production is their major source of income, as in other rural societies of the world where too agriculture sector and the associated livelihood opportunities. The aggregate losses to agricultural land and thereupon the agricultural production makes the local agriculture sector most vulnerable (McCusker and Carr 2006). These losses to agricultural economy in the rural and backward areas decrease income and hamper locals' ability to overcome the cost of natural disasters (Cash et al. 2013; Brouwer et al. 2007; Chanda et al. 2010). Global studies also confirm endorse that the negative impacts of flood and lack of abilities of the rural community swiftly degrade the livelihood patterns and income, even in the after floods for months and years that surely effect efforts towards poverty reduction. The impacts of floods on the Malakand division in the form of degreading the rural economy and rise in poverty are backed by other global studies (*see:* Kreimer and Arnold 2000; Chaudhuri 2002; Rayhan 2008; Few and Tran

2010) where they found that HHs in the flood-prone areas are more vulnerable and face major impacts on their livelihood patterns.

Further, in the discussion, this research study confirmed that livelihood was more affected as due to larger vulnerability of the households as laying in the flood-prone areas, i.e., 1% increase in flood led to 0.857% decrease in livelihood/means of living of the locality in the flood-prone area. A positive sign of socio-demographic characteristics showed abilities of the people to recover from the damages or vulnerability to (livelihood, economic status, and poverty) floods. It is found that 1% increase in socio-demographic characteristics leads to 2.413%, 1.75% and 1.236% increase in livelihood, economic status, and poverty, respectively (Table 17). Thus, socio-demographic characteristics can be used for flood management policies as they influence such efforts. It is because the dissimilarities in social-demographic characteristics represent the inequality in influencing natural disasters. This inequality triggers severity of the disaster and associated impacts on the individuals and society, as a whole (Coninx 2010; Walker 2006; Viswanath et al. 2011).

Amongst other damages due to floods of 2010, poor people of Malakand division experienced loss to livestock. The severity of the damages was due to livestock as second main source of livelihood and food provision for sustenance. The study found that (almost) 95% of the poor people in the study area rely simultaneously on their livestock. Impacts on livestock also imposed financial cost and leftover livestock assets were sole sold at a lower price to generate income for buying food items and procuring assets to rebuild houses to cope up with in the emergency situation. Along with for life survival effected community borrowed money at higher interest rate that they were unable to payback. These debts further led to rise in HHs income. Yamin et al. (2005) found that this poverty and debt trap drag people to more worst situation. These borrowers or poor people cannot fail to return to their original economic level. They become poorer by every single day.

In the proceeding discussion, the significant relationship of livestock to livelihood and economic status was found, whereas there is negative association of livestock to the poverty level. It is found that 1% increase in the livestock of the poor people of Malakand leads to 2.718% and 3.03% increase in their livelihood and economic status, respectively, whereas 0.713% decrease in poverty level. Furthermore, the study confirmed positive relationship of crops with livelihood and economic status of the poor people as 1.99% and 1.43%, respectively, while negatively associated with poverty level with 2.04% increases in their poverty level as flood damage to the cultivated crop in the flood-prone area.

4 Conclusion

Pakistan, amongst the other South Asian countries, is by no exclusion remains at the hit list of natural disaster, importantly the floods. Pakistan is amongst those topmost flood-prone zones where recurrent of disastrous floods poses long-lasting impacts on rural societies. The intensity and frequency of 2010 floods have severely affected communities living in the flood-prone areas of Malakand division. It is found in this study that floods of 2010 had hit hard the livelihood of the locality and there upon degraded the economic status, further led to rise in poverty level amongst already poor and vulnerable societies of Malakand division. The results showed that livelihood and economic status decreased by 0.44%, 0.31%, respectively, whereas poverty increased by 1.947% by 1% increase in flooding in the study area.

Table 17 Logistic regression analysis for the impact of floods. *Source*: Author's calculation using survey data

Variable	Livelihood # 1			Economic Status # 2			Poverty # 3		
	Coefficient	Z-Score	Odds ratio	Coefficient	Z-Score	Odds ratio	Coefficient	Z-Score	Odds ratio
Constant	.816* (.314)	2.62	2.732	2.999* (.958)	3.13	20.06	− 3.142* (1.23)	− 2.55	.059
Floods	− .773*** (.468)	− 1.65	0.441	− 1.141*** (.774)	− 1.47	0.031	1.45** (.761)	1.90	1.947
Institutional Support	− .305*** (.179)	− 1.70	0.061	− .569** (.241)	− 2.36	0.097	− .584** (.249)	− 2.35	.026
Vulnerability of the HH	− .619** (.313)	− 1.98	0.857	− .527*** (.323)	− 0.66	0.071	1.026** (.525)	1.98	1.358
Demographics	.695 (.499)	1.39	2.413	.561 (.371)	1.51	1.75	1.39 (.991)	1.40	1.236
Livestock	.391*** (.214)	1.83	2.718	1.387* (.279)	4.98	3.03	− .347*** (.222)	− 1.65	0.713
Crops	.481*** (.624)	2.77	1.991	.471 (.399)	1.18	1.43	− .771** (.370)	− 2.08	.044
Number of observation = 500 LR chi²(6) = 25.94, Prob > chi² = 0.0048, Pseudo R^2 = 0.129 Log likelihood = − 122.74			Number of observation = 500 LR chi²(6) = 48.97, Prob > chi² = 0.0000, Pseudo R^2 = 0.1828 Log Likelihood = − 171.3312				Number of observation = 500 LR chi²(6) = 12.66, Prob > chi² = 0.0043, Pseudo R^2 = 0.253 Log Likelihood = − 192.975487		

Livelihood, economic status and poverty are dependent variables in Eqs. 1–3, respectively

Parentheses show the values of Standard errors

For analysis *, ** and *** shows significance at 1%, 5% and 10% levels, respectively

Thus, results confirmed that floods remained more dangerous for community as it hit hard agricultural production which was the major source of their income, thus immediately degrading their earnings. Besides, it is established that low economic status (due to loss of means of living) led to having a larger probability of getting affected by flooding events and vice versa. In the debate, it was noticed that HHs with low economic status also had minimum livestock, which was also lost due to flooding. Also, the HHs with high economic status were seen to have large probability of getting the institutional/government support than the HHs with low economic status, the actual needy of such support. This study also highlighted that institutional/govt. support in flood emergency situation arrived either late, could not reached to penurious people or no support was provided to needy in the serious moment of the floods. Similarly, the HHs in poverty were found to be more prone to flooding and these HHS with high level of poverty got less institutional/governmental support than those living in comparatively better poverty/economic status in this flood-prone area. Thus, the flooding events were found to have started a chain process where loss of livelihood resulted in degradation of the economic status and rise in poverty in the already poor society of Malakand division.

4.1 Limitations of the study

The limitations faced during the conduct of this study are:

a. Non-availability of baseline data of HHs' assets, before the 2010 floods.
b. Lack of road infrastructure increased the cost and time of the field survey.

4.2 Policy implications

The key areas where policies and strategies are required to reduce the flooding risks are:

a. In the events of floods, training of local farmers to ensure the safety of their farmlands through terrace farming, flood protection walls, stone and gabion structures, etc.
b. Capacity building of the vulnerable communities to evacuate along with their livestock and other assets to minimize the loss of resources.
c. Designing effecting foresting water-absorbent trees, like eucalyptus in riverine watersheds to control floodwater.
d. The reactive governmental response towards risk mitigation and efforts towards provision of non-agricultural employment opportunities are desired to avoid sudden loss of employment opportunities and the resultant rise in poverty.
e. The proactive governmental response towards long-term/sustainable adaptive measures, e.g., construction of water channels, small dams, etc. in the flood-prone areas to avoid such natural disaster in the future.

Compliance with ethical standards

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