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ORIGINAL PAPER

Determinants of flood risk mitigation strategies at household level: a case of Khyber Pakhtunkhwa (KP) province, Pakistan

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Abstract Pakistan is one of the most adversely affected countries by climate-related extreme events such as floods owing to its geographical and climatic conditions. Over the last two decades, frequency and severity of flood events have been increased and has adversely affected the livelihood and well-being of millions of people in Pakistan. The development of effective mitigation policies requires a clear understanding of the impacts and local responses to extreme events, which is quite limited in Pakistan. This study used a dataset of 600 households collected through face-to-face interviews from two districts of Khyber Pakhtunkhwa province that were severely affected from 2010 floods. The correlation and probit model methods are used to assess the study objectives. The findings of the study revealed that elevated ground floor, foundation strengthening, construction of house with reinforced material and precautionary savings were the main adaptation measures adopted at household level. The results from the probit model showed that gender, age, location, monthly income, family size, house ownership, disability, and education influence the households' choices of mitigation strategies. The study further indicated that adoption of mitigation strategies at household level is constrained by several factors, i.e.,

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financial constraint, lack of early warning system, lack of land use planning and inadequate resources. Further mitigation strategies also varied across different groups of households based on education, age, and income. Additionally the study discovered that the local policies on disaster management need to be improved to address the barriers to the adoption of advanced level adaptation measures at the household level such as advanced level early warning system, flood forecasting and dissemination of updated information and support, house building codes, infrastructure building practices, and adequate spatial planning.

Keywords Climatic risks · Flood risks · Mitigation strategies · Adaptation constraints · Probit model · Pakistan

1 Introduction

Among all the natural hazards to which humans are exposed, floods are the most common and the leading source of fatalities involving social and economic risks to the society (Doocy et al. 2013). The rural populations, particularly those living in developing countries, are highly vulnerable to floods due to lack of resources and adaptive infrastructure for flood mitigation (Abbas et al. 2015). Estimates show that the frequency and intensity of flooding, especially in South and Southeast Asia, have increased over the past several decades (Leichenko and James 1993; Krausmann and Mushtaq 2008; Hirabayashi et al. 2013). The increase in flood risks in developing countries is mainly associated with environmental and climatic changes in addition to some anthropogenic factors such as human encroachments onto the rivers (Gaurav et al. 2011; Shifeng et al. 2011).

Pakistan, the focus of this study has become one of the most affected countries from natural hazards including floods over the last two decades (Abbas et al. 2015). In Pakistan, floods are mainly associated with either rainfall cycle during the monsoon in downstream Indus river basin or melting of glaciers in upstream mountains region connected to the Indus River. The worst flood in the country's history was experienced in 2010, which affected 24 million people in Punjab, Khyber Pakhtunkhwa (KP) and Sind provinces, damaged more than 2 million hectares of standing crops and caused a total economic loss of 10 billion US dollars (UN 2011; Rafiq and Blaschke 2012; Atta-ur-Rahman and Khan 2013; Abid et al. 2016b).

The households which are located near river's source are always prone to floods and need to be well prepared to avoid human as well as economic losses. Further, the loss from adverse impacts can also be reduced by adopting different mitigation measures at household and community level (Mavhura et al. 2013; Islam et al. 2012; Paul and Routray 2010; Wisner et al. 2004; Few 2003). In this regard, the combination of structural and non-structural mitigation measures is the effective way to combat flood risks (Ran and Budic 2016). The government can play an integral role in reducing vulnerabilities and enhancing local adaptive capacities through developing effective flood mitigation and adaptation policies and options. The households in the flood-prone communities may be guided and trained in different mitigation options to effectively counter floods (Abbas et al. 2015).

The development of an effective flood mitigation policy requires a clear understanding of local vulnerabilities, adaptive capacities, ongoing measures, and current needs (Abid et al. 2015; Wisner et al. 2004; Few 2003; Jabeen et al. 2010). It is globally acknowledged that community inhabitants have a leading role to play in flood risk management (Hylton

2014; Bubeck et al. 2012). It is said that policies that are made involving locals and communities and their concerns were found to be more successful compared to the policies that are based on just assumptions or policy makers own perceptions (Osberghaus 2014; Birkholz et al. 2014; Lopez-Marrero and Yarnal 2010).

Vast literature (e.g., Osberghaus 2014; Birkholz et al. 2014; Lopez-Marrero and Yarnal, 2010; Wilby and Keenan 2012; Paul and Routray 2010; Wisner et al. 2004) is available from developed as well as developing countries on flood risk management at local communities, the factors affecting the choice of mitigation measures and constraints in mitigating and adapting to flood risks. However, most of the flood-related research focuses on the economic effects of floods on local livelihoods or agricultural productivity and little work has been done there on the post-flood effects and mitigation strategies adopted at local level (Abid et al. 2016b, Abbas et al. 2015). Such kinds of studies are important to understand the local exposure to flood risks, their adaptive capacities, and constraints. The findings of such study can be used for further research as well as to design different policy instruments that strategically target the specific households.

Keeping in view the current research gaps, this study focuses on the flood-affected households in Pakistan to understand the local adaptive capacities and types of mitigation measures adopted against flood risks. Specifically, this study seeks to answer four research questions: (1) What are the most adopted flood mitigation strategies employed by the households; (2) What are the factors that affect the households' choice of mitigation strategies; (3) How adoption measures vary across different household groups based on education, age, and income; (4) What are the constraints that restrict the implementation of flood mitigation strategies among households to flood risks.

2 Materials and methods

2.1 Study area description

The study was conducted in the rural areas of Khyber Pakhtunkhwa (KP) province (Fig. 1). It was selected as the study area because it is plagued by natural disasters like floods consequent to the Indus River and earthquakes that occur since it lies in the weak tectonic zone.[1] These floods usually occur every year during the monsoon season and bring unprecedented damage to property and human lives. KP has witnessed various devastating floods in the last two decades. Out of the 22 recorded floods from 1950 to 2014 (EREN et al. 2015), 2010 was the most disastrous affecting millions of households and their livelihoods in the province. In the mountainous regions, flooding occurs due to landslides and torrents, whereas glacier run and glacial lake outburst floods[2] are also causing flooding in rare cases. In the northern side of the province, avalanche holds way during the winter season and drought occurs during the summer in the southern part of the province (NWFP 2010). The climate of KP is peculiar consequent to its size and consists of most of the climate types found in Pakistan. Rainfall also varies enormously as majority of the parts are usually dry (NWFP 2010); however, the eastern side of the province is known to be the wettest side of Pakistan especially during the month from June to mid-September (Atta-Ur-Rahman et al. 2015).

[1] International Disaster Database EM-DAT, Centre for Research on the Epidemiology of Disasters.

[2] Glacier run is a phenomenon involving flash floods that occur when the melting or breaking off of glacial ice releases torrents of water that have up to then has been dammed. These are usually glacial lakes that have been prevented from escaping by a glacier and are suddenly released when the ice becomes thinner.

Fig. 1 Sample study districts in KP province, Pakistan (Jamal 2016)

2.2 Sampling and data collection

The primary data collection was done between February and June. About 600 households were interviewed targeting mainly the household heads in a field survey to explore the research objectives of the study. The study adopted a multistage sampling technique to select our study sites and sample households. In the first stage of sampling, the KP province was selected as mentioned earlier. In the second stage, we selected two districts out of 24 affected districts from 2010 flood using purposive sampling. In the third stage, three union councils (UCs) were selected from each district depending on their high exposure to the flood risks. In the fourth stage, two villages were selected randomly from each UC using KP-PDMA (2014) report. In the last and fifth stage, we selected about 50 households from each village through simple random sampling using the list of affected households provided by UC *Nazim*[3] (Administrative head of the union council) (Table 1).

[3] A union council is an elected local government body headed by a Nazim (which is equivalent to a mayor).

Table 1 Population and affected households and sampled size in the selected villages. *Source* corresponded from communication with UC *Nazim*

District	Union council	Sampled villages	Selected village	Affected households	Sampled households
Charsadda	Agra	10	Agra Payan	400	50
			GeedarKally	450	50
	Dolatpura	7	Sooker	250	50
			Naqhi	200	50
	Dosehra	6	Sher Bahadar	400	50
			Dosehra	300	50
Nowshera	Akbar Pura	8	BandaMalla Khan	350	50
			Tarkha	300	50
	Pirsabak	6	Pirsabak	470	50
			Zandy Banda	360	50
	Mohib Banda	7	Camp Koruna	550	50
			Banda Shaikh Ismail	500	50
Total					600

All interviews were conducted in the context of shared research principles and research ethics (Bogner et al. 2009). Formal permissions were sought before initiating household interview explaining the purpose and objectives of the study and usage of data for research purpose. The respondents (mainly female household heads) who refused to provide any answer at the briefing stage were replaced with the other households.

2.3 Empirical Modeling

A probit model is used to estimate the factors affecting the choice of different flood mitigation strategies by households in the study regions. We used probit model because our dependent variable is dichotomous in nature and takes only two values (Ullah et al. 2015c). The empirical model may be written as:

$$Y_{ik} = \alpha + \Sigma X_{ik}\beta_{ik} + \varepsilon_{ik} \tag{1}$$

where Y_{ik} is the dichotomous dependent variable, i.e., the adoption of k flood risk management/coping strategies adopted by *i*th household in the study region; X_i is a vector of independent variables used in the study; β_{ik} is the vector of unknown parameters to be estimated; and ε_{ik} is the error term. The model is estimated using Maximum Likelihood Estimation (MLE) technique.

2.4 Description of dependent and independent variables

As here we consider four different mitigation strategies, i.e., elevated ground floor (EGF), foundation strengthening (FS), construction of house with reinforced material (CHRM), and precautionary savings (PS). We developed in total four different models to explore each mitigation strategy. For each dependent variable, we assign value one to the *i*th household, who adopted specific measure and zero otherwise. A brief description of dependent variables is as mentioned under;

Table 2 Descriptive statistics of the variables. Derived from survey data, 2016

Explanatory variables	Description	Mean	SD
Gender	1 = Male	0.81	0.395
	0 = Female	0.19	
Age	In years	44.79	13.29
Education	Years of schooling	6.01	5.160
Location	1 = River lot	0.70	0.592
	0 = Rural/urban lot	0.30	0.546
Monthly income	Monthly income (PKR)	20,442	9863
Family size	Number of family members	5.62	2.150
House ownership	1 = Own house	0.80	0.593
	0 = Rented house	0.20	0.598
Disability	1 = Yes	0.10	0.24
	0 = No	0.90	

Elevated ground flood When the finished floor level (FFL) is kept higher than the high flood level (HFL), it is called elevated ground floor. Subject to availability of hydrological data, HFL may be fixed on the basis of flood frequency to stop water from entering into the house or other property.

Foundation strengthening The term strengthening refers to the technical interventions in the structural system of the substructure of the house or building to improve its resistance by increasing the strength, stiffness, and ductility.

Construction of house with reinforced material Reinforced material is one of the most widely used modern building materials, and concrete is a kind of reinforced material obtained by mixing cement, sand, and aggregates with water and steel bars which are embedded in concrete to form a composite material called reinforced concrete (RC).

Precautionary savings Precautionary savings defined as the willingness to save more in the present in response to an increased uncertainty in the future. In the context of natural disasters, Roson et al. (2005) argue that enough saving is always a good way to deal with the natural hazards like floods. Freeman et al. (2003) showed that the optimal amount of precautionary savings depends positively on expected loss, and thus on both the disaster probability and disaster loss. Natural disasters might increase expected losses and thus increase precautionary savings. This effect should be the more pronounced in more risk-averse individuals (Fuchs-Schündeln and Schündeln 2005).

The explanatory (independent) variables used in this study are selected based on the data availability and review of the literature and include gender, age, location, monthly income, family size, house ownership, disability, and level of education. Here, gender, location, house ownership, and disability are ordinal variables, while age, income, family size, and level of education are continuous variables (Table 2).

3 Results and discussion

3.1 Descriptive statistics

Descriptive statistics of the variables used in the study are presented in Table 2. The majority of the respondents were male (81%). Averagely respondents were 45 years old and received 6 years of formal education. The majority of the households were located in river lot (70%) (in close proximity to the river) followed by rural (24%) and urban lots (6%). Each household in the study area consisted of an average of six members and averagely earned around 20,442 PKR[4] per month. The majority of the respondent owned a house (80%) to live. Similarly, more than 10% of the household agreed that physical disability might affect their ability to prepare and recover from natural hazards/disasters (Table 2).

3.2 Household-level adaptation strategies and constraints

Individuals or households can adjust to the negative impacts of floods in many ways depending on available resources, information, and connections (Daramola et al. 2016). Figure 2 provides a description of different types of adaptation strategies employed by the households to cope with the negative effects of floods. The findings of the study show that about 62 and 81% of the households in Charsadda and Nowshera, respectively, adopted at least one measure or more to manage flood risk at household level. The low adoption rate in case of Charsadda may be due to various constraints that are discussed in next paragraph. In general, respondents adopted various measures to mitigate adverse impacts of floods at the household level. Particularly, the most implemented mitigation strategies adopted by households include EGF, FS, CHRM, and PS, deployment of sand bags (DSB) and preparing a place for storage of food items on the second floor (FSP2F) as an effective risk mitigation tools. Other least adopted measures include building dikes in front of their homes (BDH), cleaning canals which surrounded the houses (CCSH), construct houses with the second floor (CH2F), sump pump in the basement (SP), valve in the sewer system (VSS), lifesaving small boats (LSB), and buying food stock (BFS). All these findings imply that households implemented only well-known measures that require less technical knowledge. For example, implementation of technical and long-term measures such as BDH, using LSB, developing storage and alternative livings spaces was very rare in both study districts. In line with our findings, Daramola et al. (2016) also reported that the low adoption of advanced measures by households is mainly due to lack of financial as well as institutional support from local governments. Another important aspect of mitigation to flood risks in the study districts is the lack of common or joint mitigation strategies among the people. Households were mainly found investing more in individual measures and less in joint measures.

Whereby, EGF = Elevated Ground Floor; FS = Foundation Strengthening; CHRM = Construction of house with reinforced material; PS = Precautionary Savings; DSB = Deployed Sand Bags; BDH = Building Dikes in front of house; CCSH = Cleaning Canals surrounding house; CH2F = Construction of houses with 2nd Floor; FSP2F = Preparing place for storage on 2nd Floor.

Regarding the constraints in mitigating flood risks, households reported that lack of financial means (33%), land use planning (31%), and poor early flood warning system (27%) were the key obstacles in mitigating households to floods by the households in the study regions. Financial limitations at the household level may also be observed through daily average per capita household income (approximately 1$ a day), which is quite below than the poverty line limit set by the Government of Pakistan (2$ a day) (Abid et al. 2016b). The respondents reported that sufficient financial arrangements will make them able to adopt advanced flood mitigation measures. Further, the access and use of formal credit at the local level especially limited due to lack of collateral and high-interest rate. Moreover, households

[4] PKR is abbreviation for Pakistani Rupee, 1 PKR is approximately equal to 0.01 USD.

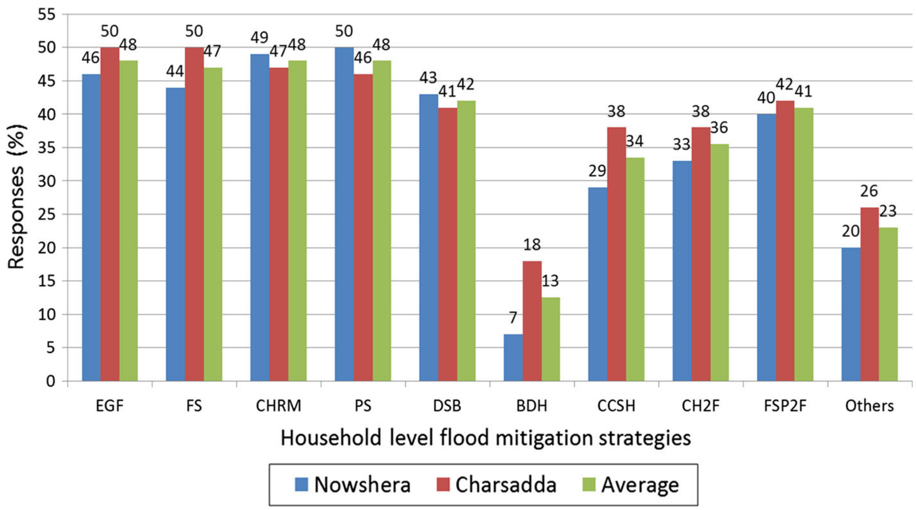

Fig. 2 Adaptation measures adopted by HH across two study areas in KP, Pakistan

reported a lack of land management planning as another major constraint to adapting to flood risks. Households reported that they were never trained or provided sufficient information about house building codes, infrastructure building practices, and adequate spatial planning by the related departments. The early flood warnings could be a lifesaving option for households and communities living at the river edges. Through early warnings, people may get enough time for precautions to protect themselves and their livelihoods from flood risks. However, most of the households reported the poor performance of early warning system due to lack of infrastructure and outdated information dissemination system. Further, inadequate resources including emergency funds and relief stock are identified as other constraints faced by the respondents in the study area (Fig. 3). The findings of this study regarding potential constraints faced by the households reported during the field survey are in accordance with Daramola et al. (2016) which found adaptation possibility is usually confined to financial resources and individuals may take some additional resources in the form of loans and other forms of support to access resources which cannot be covered by regular income. Similar constraints, i.e., lack of early warning system and lack of land use planning, are supported by Qasim et al. (2016), which found that institutional resilience should support in strengthening and the establishment of local networks and organization and the government should not allow people to build a house in the flood-prone areas.

3.3 Factors affecting adaptation measures at household level

The determinants of the choice of different flood mitigation strategies among households were measured through probit analysis presented in Table 3. The adaptation strategies are considered in the context of approaches people employ to deal successfully with a crisis (Clapham 2002). The current study finding suggested that the local response to flood does not involve the adoption of all strategies but rather the sequential implementation of preventative and mitigate initiatives (Paul and Routray 2010). The sequence associated with adaptation strategies includes EGF, FS, CHRM, and PS. It is not necessarily the case that all affected households move along this continuum; rather, it depends on their level of vulnerability and their ability to absorb the shocks of floods.

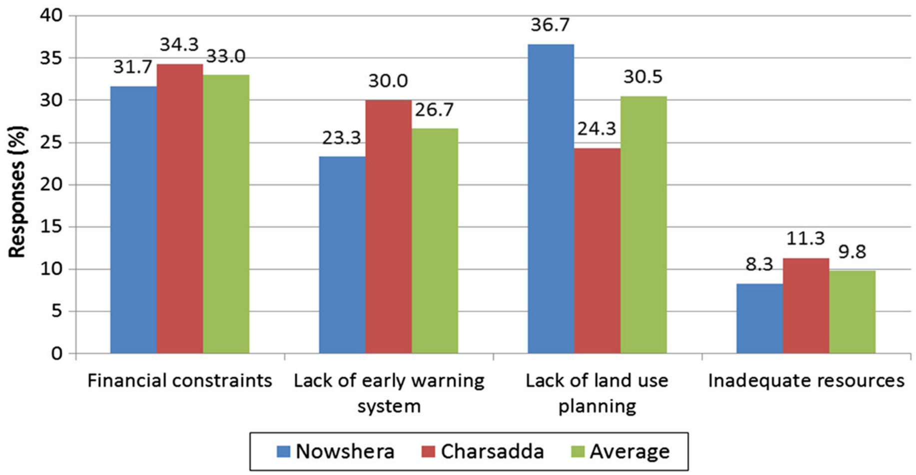

Fig. 3 Constraints to adaptation to flood mitigation measures in the study area

Table 3 Effects of socioeconomic and demographic attributes on flood coping strategies

Variables	Elevated ground floor (EGF)	Foundation strengthening (FS)	Construction of house with reinforce material (CHRM)	Precautionary saving (PS)
Gender	0.4133** (0.1722)	0.3506 (0.2999)	1.5816** (0.6340)	1.1008*** (0.2639)
Age	0.0122** (0.0061)	0.0009 (0.0121)	−0.0191 (0.0297)	−0.0030 (0.0115)
Location	0.2279** (0.1030)	0.5858*** (0.1639)	2.0243*** (0.3852)	0.0604 (0.1684)
Monthly income	0.0000** (0.00001)	0.00001*** (0.00001)	0.0000*** (0.0000)	0.0001*** (0.0000)
Family size	0.0106 (0.0274)	−0.0416 (0.0537)	−0.1862 (0.1335)	−0.1193** (0.0508)
House ownership	0.7907*** (0.1366)	0.4998*** (0.1248)	1.4685** (0.6237)	0.0647 (0.1633)
Disability	−0.5046*** (0.1056)	0.2605 (0.2007)	−0.11297 (0.4485)	−0.0444 (0.2100)
Education	−0.0420*** (0.0145)	0.1129*** (0.0340)	−0.0604 (0.0550)	−0.0529** (0.0228)
N	600	600	600	600

Values in parenthesis are standard errors

*, **, and *** represent statistical significance at 10, 5, and 1% probability levels, respectively

3.3.1 Gender

Gender has a positive sign for the most of the adaptation measures, indicating a positive relationship between gender and flood risk management tools. According to the results in Table 3, gender significantly encouraged the adoption of EGF, CHRM, and PS. One possible explanation for these findings is that the study region is mainly male dominant where men have more liberty to implement certain measures then women due to local customs and tradition. Similarly, various measures such as house construction need more physical work and construction knowledge which is limited in women household heads. Therefore, male household heads tend to adopt more measures to safeguard their property and household from such catastrophes. Our results are corroborated by those from Murphy et al. (2005) who also found that men are dominate in both indoor and outdoor activities and are responsible for any kind of risk-reduction strategies.

3.3.2 Age

Age is an important social indicator of vulnerability, particularly in rural areas where people's capacities or potentials need to be improved (Buckle et al. 2000). It is an important fact that people's ability and capacity to respond and recover from natural hazards like floods in hazard-prone areas depends on age (Cannon 2000). In our study, age has mixed effect on the adaptation measures, i.e., positive significant relationship with EGF, whereas a positive insignificant relationship has been found with PS. On the other hand, a negative but insignificant relationship is found with CHRM and PS. The positive age coefficient for EGF implies that more aged households would prefer to implement EGF compared to young heads. Similar positive results were found by other studies (Ullah 2014; Sultana and Rayhan 2012; Berman et al. 2014).

3.3.3 Location

The coefficient of inhabitant in or near the vicinity of the river has a positive sign for most of the adaptation measures, indicating a positive relation between location and probability of adopting EGF, CHRM, and FS measures. This implies that more of the households living near to the river would prefer to implement EGF, CHRM, and FS compared to the households living away from the river. This is true in the sense that households living near to river need more precautionary measures than others living away from the river. Our results are consistent with other studies (Bantilan et al. 2015; Gioli et al. 2014; Mondal 2014), which found the location as an important factor in determines the choice of mitigation measures in developing countries.

3.3.4 Income

Economic status of a household is an important indicator of household's adaptive capacity to flood risks and in determining the choice of coping strategies. Households with high income or savings can readily help themselves during a flood event and as such are less vulnerable to flood impacts (Green et al. 1994). In this study, we found that income is positively associated with all the key measures (EGF, FS, CHRM, and PS), which implies that an increase in the income of the households leads to the adoption of multiple risk management tools by households compared to the one with lower incomes. Our findings agree with Ullah et al. (2015b), which also found a positive and significant relationship between income and the adoption of coping strategies to mitigate climatic risks.

3.3.5 *Family size*

The size of a household may be an important determinant of implementing certain measures as it may affect the household adaptive capacity either positively or negatively. In our case, a negative coefficient of household size for PS implies that larger households tend to save less due to more dependency of household on common income source. One possible explanation for this may be the fact that larger family size requires more proportion of their earnings for consumption, and therefore savings (for meeting emergency needs) will tend to be lower. This also implies that the limited income and lack of other financial means along with larger households may make a household more vulnerable to natural disasters (Peters 2008). Our findings are in accordance with Ullah et al. (2015a) who also found a mixed effect on adoption of diversification and precautionary savings to cope with climatic risks.

3.3.6 *House ownership*

Housing type owned or rented is considered to be an important factor in determining the household adaptive capacity and choice of certain mitigation strategies. As a household living in their own house will have more freedom in the choice of different adaptation measures. According to the results in Table 3, the house type is positively and significantly associated with EGF, FS, and CHRM and implies that households living in their own house are more inclined to adopt those measures compared to households living in rented or leased houses.

3.3.7 *Disability*

Mixed effects were found in the case of disability effect on adoption of flood coping strategies in the study universe. It is evident from Table 3 that disability strongly discourages the adoption of EGF to mitigate flood risks at the household level; on the other hand, it increases the probability of FS adoption. However, this relationship is statistically insignificant. Disability of the respondents also discourages the adoption of CHRM and PS; however, the relationships are statistically insignificant.

3.3.8 *Education*

Education is one of an important determinant of flood coping strategy to enhance one's resilience and quality of life in response to natural disasters (Tong et al. 2012). Education level is also very important in generating awareness of flood forecasting. In our study, education also has a mixed effect on the adaptation of flood coping strategies. Higher educational status encourages the adoption of FS and discourages the adoption of the EGF, CHRM, and PS as flood coping tools in the study area. These findings are supported by those of Ullah et al. (2015b) found a mixed effect of education on risk coping tools among agricultural producers in KP province Pakistan.

3.4 Flood mitigation measures across regions and socioeconomic characteristics categories

We further explored the choice of mitigation strategies across different groups of households categorized based on age, education, and income. For this purpose, with respect to age, we divided households into three age groups, up to 25 years, 25–40 years and above 40 years (Fig. 4). Based on education, we divided sampled households into further three categories; illiterate, up to 10 years of schooling; and more than 10 years of schooling (Fig. 5). Further, the households were divided into low-income (less than 20,000 PKR), middle-income (20,000–50,000 PKR), and high-income (above than 50,000 PKR) groups based on their monthly income (Fig. 6).

Figure 4 shows the choice of flood mitigation strategies across household groups based on age. The study findings show that in district Nowshera, the highest response was shown by middle-aged household heads (25–40 years) and least by young or old-aged household heads having age 25 and younger and above 40 years, respectively. This implies that young households may lack sufficient experience required to implement certain decisions and strategies, while old-aged heads may not have required energy to do certain tasks and preferred not to implement certain measures. These results are also consistent with findings of King and MacGregor (2000), which identified the very young and the aged as the most vulnerable groups. CHRM, EGF, PS, FS, and deployed sandbags (DSB) were the key measured mainly adopted by middle-aged household heads. In the case of district Charsadda, the study findings show mix results, where some strategies were preferred over than others in all groups. For example, EGF, PS were preferred more by middle-aged heads and FS, CHRM, and DSB were preferred by old-aged household heads. Further, BDH and FSP2F were preferred more by young household heads.

Adoption of flood mitigation measures across different household groups categorized according to education level is shown in Fig. 5. According to the study, findings show in Fig. 5, in Nowshera most of the educated household heads adopted a wide range of

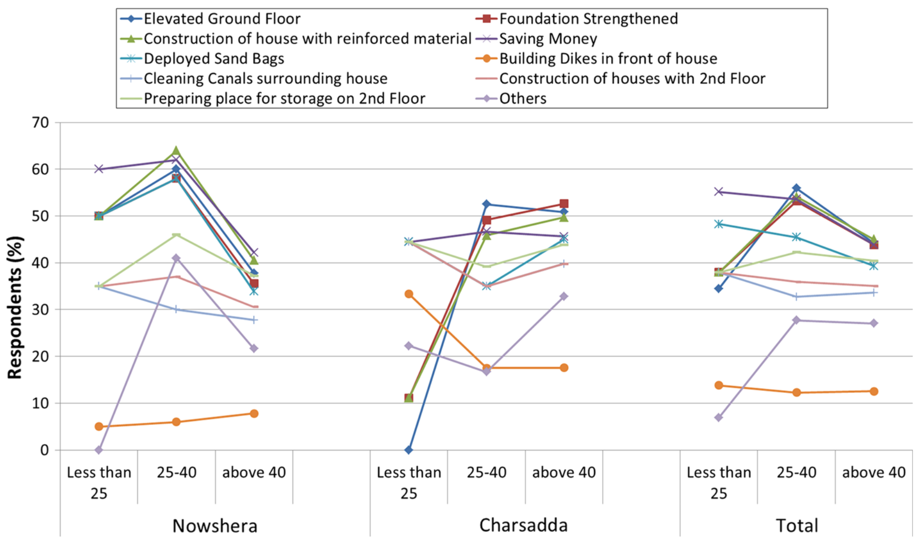

Fig. 4 Flood mitigation measures across different categories of households based on age

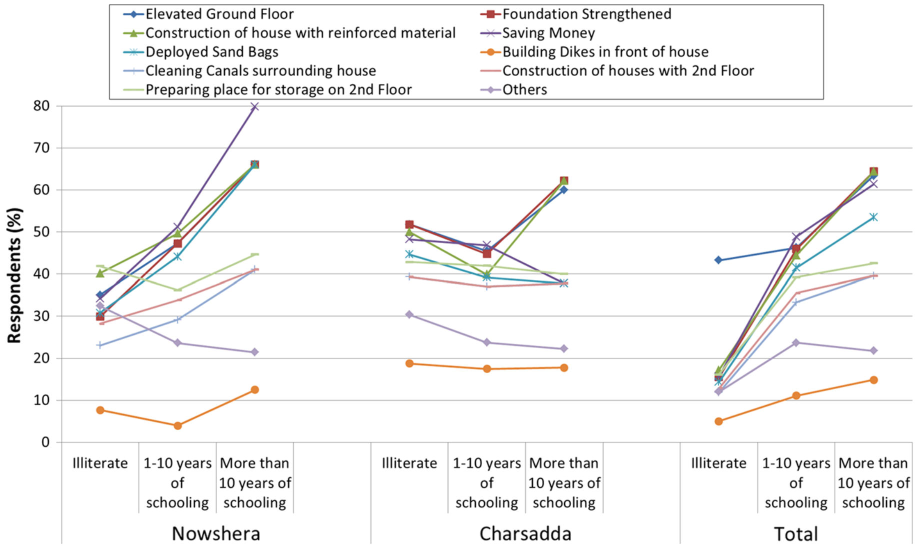

Fig. 5 Flood mitigation measures across different categories of households based on education level

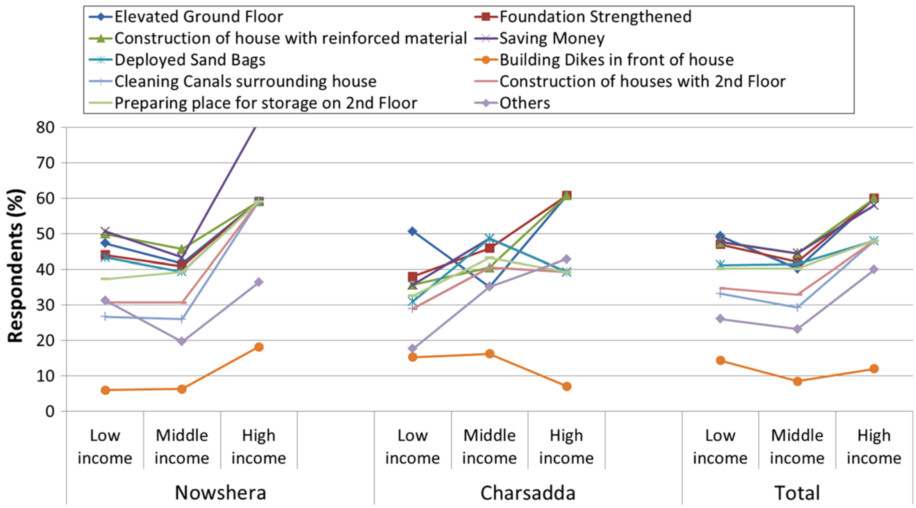

Fig. 6 Flood mitigation measures across different categories of households based on income level

mitigation measures, while in Charsadda, educated household head preferred to implement mainly CHRM, EGF, CH2F, and CCSH.

The implementation of mitigation strategies among households according to their income status is shown in Fig. 6. In both districts, the high adoption rate was found in the case of high-income households, which implies that higher income enhances the adaptive capacity of the households to implement certain measures to protect their livelihoods from flood risks.

4 Conclusion and suggestions

Over the past decades, Pakistan has become one of the most vulnerable countries to natural disasters due to its unique geo-climatic conditions and low adaptive capacity. Climatic risks including flood and other natural events have significant impacts on Pakistan's economy as causing sizeable losses to livelihoods, homes, infrastructure, property services health and psychological sufferings. Hence, appropriate adaptation measures employed at the households' level are important to mitigate flood risks. This study uses cross-sectional household-level data from two severely affected districts of KP province Pakistan to assess the households' adaptive capacities and mitigation strategies to flood risks and determinants of mitigation strategies implemented at the household level. Further, we also identified a number of constraints that restrict households' adaptation to flood risks.

The study revealed interesting findings. The study findings revealed that adoption of mitigation strategies is high in the area and choice of mitigation strategies varies across regions and depending on socioeconomic settings. The household preferred well-known and easy measures over advanced and long-term measures. The households in both regions implemented EGF, FS, CHRM, and PS as key mitigation strategies to protect their livelihoods from flood risks. However, these households identified several constraints that restrict the implementation of their mitigation plans ranging from financial constraints to limited access to early warning system and lack of land use planning. Further, the study identified the important role of different socioeconomic factors in determining the choice of key mitigation strategies. Age, education, income, house ownership, and location were the key factors in determining the choice of key mitigation strategies. In addition, households' decisions to implement certain mitigation strategies were also compared using on age, education, and income. The study results show that middle-aged household heads, high-income households, and educated households were better position to mitigate flood risks compared to young or aged, low-income and less-educated household heads considering the assets and capabilities of each group.

The study emphasizes the need to overcome the constraints in the study areas through improvements in the current institutional setup and access to weather forecasting and early warning system. Further, adaptive capacity of local households is a need to be enhanced through providing more access to financial means and diversified sources of income to safeguard livelihood sources in case of floods. Common mitigation strategies within communities are also need to be developed and implemented at the local level to reduce the mitigation cost. This could be done by the government, private, and community through developing strong linkages and partnership among different stakeholders. Furthermore, research needs to be done on low cost and advanced mitigation options for households and communities living near to river areas in order to make them less vulnerable and more resilient.

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