AIMS Environmental Science, 5(5): 305–314.
DOI: 10.3934/environsci.2018.5.305
Received: 02 July 2018
Accepted: 19 October 2018
Published: 30 October 2018

http://www.aimspress.com/journal/environmental

Research article

Socio-economic determinants of landslide risk perception in Murree hills of Pakistan

Said Qasim[1],*, Muhammad Qasim[2], Rajendra P. Shrestha[3] and Amir Nawaz Khan[4]

[1] University of Balochistan, Quetta, Pakistan
[2] Economics Department, Government Post Graduate College, Charsadda, Khyber Pakhtunkhwa, Pakistan
[3] Asian Institute of Technology, Thailand, PO Box 4, Klong Luang, Pathumthani 12120, Thailand
[4] Peshawar, Pakistan and Founder Director: Centre for Disaster Preparedness and Management (CDPM), University of Peshawar, Pakistan

* **Correspondence:** Email: saidqasim2@gmail.com; Tel: +92-819211262.

Abstract: Murree, located in the sub-Himalayan Mountains, with geographical position extending from 33 °52′ to 33 °59′ North and 73 °24′ to 73 °31′ East is the worst slide-affected area of Pakistan. This area is recurrently affected by landslides and causes severe damages to land, life lines, houses, livestock and human life. This article has tried to determine the socio-economic determinants of landslide risk perception in Murree hills of Pakistan. Information was collected from 200, randomly selected sample households through questionnaire survey. The questionnaire consisted of questions regarding socio-economic characteristics of the respondents and risk perceptions about landslides. Socio-economic variables affecting landslide risks were also determined through relevant literature. A binary logistic regression was used to find out determinants of landslide risk perception in the study area. Results revealed that out of five variables, three variables including educational level, location and past experience had significant impact on landslide risk perception. The study recommends important policy implications for preparedness and mitigation plans against landslides in the study area.

Keywords: landslides; risk perception; logistic regression; Murree hills

1. Introduction

Landslides are a common hazard on Earth [1]. In 2003 alone, the total reported deaths by landslides were about 18,200 throughout the world [2]. Landslides may affect small areas but often lead to severe financial losses and human casualties [3]. Landslides have significantly affected people's lives, livestock, infrastructures, life-lines, housing and agricultural lands throughout the world [4]. Like other parts of the world, Pakistan is also faced with landslides hazards, especially in the mountainous parts of the country (Table 1). One of such landslide prone region of the country is the Pakistani Himalayan region [5,6]. This region includes one of the worst landslide affected areas of Pakistan, the Murree hills. Murree is positioned on a lateral spur of the sub-Himalayan Mountains [7]. Murree hills receive highest average annual rainfall (1640 mm) during monsoon season i.e., from July to August [8]. Therefore, landslides mostly occur during this season. Murree hills are composed of rocks of fragile nature, inter-bedded with soft calcareous shale [9] and are therefore, prone to landslides [10,11]. Besides fragility of the natural settings, human mismanagements including irrational land use and deforestation have also paved the way for landslides in the area. Analysis of risk perception of disasters and natural hazards is imperative for devising policies for preparedness and mitigation actions [12].

Previous studies conducted about landslides in Pakistan were focused on landslide hazards and policy response in Murree [13], impacts of landslides on housing and socio-economic characteristics in Murree [7], landslides triggered by the 8 October 2005 Kashmir earthquake [14], evolution of earthquake-triggered landslides in the Kashmir [6], causes and extent of landslides in Murree hills [15] and landslide causes and damages in Kashmir area [16]. To our knowledge, there has not been a single attempt made in Pakistan to empirically assess the landslide risk perceptions of the households living in the landslide prone regions of Pakistan. Based on the above, we made an attempt to determine the risk perceptions of the households in the landslide prone Murree hill station of Pakistan.

Table 1. Historical record of landslides in Pakistan.

Year	No. of lives lost	Location
November 3, 2017	08	Bajaur Agency (FATA), KP
January 4, 2010	20	Attabad, Gilgit Baltistan
March, 2007	80	District Dir, KP
January, 2007	20	District Kotli (Kashmir)
September, 2006	04	Murree Hills, KP
July, 2006	29	Ghaeel Village (Kalam area), KP
May, 2003	12	Ronala Village (Kohistan), KP
July, 2001	16	Karachi, Hyderabad, Sukkur, Sindh
July, 2001	15	Chitta Katha, Kaghan Valley, KP

Source: [17]

2. Social vulnerability to natural disasters

Disasters are considered as sociological processes by researchers [18]. Social conditions of the people can affect the vulnerability factors and may thus turn a hazard in to a disaster [19]. Social vulnerability or socio-economic vulnerability is defined as the inability of the people, organizations and societies to combat the impacts of natural disasters [18–20]. Social vulnerability to natural disasters is usually determined based on individual characteristics of the people including socio-economic status, gender, race, age, employment, occupation, residential property, infrastructure and lifelines, education and family structure [20–22]. Earlier, qualitative assessments were preferred for measuring social vulnerability to natural disasters [21,23]. Social vulnerability attracted less attention by researchers due to difficulties faced in its quantification [23]. Researchers then tried to quantify social vulnerability to natural disasters using proxy indices and indicators [19–21]. Since then social vulnerability indices have been used by researchers to find vulnerability to natural hazards [23–26], coastal hazards [27], earthquake losses [28], landslides [19] and floods [29].

3. Risk perception: concepts and approaches

Risk perception studies originated with the studies of Gilbert White about adaptations to floods in United States during 1940s. Two decades later, risk perceptions were used to understand the views of public about nuclear technologies. Analysis of risk relies on measurement of probabilities and consequence [30,31]. Therefore, risk can be quantified through objective measurement of probabilities and consequences [32]. To be responsive to a natural hazard, an individual's perception of its risk is very important [33]. An individual's perception of risk is affected by his knowledge, personnel beliefs, experiences of previous events as well as environmental circumstances [34]. The perceived risk tells us about an individual's attitude, cognition and vulnerability [35,36]. Psychometric and cultural theories are the only two approaches being followed by the researchers for studying risk. As the names suggest, psychometric approach is related to studies in the field of psychology and cultural theory is related to the fields of anthropology and sociology. Questionnaires and factor-analytic techniques are employed to study risk communication, gender, race and demographics in psychometric approach [36]. Supporters of the cultural theory on the other hand believe that risk perceptions and risk acceptance have their origin in the social and cultural values in the society. Both these approaches faced severe criticism in the research community due to qualitative nature and operationalization in their measurements. Despite severe criticism these approaches have been widely used for studies of risk perception worldwide.

4. Research methodology

4.1. Study area

Murree is located in the sub-Himalayan Mountains with geographical position extending from 33°52′ to 33°59′ North and 73°24′ to 73°31′ East (Figure 1). It is one of the severe slide-affected area of Pakistan. Mountains of Murree reach an altitude of about 5000 to 7500 feet above sea level [7].

Murree, being located on fragile rocks of the Himalayas, faces frequent landslides. During monsoon season, the landslides become more frequent due to high precipitation received over Murree Mountains. Geologists are of the view that Murree is built on a lateral spur of the Himalayas. The study area has temperate climate. Summers are cool and winters are cold. June is the hottest month (with mean maximum and mean minimum temperatures of 80°F and 56°F, respectively). January and February are the coldest months (with mean maximum and mean minimum temperatures of 43.4°F and 31.1°F, respectively) [7]. This area receives highest average annual rainfall (66 inches) and more number of rainy days (85 per year) than any other area in Pakistan. Snowfall begins at the end of December and lasts up to the end of February and covers the ground with about 5 to 6 feet of snow. As soon as March begins, the snow starts to melt but still remains in freezing condition at some peaks on northern aspects.

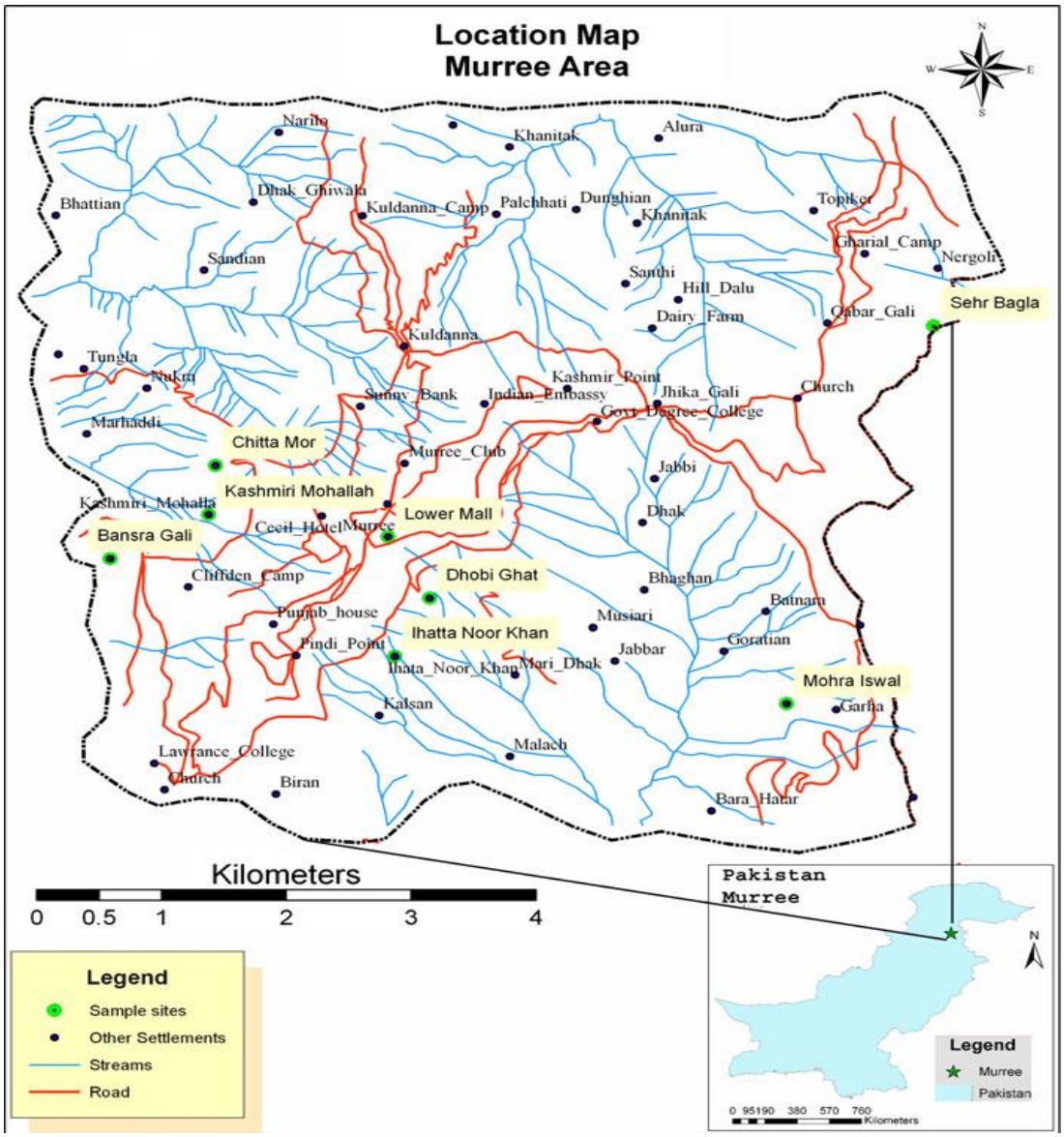

Figure 1. Location Map of Murree (Source: Rahman et al., 2014) [16].

Lives and properties are often at risk due to fragile nature of the rocks and high rainfall. Besides these natural conditions, deforestation, accessibility, growing population and unplanned urban development have paved the way for frequent landslides in the area. People living in Murree are therefore frequently faced with disrupted roads, broken communication lines, damaged houses and damages to scarce agricultural lands. Electricity and water supply are also affected by recurrent landslides in the area. Livestock and humans are also lost due to severe damages caused by landslides in the study area.

4.2. Sample size and data collection

Murree has a total population of about 21,371 [37]. We determined the sample households with formula for sampling devised by the analysis introduced by Yamane T [38]. The formula suggested a sample of 200 households with 93% confidence level. To equally represent socio-economic and cultural differences among the respondents and their perceptions about landslide risk, the study area was divided in to (i) Inner city (ii) Urban fringe and (iii) rural fringe. The inner city includes Kashmir point and Station area. The people here are mostly engaged in retail activities. The Urban fringe consists of Kashmiri Mohalla, Chitta More, Abbasi Mohalla, Dhobi Ghat and Dhok Jabar Topa. The people belonging to this site are engaged in agricultural and retail activities. The rural fringe looks like a semi-urbanized area and presents the rural settings. It includes the areas of Dhok Jabar, Bari Nakkar, Hill Dholu, Dhak, Bangan, Chawana, Choora, Mohra, Maula Dohongi, Batnara, Ihata Noor Khan and Murree Brewery. In the rural fringe, the main occupation of the people is agricultural activities.

The data were collected from May to August 2017. The respondents were selected for survey through simple random sampling from the three sites. Primary data were collected from the respondents through field survey. Questionnaire was used for primary data collection and contained information regarding the socio-economic and demographic characteristics of the respondents and their perceptions about the indicators of risk perception. Household heads were interviewed during survey. In absence of household head, the elder family member was interviewed.

Both natural environment and socio-economic conditions of the people are responsible for causing landslides and influence perception of risk from landslide [19]. Therefore, literature review was also performed to find out the variables affecting landslide risk perceptions. These include age, income, level of education, past experience and location (Table 2). The dependent variable used was dichotomous variable i.e., "perception of landslide risk (PRCPLSRSK)". The PRCPLSRSK was given a value of 1 if the household perceived that landslide would occur within the next coming five years, otherwise 0.

4.3. Data analysis

The primary data collected in the field survey were entered in to SPSS version 16 for analysis. Pearson correlation was first performed to check correlation among independent variables. Logistic regression analysis was performed using the enter method.

Table 2. Independent variables affecting landslide risk.

S.No.	Indicator with direction of influence	Unit for measurement	Justification	Source
1	Age (+)	Years (Continuous)	The more the age of the respondents, the more their perception of landslides based on experiences	[22,39,40]
2	Income (+)	Rupees/year (Continuous)	The more the income of households, the more they may be concerned with their safety against landslides	[3,22,39,41,42]
3	Education level (+)	People with or above higher secondary school education (Continuous)	The more the educated members in the family, the more they have knowledge about landslides	[22,39–41,43]
4	Location (+)	Yes/No (Dummy, 1 if house is located on or near slope, otherwise 0)	The more the people make houses on or near slopes, the more they perceive the risk	[31,40]
5	Past experience (+)	Yes/No (Dummy, 1 if past experience, 0 otherwise)	The more the past experiences with landslides, the more they are concerned about occurrences of landslides	[3,39,40]

5. Results and discussion

5.1. Socio-economic conditions of the surveyed households

About 81 percent perceived landslide risk in the next five years. Average size of family was almost 10 in the area. Average age of the household heads was 46. About 41% of the surveyed population were literate. Average income per year per family was about 66,000 Pakistani rupees. Almost 32% households had built their houses at risky locations. Nearly 55% of the surveyed household reported to have experienced landslides in the past.

5.2. Determinants of landslide risk perceptions

As discussed earlier, socio-economic characteristics of the households greatly affects their perceptions about landslides. Through literature review, we identified five variables that affect landslide risk perceptions including age, income, educational level, location and past experiences (Table 2). The nature of the dependent variable in this study was binary as explained above in the methodology section. Other models of regression like probit and discriminant analysis could be used, but logit model is easy to use. Therefore, we used logit regression model for this study. Pearson correlation was performed on the independent variables before application of regression model, to check if correlation exists among the independent variables. As no correlation was seen among independent variables, we applied logistic regression model using the enter method.

Of the five variables, three variables including, past experience, location and educational level were found to have significant positive effect on the dependent variable of PRCPLSRSK (Table 3). The household size, respondent's age and income per year showed positive association with landslide risk perception but were not significant. [44] in their study have also shown that household size has no significant relationship with perception of natural hazards. The variable age of the household head was also found to have no significant impact on risk perceptions about natural hazards [45,46]. Income was also found non-significant by [47] for risk perception of natural hazards.

The variable past experience had positive and significant association with PRCPLSRSK. It was found that a unit increase in the past experience increases the perception of landslide risk by a factor of 2.78. This may be because the study area is one of the worst slide-affected areas of the Punjab province of Pakistan and the people of this area have experienced recurrent landslides due to fragile nature of the rocks and high rainfall in the area as mentioned earlier in this study. The findings of this study are in line with the studies of [3] and [48], who found that past experience is a good predictor for risk perceptions of natural hazards. Variable location was found to have significant positive correlation with the landslide risk perception of the households. This may be because the people who have built houses on or near slopes might have experienced more damages to their houses than the people who lived far away from such places.

Results showed that a unit increase in the location variable increases the odds of PRCPLSRSK by a factor of 2.37. Studies of [46] and [47] were also of the view that location near a risky place has significant impact on household's perception of natural hazards. The third significant variable of this study was educational level of the respondents. This may be because education plays a key role in making the people aware about their environmental settings and natural hazards. Results showed that a unit increase in education variable increases odds of landslides risk perception by 1.19 factor. Studies of [47] and [3] also showed that education of the households had the significance impact on their risk perception.

Table 3. Results of the logistic regression model.

Independent variable	B	Wald	Significance	df	Odds ratio
Age	0.002	0.013	0.908	1	1.002
Income	0.000	2.504	0.114	1	1.000
Education level	0.176	4.848	0.028*	1	1.192
Location	0.862	3.660	0.056*	1	2.368
Past experience	1.021	7.111	0.008**	1	2.775
Constant	−0.510	0.644	0.422	1	0.600

Note: *, ** represent significance at 95% and 99% confidence level, respectively. −2log likelihood = 182.71, Cox & Snell R^2 = 0.096, Nagelkerke R^2 = 0.0151.

6. Conclusions and recommendations

The perceptions of the local people are rarely incorporated in the preparedness and control programme for landslide risk management. This study analyzed the landslide risk perceptions of the households in Murree area of Punjab province of Pakistan. Disaster risk reduction of landslides depends upon perceptions of the local people of the affected area and is closely associated with their economic and social conditions. Results of the study showed that risk perceptions of the people in the area about

landslides were affected by educational level, past experience and location. Education plays a key role in enhancing risk perception of the people about landslides, therefore, the government organizations and non-governmental organizations should try to provide training and awareness programmers to safeguard communities in case of landslide hazards. The people should be made aware of the need to make their dwellings at safe locations. This study therefore has policy implications for reducing landslide risk in the area.

Acknowledgements

The authors are thankful to the editors of the journal and two anonymous reviewers for constructive comments on the manuscript.

Conflict of interest

All authors declare no conflicts of interest in this paper.

References

1. Solana MC, Kilburn CR (2003) Public awareness of landslide hazards: the Barranco de Tirajana, Gran Canaria, Spain. *Geomorphology* 54: 39–48.
2. Nadim F, Kjekstad O, Peduzzi P, et al. (2006) Global landslide and avalanche hotspots. *Landslides* 3: 159–173.
3. Ho MC, Shaw D, Lin S, et al. (2008) How do disaster characteristics influence risk perception? *Risk Anal* 28: 635–643.
4. Papathoma-Köhle M, Neuhäuser B, Ratzinger K, et al. (2007) Elements at risk as a framework for assessing the vulnerability of communities to landslides. *Nat Hazard Earth Eys* 7: 765–779.
5. Kamp U, Growley BJ, Khattak GA, et al. (2008) GIS-based landslide susceptibility mapping for the 2005 Kashmir earthquake region. *Geomorphology* 101: 631–642.
6. Khattak GA, Owen LA, Kamp U, et al. (2010) Evolution of earthquake-triggered landslides in the Kashmir Himalaya, northern Pakistan. *Geomorphology* 115: 102–108.
7. Khan AN (2001) Impact of landslide hazards on housing and related socio-economic characteristics in Murree (Pakistan). *Pak Econ Soc Rev*: 57–74.
8. Archer DR, Fowler HJ (2008) Using meteorological data to forecast seasonal runoff on the River Jhelum, Pakistan. *J Hydrol* 361: 10–23.
9. Farooq S, Malik M (1996) Landslide Hazard Management and Control in Pakistan-A Review: International Centre for Integrated Mountain Development (ICIMOD).
10. Pearce A (1987) Plan for demonstration in Tehsil Murree for improving landslide-stability by reforestation and drainage improvement. *Consultant's Report to FAO/UNDP Project PAK/78/036.*
11. Abbasi A, Khan M, Ishfaq M, et al. (2002) Slope failure and landslide mechanism in Murree area, North Pakistan. *Geol Bull Univ Peshawar* 35: 125–137.
12. Calvello M, Papa MN, Pratschke J, et al. (2016) Landslide risk perception: a case study in Southern Italy. *Landslides* 13: 349–360.

13. Khan AN (1995) Landslide Hazards and Policy-Response in Pakistan: A Case Study of Murree. *Commission on Science and Technology for Sustainable Development in the South*: 35.
14. Owen LA, Kamp U, Khattak GA, et al. (2008) Landslides triggered by the 8 October 2005 Kashmir earthquake. *Geomorphology* 94: 1–9.
15. Khan AN, Collins AE, Qazi F (2011) Causes and extent of environmental impacts of landslide hazard in the Himalayan region: a case study of Murree, Pakistan. *Nat Hazards* 57: 413–434.
16. Rahman A, Khan AN, Collins AE (2014) Analysis of landslide causes and associated damages in the Kashmir Himalayas of Pakistan. *Nat Hazards* 71: 803–821.
17. EM-DAT. The OFDA/CRED International Disaster Database.
18. Myers CA, Slack T, Singelmann J (2008) Social vulnerability and migration in the wake of disaster: the case of Hurricanes Katrina and Rita. *Popul Env* 29: 271–291.
19. Eidsvig UM, McLean A, Vangelsten BV, et al. (2014) Assessment of socioeconomic vulnerability to landslides using an indicator-based approach: methodology and case studies. *Bull Eng Geol Environ* 73: 307–324.
20. Kuhlicke C, Scolobig A, Tapsell S, et al. (2011) Contextualizing social vulnerability: findings from case studies across Europe. *Nat Hazards* 58: 789–810.
21. Shirley WL, Boruff BJ, Cutter SL (2012) Social vulnerability to environmental hazards. *Hazards Vulnerability and Environmental Justice:* Routledge. pp. 143–160.
22. Lin S, Shaw D, Ho MC (2008) Why are flood and landslide victims less willing to take mitigation measures than the public? *Nat Hazards* 44: 305–314.
23. Siagian TH, Purhadi P, Suhartono S, et al. (2014) Social vulnerability to natural hazards in Indonesia: driving factors and policy implications. *Nat Hazards* 70: 1603–1617.
24. Chen W, Cutter SL, Emrich CT, et al. (2013) Measuring social vulnerability to natural hazards in the Yangtze River Delta region, China. *Int J Disaster Risk Sci* 4: 169–181.
25. Yoon DK (2012) Assessment of social vulnerability to natural disasters: a comparative study. *Nat Hazards* 63: 823–843.
26. Zhou Y, Li N, Wu W, et al. (2014) Assessment of provincial social vulnerability to natural disasters in China. *Nat Hazards* 71: 2165–2186.
27. Zou LL, Wei YM (2010) Driving factors for social vulnerability to coastal hazards in Southeast Asia: results from the meta-analysis. *Nat Hazards* 54: 901–929.
28. Schmidtlein MC, Shafer JM, Berry M, et al. (2011) Modeled earthquake losses and social vulnerability in Charleston, South Carolina. *Appl Geogr* 31: 269–281.
29. Rufat S, Tate E, Burton CG, et al. (2015) Social vulnerability to floods: Review of case studies and implications for measurement. *IJDRR* 14: 470–486.
30. Kellens W, Zaalberg R, Neutens T, et al. (2011) An analysis of the public perception of flood risk on the Belgian coast. *Risk Analysis*31: 1055–1068.
31. Sjöberg L, Moen BE, Rundmo T (2004) *Explaining risk perception. An evaluation of the psychometric paradigm in risk perception research* 10: 665–612.
32. Raaijmakers R, Krywkow J, van der Veen A (2008) Flood risk perceptions and spatial multi-criteria analysis: an exploratory research for hazard mitigation. *Nat Hazards* 46: 307–322.
33. Burn DH (1999) Perceptions of flood risk: a case study of the Red River flood of 1997. *Water Resour Res* 35: 3451–3458.
34. Ludy J, Kondolf GM (2012) Flood risk perception in lands "protected" by 100-year levees. *Nat Hazards* 61: 829–842.

35. Sjöberg L (2000) Factors in risk perception. *Risk Anal* 20: 1–12.
36. Armaş I, Avram E (2009) Perception of flood risk in Danube Delta, Romania. *Nat Hazards* 50: 269–287.
37. Government of Pakistan (GOP) (1999). 1998 district census report of Rawalpindi. Population census organization of Pakistan, Islamabad.
38. Yamane T (1973) Statistics: An introductory analysis.
39. Salvati P, Bianchi C, Fiorucci F, et al. (2014) Perception of flood and landslide risk in Italy: a preliminary analysis. *Nat Hazard Earth Eys* 14: 2589–2603.
40. Landeros-Mugica K, Urbina-Soria J, Alcántara-Ayala I (2016) The good, the bad and the ugly: on the interactions among experience, exposure and commitment with reference to landslide risk perception in México. *Nat Hazards* 80: 1515–1537.
41. Sudmeier-Rieux K, Jaquet S, Derron MH, et al. (2012) A case study of coping strategies and landslides in two villages of Central-Eastern Nepal. *Appl Geogr* 32: 680–690.
42. Pilgrim NK (1999) Landslides, Risk and Decision making in Kinnaur District: Bridging the Gap between Science and Public Opinion. *Disasters* 23: 45–65.
43. Larsen M (2008) Rainfall-triggered landslides, anthropogenic hazards, and mitigation strategies. *Adv Geosci* 14: 147–153.
44. Kreibich H, Thieken AH, Petrow T, et al. (2005) Flood loss reduction of private households due to building precautionary measures--lessons learned from the Elbe flood in August 2002. *Nat hazard earth sys* 5: 117–126.
45. Grothmann T, Reusswig F (2006) People at risk of flooding: why some residents take precautionary action while others do not. *Nat Hazards* 38: 101–120.
46. Miceli R, Sotgiu I, Settanni M (2008) Disaster preparedness and perception of flood risk: A study in an alpine valley in Italy. *J Environ Psychol* 28: 164–173.
47. Botzen W, Aerts J, Van Den Bergh J (2009) Dependence of flood risk perceptions on socioeconomic and objective risk factors. *Water Resour Res* 45.
48. Siegrist M, Gutscher H (2006) Flooding risks: A comparison of lay people's perceptions and expert's assessments in Switzerland. *Risk Anal* 26: 971–979.

AIMS Press