THE ECONOMIC COST OF LANDSLIDES IN HALI-ELA DIVISIONAL SECRETARIAT OF SRI LANKA

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ABSTRACT

Landslides which cause degradation of slopes through soil loss is one of the major climate related disasters in Sri Lanka and the highest number of landslides was recorded in Badulla district. This study attempts to identify the economic costs of landslides in Hali-Ela Divisional Secretariat Division (DSD) which recorded the highest number of displaced people in recent landslides in the Badulla District.

Primary data collected through a questionnaire was used for this study. Two stage cluster sampling technique was used to select 160 households in six Grama Niladhari (GN) divisions including Bogahamadiththa (20), Spreenweli (40), Panakenniya (20), Kandana (25), Bulatwatta (25) and Ketawala (30) from the 57 GNs in Hali-Ela DSD and the systematic random sampling technique was used to select households. Descriptive statistics, simple regression and chi-square test are used for the analysis.

Majority of the sample are in high (46.8%) and medium risk (34%) areas of landslides. Mean distance between house and the nearest recent landslide is recorded as 478m. Landslides have both direct and indirect economic costs. Regarding direct costs, mean damage cost and mean replacement cost for last five years are recorded as Rs.115,790.91 and Rs.78,954.55 respectively showing that only half of the damage is recovering. Regarding indirect economic costs, land value has been deteriorating due to landslides as found by the positive relationship between the land value and the distance to the nearest landslide using hedonic pricing approach. The uncertainty created by the risk of landslide reverses the overall development of the household (62%) including delay of housing construction (62%), agricultural activities (21.6%), road construction (9.3%) and getting electricity (5.2%).

Keywords: *Disaster, Economic Costs, Landslides, Hali-Ela, Sri Lanka.*

1. INTRODUCTION

Landslides which cause degradation of slopes through soil loss is one of the major climate related disasters in the world and it is responsible for huge physical, human and economic losses. According to Centre for Research on the Epidemiology of Disaster (CRED) (2010; cited in Akinci *et al.*,2011), landslide is the third leading disaster faced by the people in the first half of the year 2010, reporting 10% of the total disasters in the world, while flood and storms comes first and second in the disaster profile. According to United Nations University (2006; cited in Asch *et al.*, 2007), Asia reported 220 terrible landslides in past century.

Poor composition in geological structure, rock or soil formation, heavy rain, changing ground water levels are some natural causes for landslides, while changing natural slopes due to unplanned construction activities without proper engineering inputs, unplanned farming and deforestation are reported as some man-made causes (Sri Lankan-German Development Corporation, 2006). Global warming and anthropological actions are identified as important causes of landslides by Schuster (1996; Cited in Asch *et al.*, 2007).

According to Department for International Development (2005), economic losses of landslides are categorised as direct, indirect costs as well as micro level and macro level economic costs. Direct costs include physical and human capital losses, cleaning, re-establishment, reconciliation and administrative costs, while indirect costs include production and investment losses due to macro economic instability,

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reduction of the land value of the risk areas, reduction of income taxes imposed on property values, reduction of tourism income and the opportunity cost of government expenditure due to sudden disaster recovering expenditure. Micro economic cost of landslides includes the losses of household, houses, vehicles, furniture and other property equipments and cultivation. Macroeconomic loss includes influence on gross domestic product, unemployment, consumptions, savings and business.

According to Sassa *et al.* (2005; cited in Popescu and Sasahara, Undated) the economic losses caused by landslides sometimes equal or exceed the gross national products of developing countries. Economic losses of landslides recorded nearly 1-2% of the gross national products in many developing countries (Schuster and highland, 2001; cited in Asch *et al.*, 2007). Direct and indirect losses generated by landslides in Japan exceed four billion dollars (Schuster, 1996; cited in Popescu and Sasahara, Undated), while United States, Italy and India spend an annual cost between one to two billion dollars due to landslides (Sassa *et al.*, 2005; cited in Popescu and Sasahara, Undated).

According to Sri Lanka National Report on Disaster Risk, Poverty and Human Development Relationship (Draft Report for Review), during 1974 to 2008, l,174 landslide events were recorded in Sri Lanka (UNDP, 2009). Nearly nine percent of total natural disasters were landslides in Sri Lanka. There is a seasonal impact of landslides simultaneously with the two monsoons faced by Sri Lanka. Therefore, November, December and January are the months reporting higher incidents of landslides. Considering spatial distribution, the highest impacts of landslides were recorded in Badulla, Nuwara-Eliya and Ratnapura. The highest numbers of deaths due to landslides were–recorded in years 1989 and 2003. Nuwara-Eliya district recorded the highest numbers of death due to landslides (UNDP, 2009). Destruction of buildings is another impact of landslide and the highest numbers of such incidents were recorded in 2003 and 2007.The highest agricultural or crop related loss was recorded in 2007. Destruction of buildings and crop loss were high in Badulla and Kandy districts (UNDP, 2009).

This study selected Badulla district to study the economic cost of land slide, since it reports the highest property and agricultural loss (UNDP, 2009). According to the disaster information report of January and February 2011 at Badulla district, 3645 of displaces families, 13312 of displaced persons, 3 deaths, 5 injured, 1 missing person, 294 of fully damaged houses, 2517 of partly damaged houses, 70 displaced camps, 1620 of families displaced at camp, 6069 persons displaced at camps were reported due to natural disasters including landslides. Badulla district has 12 divisional secretariat divisions which are affected by landslides including Badulla, Hali-Ela, Bandarawela, Haputhale, Soranathota, Uvaparanagama, Welimada, Lunugala, Passara, Mahiyanganaya, Haldummulla and Migahakiula. Hali-Ela divisional secretariat was selected for this study, because it reported the highest number of displaced people in recent landslides in the Badulla District according to the Disaster Management Centre situated at Badulla (2011).

Accordingly, the aim of this study is to identify and to quantify the economic costs of landslides in Hali-ela DSD. Economic cost includes both direct and indirect costs. Supplementary, this study analyses the socio economic vulnerability of the people living in land slide risk areas.

2. METHODS

The study used primary data collection through a questionnaire survey. The questionnaire includes basic information on the household including monthly family expenditure, and changes in living conditions, education, employment and income profiles, information on landslides including risk of landslides, number of times affected and nature of landslide, distance to the landslide from home, knowledge and the steps were taken to prevent landslides, information on the cost of landslide including direct costs of property, agricultural and business losses and indirect cost due to risk and uncertainty created by the landslides.

Hali-Ela DS division was selected for the survey due to having the highest record of displaced people by landslides among other DS divisions in Badulla District. Two stage cluster sampling was used to select the sample. Six GNs out of the 57 GNs in the Hali-Ela DSD were selected first representing high, medium and low risk areas to the landslides. The selection was as follows: Bogahamadiththa (20), Spreenweli (40), Panakenniya (20), Kandana (25), Bulatwatta (25) and Ketawala (30). The systematic random sampling technique was used to select the final entities (160 households) from each cluster as given above. A

Sample Survey was carried out in September 2011.

Descriptive statistics were mainly used for the analysis including frequencies, cross-tabulations and means. The hedonic pricing approach was further used to see the indirect cost of landslides through the reduction of land value in the affected area. The hedonic pricing method is commonly used to see the reduction of property values (economic costs) due to natural disasters. The simple regression between land value per perch (as dependent variable) and the distance to the land slide or landslide mark (as independent variable) was applied to see the indirect cost of landslides through the reduction of land values due to landslide risk according to above approach. Chi square test is further used to see the relationship among the variables of distance to landslide, nature of risk, total cost; self stated life status, knowledge on landslides, delay of the family development and willingness to pay to prevent landslides in future.

3. RESULTS

Results and discussion is mainly consisted with sample characteristics including household and family profile, land use, climate and land slide profile, direct and indirect cost of landslides and the impact of landslide on land value.

3.1. SAMPLE CHARACTERISTICS: HOUSEHOLD AND FAMILY PROFILE

The sample includes 160 households with 593 family members. Out of the total number of households, 133 (83%) have faced landslides, while 27(17%) have not faced any within the last five years. Considering the distribution of sample among races, 59 percent of the sample is represented by Sinhalese, while 34 percent and 7 percent are Tamils and Moor respectively. The proportion of landslide victims among the Sinhalese community is lower than that of the Tamil and Moor communities. Considering the household and family profile of sample, the mean age of the household head is 47 years and according to the sample the mean number of family members is 4 persons (Table 1).

The educational level of the household head is another important consideration in relation to the vulnerability of people. The percentages of pre-secondary and post-secondary educated household heads (35 percent in each category) are higher than in other education categories. While 22.3% of household heads are primary educated, 5 percent and 3 percent respectively belong to no schooling and tertiary groups of education (Table 1).

The economic profile of the family is further taken into consideration by this study. Per capita income and per capita expenditure are some important economic variables considered in the study. In terms of the research sample, 68 percent of the sample has Rs. 6000 or less per capita income, while 92 percent have reported Rs. 6000 or less per capita expenditure. Poverty lines are normally derived by using per capita expenditure because the accuracy of expenditure data is believed to be higher than the income data (Table 1).

Table 1: Sample Characteristics

Ethnic Group	%	Education of the head of the household	%	Per-capita income/ per capita expenditure	Income	Expenditure %
Sinhala	59	No Schooling	5	2000 or less	16	23
Sri Lanka Tamil	26	Primary	22	2001-4000	29	57
Indian Tamil	8	Pre- Secondary	35	4001-6000	23	12
Muslim	7	Post-Secondary	35	6001-8000	19	3
Total	100	Tertiary	3	8001-10000	5	2
Family members	%	Total	100	More than 10000	8	3
1	6	Employment Status of household head	%	Total	100	100
2	13	Employment	58			
3	26	Unemployment	13	Mean values in Sample profile		Mean
4	29	Self Employed	21	Mean Age of the Head of the household		47
5	19	Retired or economically inactive	8	Mean Number of family members		4
6 or more	7			Mean Per capita income (Rs)		5334
Total	100	Total	100	Mean Per capita Expenditure(Rs)		3232

According to the per capita expenditure, poverty in the area was identified. The Poverty line for Badulla district (DCS, 2012) derived by the Department of Census and Statistics in September was used to categorise poor and non poor group. This poverty line was Rs. 3217 of per capita expenditure. According to this expenditure, 64.4 percent of the sample is in poverty, and 42.4 percent of poor are living in highland risk areas. In order to consider the relative poverty of the family, a direct stated question on the nature of the change in life status was asked. Nearly half of the sample (48%) responded that their living status has been deteriorating or stagnating during the last 5 years (Table 2), while 39 percent of the sample believed that the living status of their family is better than that of other families in the same living area.

Table 2: Absolute and Relative Poverty

Poverty	Criterion	%
Absolute Poverty according to per capita expenditure (Less than Rs. 3217)	Non Poor	35.6
	Poor	64.4
Relative poverty (Living status in last 5 years)	Increase	51.9
	Decrease	29.4
	Stagnating	18.8

Regarding employment status of the household head, 58 percent of household heads are employed, while 21 percent were self employed and 13 percent unemployed. Moreover, 81 percent of employed household heads represent private sector employment (formal private-27% and informal private-54%), while 19 percent represent government or semi government sector.

3.2. LAND USE, CLIMATE AND LAND SLIDE PROFILE

Land use pattern in the area is an important phenomenon regarding the risk of landslide. Land use of the selected area was basically classified for agriculture, livestock production and for construction. Construction is the prominent land utilisation in selected area, while half of the lands in the area was utilised for agriculture (Table 3). Tea, Paddy and the mixed crops are the leading crops, out of which mixed crops were the leading component. There is a high risk of landslides in the areas with high soil erosion and crops like tea would affect high soil erosion in the mountain areas. Crops cultivated in neighbour lands could also resulting landslide risk. Mixed crop and tea cultivation are the leading agricultural activities in the nearby area (Table 4). Regarding climate, rainfall is an important factor

dealing with landslides in the area. According to people, the duration from November to February has the highest rainfall in the area, and the risk of landslide is also high during this period. The natural slope of the land is also a significant factor in relation to the frequency of landslides. Out of the land in the selected area 25 percent were very steep, 15.2 percent steep, while 50 percent of lands have low slopes and 9.8 percent have very low slopes.

Table 3: Land Use Pattern

Land use Patterns	Each from 100%
For Crops	48.8
Livestock Production	7.5
Constructions	98.1
Other	0.6

Table 4: Types of Crops

Type of Crop	% of land from selected households	% of land from nearby
Tea	8.1	40.8
Paddy	15	10.9
Mixed crop	21.9	48.3

Distance to the most recent land slide is another key indicator of landslide risk. Among the sample, 78.1 percent lives closer to landslide risk; within half kilometre from the landslide feature. Mean distance between house and the nearest recent landslide is recorded as 478m. Therefore the selected sample reports very high risk of landslides (Table 5).

According the Figure 1 topples and lateral spreading are the leading types of landslides in the selected area, while 21 percent of people have experienced a mix of several types of landslides.

Table 5: Distance to Recent Landslide Features

Distance to the Recent Landslide or land slide sign in Meters	%
500 or less	78.1
501-1000	8.8
More than 1000	13.1
Total	100.0

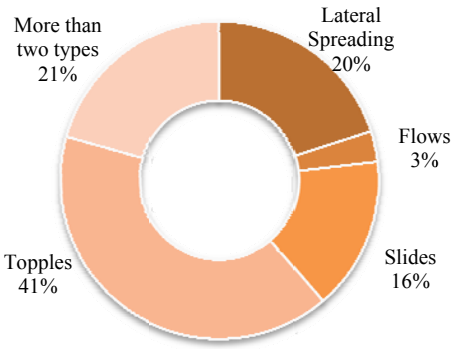

Figure 1: Type of Landslide

Terms of incidence shows the probability of the landslide disaster. According to Figure 2, 87 percent of people have faced landslide incidence once within the last five years. However the situation of the rest is very pathetic with a high frequency of such disaster incidences. According to the ideas of the residents, majority of the sample are in high (46.8%) and medium risk (34%) areas of future landslides.

Landslide risk is pre-identified by using several clues, which is apparent in the area related to the physical resources. The most common feature seen in the area is wall cracks in many houses, while 56.6 percent of households have identified landslide risk using wall cracks. Leaning lamp posts were seen in some places. However this was not much a prominent clue in the area. Two or more of such marks related to landslide give a sign of landslide risk to 29.2 percent of people (Table 6). With such a higher risk, people in the area still live in the risk area and have no expectation of leaving the area.

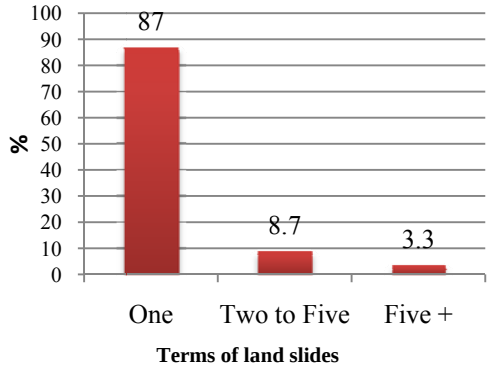

Figure 2: Terms of Landslides within Last 5 Years

Table 6: Method of Pre Identification of Landslide Risk

Method of pre identification of landslide	%
Leaning lamp posts	4.7
Wall cracks	56.6
Other	9.4
Two of the above	29.2

Land use, climatic and landslide profiles were comprehensively discussed in this section to see the nature of landslide risk in the selected area.

3.3. DIRECT AND INDIRECT COST OF LANDSLIDES

The economic costs of landslides are identified as macroeconomic and micro economic costs and as direct and indirect costs. This study is basically based on micro economic cost analysis in relation to household level information. Total direct cost of the landslide includes total damage cost, total replacement costs and total preventive costs. Out of the sample, 52.5 percent of households have responded for the cost or expenditure due to landslides during last five years, and majority of them have (45.5%) expenditure equals or less than Rs.20,000. 32.1 percent of the households spent more than Rs.100,000 due to landslides last five years (Figure 3).

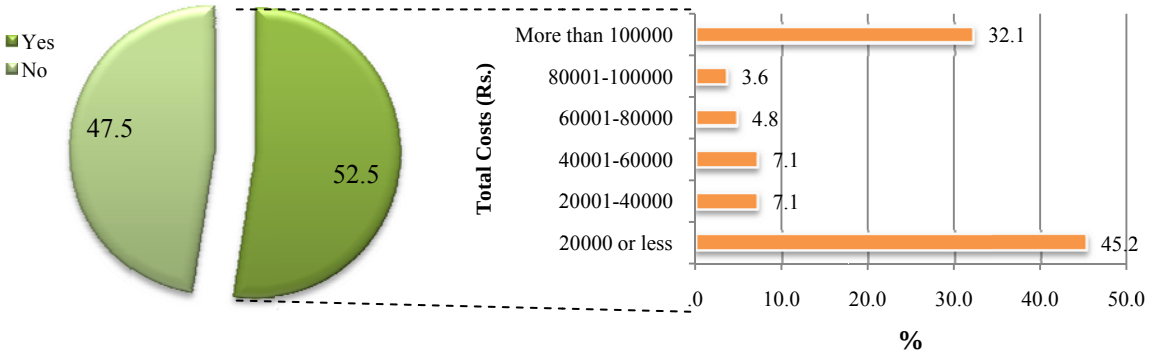

Figure 3: Total Direct Costs of Landslides

Self stated damage costs given by the respondents, which are divided as property damage (including all damages for housing and related constructions, vehicles, furniture, electronic and other equipments), agricultural damage (including the loss of harvest and damages for the field setting of the cropped area) and damage for businesses during last five years were given in Table 7. Then highest number of households stated on property damages and the highest mean cost of damage were also recorded in relation to property damages, while damage for businesses come second.

Table 7: Type of Damage and Replacement Costs Due to Landslides During Last Five Years

Type of Damage	Damage Value		Replacement Value	
	% Yes	Mean Rs.	% Yes	Mean Rs.
Property Damage	31.3	125580.00	18.8	83850.00
Agricultural Damage	3.8	9083.33	1.9	13333.33
Damage for Businesses	1.3	17500.00	0.6	50000.00

Table 8: Preventive Cost Due to Landslides

Type	Preventive Cost Yes %	Mean Rs.
Construct drain and stone ridges	16.3	58884.62
Concrete	5.0	9062.50
Other	8.1	7846.15

Table 9: Total Cost Due to Landslides

Type	Stated Costs Yes (%)	Mean Rs.
Total Damage Cost	34.4	115790.91
Total Replacement Cost	20.6	78954.55
Total Preventive Costs	28.8	37076.09

Replacement costs included all recovery expenditure to retain damaged items. Highest percentage of replacement costs are related to property replacements. When comparing mean damage and replacement costs, nearly half of the damage cost was replaced by the households in the area for property. The pattern of highest mean replacement cost is very similar to damage costs, while property replacement is the leading component (Table 7).

Regarding expenditure for preventive techniques, 16.3 percent have spent on construction of drain and stone ridges. Putting concrete and some other techniques were further used in the area in order to prevent landslides. The highest prevention cost was spent for the construction of drain and stone ridges for last five years (Table 8).

According to Table 9, the highest percentage of households faces the damage cost while the second highest expenditure is reported as preventive costs. 68% of the mean damage costs were spent for the replacement, and nearly half of the mean replacement has been spent as mean preventive costs.

In terms of willingness to pay to prevent landslide risk, 49 percent of households express their consent to do so. The majority of this group like to spend Rs 1001-1500 as Willingness To Pay (WTP) while the second highest group of people mentioned that they would like to pay more than 2000 rupees per year to prevent landslide risk (Figure 4).

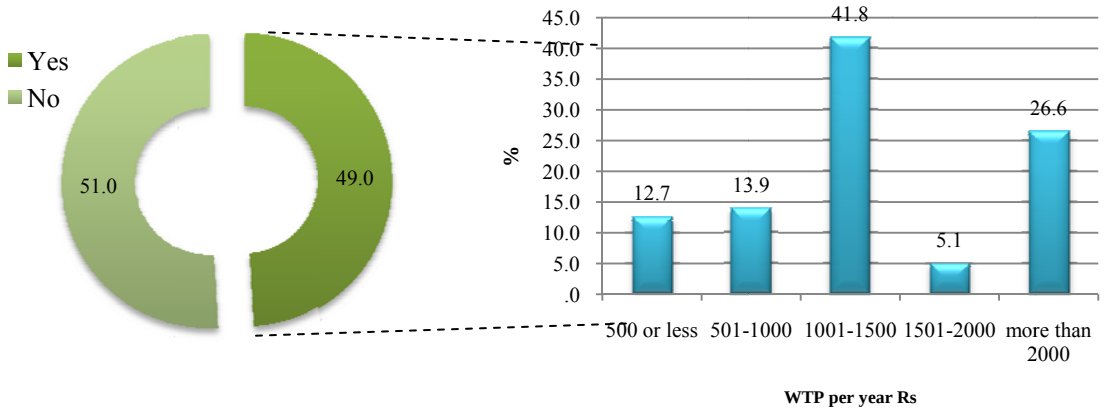

Figure 4: Annual Willingness to Pay (WTP) to Prevent From Landslide

Indirect cost of landslides included the cost of uncertainty, insurance cost and the reduction of land values. The uncertainty created by the risk of landslide causes to reverse the overall development of the household (62%) including delay of housing construction (62%), agricultural activities (21.6%), road construction (9.3%) and getting electricity (5.2%) (Figure 5). Most of the people have the uncertainty if they will be resettled by the government in another area which is safe or if the government would make safer environment for them in the same area. When they planned for the new construction or cultivation this has become a problem and this uncertainty always has a huge opportunity cost of waiting time for a solution for the disaster they faced.

Regarding life insurance, only 7.7 percent of respondents have such insurances (Figure 6), while half of them were covered from Ceylinco insurance packages. Monthly instalments of most of them are less than 1000 rupees.

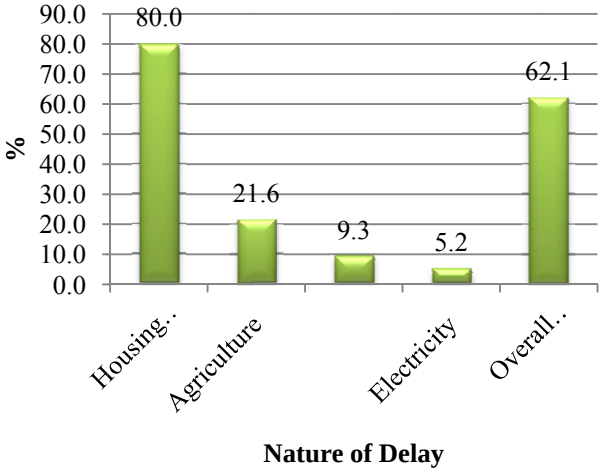

Figure 5: Delay of the Development of Household Due to Risk and Uncertainty of Landslide (Each from 100%)

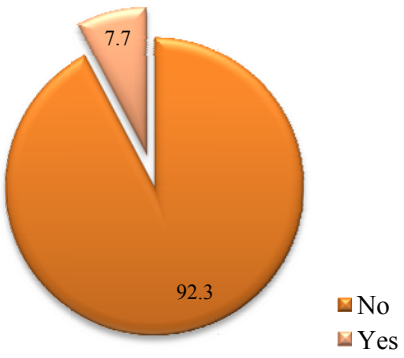

Figure 6: Having Insurance

The reduction of land value is a key indirect cost due to landslide disaster. That is explained in section 3.4.

3.4. IMPACTS OF LANDSLIDE ON LAND VALUE: HEDONIC PRICE APPROACH

Table 10: Simple Regression of Distance to Recent Landslide in Meters on Land Value per Perch

Variable	Coefficient	Standard Error	P Value
Constant	15456.792	961.397	0.000
Distance to recent landslide in meters	3.083	1.039	0.003

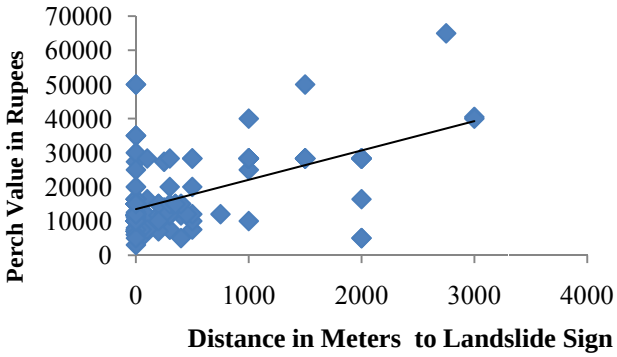

Figure 7: Scatter Plot

$$Land\ Value = 15456.792 + 3.083\ Distance$$

The relationship between the land value and distance to nearest landslide is derived as given above by using the simple regression model. The scatter plot drawn by using the selected variables is given in Figure 7 to see the relationship between two variables. According to Table 10, the model explains a positive significant relationship between land value and distance to the landslide. The land value decreases from Rs.3083 when distance is decreased by one kilometre to the landslide.

3.5. REASONS TO LIVING WITH LANDSLIDE AND FUTURE EXPECTATIONS OF VICTIMS

Although 83 percent of the households in the sample have faced a land slide within the last five years, they are not willing to leave the risk areas due to various reasons. The majority, 79.3 percent of households according to Table 11 are not willing to leave risk areas due to the unavailability of a land to shift, while 37 percent and 6.4 percent have financial problems and influence of relations respectively for being in the risk areas.

Table 11: Reasons for not Leaving Risk Area

Reasons for not leaving the place	Yes%
Influence of Relations	6.4
No land to shift	79.3
Financial problems	37.9
Other	9.2

Table 12: Future Expectations to Live in the Same Area

Future Expectation To live in the area	Yes (%)	No (%)
Household head	81.0	19.0
Children of the household	71.8	28.2

According to Table 12, 81 percent of the current generation as well as 71.8 percent of future generation expect to live in the same risk areas.

3.6. FACTORS RELATED WITH LANDSLIDE RISK, TOTAL COST AND WTP

Chi-square tests, which are further used to identify important factors related to landslide risk, total cost of landslides and willingness to pay to prevent from landslide risk is given in Table 13.

Table 13:Chi-Square Test to Seek the Factors Dealing with Landslide Risk, Cost and WTP

Relationships between variables	Chi square Value	p
Distance to the landslide and ethnic group	25.195	0.000
Distance to the landslide and delay of the family development	15.635	0.000
Distance to the landslide and knowledge on landslide	6.096	0.047
Nature of risk and total costs	24.417	0.007
Nature of risk and ethnic group	31.817	0.000
Nature of risk and self stated life status	29.592	0.000
Nature of risk and knowledge on landslide	16.394	0.000
Nature of risk and delay of the family development	5.641	0.060
Nature of risk and delay of agricultural development	5.055	0.080
Nature of risk and delay of road construction	10.422	0.005
Nature of risk and the nature of crop in the land nearby	32.345	0.000
Total cost and knowledge on landslide	15.911	0.007
Total cost and delay of the family development	11.194	0.048
Total costs and number of terms affected last year	20.062	0.029
WTP for landslide and self reported life status	18.827	0.016
WTP for landslide and Slope type	29.956	0.003

Table 13 gives significant factors related to land slide risk, cost and WTP using chi-square test at 5% and 10% significant levels. Distance to landslide has significant associations with ethnic groups, delay of the family development and knowledge of the landslide. Nature of risk is related to various factors such as total cost, ethnic groups, self stated life status, knowledge of landslides, delay of family and agricultural development, delay of the road construction and the nature of crop in the land nearby. The knowledge of land slide, delay of family development and number of terms affected in last year are related to the total cost during last five years, while self reported life status and slope type are related to WTP.

4. SUMMARY

The aim of this study is to identify the economic costs of landslides in the Hali-Ela DS division in the Badulla District of Sri Lanka. Out of the total sample, 83 percent has been facing landslide risk. Tamil and Moor communities live in high risk areas to landslide than the Sinhalese in the selected sample. This should be further concerned in policy making. Out of the total sample, 64 percent are poor and live in more vulnerable areas to landslides. Land was mainly utilised for agriculture, livestock production and for constructions. Mixed crops were leading among agricultural land. Moreover, 78 percent of people live very close to landslides; within half a kilometre. Topple and lateral spreading are the common types of landslides in the area. The key sign to identify the risk of landslides is wall cracks. Both direct and indirect costs are considered here regarding economic costs of landslides. Damage costs are higher than replacement costs and prevention costs are nearly half of replacement costs. Property damages are leading in damage and replacement costs, while the cost of the construction of drains and stone ridges is the key component in preventive costs. Nearly half of the households have willingness to pay to avoid landslide issues. Regarding indirect cost, the cost of uncertainty due to landslides is a key issue in the area. When distance to the landslide increases from one kilometre, the value of one perch of the land will increase from Rs.3083 showing the indirect cost of landslide through land value. The main reason for not leaving the area is the absence of land to shift. Most people in the current generation and the children representing future generation do not expect to leave the area due to this risk. Total costs, knowledge, development of the household were highly affected by nature of risk to landslide and the total cost was dependent on knowledge and the frequency of incidence last year. WTP was affected by the slope of the area and the life status of selected household.

The above findings of the study have important implications for disaster management practice and procedures in Hali-Ela Divisional Secretariat Division in Badulla District with high landslide risk. Since the majority of them are poor people, they have less empowerment to have self decision to shift from the risk area. Therefore disaster management authorities should directly involve for the process of resettlement of these communities. Even though people are vulnerable with the risk, the majority of them do not like to move there since their economic activities are located in the same area. Therefore, the resettlement process should further consider the economic resettlement of people. Dissemination of knowledge on landslides should be further enhanced to reduce damage caused by landslides, while disaster management authorities should further consider ways in which it could obtain community participation for risk reduction.

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