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THE DETERMINANTS OF INVESTMENT ON FLOODS MITIGATION ACTIVITIES: AN EMPIRICAL INVESTIGATION IN SRI LANKA

Muditha Karunarathna, Wasantha Athukorala

University of Peradeniya, University of Peradeniya

mudithakr@yahoo.com, wathukorala@yahoo.com

Abstract: *Sri Lanka has experienced a variety of natural disasters that have had a disastrous impact on human wellbeing as well as economic welfare of the country. Available data shows that after 1970s, number of both intensive and extensive disasters have been increasing in the country by causing considerable impacts on human life, shelter, livelihood and the economy. The most frequently reported disaster events in Sri Lanka are bushfires, floods, extreme wind events, landslides, lightning and droughts. In general, people take rational decisions of investing in mitigation activities if they understand not only the value of physical impacts of natural disasters, but also their likely social and economic consequences. Given this background this study investigates peoples' investment on mitigating activities for floods in Rathnapura and Matara districts in Sri Lanka. Floods and landslides are very common in these districts and prolonged duration of floods in many affected areas in the districts results in a high degree of damage to life and household assets in every year. This study uses survey data covering 350 households in those two districts who were victims of the 2017 floods. We estimated the economic cost of the damages which is on average 27 % of their annual income. It is found that economic loss of the poor is relatively higher than high income group suggesting that the poor are more severely impacted than the non-poor households in the study area. Regression results show that household income, education, size of the farm, family size and risk taking behavior serve as the key determinants of the investment on mitigating activities of floods in the study areas.*

JEL classification: *Q2, Q3, Q25, R58*

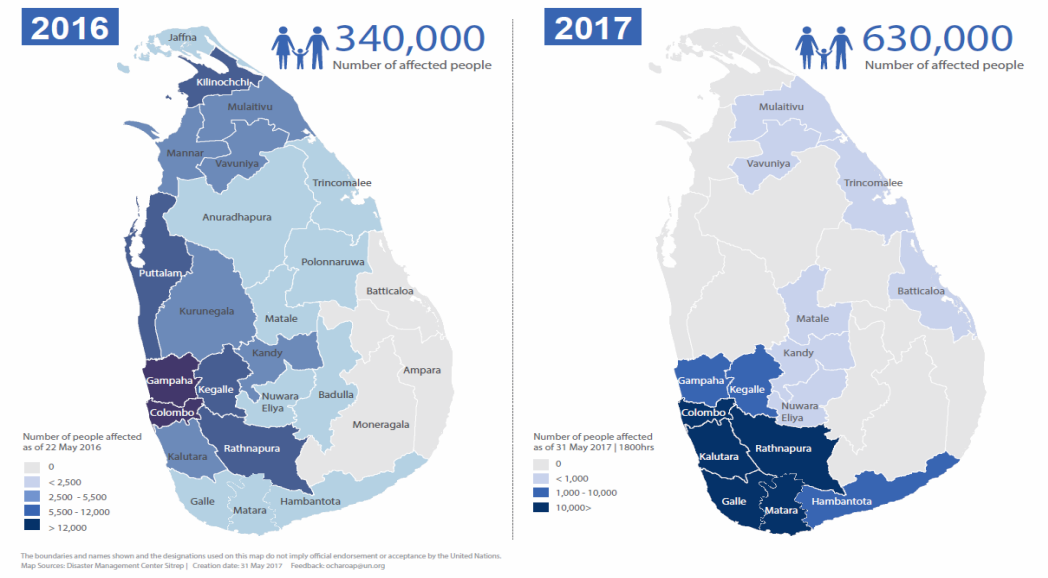
Key words: Floods mitigation, economic damage, mitigation expenditure

1. INTRODUCTION

Sri Lanka has been experiencing a wide array of natural hazards such as tsunami, droughts, landslides, floods, storms over the last few decades. Among those hazards, flood is the most frequently occurring natural hazard in the country. Riverine floods are the key type of flood hazard in Sri Lanka and it has become a severe urban flood hazards consecutively. Due to the high modification of hydrological process in the urban areas, river basins have become more vulnerable to floods. Much of the urban space is impermeable such as paved roads, concrete yards and thus the infiltration is reduced and runoff volume is rapid (Dissanayaka and Sangasumana, 2016). Recent 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 including Sri Lanka 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).

The 2017 floods in Sri Lanka resulted from a heavy southwest monsoon, beginning third week of May. Flooding was worsened by the arrival of the precursor system to Cyclone, causing flooding and landslides throughout the country during the final week of May 2017. The floods affected 15 districts, killed approximately 210 people and left a further 80 people missing. The data from Disaster Management Centre in Sri Lanka gives a picture of the adverse impact of the floods in flood affected areas including Rathnapura and Mathara. Of the total death toll in Sri Lanka due to floods in 2017, 87 (41%) deaths were reported from Rathnapura and 30 (14.2%) reported from Mathara, while 54,403 (31%) of families from Rathnapura and 33,833 (19.26%) families from Mathara were affected due to floods. A number of 5,297 (33.32%) damaged houses in Rathnapura and 6,122 (41.6%) houses in Mathara were reported. Considering the number of destroyed houses, Rathnapura reported 760 (29.8%) while Mathara reported 1,049 (41.21%) houses. Flood and Landslide comparison between 2016 and 2017 is shown in the following Figure 1. Accordingly, the number of affected people in 2016, which was 340,000 has increased to 630,000 from has increased rapidly in 46 % in 2017.

Secondary data shows that high impact disaster events has been occurring frequently in the country recent years, resulting a significant annual loss to the economy. The most affecting sectors in terms of costs are houses, agriculture, transport, infrastructure and industry. In addition, disaster events affect the provision of services such as health, education electricity, water and sanitation. The districts that were affected by the disasters in 2017 were economically highly active in agriculture, trade and services sectors. The employment sector was widely affected particularly for day laborers in agriculture, trade and services. Flooding can result in significant damage to private property, including homes and businesses. Losses occur due to damage to both the structure and contents of buildings. Disruption to industry can lead to loss of livelihoods. Damage to infrastructure also causes long-term impacts, such as disruptions to supplies of clean water, wastewater treatment, electricity, transport, communication, education and health care. Loss of livelihoods, reduction in purchasing power and loss of land value can leave communities economically vulnerable. As communication links and infrastructure such as roads and bridges are damaged and disrupted, some economic activities may come to a standstill, people are forced to leave their homes and normal life is disrupted. Displacement from one's home, loss of property and disruption to business and social affairs can cause continuing stress. For some people the psychological impacts can be long lasting.



Map Source: Disaster Management Centre

Figure 1: Comparing of the damage between 2016 and 2017.

Identifying the risks of flooding and preventing the ensuing damage is becoming crucial in any country. In order to do that, there is a need of having a more integrated approach for flood risk management with combining public structural measures and private protective measures such as mitigation, preparedness and recovery to reduce flood risks (Bubeck et al. 2012; ADPC, 2005). This requires the special involvement of individual households in terms of mitigation implementation (Dawson et al. 2011; Bubeck et al. 2012; Meyer et al. 2012; Kellens et al. 2013). However, a number of issues can be seen in developing countries including Sri Lanka in implementing flood management in practice. These are not having sufficient number of officers in different stages in flood hazard management process, problems in hazard subsidies providing regulations, lack of adequate temporary relocation places for evacuated people, hardness of providing facilities in temporary locating places according to the racial differentiation, unethical activities of certain gang of people, high political interference and bureaucracy.

Various researchers (Linnekamp et al. 2011) have indicated that households can reduce their vulnerability to floods through the implementation of coping and adaptive strategies. As Hylton (2014) highlights perceptions of risk, perceptions on the role of government, experience with flooding, knowledge of flood hazard, knowledge of solutions and access to resources have an impact on mitigation decisions made by the households. Shah et al. (2017) identify the factors that influence the households' choices of mitigation strategies and they are gender, age, location, monthly income, family size, house ownership, disability and education. Given this background, this paper attempts to identify the determinants of household investment on flood mitigating activities in Sri Lanka while incorporating the important aspects of households' individual behavior in the model. Besides generating unavailable information in the existing literature, the paper contributes by identifying the distributional aspects of the costs of floods damage in the study area. Household level data covering 350 samples from the Rathnapura and Matara districts is collected after three months of the floods incidence in 2017. The results of the study can be used to help policy makers to prepare better plan for mitigation of damages of natural disasters like floods in Sri Lanka.

The remainder of the paper is set out as follows. Section 2 discusses the relevant literature on estimating damage of floods. Section 3 explains the econometric method of estimation and provides details of data and variables used in this study. Section 4 reports and discusses the results. The final section summarizes and concludes.

2. LITERATURE REVIEW

Economic and social costs due to floods have dramatically increased over the past few decades that include direct and indirect costs. Thus, there is an urgent need to gain more knowledge about mitigating and risk reduction measures of floods in developing as well as developed countries. 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). Efforts made by private households contribute in lessening flood damage to a great extent. However, these strategies may be more effective if integrated with the traditional approaches to flood defense (construction of dams, levees, etc.). Furthermore other mechanisms such as evacuation and relocation may be necessary in some instances (Hylton 2014). Most people who are at risk of flood, however, do not automatically take mitigation measures (Siegrist and Gutscher, 2006; Aerts and Botzen, 2011). This has led to a large number of studies on the factors that influence mitigation behavior so as to provide insights in designing in flood management and communication policies effectively (Kellens et al. 2011; Terpstra 2011; Botzen and van den Bergh 2012).

Jabeen et al. (2010) points out that there is a growing integration of these two fields, as there is greater understanding that alleviating socioeconomic vulnerability to natural hazards (Hylton, 2014). Several authors also presented information regarding the types of coping strategies (Wisner et al. 2004; Paul and Routray, 2010; Jabeen et al. 2011; Islam et al. 2012; Mavhura et al. 2013). Wisner et al. (2004) differentiated between preventative and impact minimization coping strategies and suggested that the decision to avoid living on flood plains is a preventative coping strategy. In contrast to preventative strategies, impact minimizing

strategies are aimed at reducing loss and facilitate recovery. Unlike Wisner et al. (2004) who linked the term 'preventative strategy' to decision to avoid living in flood prone areas; authors such as Islam et al. (2012) and Paul and Routray (2009) use the term 'preventative strategies'on a temporal basis - to refer to actions applied before the event, whilst using the term 'mitigative strategy' to refer to actions taken during and after flood events.

Meanwhile some studies argues that the role of government, experience with flooding, knowledge of flood hazard, knowledge of solutions and access to resources have an impact on mitigation decisions made by the households. Shah et al. (2017) elaborates on the factors that influence mitigation strategies as that gender, age, location, monthly income, family size, house ownership, disability, and education influence the households' choices of mitigation strategies. According to Shah et al (2017) gender has a positive sign for most of the adaptation measures, male household heads tend to adopt more measures to safeguard their property and household from such catastrophes and men dominate both indoor and outdoor activities and are responsible for any kind of risk-reduction strategies. According to Cannon (2000) People's age play a major role in their ability and capacity to respond and recover from natural hazards like floods in hazard-prone areas and as Buckle et al. (2000) points out age is an important social indicator of vulnerability, particularly in rural areas where people's capacities or potentials need to be improved. Accordingly, location is an important factor in determining the choice of mitigation measures, especially in developing countries.

Shah et al. (2017) further points out 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. Danh (2015), shows that public awareness or concern levels regarding urban flooding, education levels, household location, and probability of relocating homes to avoid floods in future were factors statistically affecting the economic losses incurred due to floods. Public awareness and education levels has a negative effect on economic loss (losses were lower) and the probability of relocating to another place affect positively on the value of economic losses (losses were higher). According to cost calculations people living on a main street incurred more business damage or revenue losses than the ones living in a residential

cluster. On the other hand, researchers such as Abid et al. (2016), Abbas et al. (2015) and many others have done studies focusing on the economic effects of floods on local livelihoods or agricultural productivity but only a little work has been done focusing on the post-flood effects and local level mitigation strategies adopted. The households need to be capacitated through developing effective flood mitigation and adaptation policies and options. The households in the flood-prone communities need to be guided and trained in different mitigation options to counter floods effectively (Abbas et al. 2015). Housing damage was the largest cost component of economic damage and differed significantly between households. In contrast, households with lower income had to bear a greater indirect cost associated with lost wages (Danh, 2015). As Abbas et al. (2015) emphasize the role of the government as an integral part of reducing vulnerabilities and developing the adaptive capacities though effective flood mitigation and adaptation policies. The households in the flood-prone communities needed to be guided and trained in different mitigation options to counter floods effectively.

Studies have shown public awareness and risk perception has a varying impact on flood mitigation behaviours of people. Danh (2015) highlights the economic losses due to flooding results from, respondents' education status, household location and the probability of moving to another place to avoid the flood. People living in large cities on low income and in countries which are located in low latitudes are more likely to be subjected to the economic losses due to floods. The seriousness of the forecast of the floods drives people to be more concerned about responding to the floods. Danh (2015) finds that higher the level of education, higher the respondents' concern was. Hylton (2014), has found that there is a positive relationship between risk perceptions and householders' mitigation behaviour; Flood mitigation increases with damage experience and damage expectations (Osberghaus, 2015, EEPSEA, 2015) while other studies have found the opposite. According to Danh (2015), most households take preventive measures before a disaster and experience has lead them to use impact minimizing actions as an integral part of their regular practice. Many people use 'emotionally oriented strategies of adaptation' during a disaster and after a disaster most households make alterations while rebuilding their structures. Households expecting insurance coverage do not reduce their mitigation efforts (Osberghaus, 2015). Shah et al.

(2017) suggests, in case of floods, 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.

According to the review of previous studies it becomes clear that many of them have used qualitative approach to analyze the different aspects of flood related damage in different countries. However, while the context of most studies is developed countries only a few considered the impact of various forms of damages to the households in developing countries. As a result there is still a considerable lack of understanding about the policy relevant variables and their importance on mitigating floods related damages in developing countries. This study attempts to fill this gap in the literature.

3. METHOD AND DATA

The southwest monsoon typically peaks during late May to the beginning of June in Sri Lanka, with prevailing winds from the south and southwest, streaming toward the Bay of Bengal. The areas that usually receive the heaviest rain during this season are the south and west of the country, including Matara, Kalutara, Ratnapura, and Colombo. In 2017, Sri Lanka experienced a massive torrential downpour in these districts, ending the dry spell across the island and many areas continued to experience heavy downpours as high as 600 mm in some areas which led to floods, landslides, and high winds, causing death, injury and extensive property damage. Ratnapura, Galle, Matara and Hambantota districts were the worst affected districts during this session. After approximately three months later in this flood incidents, survey was carried out covering four Divisional Secretariats (DS) in Rathnapura and Matara districts for this study. These two districts as well as two DS divisions (Rathnapura and Elapatha) from Rathnapura district and two DS division from Matara district (Matara and Akurassa) were selected purposively. We collected all the Grama Niladari(GN) divisions which were severely affected by the floods in each DS division and five GN divisions from each DS divisions were selected randomly. Based on the floods affected households name list taken from the Grama Niladary (village officer), 200 households from each district were selected randomly. Then the survey was conducted covering those households and finally 180 households' information from Rathnapura district and 170 households data taken from

Matara district were used for this study. A structured questionnaire was used to collect relevant information about their socio-economic characteristics, estimated damages the property, consumable, agriculture and loss labour during the flood days. The survey was conducted by highly trained ten undergraduates for a period of approximately one month. A well structured and field pretested comprehensive interviewing schedule is used for the collection of detailed information on various aspects of flood related damages and investment on mitigating activities in the area.

This study uses OLS regression method to investigate impacts of different variables on investing mitigation activities of the floods related damages in the study area. The empirical model is as follows:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 D_1 + \beta_{10} D_2 + \beta_{11} D_4 + \beta_{12} D_5 + \varepsilon$$

where β_0 is constant, β_i are the coefficients, X_i are independent variables and D_i are the dummy variables in the model. Dependent variable in the model mitigating expenditure to avoid floods for the next time after facing the incident in May 2017. Definition of the each variable is given in the following Table 1.

In general, flood risk management seeks to reduce the risk from flood events to the people who are located in flood-prone areas. The magnitude of that risk is a function of the flood hazard, the characteristics of a particular location, measures that have been taken to mitigate the potential impact of flooding, the vulnerability of people and property, and the consequences that result from a particular flood event (NRC, 2013). Depending on locality and the nature of the flooding, a number of structural and non-structural mitigation measures may be available. However, flood mitigation measures may only lessen the impact of flooding. No amount of intervention can stop heavy rain in these areas. The prevention and mitigation of flooding can be implemented on three levels such as individual, communities and whole towns or cities. In this study we considered the individual level of measures that have been taken to mitigation of flooding and their costs. As the individual level measures, property owners may fit their home to stop water entering by blocking doors, sandbagging the edges of the building, keep flood waters out of homes by installing solid fences, raising

windows, sealing doors etc. During the survey, we obtained the details of the costs of such measures that have been taken by households to manage the risk level of the floods in the study area. This cost is defined as the mitigating costs and used as the dependent variable in this study.

Table 1: Variables and their definitions

Variable	Definition
Mitigation (Y)	Household expenditure for mitigating activities in order to minimise the possible damage that could result from the next possible flood incident (Rs.)
Agriculture (X_1)	Size of the agricultural land owned to the household (Acres)
Family size(X_2)	Size of the family unit excluding outsiders (number)
Income (X_3)	Total monthly income of the household (Rs.)
Education(X_4)	Formal education level of family members whose age is greater than 15 (number)
Distance town(X_5)	Road distance to the nearest town (Km)
Distance to the main road (X_6)	Road distance to the nearest main road (Km)
Distance to the nearest house (X_7)	Direct distance to the nearest nebouring house (Km)
Risk preference(X_8)	Risk preference of the interviewee (range zero to ten)
Self employed (D_1)	Dummy: 1 if full time self employed, 0 otherwise
Risk area (D_2)	Dummy: 1 if living closed to the inundated river, 0 otherwise
Migrated (D_3)	Dummy: 1 if migrating from another area within last 20 years, 0 otherwise
District(D_4)	Dummy: 1 if Rathnapura district, 0 otherwise

Note : Main road is defined as any road where the public transport is available

Agricultural land area, size of the family unit, total income of the family and education level is included as the independent variables in the model. Flooding in key agricultural production areas can lead to widespread damage to crops and fencing and loss of livestock. Crop losses through rain damage, waterlogged soils, and delays in harvesting are further intensified by

transport problems due to flooded roads and damaged infrastructure. In addition to the direct loss of animals, floods can bring a range of animal health problems, from food shortage and plant toxicity to dehydration, infection and disease. We included agricultural land area as a independent variable to test whether there is a relationship between agricultural land area and households investment on mitigating activities. The size of the family unit is important to provide required labour for determining mitigating activities within the family unit. Family income can release the financial constraints for investing on flood mitigating activities. In the case of education, we included the number of formal years of education for those aged over 15 in the family as the decision making ability of the family unit is a joint decision rather than individual.

Rural people are very resilient to floods than urban people. Some of the more remote or isolated families are proven difficult to assist and it is difficult for them to reach in the safe places as well. If the property is flooded, those household could become isolated (surrounded by floodwater), access to other areas might be cut and they could lose their power, water supply and other low-lying infrastructure such as drainage and sewage may also become blocked. This will increase the risk level of the flood. In order to capture the impacts of this time of risk on investing on mitigating activities, we included three variables into to model. Those are road distance to the nearest town (Km), road distance to the nearest main road (Km) and direct distance to the nearest nebouring house (Km). Further, we want to investigate where the risk preference behavior of the household has some impact on their investment on flood mitigation activities. During the survey we asked interviewee to rank their risk preferences from zero to 10 where zero represents no risk while ten represents maximum risk in decision making in day today activities.

We also included four dummy variables to capture various aspects household's mitigating behaviour. First dummy variable capture the nature of the employment of the household head. In general, self employed are more affected by the flood than others. Therefore, a dummy variable representing whether household head is self employed or not is included into the model. The initial risk of the floods is represented by the area's characteristics which will mainly determine the vulnerability of the population in a specific location. Some rivers are

inundated during the rainy season in almost every year and peoples who are located around those rivers are victims of the floods. In order to capture this characteristic a dummy variable is used in this study. We assume that people whose houses are located within 300m distance from the rivers are assumed high risk and use one and otherwise zero. We also want to know whether there is a difference of the investment on mitigation activities between household who settled in the current location within the last ten years (migrated from another place in the country) and people who lives even before that. Our hypothesis here is that newly settled households are more likely to invest more on flood mitigation activities than the traditional residence in the area. Finally a dummy variable to capture the district heterogeneity is used in the model.

4. RESULTS AND DISCUSSION

Data used in this research are mainly come from a survey and it is an analytical study primarily based on primary sources of information. However, the necessary and required data was also collected through secondary information by reviewing the published and unpublished reports. Primary data was gathered through household survey, key informants' interview and focus group discussions. Table 1 summarizes the descriptive statistics of the variable used in the analysis.

According to the Table 1, households' average expenditure on mitigation is Rs. 5,587 with the highest expenditure being Rs. 18,677 and lowest being Rs. 1,749. The highest income records as Rs. 149,695 and the lowest being recorded as Rs. 4,000 while average income being Rs. 53,158. A number of 40 families have received formal education and 8 families are reported without any member having formal education. The people living in the remotest areas have to travel 21 kms to reach the nearest city and 10 kms to the main road while average being 6.89 kms and 2.64 respectively. From the study, it was found 79% of the area is a risk prone area and 37% of the population has migrated from another place during the last 20 years, and 12% of the households were subjected to property damage in the study area.

Table 1: Descriptive Statistics of the Variable

Variable	Mean	Maximum	Minimum	STD
Mitigation (Rs.)	5587.74	18677.18	1749.59	1933.00
Agriculture (Acre)	1.90	3.00	0.50	0.38
Family Size	3.97	6.00	3.00	0.70
Monthly Income (Rs)	53158.29	149695.00	4000.00	21635.13
Family Education	24.33	40.00	8.00	5.34
Distance to the nearest town	6.89	21.00	0.20	5.06
Distance to the main road	2.64	10.00	0.10	5.06
Distance to the nearest house	0.80	2.00	0.01	0.48
Risk preference	3.72	10.00	0.00	2.02
Risk area	79 %			
Migrated	37 %			
Property Damage	12 %			

It is evident that flooding has the potential to cause social, economic and environmental damage. Thus flooding is capable of disrupting sustainable development initiatives. Flood is a major factor preventing development and improved quality of life for poor communities. Given this background, we first estimated the cost of the damage under each categories in the sample area. Average costs of the damages and percentage of households under each category is given in Table 2.

Table 2: Estimated costs of the damage

Categories	Average Cost (Rs.)	Percentage of households
Agriculture (crops)	12,450 (9.54)	82.5
Livestock	15,925 (12.20)	28.4
Loss of Labour	12,500 (9.57)	89.7
Business (including capital goods)	20,750 (15.89)	52.5
Household items	6,550 (5.02)	92.8
Property Damage	62387 (47.78)	11.70

Note: Average cost within the group is reported here. Percentage of each cost component of the total is given within the brackets.

It is evident that major cost component is the damage the property of the households (47 %). Average cost of the damage on business and livestock are Rs. 20,750 and Rs. 15925 respectively. In terms of affected households percentage, the most adverse effects due to floods is that its impact on household items. Approximately 92.8 % of households' household items were damaged costing Rs. 6,550 followed by loss of labour amounting to 89.7 % and agriculture amounting to 82.5 %. Despite highest number of households were affected by damages to the household items, these damages were the lowest in terms of costs. After identifying the costs of the damage, next we estimated the distribution of the costs of total damage under different income groups which is shown in Table 3.

Table 3: Distribution of total cost of damage among different income groups

Income Categories (monthly family income / Rs.)	Percentage of Households	Estimated cost of the damage as a percentage of total costs
4000 - 19999	4.57	24.54
20000 - 39999	15.14	21.25
40000 - 59999	52.29	12.45
60000 - 79999	18.86	6.32
80000 - 99999	6.00	3.42
100000 - 129999	1.43	1.39
120000 - 139999	0.86	1.16
140000 - 160000	0.86	1.24

Most of the households (52.29%) come under the income level of Rs. 40,000-59,999 with the estimated cost of 12.45 % of the total cost. The highest estimated cost of the damage was borne by the lowest category of households in the income strata (24.54 %). The lowest cost of damage was born by the income category Rs. 120,000-139,999, which is followed by the highest income category level of Rs. 140,000-160,000 with 1.24 % cost of damage and the income category level 100,000-129,999 with 1.39 cost of damage, which are all in the category of highest income levels. Table 3 clearly shows that the highest cost of the flood damage was borne by the households that fall under the lowest income category.

The detailed questionnaire used in this study collected perception of flooding impacts of the respondents. This included data on attitudes of impending flooding on various socio-economic variables in the study area. Summary results of the attitudes are reported in Table 4. Based on the respondent's perceptions, most respondents believed that unavailability of medicines is a serious issue during the flooding period. Approximately, 89.14 % of the sample perceives that the medicine unavailability exacerbates the damage resulting from floods and only 0.57 % perceived otherwise. The impact on businesses activities due to floods are regarded by 82.29 % of the sample as very high while 0.57 % regarded floods had no impact on them. Transportation was adversely affected to many of the sample and 71.17 % were severely affected due to floods while, 18.57% experienced the effects highly, 8 % and 1.71 % of the sample had experienced flood effects moderately and 1.71 % had no impact at all. The adverse impact of the flood effect on the houses is very high on 56.57% of the households. The effect is highly felt by 33.71% of the sample. 9.14% perceive they had a moderate impact from the floods while 0.57% of the houses had no impact. Such issues as highlighted by participants on the part of relevant government departments as well as the other agencies undermine any action (relief and compensation) taken after the floods in the area. Also consistent with the previous analysis, most respondents have mentioned that impacts of floods on business activities as well as agriculture are very high.

Table 4: Respondent's attitudes about the severity of the damage in the area

	Very High	High	Moderate	No impacts
Business activities (impacts)	82.29	13.71	3.43	0.57
Agriculture(impacts)	84.86	14.86	0.29	0.00
Transportation (impacts)	71.71	18.57	8.00	1.71
Housing (impacts)	56.57	33.71	9.14	0.57
Health issue	60.57	28.00	7.43	4.00
Drinking water shortage	54.86	32.00	9.14	4.00
Electricity unavailability	32.86	54.57	9.71	2.86
Foods shortage	60.29	31.43	5.71	2.57
Medicine unavailability	89.14	6.86	3.43	0.57

Drinking water shortage had a very high impact on 54.86 % of the people, high impact on 32% of the sample and 9.14 % of them had moderately been affected and 4 % had not experienced any shortage of water due to the floods. Floods have caused a halt in power supply during the time it had occurred. 32.86 % of the sample has encountered a very high unavailability of electricity and 54.57% had experienced high shortage in electricity. The impact was moderately and not experienced at all by 9.71 % and 2.86 % of the people respectively. Food shortage was one of the many challenges people had to go through during the time of floods. A very high impact was revealed in the data for 60.29 % and a high impact for 31.43 % of the sample while 5.71 % was challenged moderately and 2.57 % did not face any food shortage during this period of time.

It is also imperative to study the factors affecting the mitigation decisions made by the individuals in the study area. Therefore, as the final steps of the analysis, determinant of flood mitigation expenditure is investigated using OLS method. For this purpose, different models were run after controlling different variables in the model. Results of the different models are reported in Table 5. In general flood can have a significant challenge for agricultural lands such as directly damaging the crops and livestock while indirectly deposition of sand and debris on productive lands and erosion of agricultural soils. As a result of these effects after floods, farmers are challenged by yield losses directly and indirectly. Such experience of farmers provides more incentives for them to invest more on floods mitigating activities. We included the size of the agricultural land to capture this relationship. It is found that this variable is highly significant and has taken positive signs in all models implying that households who own higher agricultural lands are likely to invest more on floods mitigating activities in the study area.

Table 5: Determinants of the mitigation expenditure

VARIABLES	M1 (Mitigation)	M2 (Mitigation)	M3 (Mitigation)	M4 (Mitigation)
Agriculture	805.849***	765.486***	639.027***	395.513*
	(217.155)	(217.313)	(207.173)	(237.198)
Family size	707.262***	628.897***	502.260***	440.250***
	(141.702)	(139.713)	(131.306)	(124.590)
Income	0.030***	0.028***	0.024***	0.021***
	(0.005)	(0.005)	(0.005)	(0.005)
Education	120.141***	125.102***	87.367***	73.180***
	(16.842)	(15.321)	(14.473)	(13.521)
Distance town		-32.775***	-33.142***	-34.378***
		(12.350)	(11.368)	(11.233)
Distance to the main road		-86.342***	-60.349**	-53.885*
		(32.441)	(29.606)	(29.772)
Distance to the nearest house		-215.937	-79.746	-74.819
		(154.127)	(139.636)	(134.830)
Risk preference			-269.401***	-246.960***
			(39.947)	(40.002)
Self employed				-403.518***
				(125.234)
Risk area				275.177*
				(152.130)
Migrated				586.595***
				(126.760)
District				115.567
				(135.648)
Constant	-3,244.593***	-2,248.924***	443.031	1,374.371*
	(621.185)	(680.719)	(807.762)	(772.580)
Observations	350	350	350	350
R-squared	0.584	0.607	0.658	0.693

Note: Robust standard errors in parentheses***, **, and *denote 1%, 5% and 10% levels of significance respectively.

The size of the family is an important determinant in implementing certain measures as it affects the adaptive capacity of the household as larger the family size, risk level may be higher while more labour are available for investment on mitigation measures which lead them less vulnerable to disasters. It is found that this variable is highly significant and has taken positive signs in all model implying that households with higher family size is more likely to invest more on mitigation activities. A household's adaptive capacity to flood risks as well as determining the choice of coping strategies depends largely on the income. Further, as shown by regression results, households with high income tend to invest more on flood mitigating activities compared to the households with low income. Education has a large impact on the decisions made on mitigation strategies. This variable is significant in all four models and taken the expected signs suggesting that more educated families are more likely to invest on flood mitigating activities in the study area.

It is evident that that distance to the nearest town as well as the main road may be crucial factors in determining investment on flood mitigation activities. This is because people, people who are living closer to the town and main roads may be more aware about the damage of the floods and more likely to invest more on flood mitigating activities rather than rural isolated communities. The results of this study clearly support these arguments showing that negative as well as significant coefficient for both variables. However, variable related to the distance to the nearest house is not significant implying that no impacts of household who lives in nearby on making decision of mitigating activities. As expected evidence of risk taking behavior risk adverse households are more likely to invest on flood mitigating activities. Results also suggest that self-employed households are less likely to invest on mitigation activities. This may be due to their low income level and their ability to invest may be less. Further, people who are migrated from other places in the country or live in risk are more likely to invest on flood mitigating activities. The district dummy variable is not significant implying no significant difference of the results between two districts.

Conclusion and Policy Implications

Sri Lanka has experienced a variety of natural disasters that have had a disastrous impact on human wellbeing as well as economic welfare of the country. Given this background this study investigates peoples' investment on mitigating activities on floods in Rathnapura and Matara district in Sri Lanka. Floods and landslides are very common in these districts and

prolonged duration of floods in many affected areas in the districts results in a high degree of damage to life and household assets in every year. The study takes into account the individual level of measures that have been taken to mitigation of flooding and their costs.

This study uses the survey data to identify the costs of the floods in 2017. During the survey, details of the costs measures were obtained. From the study, it was found 79% of the area is a risk prone area and 37% of the population has migrated from another during the last 20 years, and 12% of the households were subjected to property damage. It is found that economic loss of the poor is relatively higher than high income group suggesting that the poor are more severely impacted than the non-poor households in the study area. In the regression model, this cost is defined as the mitigating costs and used as the dependent variable in this study while agricultural land area, size of the family unit, total income of the family and education level are included as the independent variables in the model. Regression results show that household income, education, size of the farm, family size and risk taking behavior serve as the key determinants of the investment on mitigating activities of floods in the study areas. The study reveals the most adverse effects due to floods have impacted on household items followed by loss of labour and agriculture. In terms of cost, the highest damages were done to properties followed by business and livestock. It was found that the highest estimated cost of the damage was borne by the lowest category of households in the income strata.

In general flood can have a significant challenge for agricultural lands such as directly damaging the crops and livestock while indirectly deposition of sand and debris on productive lands and erosion of agricultural soils. As a result of these effects after floods, farmers are challenged by yield losses directly and indirectly. Such experience of farmers provides more incentives for them to invest more on floods mitigating activities. Flood condition in Rathnapura and Mathara has caused people living in those areas in many ways. People were being affected by floods in terms of medicine unavailability, impact on business activities, unavailability of transport, arise of health issues, food shortage, impact on households, which have significant impact on households, drinking water shortage and lack of power supply respectively. The adaptive capacity of households and choice of different

adaptive measures are largely determined by the family size, income level, education, ownership of a house, and lack of information.

It is noticed from the survey that developing construction standards and building codes and enforcing at local level could largely reduce the damage caused by floods. Government investments on hazard forecasting, early warning systems, preparedness awareness for people living in flood prone areas, structural mitigation strategies and post flood recovery can contribute largely on the cost of individual investment on flood mitigation. While the individuals take measures to decrease the level of damages at household level the government has to play a major role in mitigating flood effects as often the government constructions that exacerbate the impact of floods on individuals.

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