

*Original Research Article*

# The causes and socio economic impacts of landslides in Kerio Valley, Kenya

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## Abstract

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The main aim of this report was to explore some of the socio-economic factors affecting the vulnerability of households to the recurrent and escalating landslide hazards in Elgeyo Marakwet. This report analyzes the causes, extent and nature of the increasing adverse effects of landslides on communities in relation to the elements of socio-economic characteristics of the households. The main objective of this analysis is to draw inferences and establish the relationship of vulnerability of the communities to the adverse Socio-economic effects of landslides. After presenting methodology adopted the paper goes on to examine the extent of the adverse effects of landslides on homesteads, including the degree of damage to housing and the financial costs on recurrent slide-related damage in relation to the elements of socio-economic characteristics of the households. The evidence discussed in this report reveals that the socio-economic factors play a very important role in the vulnerability of households to the adverse effects of landslides.

**Keywords:** Adaptation, disaster, escarpment, mitigation, survival strategies and mitigation

## INTRODUCTION

A landslide is defined as “the movement of a mass of rock, debris, or earth down a slope”. Apart from the vast alluvial Elgeyo Marakwet County in Kenya, where people are mostly vulnerable to devastating floods, water logging and related hazards, a major part of the county is hilly which is where people, their houses and other properties are vulnerable to natural hazards of various types like earthquake, mass movements, landslides, flash floods and several others.

Landslides regularly occur in localized areas across the region and pose a serious threat to people and property. They occur over a wide range of velocities and are often at their most damaging when they happen suddenly and without warning.

It has been observed that due to natural conditions, like immature geology and the high rainfall patterns, the

landslide hazards in Elgeyo Marakwet County have been a cause of great concern for the safety of life and property since the earliest times.

However, these natural conditions in combination with easy accessibility, rapid growth of population and urban development have tremendously increased the likelihood and frequency as well as the adverse effects of landslides in Elgeyo Marakwet. (Figure 1, 2)

Landslide are one of the type of environmental hazard in Kenya, Their occurrence cause a huge damage that include;-Loss of human life, domestic and wild animals life loss, destruction of crops, loss of top soil, destroy natural vegetation (natural cover), destroy buildings and property, Interference of cultural sites, and thus affecting community lives and man's daily life, They also disrupt water supplies and plantations.

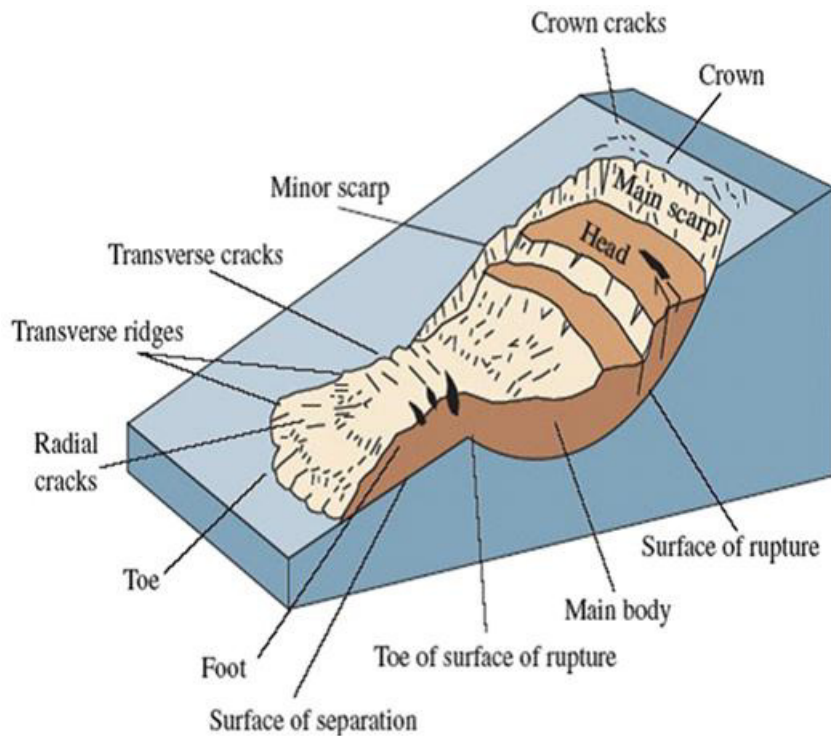


Figure 1. Showing the main parts of typical landslide

Velocity Class	Description	Velocity (mm/sec)	Typical Velocity
7	Extremely Rapid	$5 \times 10^3$	5 m/sec
6	Very Rapid	$5 \times 10^1$	3 m/min
5	Rapid	$5 \times 10^{-1}$	1.8 m/hr
4	Moderate	$5 \times 10^{-3}$	13 m/month
3	Slow	$5 \times 10^{-5}$	1.6 m/year
2	Very Slow	$5 \times 10^{-7}$	16 mm/year
1	Extremely Slow		

Figure 2. Landslide velocity and damaging effect

- Orange zone-Danger zone people cannot escape.
- White zone- Zone of property damage.
- Green zone-Zone of minimum damage.

Little research has been done on the causes and economic significance of landslide in Kenya and as a result, Thus This research is aimed at finding out what has been done to the problem earlier and what the researcher intends to do to curb the issue of landslide in the Elgeyo Marakwet County.

The main purpose for the study is to find out the main causes of landslides in Anin- Siroch location and to evaluate the effects of landslides on the environment. Emphasis is only put to the lives lost and the little is done on the structure and property destroyed, thus this study aims at widening peoples perspective on the causes and economic significance of landslides. This will help in minimizing the effects of landslides and finding out the appropriate solutions to curb the issues of landslides in the area.

## **MATERIALS AND METHODS**

### **Reconnaissance trip**

Before the collection of the field data began, a reconnaissance visit was made to all three ecological zones which make up Elgeyo Marakwet County, in order to familiarize with the spatial distribution of the landslides and to plan for the logistic of sampling. The trip also helped in establishing good relationship with government officers, elders and the community at large who later assisted in many ways during data collection.

### **Research approach and design**

A descriptive survey was selected because it provides an accurate portrayal or account of the characteristic, for example opinion abilities, beliefs and knowledge of an individual or a group of people pertaining landslide.

This design was chosen to meet the objective of the study namely determine the effects of landslides on socio-economic development of Elgeyo Marakwet County.

### **Research setting**

Elgeyo Marakwet was divided into three areas based on environmental characteristics, i.e. Valley, Escarpment, and the Highlands.

The study was conducted at the escarpment which was majorly affected by the 2008 and 2011 landslide.

### **Climate and topography**

The climate of the region lies between a temperatures of

a minimum of 14<sup>o</sup>c to a maximum of 24<sup>o</sup>c. The rainfall ranges between 1400mm per annum

There are three main agro-ecological zones namely:-

- Highlands: - Receives the highest rainfall (over 1000 mm/year) and has the following enterprises; Maize, Beans, Coffee, Wheat, Horticultural crops/vegetables, Potatoes, Pyrethrum and Dairy farming.
- Escarpment: - Receives a lot of run-off from the highlands. Supports mainly Maize/Beans, Tomatoes, Coffee and Zero grazing, avocados, Passion fruits.
- Kerio Valley: - Has the lowest rainfall (Less than 800 mm/year). Main crops include; Groundnuts, Mangoes, Cowpeas, Green grams, Pawpaw's, Cotton, Sorghum Beef cattle, Goats, Sheep and Beekeeping.

### **Population and tribes**

Elgeyo Marakwet County has a population of 369,998, where male population is 183,738, and female population of 186,260 as per census of 2009. The local people are predominantly of the Elgeyo and Marakwet sub-tribes tribes of a Kalenjin tribe.

### **The study population and sample**

A convenient sample of 30 subjects was selected from Anin- Siroch area. The sample included 19 men and 11 women. Available subjects were entered into the study until a sample of 30 was reached.

The sample size 19 men and 11 women were the total of the subject who were willing to participate in the research and who met the sampling criteria.

### **Sampling criteria**

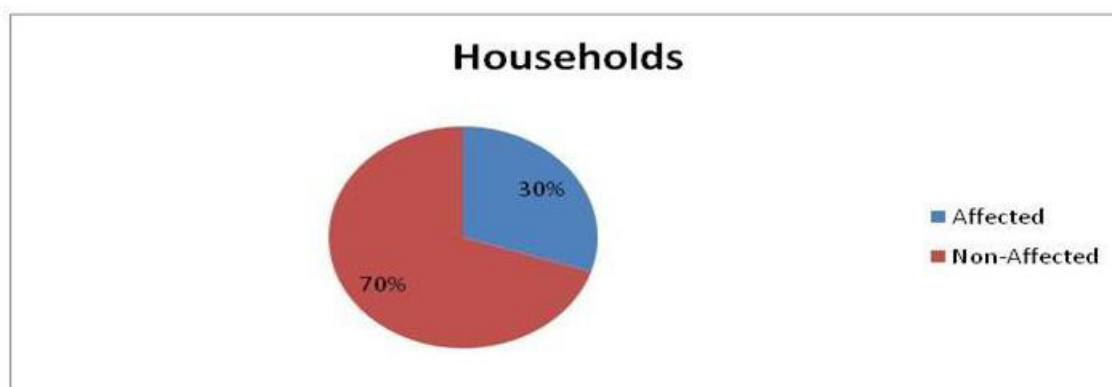
Subject in the sample were selected to meet the specific criteria.

They included;

- (i) Have lived in an area of study for duration of 7 years and above (Anin- Siroch)
- (ii) Mentally sound
- (iii) 18 years and above
- (iv) Of either sex or any tribe (at least 30% from either gender)
- (v)Willing to participate

### **Data collection**

Data for the study was obtained from primary and secondary source determined at Anin- Siroch area, The site survey was considered as most appropriate tool for collecting data necessary for the study. Ideally, the entire



**Figure 3.** It shows the number of household affected by the landslides to be 30% while the remaining 70% were not affected

population of the county should have been interviewed. However, given the time and resources available, it was considered necessary to conduct a sample household survey of those closely affected by the landslide.

#### Data collection instrument

A questionnaire was chosen as a data collection instrument. Data was collected with the aid of questionnaire to evaluate the socio-economic effects of landslides on in residence of Anin- Siroch location. Questionnaire was used.

#### Data analysis

After the data was collected, it was organized and analyzed. Data was analyzed by using descriptive statistic. Frequency tables were drawn and from these the data was presented in a pie chart and bar graphs. Also there were the uses of frequencies, percentages and means

### RESULTS AND DISCUSSIONS

It was found that the most affected area was in Kapkoywa village in Anin- Siroch location and had about 300 households. Due to heavy rains in the highlands, there has been a lot of infiltration, raising water tables in various parts of the escarpment. The situation of the raised water tables has led to weakening of cliffs and flooding of pit latrines, some of which have given way. Apart from structures and land forms giving way, there are also several houses weakened by the raised water table-floors and walls moist.

Specific cases witnessed on this visit included:

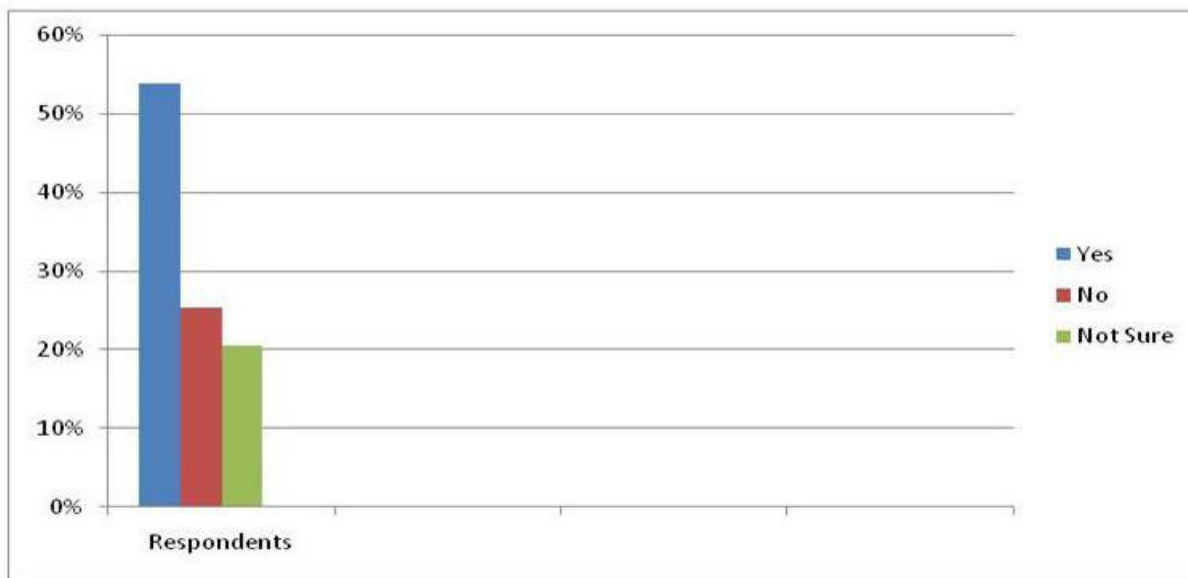
- A pit latrine flooded and abandoned at Nyawa Primary School, the last time a pit latrine sunk in the school was 2004. Around the school recently a pit latrine sunk and a house was crumbled by floods.
- A pit latrine sunk at Albert Sertoi's home.
- A cliff gave way near Mrs. Magrine Kibet's home
- Another cliff fell on Mrs. Lilian Chepkangor Amtany's house.

#### Housing and landslide damage

Damage to housing was considered to be the determining factor in the extent of the adverse effects of landslides. The study found that almost all houses in the area were slide-prone. It was also discovered that, of all the sectors, housing and development e.g. pit latrines; animal sheds were the ones which were by far the most seriously affected by landslide hazards. In response to the question, "Did landslide affect housing in the area?" all the respondents replied, "Yes".

Analysis of responses to the question, "In what way did the landslides affect housing in the area?" revealed that households have full knowledge of how landslides have adversely affected housing through a sequential manner.

The respondents described in detail the process of impact of landslides on their houses. It was found that not all the landslides in the area are of a sudden nature, the majority of them are slow moving slides called 'soil creep'. Therefore, the impact of these landslides on housing and other properties in the area is slow and steady in nature. The first sign of slide impact on housing, according to the residents, appears in the form of small cracks and/or bulges in the walls and/or floor of the house. These cracks expand with time and ultimately lead to either the partial collapse or total destruction of houses, roads and other infrastructure.



**Figure 4.** This table shows that 54% of the un affected household expect future landslides to affect them, 25.5% said that they will not be affected in future while 20.6% were not sure they will be affected or not in future

### Households affected by landslides

The survey revealed that a sixth of the houses of the sample population have been affected by landslides.

In response to the question, “Has landslide affected your house so far?” it was found that a total of 30% of the households were affected by landslides. Analysis disclosed that among the total of 38.5% belonged to the outside town, and 17% were from town fringe, whereas 44.5% were living in the rural fringe. (Figure 3)

The effects also seem to be more severe in the rural fringe, followed by the outside town, while in the urban fringe the effects appear to be felt comparatively slowly. Furthermore, a dominant number of households who have not been affected so far also did not feel safe from the adverse effects in the near future. (Figure 4)

### Economic cost of damage to housing

Among the affected households, houses of 11.5% (20 houses) had totally collapsed where as 88.5% of the houses affected were not totally collapsed. This meant that 8.6% of the total sample population has suffered serious damage leading to the collapse of their houses. When the concerned respondents were asked to give details of the slide damage to their houses a multiple response answer (up to three) was given by them, making a total of 45 responses.

All the affected 30 respondents (making 40.4% of the total responses) made the point that due to the seasonal recurrence of slides, they get many minor types of

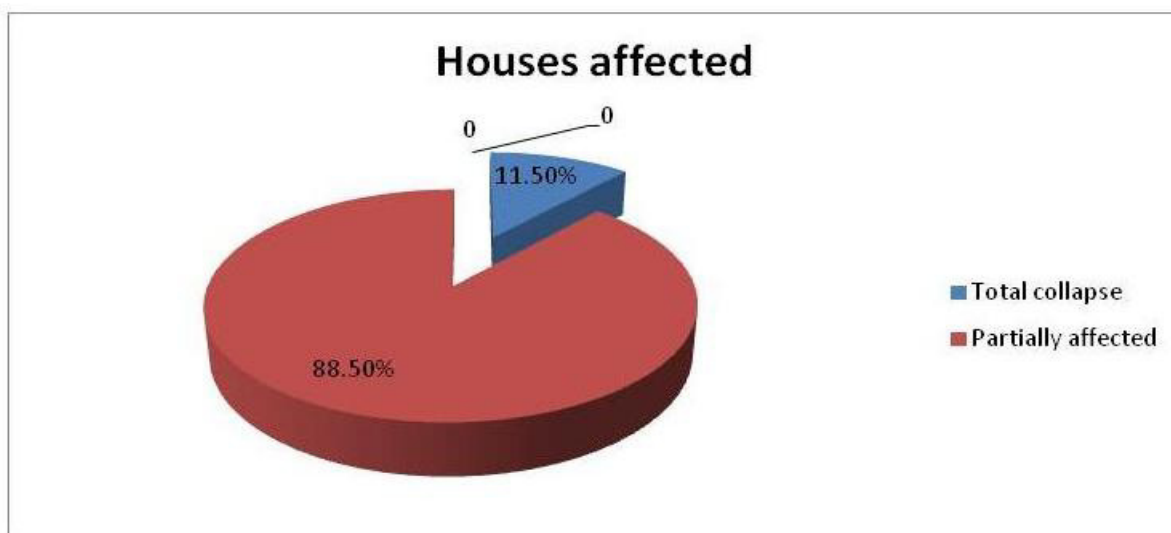
damage to their houses every year. Therefore, they repair their damage annually. It is due to this factor that after each rainfall period (heavy rains season) repair of damage to houses has become a regular feature for the residents. Many of the respondents specified the problems for their houses. Prominent among these were: (Figure 5)

- (25.7%) were cracks and bulges in the walls of rooms or courtyards.
- A further 14.6% response was about floor-sinking.
- 11.5% related to partial collapse, such as damage to wall or roof of a room in the houses.
- 4.4% were about the total collapse of houses.
- There were also a few responses (3.3%) about the seepage of water in the houses.

### Case study

During the visit, one homestead that had special media attention was visited. This was the homestead of Mr. Philip Amdany, situated on a half acre parcel of land estimated to have a 60-70% slope. The main house is a temporary flat-roofed iron sheet structure with mud walls. There are two grass-thatched houses-one for the boys and another for the girls-which also acts as the kitchen. There are two small granaries-one usable and the other abandoned.

It is a family of 7 (2 parents and 5 children).The parents migrated from Barwesa Division in Baringo District. Since they settled on that piece of land in 1996 no landslide has affected them. The family has 3 heads



**Figure 5.** Table above shows the number of houses which were totally affected and partially affected by landslide in percentage (%). 11.5% of the affected houses were totally collapsed whereas 88.5% were partially affected.

of cattle, 2 sheep and 10 goats-all on the valley floor, and about 25 chickens in the homestead. The landslide occurred on Saturday 8th November 2008. The landslide hit and destroyed one section of the girls' house. No human injuries occurred. Three sack-loads of unshelled maize from the year's harvest were buried in the rubble, together with a few household items.

- The estimated value of the collapsed house is Kshs.15, 000. Values of the other houses could add up to Kshs30, 000.
- Three sacks of unshelled maize valued at Kshs.2, 500.
- It is estimated that the family required 7 bags of relief maize and 3 bags of beans the following year.

The family was to relocate to higher safer grounds but so far they had not identified where and how they would do so.

The acting chief at the time chief Kamogich gave an estimate of 19 households affected directly and 17 households in danger at this location alone. Another Chief, Chief Chebor of Kokwao location identified four sites where residents and commuters were likely to encounter landslides during their day to day activities.

These responses came mainly from the survey area i.e. households of the Anin area. From these figures we can deduce that one major effect in this area is household expenditure on repairs for damaged buildings. Due to the recurrent nature of landslides repair of slide damages is a regular

feature of Anin. Hence, households have to spend a considerable proportion of their earnings on slide-related housing damages. The affected households were, therefore, asked about their spending on slide-related

housing damage. In response to the question, "How much of your annual income do you spend on slide-related damage to your house?" it was found that 41.8% of the households spend over half of their annual income on slide-related damages, 34.1% households spend up to a quarter, whereas 24,% respondents spend between 26 and 50% of their income. The analysis revealed that the percentage of a household's annual income spent on landslide damage had a significant association with the important socio-economic characteristics, like education and occupation of the household head and income level of the household.

### Settlement on Slope

Field observation revealed that, people have settled on slopes of the escarpment by creating artificial platform for reconstruction of houses. The cause of this is the high population density. Every piece of land was under some form of land use. Mostly been crop cultivation.

Due to intensive land use and nature of the topography, houses are commonly constructed on steep slopes by creating artificial terraces (Platform) on the slopes flat enough to hold a house. The equilibrium of the slope is thus disturbed and the construction is in fact an overload of the slope. This, in itself, may lead to sliding of loose materials on the slope.

Field agricultural officer, Mr Kiprop said that, another probable cause by this is impeding of free surface drainage run-off such that water seeps through the upper side of the created flat surface which lead to an accumulation of water below the building and continued



**Figure 6.** Picture of the area of Kapsokom where the landslide occurred. (Picture courtesy of standard newspaper dated 3<sup>rd</sup> December, 2011)

to say that the effect of it may lead to sliding which may destroy the building

From the area acting chief, he confirmed that, there are more than 100 household settling along the slope of the escarpments, which all of them are more likely to be affected by the future landslide and there is a need for the government to resettle them before another unfortunate happens.

#### **Other socio-economic effects determined**

Apart from the repair of houses each year, all the other responses regarding degree of damage to the houses were further analyzed for various other socio economic effects these results were:

#### **Deaths**

Just last year at least 10 people among them three children are reported to have been killed in landslides in Elgeyo Marakwet County of Kenya. Baringo County also reported deaths resulting from the said landslides. The landslides occurred in Kocholwo, Simit, Kapsokom, Kaptarkom and Toroplongon areas of Marakwet. (Figure 6)

#### **Injuries resulting in decapitation**

Most of those saved from the rubble after being under-

neath the landmass usually have one or both of their limbs decapitated after being injured and not getting medical attention fast enough. This affects the household drastically if the victim was also a bread winner.

#### **Financial cost for burials and relocation**

The costs emanating from both the medical expenses for survivors as well as the ones to be buried is usually a heavy burden on the surviving family members as they always tend to be families from poverty backgrounds who not only have they lost their homes but have to contend with the costs of burying their loved ones. This factor ensures that they cannot relocate to safer stable areas to continue with their lives.

#### **Trauma**

Without proper psychological help, survivors of landslides tend to live their lives in fear for another one occurring while they sleep. Some may also develop a phobia of some kind for regions they have heard to be landslide prone and this may affect their lives currently as adults or in future for young children who don't know where or when they may find themselves in such regions.

#### **Interruption in school programs**

As indicated from the research a number of the schools

including Nyawa primary school had their pit latrines sunken due to landslide. This obviously meant that the school had to close first for safety reasons before it could begin digging another pit latrine. This leads to loss of valuable time for the school children to clear their syllabus before exams begin meaning children from these areas have an unfair disadvantage compared to children of other areas.

## CONCLUSIONS AND RECOMMENDATIONS

### Conclusions

During the analysis it was found that slide-proneness of housing has nothing to do with the socio-economic characteristics of the households whereas vulnerability is entirely dependent upon these characteristics.

Landslides in Kenya are predominantly triggered by an increase in pore water pressure from intense short period or prolonged rainfall. Human activity can impact both positively and negatively on the occurrence of landslides. The irregular occurrence of landslides across Kenya makes it difficult to estimate their cumulative impact in socioeconomic terms as costs are distributed, misreported or not documented. The analyses also revealed that of all the sectors housing is the one which has been most seriously affected by the landslides.

It was observed that all the affected 182 (three-quarters of the sample) households repair the slide damages annually. Among these affected households 11% suffered total collapse and 28.6% suffered partial collapse of their houses.

Cracks and bulges in the walls and floor were other common damages suffered by these households. The analyses revealed that households which suffered partial or total collapse of their houses were mainly those with low-income, low level or no education, and/or having badly paid and insecure jobs.

Similarly, due to the recurrent nature of landslides, out of the total affected households, 41.8% were found to spend more than half of their annual income on slide-related housing damages, which includes a fairly high number (36.8%) of those who spent up to 80% of their entire savings on the damage. Among these 41.8% households, 65% of households were those with low socio-economic status.

These findings reflect the importance of elements of socio-economic factors in the vulnerability of a household to the adverse effects of landslides. The high correlation of educational attainment, occupation and income level with the annual spending on slide related damage could be due to the extra amount of finances made available for repairs, after the normal family expenditures have been met.

Hence, it can be concluded that the higher income

level are more likely to keep the percentage of a household's annual expenditure on landslide damage to a very low level. Any improvement in these socio-economic factors, therefore, makes a positive contribution towards reducing the vulnerability of a household to the adverse effects of landslides.

It was revealed that a household's spending on slide-related housing damage has a significant relationship to educational attainment, occupation and income level of a household. It points to the fact that high level of education, better job opportunities and higher income level of a household could make a positive contribution in reducing the adverse effects of landslides. It can, therefore, be concluded from the analysis that all the households in Elgeyo Marakwet are equally threatened by landslide hazards.

However, households with a lower income, poor education and insecure job opportunities were weak, and at the same time threatened by landslide hazards. They were, therefore, the hardest hit and the most vulnerable to the effects. So the only difference is that of vulnerability. Weak and poor communities are more vulnerable to the landslide effects on housing than rich, educated and powerful households.

It was, therefore, established by the study that vulnerability to slide hazards in Elgeyo Marakwet is actually a function of the factors like level of income, awareness, access to risk reduction elements all these are variable factors relating to human environment, while the physical environment may remain constant.

### RECOMMENDATIONS

Members of the general community have a responsibility to be aware of how their activities might impact upon their own property and that of their neighbors.

While it is possible for marginal land to be developed within tolerable levels of risk, meeting any imposed maintenance requirements is the responsibility of the homeowner.

Communities occupying homes in proximity to, sloping land or a cliff should contact their local council for guidance on slope instability or development issues. Individuals should be given expert advice on slope stability in their area and any landslide mapping that is available for site specific analysis is made available at the council offices.

The adoption of best practice guidelines and methods is an important step in minimizing and managing landslides impacts.

Further work in the areas of landslide inventories, including reliable maintenance of landslide databases and model development is important.

There is also a need to contribute to management of landslide risk at the technical level through support for

nationwide landslide susceptibility mapping at the scale of regional or local government areas.

The management of landslide risk is important for all levels of government, non-governmental organizations groups and the community. However local county government has a major statutory responsibility for managing landslide risk and the private industry plays a fundamental role in this process. Skills shortage and resource limitations are primary constraints in furthering landslide research.

Ongoing analysis of the influence of triggering factors, such as rainfall events, on representative and problematic areas of the country is needed. Monitoring programmes, including the use of near real time technologies, can provide information on the relationships of landslide movement to triggers. This is important if public safety warning systems are to be developed as part of risk management and disaster plans.

At the local and regional levels, there is a need for research programmes that determine the relationships of contributing factors to landslide occurrence, magnitude-frequency rules and runoff limits for representative areas across the country. As a strategic exercise, in the absence of national mapping strategies, this would provide context for site specific investigations and other regional mapping exercises. Coupled with this aspect is the ongoing development of methods for implementation in applications such as landslide zoning.

Deep rooted trees which take up a lot of water from the ground should be used for the rehabilitation of the landslide affected areas so that the water which collects in the scars does not accumulate to cause secondary slides.

The deep rooted trees also help to increase the shear strength of the slope material, such trees as Eucalyptus and Wattle are good for rehabilitation.

Cypress trees are not recommended because they have very short roots which do not reach deep in the soil nutrients, the short roots cannot be used to increase the shear strength of the slope materials as in the cases with Eucalyptus and wattle trees and the Cypress does not have high ability to suck water which collects in the landslide scar from the soil like Eucalyptus trees.

Settlement should be limited to slope of less than  $34^{\circ}$  since according to the study; slopes higher than this are prone to sliding of land.

Soil testing for the strength or stability should be required before any major construction like road, laying of water pipes, canals and factory is done. This should be done by the district engineers in liaison with the local administration.

Other mitigating recommendations arising from the local community were:

- Drainage of the swampy areas by cutting water channels to divert the water.(Dredging)
- Practicing of soil conservation measures in the area. (use of terracing)
- Afforestation of the area.
- Slope stability inspections by local residents.
- The department of mines and geological department to work in collaboration with the following departments:
  - Ministry of Agriculture, Water and Irrigation.
  - Kenya Forest Service.
  - National Environmental & Management Authority.

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