3. LANDSLIDES IN UGANDA.

3.1 Landslide hazard assessment.

Landslides are common in mountainous areas. Mass wasting on the national scale was assessed by combining the following parameters in ArcGIS model builder (Figure 3.1).

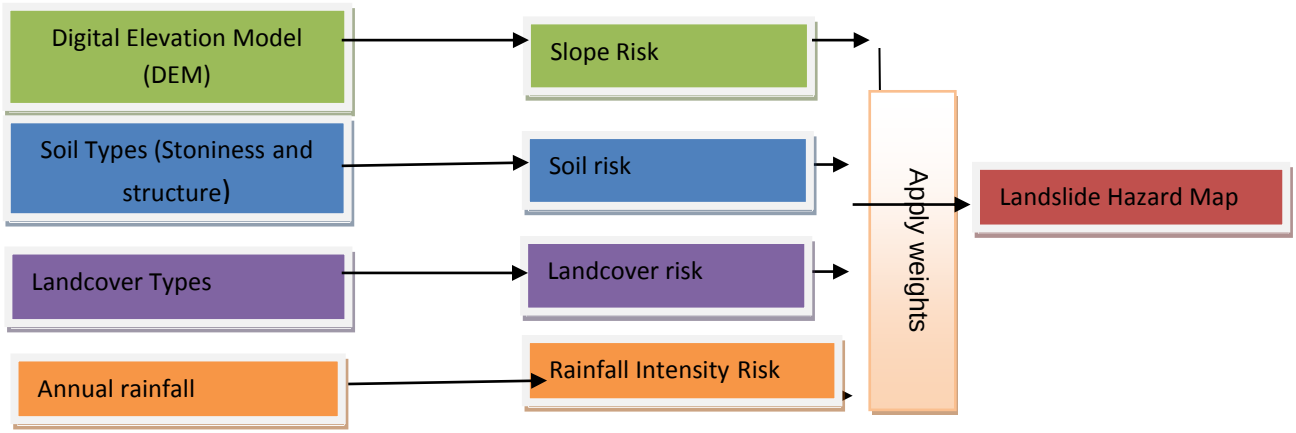

Figure 3.1 Landslide model for landslide assessment.

The Digital Elevation Model was derived from contours obtained from the Department of Surveys and Mapping in Entebbe. The soil types were obtained from the existing soil map prepared by the National Agricultural Research Laboratories at Kawanda. Many areas in the country are prone to mass wasting processes (Figure 3.2). The areas where landslides have occurred are Ruwenzori, Mount Elgon and the Kigezi region. These regions have high populations which makes them high risk areas.

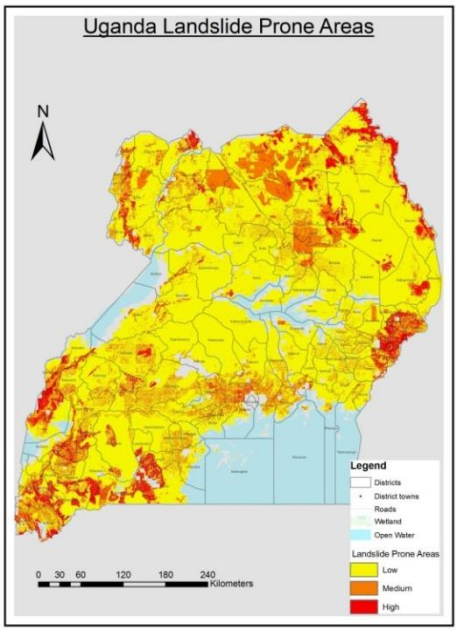

Figure 3.2: Landslide hazard map of Uganda.

3.2 Landslide occurrences.

Date	Sub-county	Parish	No. of people killed.	No. of people affected	Damage to property	Cost of damage
2011	Buluganya	Sooti	10	316	houses destroyed	376,000,000
2011	Namisuni	Nambeche, Kisekye, Namezi, Namudongo	0	393	latrines washed away and crops destroyed	380,000,000
2011	Buginyanya	Gozi, Tabali, Bunataje, Gidno, Longoli, Kiwali	0	250	Roads blocked, crops swept down the hill	
2011	Masira	Gabugoto	0	0	Roads submerged, destroyed, completely inaccessible by direct route except through Kapchorwa	630,000,000
2011	Gamogo	Kapnarbaba		953	Three (3) houses were buried crops and animals destroyed	
2011	Chema		1	42	A number of households buried in soil, one old child died and a mother was rescued. Atari and Kaptokwi bridges swept by running water	
2011	Tegeres	Basar	0	37	4 cows injured and crops destroyed	
2011	Kapchesombe	Kaplak, Kwoti, Tariet and Kween	0	316	3 cows killed and crops (maize) destroyed	
2011	Sipi	Chepterich	0	6	5 children were injured and one house hold buried	
July-September 2007	Kortek		3		Three (3) lives lost, Crops destroyed and planted tree destroyed. Main truck road blocked for 3 months latrines sunk	
April to 2012	Riwo	Aralam			crops, animals and houses destroyed. Culverts washed away.	
May-June 2012	Kwosir		0	250	50 acres of land affected. Siltation of bridge on Kere river	
July 31 2012	Bugitimwa		0	0	4 commercial ponds leaving about 18,000 fish destroyed	
2012	Bukiise, Bumasifwa, Bumalimba and Busulani				52 acres of land destroyed, 42,000 trees of coffee washed off along with 20,000 banana stems.	
2012	Kaabong		7	2	several families resettled in a camp	
2012	Buhweju			90		
2012	Kisoro			1,011		
2012	Kabale		6	6,200		
2013	Kasese				Many soil slips in the Kilembe hills	

1942	Bududa	Bulucheke			Killed very many wild animals such as monkeys, snakes and baboons. A lot of debris was poured blocking roads, When the dam broke Destroyed rice fields and killed people in Bunyole, Tororo District about 20km downstream, destroyed coffee farms	
1922	Bulucheke	Bumwalukana	20		Killed about 20 farmers who were celebrating the end of the harvest season.	
1927	Bulucheke	Busiliwa	1		One man killed and his home and farms swept down slope.	
1997	Bulucheke	Bubita	48		About 48 people killed; houses and bridges destroyed, Roads were blocked with debris for about one week.	
1970	Bulucheke	Nusu	60		Over 60 circumcision dancers buried alive. Houses were also destroyed.	
1967	Bududa	Bushika			At Buwali valley water was dammed for one day and destroyed many houses downstream. A family of 6 was killed and bodies have never been recovered.	
2010	Nametsi	Bukalasi	365		About 365 missing	
2012	Bumwalukani		8		8 people killed	
1918	Bududa	Busayi	0		0	
2012	Sironko		8			
1900	Bududa	Konokoyi	Not known	Not known	The landslide incised the Konokoyi valley	Not known
1999	Bududa, Bulucheke , Bubita and Bukalasi		5	Not known	5 people killed	Not known

Table 3.1 Landslides that occurred countrywide

About 542 people have been killed and 9866 displaced countrywide by landslides since 1818 (Table 3.1). The numbers could be more or less because the occurrences are not well documented.

3.2 Assessment of landslides in hotspots.

3.2.1 Landslides in the Mount Elgon region.

3.2.1.1. Introduction.

Mount Elgon from which the National Park derives its name is an extinct volcano with an age of about 24 million years (Figure 3.3). Eight districts share Mount Elgon and these are Bukwo, Kween, Kapchorwa, Bulambuli, Sironko, Mbale, Manafwa and Bududa. The word Elgon is of Masai origin and believed to have been derived from the word El Gonyi, the name of a tribe who lived on the southern slopes of the mountain (Davies 1957). This name is not used by the greater majority of the native tribes who inhabit the slopes. For the Bagisu tribe on the west it is known as *Masaba*, to the Luo it is *Masawa* and to the Kitosh (Babukusu) on the east *Luteka*. The Elgon massif extends for about 80Km north to south and about 50 Km west to east. The highest point on the crater rim is 4321 meters above sea level making Elgon the eighth highest massif in Africa and the second highest in Uganda after Ruwenzori. The general outline of the

mountain is typical of a shield volcano with very gentle slopes in the order of 3^0 to 4^0. The lower part of the mountain is made up of a series of benches separated by prominent cliffs often up to 305m in height. This characteristic terrain is the product of differential weathering of the various volcanic materials resulting in a rugged landscape with cliffs and masses. The rainfall in the Mount Elgon area ranges from 1000 to 2500 mm per year.

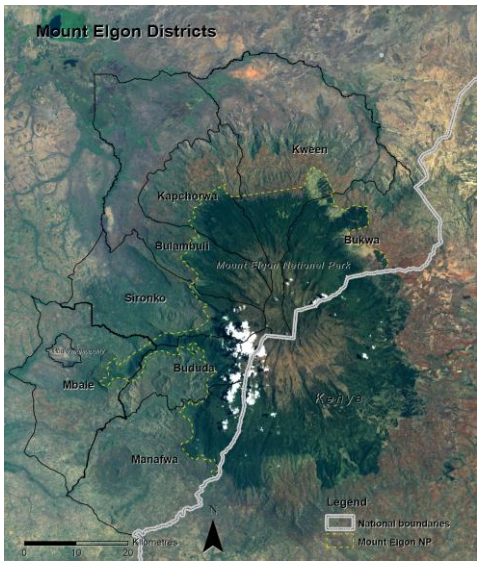

Figure3.3: Boundaries of Mount Elgon districts overlaid on a Landsat TM image. The volcano stands out distinctly. Map credit: United States Geological Surveys.

3.2.1.2. Socio-economic impacts and the perception of communities on landslides in the Mount Elgon region.

This study examines the activities carried out by the population living around Mount Elgon National Park and also assessed the perception of communities on forest conservation. The study further attempts to ascertain the effect of loss of forest cover on the landslide disasters. Six parishes of Sume, Shishendu, Bunamulunyi, Elgon and Buboolo, surrounding Mt. Elgon National Park were selected using simple random sampling. A sample of 180 respondents was analyzed using Statistic package for Social Sciences (SPSS). Data was obtained through household survey.

Focused on the source of livelihood for the people in the area, this topic created some reluctance to give answers with accuracy. More information was obtained through observations and informal discussions with local authorities and elders from the six parishes. The study revealed that the main economic activity is farming and both cash and food crops are grown. It was further revealed that communities are strongly dependent on forest land for farming, food, firewood, among others. It is therefore important; to change the dependency on land as the only source of livelihood by creating awareness on the importance of forest conservation and finding alternative source of income. The level of education is low and 60% of the communities have attained primary level education and 10% have no formal education. This makes it difficult for many to easily understand the conservation measures that reduce landslide disasters. Figure 3.3 shows the boundaries of Mount Elgon districts overlaid on a Landsat TM image. The volcano stands out distinctly.

All the respondents acknowledged that the forest is of great importance, as it provides them with medicinal plants, food, rainfall, farming source of energy and construction materials. The people have long been dependent on the forest for construction materials, food and bamboo shoots. When asked about clearing of the forest, 78.2% of the respondents agreed that there has been forest loss, while 21.8% did say there has been no loss. Those who say no fear the repercussions, if their identity is revealed to the forest authorities. This implied that community is aware of the consequences of forest encroachment and illegal activities carried out in the forest reserve. 167 out of 180 respondents revealed that landslides occurrences are due to clearing of forests. Some of the alternative interventions suggested by the community included, sensitization of the community about the usefulness of afforestation, they further suggested that, the Government should come up with strict rules on those who encroach on forests.

3.2.1.3 Landslides in Bududa District.

Bududa district situated in the surroundings of Mount Elgon volcano is the hotspot for landslides in Uganda. Degradation of slopes through soil loss due to landslides in this district is a problem with fatalities, environmental consequences and food shortages in the future. During the period 1997 to 1999, landslides killed 48 people and displaced 10,000 ***(Kitutu et al., 2004****)*. Further still in 2010 and 2011 about three hundred and eighty people were killed by landslides in this area.

3.2.1.3.1 Causes of landslides in Bududa.

The main triggering factor for landslides in Bududa is rainfall. Rains that go on for days while delivering little amounts of water cause more landslides because of high infiltration of the water into the soils causing stagnation. The preparatory or causal factors are geology, slope shape, slope undercutting and soils texture (***Knapen et. al 2006***). The fenitized basement rocks and dykes are most susceptible to landslides in Bududa ***(Figure 3.3).*** The formation of the Butiriku carbonatite fenitized the basement granites. This process resulted in the partial replacement of the original quartz by sodic amphibole or Hornblende ***(Reedman, 1973).*** The stable minerals such as quartz were replaced by amphibole which is weaker on the stability series of minerals. This weakening resulted in accelerated weathering of the basement rocks forming thick soils rich in clay hence vulnerable to landsliding (***Kitutu et. al. 2010).***

The influence of vegetation is difficult to assess because almost no natural forest exists in Bududa. It is even difficult to know when the vegetation was cleared because it seems to be a long time ago. Despite this a few hills which had trees in the 1997 rainfall event did not suffer from landslides an indication that vegetation has a lot to play in preventing landslide occurrences ***(Plate 3.1 and Plate 3.2).***

Plate 3.1: Nusu dyke one of the area with frequent landslides. Photo credit: Knapen 2009

Plate 3.2: Areas with vegetation had no landslides while bare areas had surficial slides in1997.

More research should be carried on the influence of vegetation and also what type of vegetation is suitable. For example the ***Cordia Africana*** an indigenous tree in the Mount Elgon area has been singled out by communities to prevent landslides on slopes. However given the small sizes of farmlands its agro-forestry potential should be well researched. Other countries such as china and India have used the Vetiver grass to stabilize slopes from landslides. This may also be an area where more research is needed. Population is a very significant driver to landslide occurrences and it also increases the risk as many people settle in the steep slopes with high landslide hazard. The communities in this area because of ignorance rarely use family planning methods. Under-age marriages have also been identified as a contributing factor to a fast growing population.

3.2.1.3.2: Impacts of landslides in Bududa.

About 507 people have been killed by landslides since 1800 (Table 3.2 and Table 3.3). The economic damage from these landslides is not well documented which is one of the shortfalls in

this process. For example in 1997 all bridges in Bududa were damaged by rivers and roads were completely destroyed by rivers. This was more prominent in Bushiyi, Bukalasi and Bubita areas. Currently these roads have been opened without putting in place measures to reduce the damage if extreme rainfall events occurred.

Year	Sub-Counties affected	Causes of landslides	Losses
1818	Bududa, Bulucheke	Rockslide triggered by rainfall in weathered granite in Bulucheke.	Not known
1900	Bududa,	A landslide that incised the Konokoyi valley. Triggered by heavy rainfall.	Not known
1918	Bududa (Busayi).	A rotational slump	No death.
1922	Bulucheke (Bumwalukana).	Landslides caused by river undercutting by Sakusaku river.	Killed about 20 farmers who were celebrating the end of the harvest season.
1927	Bulucheke (Busiliwa)	Landslide caused by heavy rains	One man killed and his home and farms swept down slope.
1933	Bulucheke, Bubita	Rock slides at Buwali	Not known
1942	Bulucheke	Landslides triggered by rainfall	Killed very many wild animals such as monkeys, snakes and baboons. A lot of debris was poured blocking roads.
1944	Bulucheke	Landslides triggered by rainfall	None
1960	Bulucheke	Triggered by heavy rains	destroyed coffee farms
1967	Bududa, Bulucheke	Landslide dammed river Sakusaku for three days forming a lake of 2km in length.	When the dam broke Destroyed rice fields and killed people in Bunyole, Tororo District about 20km downstream.
1970	Bulucheke (Nusu)	Landslide triggered by rainfall.	Over 60 circumcision dancers buried alive. Houses were also destroyed.
1997	Bududa, Bulucheke, Bubita, Bushika,	Triggered by heavy rains	About 48 people killed; houses and bridges destroyed
			At Buwali valley water was dammed for one day and destroyed many houses downstream. A family of 6 was killed and bodies have never been recovered.
			Roads were blocked with debris for about one week.
1999	Bududa, Bulucheke, Bubita, Bushika,	Triggered by rainfall	About 5 people killed and houses destroyed.
2010	Nametsi, Bukalasi	Triggered by rain	About 365 missing.
2012	Bumwalukani	Triggered by rain	8 people killed

Table. 3.2, Records of landslide occurrences in Bududa district.

Period	Number of deaths
1800-1900	0
1900-1950	21
1950-2000	113
2001-2013	373
Total	**507**

Table.3.3: Number of people killed by landslides between 1800 and 2013 in Bududa District.

Plate. 3.3: Communities searching for the dead in the Bumwalukani landslide, 2012. Photo credit; Dr. Kitutu Goretti

Nametsi landslide.

Following continuous rains that started on the 25th February 2010 several soil slips occurred in Bududa. However, the most devastating was the debris flow that occurred on 1st March in Nametsi village killing about 365 people. These particular sites suffered from a landslide in 1997 and 4 people were killed. A huge boulder from this landslide in 1997 narrowly missed the Health Centre built by Care International but completely swept away in the 2010 debris flow. It was also reported that this site again suffered from a small landslides early this year with no damage. This could have been early warning signs for an impending major slope failure. The type of mass movement is a debris flow. Debris flows are one of the most dangerous of all mass wasting events. They can occur suddenly and inundate an entire village in a matter of minutes a case of what should have happened at Nametsi. Debris flows occur when masses of poorly sorted sediment, agitated and saturated with water, move down slopes.

Nametsi landslide, 2010

Bumwalukani landslide

On 25th June 2012 at 2.00pm a landslide occurred at Bumwalukani in Bududa district destroying two villages. Plate. 3.2 shows communities searching for the dead in the Bumwalukani landslide, 2012. About 25 houses were destroyed and 8 people killed. The length of the landslide was 540m, the average width was 130m and the depth of the scar was about 15m. The depletion zone was about 300m of long and the deposition zone was about 240m. The volume of soil displaced was about 700,000m^3 which qualifies it to be a huge landslide. The upper slope of the landslide is about 40^0 and the lower slope 20^0. The type of landslide in an earth slide.

What could have happened?

It was reported that it rained continuously for seven days and rain water infiltrated through a deep crack that formed on this slope in 2009. The water stagnated in the deep soil profiles causing water saturation and slope failure. The crack was as a result of movement of soil block because of water infiltration through the terraces and foot paths across the hill. The water that infiltrated through the cracks was trapped at the interface between the rock and soil which is known as saprolite (i.e. this occurred at an estimated depth of 15m). This water first moved the block of soil of about 300m in length including the trees and houses in the Northwest direction and later turned it in the southwest direction possibly following the flow of water underneath and deposited on a village about 500m downslope. So many questions have been asked why the eucalyptus forest could not stop the landslide. The reason is that the failure plane was deeper than the influence of the roots given that eucalyptus has shallow roots.

Bumwalukani landslide, 2012.Photo credit: Dr Kitutu Goretti

3.2.1.2.3 Landslide hazard and risk assessment in Bududa District.

Assessment was done using existing data. More data was collected in the field through interviews. Landslide risk was assessed for Bududa District the areas with high incidents of deaths from landslides. These will then be used to establish the areas of risk from landslides. The landslide risk was prepared by overlying houses location on to the landslide hazard map ***(Figure 3.7).*** The areas with high hazard and have settlements are at high risk of landslides. The eastern part of Bududa district has the highest risk to landslides ***(Figure 3.8).*** In 1997 over 66 landslides occurred in this area killing 48 people. Worse still in 2010, three hundred and sixty five people died in one landslide at Nametsi and in 2012 eight people died. This area is most sensitive to landslides in Uganda. Figure. 3.4 shows landslide hazard in Bududa overlaid with location of houses. Houses mapped from high resolution satellite images while Figure. 3.5 shows the landslide risk map for Bududa District overlaid with the landslides that occurred in 1997

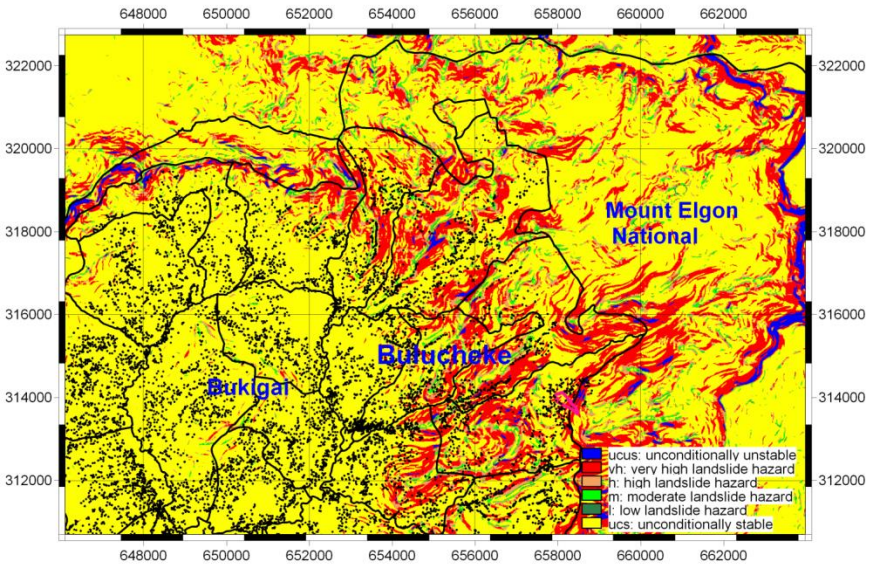

Figure. 3.4: Landslide hazard in Bududa overlaid with location of houses. Houses mapped from high resolution satellite images. Courtesy: United States Geological Surveys (USGS).

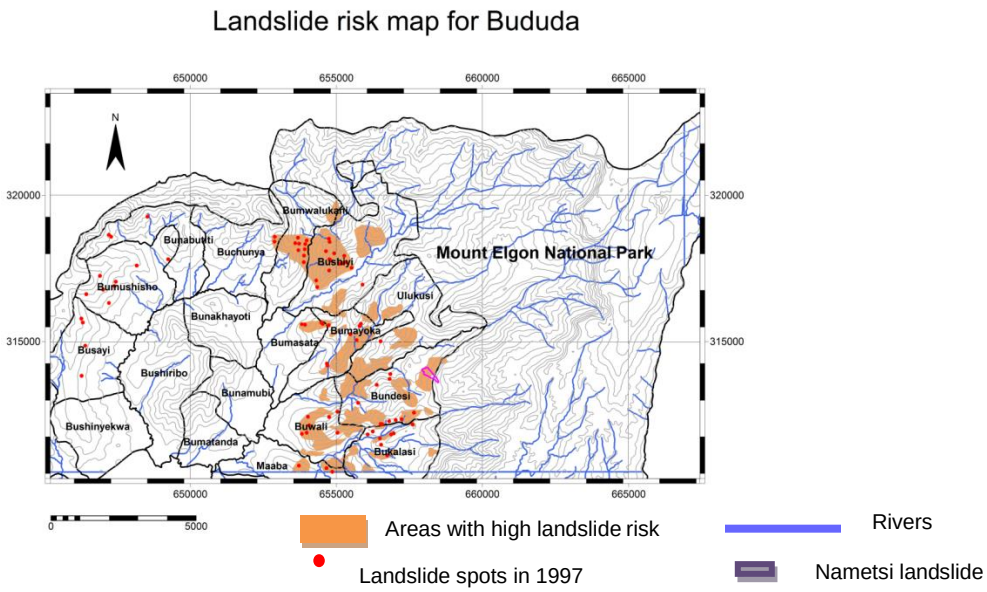

Figure. 3.5: Landslide risk map for Bududa District overlaid with the landslides that occurred in 1997.

3.2.2. Landslides in Bulambuli and Sironko Districts.

Bulambuli District was curved out of Sironko District in 2010. Part of the district falls within the Mount Elgon volcanics which are known for its environmental sensitivity. On the night of 29th to 30th August landslides devastated the parts of Sisiyi and Buluganya killing 26 people. It was also reported without confirmation that some four people were swept down by flash floods making the number of the dead 30. In addition on the 3rd June 2012 a landslide occurred in Bumasifa in Sironko district destroying 7 houses and killed two people.

Landslides mostly occur in 11 sub-counties and these included Zesui, Buginyanya, Bumasifwa, Buluganya, Masila, Bulago, Buyobo, Buwalasi, Butandiga, Busulani and Sisiyi. In Sironko Zesui area is most affected while in Bulambuli Namusuni and Lusya are the area's most prone to landslides. Since 1951, Ninety five landslides have occurred and 32 people killed (***Table. 3.4)***. The records for the people killed and affected is very scanty and unreliable because there are no official records for these disasters and people tend to remember those landslides where there is loss of life as compared to those without.

	Period					
	1951-61	1962-71	1972-81	1982-91	1992-2001	2001 - 2013
No of landslides	7	13	6	13	53	3
No. of people killed.	Not known	Not known	Not known	Not known	Not known	32

Table. 3.4: Landslide occurrence between 1951 and 2001

Many sub counties in Sironko and Bulambuli recognize landslides as a major social problem and they have been integrated in their Sub-county Development plans. However, mitigation measures put in place are on individual basis and they are inadequate. Neither the sub-county nor the district local governments have made any effort to mitigate the landslide problem. High population pressure, over-cultivation and deforestation were seen as drivers to landslide occurrence and they are more common on cultivated land. Based on indigenous knowledge, the local population can tell with a high degree of certainty using early warning signs the landslide prone areas. However, very few respond to such warnings because of the costs involved. As an intervention some sub-counties were aided in 2001 through a Germany funded project to begin tree seedling banks for farmers but this has been abandoned since the project ended. Plate. 3.3 shows a landslide in Bumasifa which killed one elderly person in 2012.

Plate. 3.4: A landslide in Bumasifa which killed one elderly person in 2012.

Mabono landslide, 2011 (Bulambuli District)

On the night of 29th to 30th August 2011 landslides devastated the parts of Sisiyi and Buluganya killing 26 people. Mabono Parish in Sisiyi sub-county was most affected with over 10 landslides of which three were disastrous. The other sub-county affected was Buluganya where surface water flow from the Butandiga ridge caused many slips. Most of the landslides in Mabono parish were caused by high run-off from the steep cliffs however the most disastrous landslide was a translational slide that ended up in a mild flow. This landslide killed 16 people and was triggered by heavy water flow from the agglomerate cliff in Buginyanya. This water saturated the B horizon of the soils below the cliff that is rich in clay causing the soil block to move for about 300m before it was deposited on the lower area where there were houses. One of the survivors from this landslide narrated her ordeal and how she survived narrowly. It was reported that it rained continuously for about eighteen hours. The length of the landslide was 500m, the depth of the scar was 4m and the volume of debris displaced was 400,000 cubic meters. The main impacts of these landslides are loss of life, loss of farmlands, damage to property, roads and bridges.

Photo credit: Dr. Kitutu Goretti, 2011

3.2.3 Recommendations for Bulambuli and Sironko district on how to minimize landslide disasters.

- Areas below agglomerate cliffs should be vacated. This includes areas below the Buginyanya ridge, also those below the Butandiga ridge and also in Buluganya.
- Settlements should not be allowed in areas of 1000m (minimum) from the ridge unless if the ridge has thick forest cover.
- Areas with cracks should be vacated and restored with intensive agro-forestry.
- Areas with known landslide risk (moisture zones) should not be used for settlement. This includes valleys and depressions on hills were water collects.

- Education of the youth should also be taken as priority to reduce the pressure on land. This will enable them get skills and look for alternatives rather depending on land alone.

- Community sensitization on development programmes should be taken as a priority.

3.2.4 Early warning signs for landslides.

- Watch out for landslides during seasons of intense rainfall and also during El Nino years.
- Rainfall events that go on for days while delivering little amounts of rainfall cause more landslides.
- The months of May to June and August to November have more landslide occurrences.
- Slopes with cracks are early signs of an impending landslide and should be avoided.
- Bent trees and appearance of water suddenly from the ground during rains are also signs of a likely landslide.
- Small soil slips after undercutting of a slope during road or house construction are early signs of a failing slope this mostly occurs in Bududa.
- Avoid areas of water collection commonly known as moisture zones.
- In Bududa district avoid settlement in areas with dykes, these are very steep and are affected by landslides every year.
- Areas below bare agglomerate cliffs more especially in Sironko and Bulambuli are prone to landslides.
- Slopes that steep and bare in the Mount Elgon and Rwenzori regions should not be used for settlements.