LANDSLIDE DISASTERS' CAUSAL/TRIGGER FACTORS AS UNDERSTOOD BY THE INDIGENOUS PEOPLE IN MURANG'A COUNTY, KENYA

Landslides constitute a considerable number of natural disasters globally. Landslides are not new in Kenya yet a dearth of information about the disasters has been reported. Murang'a County presents a unique case of geographical interest because of all the counties traversed by the Aberdare Ranges, it is the only one with the most serious, deadliest and recurrent landslides, especially in the recent past. Most studies on landslide disasters are limited to the scientific assessment and understanding neglecting the indigenous knowledge albeit the fact that indigenous people are affected in one way or another by the disasters. This research aims at highlighting the residents' indigenous knowledge of landslide causal and trigger factors. Primary data are analyzed through descriptive and inferential statistics in IBM-SPSS package. A total of 336 household questionnaires were administered, with an average response rate of 86%, complemented with, 8 Key Informants Interviews and 7 Focus Group Discussion. The key research findings were that indigenous people understood the landslide causal/trigger factors and their contribution landslides occurrences. The identified factors were rainfall, elevation, slope, soils and land-use land-cover. In conclusion, the study recommends the application and integrated of indigenous knowledge with existing scientific knowledge in the understanding of landslide disasters formulation of a policy framework at the county or national government levels. Also, landslides being highly localized, the study recommends further localized research targeting only the households affected by the landslides to gain closer understanding according to their knowledge and experiences through interaction with landslide disasters.

Keywords: landslide disasters, cause/trigger factors, indigenous people, indigenous knowledge, Murang'a County

1. INTRODUCTION

The First United Nations (UN) Sustainable Development Goal (SDG) seeks to end poverty in all its forms everywhere in the world. Its target number Five (1.5) aims to build resilience of the poor and those in vulnerable situations and reduce their exposure and susceptibility to, among others, climate-related extreme events, environmental shocks and disasters by the year 2030. Building resilience of the poor and strengthening disaster risk reduction is a core development strategy for ending extreme poverty in the most afflicted countries [1]. On the same strength, the social pillar of Kenya's Vision 2030 seeks to have *'a just and cohesive society enjoying equitable social development in a clean and secure environment'* [2] (Page. 2). The pillar emphasizes on 'investing in people of Kenya' and with respect to the environment, it seeks to enhance disaster preparedness in prone areas and improve adaptation capacity of the people [2].

Global inventories of natural hazards which extends over a large geographical space such as hurricanes and earthquakes can be cited, contrary to the cases of hazards of small spatial extents such as landslides [3]. Landslide disasters are climate-related extreme events which are recognized [4] but are poorly documented and characterized in the world [5] [6], yet are projected to increase in future due to population pressure and associated land-use changes exacerbated by climate change in the tropics [6]. In a cited case, though debatable, it was contended that landslide studies are available only in areas where development projects are to be initiated [7]. A noticeable geographical bias against Africa, South America and Oceania in landslides vulnerability research where the disasters are poorly studied as opposed to regions such as China, Italy, Turkey and India [8].

The East African region has reported major landslides [9] and Kenya is indeed characterized as a disaster prone country [10]. Like many areas of the world, particularly in the tropical developing countries, Kenya is at risk of landslides and their associated effects [11] which leads to hundreds billions of Dollars loss [12]. Landslide disasters are not new phenomena in Kenya [13] [14] [15] yet a dearth of information about the same has been cited in the country [13] [14] [16]. Murang'a County presents a unique case due to its geographical location within the Aberdare Ranges, which runs across other counties such as Nyeri, Nyandarua and Kiambu, but with Murang'a landslides being recurrent in the recent past [15] and deadly [9].

Landslides are highly localized and occurs in small geographical extents. Indigenous people are some of the main players in disaster risk management continuum and are affected in one way or another [15]. People living in landslides prone areas have huge experiences about landslides but have remained hugely unexploited. Generally, landslide disaster research have concentrated on the scientific understanding of landslides and their effects. A dearth of the local people's understanding exists not only in Murang'a but across the world. Kenya's disaster management policy provides a general architectural guidance on the country's disaster management. The framework outlines how the disaster actors and sectors should coordinate and act but not specific on any one given disaster. It stipulates that research investments should include best practices based on indigenous knowledge and traditional technologies which helped a given community to sustainably be resilient to disasters in the past. It further advocates for the local community to be viewed as not only vulnerable but as having potential and strength in disaster management. This is in line with the current approach in disasters risks management approaches in the world that advocate for local participation and a people-centered approach [17]. However, the policy is an abstract and a general framework for any disaster and fails to show how indigenous knowledge can be mainstreamed.

2. METHODOLOGY

2.1 The study area

The study area is located in Kenya, which is in the Eastern part of Africa, lying approximately between Eastings 34^o and 42^o and Northings 4^o 22' and -4^0 28'. The country is divided into almost two equal parts by the equator and borders Uganda to the West, Ethiopia and Southern Sudan to the North, Tanzania to the South-West, Somalia to the East and the Indian Ocean to the South East. The country's area coverage is approximately 587,000 km^2 of which 11,000 km^2 consists of water bodies. The new Constitution of Kenya, promulgated on 27^{th} August 2010, provides for a two-tier government structure with one national government and fourty-seven (47) devolved county governments. Murang'a County is one of the five counties of the former Central Province and is county number 21 according to the First Schedule of the Kenyan Constitution [18]. The county borders the following counties: Nyeri (North), Kiambu (South) and finally Nyandarua (West) and Kirinyaga, Embu and Machakos counties to the east as shown in Figure 1. Murang'a County lies between latitudes 0^o 34' South and 1^0 7' South and longitudes 36^o East and 37^o 27' East and has seven sub-counties namely: Kiharu, Gatanga, Kigumo, Kandara, Mathioya, Kangema and Maragwa. The administrative units of are: Murang'a East, Kahuro, Murang'a South, Gatanga, Kigumo, Kandara, Mathioya, Kangema [19]. Administrative units Murang'a East, Kahuro and Kiharu are in Kiharu Sub-county while Muragwa Sub-county is made up of Maragwa and Murang'a South administrative units. The county is spatially expansive, spanning from an alpine zone defined by a tropical forest called the Aberdare Forest to semi-arid zones bordering Machakos and Embu Counties. The altitude ranges from 914 meters ASL in the lowlands East and 3,354 meters ASL in the highlands west along the slopes of the Aberdare Ranges. The highlands consists of volcanic rocks of the Pleistocene age containing porous beds and disconformities which acts as important aquifers and is origin of many streams while the lowlands has basement rocks of Achaean type. The latter has dissected terrain characterized by valleys and ridges which makes the zones prone to landslides and erosions.

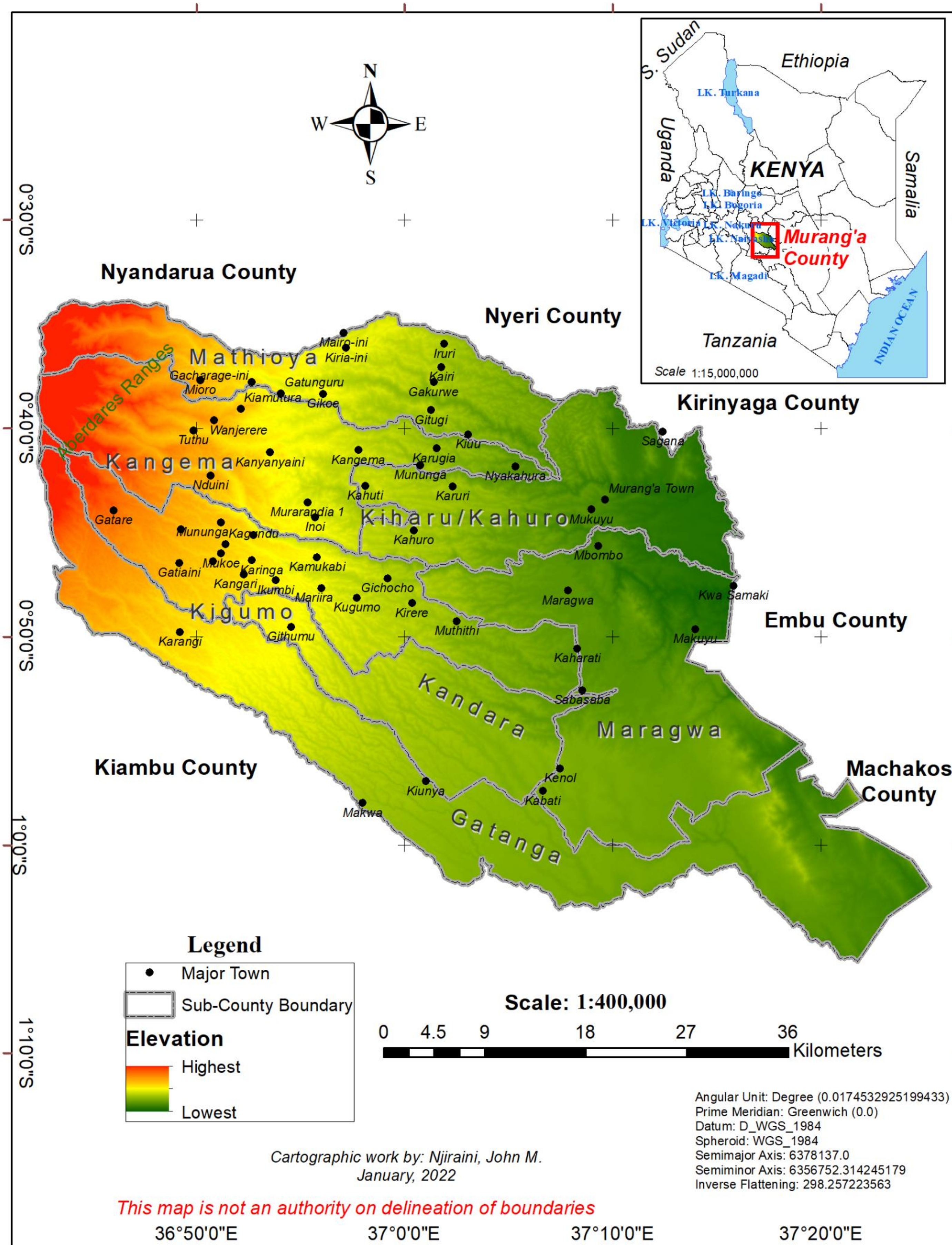

Figure 1: The Study Area in Murang'a County, Kenya

2.2 The Study Population

According to [20], a clear definition of the study population is the first stage in the sampling process. Population is usually related to the inhabitants of a given region. A target population is the finite collection of units from which data is sought in a survey [21]. The study area comprised of six sub-counties which were purposively selected according to the reported landslides cases for the year 2018. The sub-counties are: Kangema, Mathioya, Kiharu/Kahuro, Kigumo, Kandara and Gatanga. Murang'a has had recurrent landslides over the years but March-April-May (MAM) 2018 had the highest number of serious landslide cases ever reported in the county according to the Murang'a Meteorological Services [22]. Out of the seven sub-counties of Murang'a County, only Maragwa had no serious reported cases in the reference year hence was not studied. The study locations had a total population of 85,895 people distributed over 26,201 Households (HHs) [23].

2.3 Sampling

2.3.1 Sample Size Calculation

The sample size was calculated using the Slovin's computation formula expressed as follows:

$$n = N/1 + N(e)^2$$

Where:

N is the total HH numbers,

n is the sample size,

e is the margin of error at 0.05

The Slovin's computation, previously used in a research about indigenous perception and strategies on climate change [24], yields a total sample size of 30,247 people at a confidence level of 95%. Finally, weighted computation was calculated to standardize the final HHs to be sampled through proportionate HHs for each administrative location according to the respective population and the total population for all the target locations [25]. For proportionate sampling, below formula was used:

$$n = \frac{p}{u} * s^n$$

Where:

n is the proportionate HHs

p is the total sample size for respective location

u is the total HHs in all locations

s^n is the total proportionate HHs

From the proportionate HHs computation, a total of 393 proportionate HHs were to be sampled in the study. A complete computation matrix for the Slovin's formula and proportionate HHs computation are shown on Table 1.

Table 1: Sample Size and proportionate sample HHs Computation

Sub-county	Location	Total Population	Total HHs	Sample Size	Proportionate HHs Sampled
Kangema	Kihoya	6,423	1,984	4,396	57
	Rwathia	7,417	2,261	3,939	51
Mathioya	Gitugi	7,682	2,308	3,870	50
	Kiru	10,381	3,266	2,859	37
Kiharu/Kahuro Kigumo	Murarandia	11,880	3,714	2,547	33
	Mariira	10,180	3,130	2,969	39
Kandara Gatanga	Kinyona	7,911	2,440	3,690	48
	Kibage	16,913	4,870	1,989	26
	Mbugiti	7,108	2,228	3,988	52
Total		**85,895**	**26,201**	**30,247**	**393**

Source: *Landslide for MAM, 2018 from Murang'a Meteorological Services (2021) and Populations and housing data from Kenya National Bureau of Statistics [23]*

2.4 Sampling Design and Techniques

2.4.1 Purposive sampling

Purposive sampling is non-probability judgmental sampling where a researcher deliberately selects the samples to obtain information that cannot be obtained from the rest of alternative choices [26] such as certain culture domains [27]. The techniques is selected as it is said to be suitable for studying and analyzing real-life phenomena [28]. The information in the context of the study is about the landslide disaster risks and more specifically the local peoples' understanding, was sampled from purposively selected sub-counties and locations in Murang'a County. For each of the study sub-county, administrative locations were also purposively selected based on the serious cases from MAM 2018 report by KMD which culminated in the following locations per sub-county: Kangema Sub-county had Kihoya and Rwathia Locations, Mathioya Sub-county had Gitugi and Kiru Locations, Kiharu/Kahuro Sub-county had Murarandia Location, Kigumo Sub-county had two locations namely Mariira and Kinyona, Kandara Sub-county had Kibage Location and lastly, Gatanga Sub-county had Mbugiti Location.

2.4.2 Systematic sampling for the Households (HHs)

The final stage in establishing the respondents for the questionnaires was through systematic sampling of the HHs in each selected administrative location. The starting point for the sampling was a centrally-located HH in each location as identified from the spatial distribution and positions of HHs on remote sensing image of each area. A centrally located HH with a previously reported landslide case was preferred but where such a scenario was impossible, any central HH was picked. Subsequent HHs were selected radially in all directions from the starting point at an interval of 80 HHs. The 80th HH interval was arrived at as it ensured a field coverage of 96% for all study locations. .

2.4.3 Sampling Frame

A sampling frame aids in obtaining the actual cases from which the survey is done and it must adequately represent the entire population [20]. The sampling frame of the study are HHs in the landslide disaster affected administrative locations as per MAM 2018 when the county experienced the largest number of landslide events over the history [22]. The respondent for each HH was the head of each household who is a male or female of mature age. In the cases where HH heads were unavailable, any other person of above 18 years of age were selected as respondents for the HH questionnaires.

2.5 Data sources

1. Household (HH) Questionnaires

Semi-structured and open ended questionnaires were used to collect data. Apart from the background information about the respondents' socio-demographic characteristics, the questionnaires had two thematic area sets of questions related to the study topic. These were the understanding of the factors causing or triggering a landslide and the degree of causality for each of the factors as understood by the indigenous people. Cronbach (1943) test was used to test the reliability and consistency of the questionnaires in which the scaled questions were subjected to Cronbach's to test the actual reliability and internal consistency of the instruments as shown in Table 2 below. Questions for the eight factors viewed as landslide causal/trigger factors had an Alpha value of 0.816 while for the same factors in terms of their degree of causality had 0.765, both of which are 'acceptable, values.

Table 2: Landslides causal/triggers factors Reliability Test

Theme	**Cronbach's Alpha**
As a Landslide Causal/Trigger Factor	
Rainfall	0.810
Slope	0.802
Elevation	0.802
Soil	0.801
LULC	0.777
Vegetation cover	0.787
Infrastructural development	0.797
Population	0.780
Degree of causality	
Rainfall	0.768
Slope	0.749
Elevation	0.741
Soil	0.762
LULC	0.716

Vegetation cover	0.723
Infrastructural development	0.726
Population	0.716

Source: Field Data

Key Informant Interview (KII)

KII interview is used to obtain first-hand and in-depth information from the local people [29]. KIIs supplemented the HH questionnaires as they provided data that would not have been captured through the main questionnaires [30]. KII have been used in a similar studies such as research on the role of traditional knowledge in botanical sustainable land management in Western Kenyan Highlands [29], indigenous perception and strategies in climate change adaptation in rural Ghana [24]. The key informants for the study were drawn from people with knowledge about the landslides, the experts and administrators or community leaders each of whom were interviewed through structured interview guides.

2. Focus Group Discussion (FGD)

FGD was used mostly to get an in-depth knowledge about the indigenous understanding of the landslide disasters in each study location. Members were largely drawn from the local population regardless of their education background or leadership status. Previously, FGD has been used to obtain indigenous knowledge for disaster mitigations through the discussions with community elderly and traditional leaders [31] and in studying the role of traditional knowledge in botanical sustainable land management in Western Kenyan Highlands [29]. It is notable that small cohorts of the population focuses on specific areas of study to yield valuable information [29]. The participants in the FGD were subjected to interviews through preset questions. A total of six FGDs were conducted with each location having one of between six and twelve members, a number which is considered adequate [32].

3. RESULTS AND DISCUSSION

3.1 HH Questionnaires Response Rate

Out of the Three hundred and ninety-three (393) HH questionnaires, a total of three hundred and thirty-six (336) were successfully completed and returned by the respondents, an overall average questionnaire return rate of approximately 86%. The rate is above the recommended return rate of 80% [33]. Individual return rate though varied per the purposively selected administrative locations. The HH questionnaire response rate per the study administrative location had a high rate recorded being 100% for Kibage Location while the lowest was recorded in Rwathia Location at 78%. The overall and the individual response rates per location were above the prescribed threshold of 70% [34], hence considered sufficient for a scientific study.

3.2 Demographic characteristics of the HH survey respondents

The demographic characteristics of the HH questionnaire respondents were varied in terms of their age, sex, and marital status and education levels. Age and education characteristics are of importance in the study as both may influence the understanding of landslide causal/trigger factors. In terms of sex, a total of 207 respondents were males comprising (61.6%) while 129 (38.4%) were females. There were no reported cases of intersex, which is in conformity with the Kenya Population and Housing Census (KPHC), 2019 data by Kenya National Bureau of Statistics (KNBS) which indicated insignificant intersex sex composition in the county. The marital status recorded comprised of 274 (81.5%) being married, 46 (13.7%) singles, 08 (2.4%) deceased and 04 (1.2%) being either separated or divorced. Age-wise, respondents who were above 50 years were 47.9%, with the youngest and oldest being 20 and 102 years respectively. The upper age cohorts were considered relevant to the study because of their accumulated years of experience and knowledge. The highest levels of education attained were reported as being primary and education levels at 139 (41.4%) and 130 (38.7%) respectively. Only 19 respondents representing a 5.7% had attained at least either diploma or undergraduate education level whereas 11.9% had no formal education but still considered relevant for the study.

3.3 Social-demographic characteristics of the HH survey respondents

The social-demographic characteristics of the HH questionnaire respondents were structured in terms of their occupation, approximate monthly income, place of birth, length of stay, land size, and the perceived population change in their localities. The dominant occupation was farming by 226 (67.3%) with tea farming being prominent crop by164 (48.8%), followed by coffee 60 (17.9%) and a mixture of the two crops by 51 (15.2%). Other notable crops on land included avocados, maize, bananas, Napier grass and a mixed cropping of at least two crops in one farmland. The type of crops on land is important in the study as Land-use land-cover

(LULC) types have an influence of the occurrence of landslides. The average farmland size was 1.79 acres with a vast number of occupants (84.4%) occupying less than 2.0 acres of land, an indication of land fragmentation which also indicates pressure on the farmlands. Impacts of diminished land sizes were portrayed also in in the income bands where 82.7% of the HHs reportedly having less than Kenya Shilling (Ksh.) 10,000 average monthly income. Only 11.0%, mostly in formal employment, were earning more than Ksh. 30,000 per month.

As far as the population dynamics were concerned, it was almost unanimously agreed by 324 respondents (96.4%) that, generally the population has changed over time. 294 respondents (87.5%) were in agreement that the population had increase over time as opposed to 29 (8.6%) and 13 (3.9%) who contended that there were a decrease and no change in population respectively. A vast number of respondents were locally born 280 (83.3%), out of which 94.7% have lived in their areas for more than thirty (30) years hence forming an important constituency with years of experience and knowledge. The numbers were boosted by 67.3% of immigrants, born elsewhere but relocated to their current locations and had over 30 years of stay as well.

3.4 Indigenous knowledge understanding of landslide disasters

The initial task was to seek an understanding of the indigenous peoples' interactions and experiences with landslides over time. Affirmatively, all the respondents (100%) said that they knew what a landslide is and a total 97.0% termed them as disastrous. In terms of their landslide frequencies, 298 (88.7%) agreed that there has been an increase in cases over time, whereas 24 (7.1%) and 14 (4.2%) were of contrary opinions as they indicated no increase and decrease respectively. Those who reported to have experienced a landslide were 317 (94.3%) out of which 252 (80.8%) cases were within a close proximity of less than 1km from their homes. 66.4% of respondents reported that they had been affected by a landslide at least once in their stay, an indication of how recurrent and localized the landslide are in the county.

3.4.1 Understanding and ranking of landslides' causal/trigger factors by the indigenous people

Having interacted and experienced landslide disasters in their lifetime, the indigenous people had varied understanding of the causal/trigger factors and their individual contributions to a landslide occurrence. A convincing 97.6% of them reported that they were aware of the factors which cause or trigger landslides. The prominently mentioned factors included: rainfall intensity, slope/steepness/gradient of the land, altitude/elevation, soil characteristics, land-use-land-cover, vegetation type of, infrastructural development and population increase in an area. These are the same factors which are scientifically known to contribute by causing or triggering landslides. But the big question which was contentious is how each of the factors contribute to a landslide. Generally and on average, all factors were ranked by the respondents as being above 70.0% in contributing to the occurrence of a landslide as shown in Table 3. However, rainfall was ranked as the most prominent causal/trigger factor by 329 respondents (97.9%) who termed it as 'the most dreaded.' A significant number of respondents (r=0.806 at 0.01 level (2-tailed) who had migrated in their current locations described rainfall as a major causal/trigger factor. Also, in a separated FGD, an elderly female in Murarandia Location from Kiharu/Kahuro Sub-county asserted the following in describing how rainfall is considered to be the most dangerous landslide causal/trigger factor in her area:

"Kungiuira mbura utuku mugima nginya kiroko, tuikaraga na wasiwasi tondu nitumenyaga no hindi ciothe kungituika guku- An elderly female FGD participant in Murarandia Location, Kiharu /Kahuro Sub-county"

Translated to:

"When it rains the whole night, we are always worried because we know that anytime a landslide may hit the area"

Gradient or steepness of the land was also mentioned as a major cause/trigger factor by 95.5%. For example a significant number of people (r=0.806 at 0.01 level (2-tailed) who had migrated in their current locations described it as a major causal/trigger factor. On the same note, a significant 86.2% (r=0.862 at 0.01 level (2-tailed), who reported to have experienced a landslide at least once in their home areas also termed slope as a major factor. Further in support of that, a participant drawn from a FGD in Kiharu/Kahuro said that an area called '*Kiriko-ini*,' a Kikuyu word which means *'the sunken-land'* experienced a landslide due to steep gradient which caused the land to sink and curve in to a depression. About 96% of the respondents mentioned soils as another prominent causal/trigger factor. For instance in Kigumo, Kangema and Mathioya Sub-Counties, locals described some areas as having loosely layered soils with middle parts being slippery and 'riding on a hard rock' hence prone to sliding upon trigger like rainfall. Specific parts of Kigumo were locally described as having '*kingare soils*', which basically means soils which are *'smooth and slippery'* (FGD participant at Mariira, Kigumo Sub-County). Elevation factor was also mentioned by 90.2% of the respondents, a lower ranking compared to other factors. Some of the respondents who considered elevation as being less in contributing to landslides argued that since elevation rarely changes through time, it cannot be considered to be a serious factor, especially with the increasing landslide cases in Murang'a. In support of that, one FGD participants from Rwathia, Kangema said:

> *"Elevation is not a key causal/trigger factor as it never changes. Our areas has always been in high altitude but we are seeing an increase in landslide cases no more than ever. Is there elevation change with increase in landslides? The answer is No!" – A male FGD participant in Rwathia Location, Kangema Sub-county*

Apart from the above listed factors, other interesting but equally notable causal/trigger factors mentioned by the participants and respondents were: Act of God to punish people due to wrong doings as was explained by a participant in a FGD in Gatanga Sub-county. Also on act of God was an issue of fallen heavenly body which looked like a circular star. The narrative was given in two separate sessions in Kangema and Kiharu/Kahuro. The participants explained that long time ago, a heavenly body fell from heavens and was buried deep in the ground. The body looked like a star and has been causing landslides to happen since then, especially once it is triggered to move. For a landslide to occur, the star tends to marginally sink under pressure from the earth's surface under trigger such as heavy rainfall. In concurrent with the claims, a FGD participant in Kangema said:

> *"The circular shape of the recurrent landslides in this area is a clear indication of the fact that a star which fell long time age, (as we were told by our fore-father) is the cause of the landslides here. Look!.... he said pointing at a fresh landslide scar, the crack separating the area washed away by the landslide and the unaffected area is curved, meaning the landslide boundary followed the circular shape of the fallen star. Our great grandparents were knowledgeable about it and passed the knowledge to us! - FGD participant in Rwathia, Kangema Sub-county"*

Other mentioned causal/trigger factors included: diverting of water from the road sides to channels through the farms from up to downs streams. Such diversions were evidently seen on the newly tarmacked roads in all the sub-counties under study.

After establishing the prominent landslide causal/trigger factors as understood by the indigenous people, the next step was to ranks them in order to allocate respective weights according to individual contributions to landslides as understood by the locals. The considered factors were: rainfall, slope, altitude soil, and LULC. Multiple response analysis in IBM-SPSS was done to accommodate overlapping multiple responses ad the final ranks were as shown in Table 2. The linear weight for all the factors are on a scale of 0 to 1 computed using the formulae:

$$Allocated\ Weight = individual\ Percentage\ Cases/Total\ PercentageCases * 1$$

According to the respondents, rainfall, with a weight of 0.21, had the highest affirmative response as the most significant landslide causal/trigger factor as known by the local people (99.7%). Again, this is in line with the experts' opinion that rainfall is the number one factor in causing the landslides in the area. The factor which was said to be least effective in contributing to landslides was the LULC and had the lowest weight of 0.18 at 86.7% acceptance percentage.

Table 3: Landslides causes/triggers factors ranks and weights by the indigenous people

As a landslide causal/trigger factor	Percentage Cases (%)	Allocated weight (%)
Rainfall intensity	99.7	0.21
Slope	97.3	0.21
Altitude	91.8	0.19
Soil characteristics	97.9	0.21
LULC type	86.7	

	0.18

Source: Field data

4. CONCLUSION

The indigenous people are among the main players in disaster risk management and are affected in one way or another through displacements, destruction of properties, death, psychological stress and other effects. This research makes the recommendation that the local people, who have years of experience with the landslides and accumulated knowledge, should be accorded a chance to have their voices in landslide disaster management in Murang'a County. Public participation meetings should be organized to collect their views, the outcome of which should be officially entrenched in policies and other strategic documents.
The study is timely and important based on the fact that landslides in Murang'a County are recurrent and with numerous effects on the local people, who are the most affected by the disasters yet neglected in disaster management continuum in the county. The indigenous people's understanding about landslide disasters needs to be explored.

Consent

As per international standard or university standard, respondents' written consent has been collected and preserved by the author(s).

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COMPETING INTERESTS:

AUTHORS HAVE DECLARED THAT NO COMPETING INTERESTS EXIST. THE PRODUCTS USED FOR THIS RESEARCH ARE COMMONLY AND PREDOMINANTLY USE PRODUCTS IN OUR AREA OF RESEARCH AND COUNTRY. THERE IS ABSOLUTELY NO CONFLICT OF INTEREST BETWEEN THE AUTHORS AND PRODUCERS OF THE PRODUCTS BECAUSE WE DO NOT INTEND TO USE THESE PRODUCTS AS AN AVENUE FOR ANY LITIGATION BUT FOR THE ADVANCEMENT OF KNOWLEDGE. ALSO, THE RESEARCH WAS NOT FUNDED BY THE PRODUCING COMPANY RATHER IT WAS FUNDED BY PERSONAL EFFORTS OF THE AUTHORS.

AUTHORS' CONTRIBUTIONS

The corresponding authors designed the study, conducted the fieldwork, statistical analysis and wrote the first draft of the manuscript with strict guidance from Dr. F. Okaka and Prof. Paul Omondi. All authors read and approved the final manuscript."

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Appendix

DEFINITIONS OF IMPORTANT TERMS

Disaster Causal/trigger factors: These are the factors which causes and/or trigger a landslide disaster hence contributing to the occurrence of a landslide event in an area. In the context of the study, causal/trigger factors are synonymous to the pre-disposing factors, sub-elements and sub-systems. Also referred to as 'the factors'

Local people: Refers to the people living in a certain locality. In the context of the study, local people refer to the inhabitants of the study area without any qualifications. They are also referred to as local people or simples the locals

Local peoples' knowledge/Indigenous knowledge: is the basic understanding of the landslides system by the inhabitants or residents of Murang'a, regardless of their socio-economic, cultural, political or otherwise status affiliations in the community. It refers to the information held by the residents over time about the landslide disasters.

Household (HH): Refers to a person or group of persons who reside in the same homestead or compound headed by a household head who is a person above the age of 18 years regardless of the sex.

'Mzee wa mtaa': Swahili for '*village elder'*, a person appointed to lead and link the people in his or her village with government administrators as part of community policing. Also called '*mzee wa nyumba kumi'*. He/she must be a senior resident of the village hence knowledgeable about the area and is usually of age. *Mzee wa mtaa* is the first line of contact in case of any incidence such as a hazard or disaster in her/his jurisdiction hence provides a very crucial link between people at grassroots and both county and national governments.