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Article

Vulnerability Assessment to Flood Hazards of Households in Flood-Prone Areas of Kasese District, Western Uganda

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Abstract: The study evaluated the level of household vulnerability to flood hazards in Kasese municipality, Kasese district, Uganda. The study used an indicator-based methodology. About 210 respondents were randomly sampled for interview. Individual weights for each indicator were allocated using Principal Component Analysis. Indices of vulnerability were created at the home level and combined at the division level. A Chi Square test at a significance level of 5% was used to test for differences in the level of household vulnerability. The results revealed that Nyamwamba division was most exposed while Central was least exposed to floods. The Central division was also found most sensitive while Bulembia was least sensitive to floods. Central division had better capacity to cope with floods while Bulembia had the least capacity. Results revealed a significant difference in the level of households' vulnerability across the divisions. However, overall, Nyamwamba was found most vulnerable and Central least vulnerable to floods. About 43.8% of the households in Kasese municipality were found highly vulnerable to floods. Therefore, urgent attention by the government through policy action measures towards climate change adaptation should be given to address the high levels of vulnerability.

Keywords: floods; vulnerability; exposure; adaptive capacity; Uganda

1. Introduction

Disaster risk management was born out of a desire to mitigate the consequences of climate change on the built environment (Etinay *et al.*, 2018). According to IPCC (2018a), In order to increase human security, well-being, quality of life, and sustainable development, disaster risk management involves developing, implementing, and evaluating strategies, policies, and measures. It also encourages disaster risk reduction and transfer as well as continuous improvement in disaster preparedness, response, and recovery procedures. The Sendai Framework also highlights the need for a comprehensive strategy that incorporates prevention, readiness, response, and recovery for managing risks related to natural and human-caused disasters (Maini *et al.*, 2017; UNISDR, 2015).

A calamity happens when a risk encounters a weak system. It is crucial to note that managing flood hazards is required because they cannot be entirely eliminated (Nasiri *et al.*, 2016). Therefore, flood risk management plans should be created to guarantee that human casualties and financial expenses are kept at a manageable level. Establishing or evaluating the condition of the system for which this study was conducted is necessary to lessen the community's or system's vulnerability to floods. Planning mitigation (being ready for the catastrophe before it happens), response (responding to the event), and recovery are all covered by flood risk management strategies (Tingsanchali, 2012).

When a hazard event (such as a flood, cyclone, drought, etc.) occurs, triggering a loss of life and damage to infrastructure, it highlights the reality that society and its assets are

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vulnerable to such events. A disaster highlights the geographical area (where the community is settled is exposed to such a hazard); the society (including individuals) and its infrastructure, assets, and other processes as well as services that may have experienced damage or destruction. People's vulnerability (i.e., how much they lose when they are hit) is a critical determinant of the impacts of natural disasters. When poor people are affected, the share of their wealth lost is two to three times that of the nonpoor, largely because of the nature and vulnerability of their assets and livelihoods (Hallegatte *et al.,* 2017). Therefore, the commitment of the international community to tackle disaster risk reduction and disaster resilience building in the framework of sustainable development and poverty eradication (UNISDR, 2015). However, catastrophe risk and development are intimately related since development processes play a significant role in determining the assets and people at risk, as well as their capacity and vulnerability (Thomalla *et al*., 2018).

Natural disasters like floods, landslides among others are occurring with increasing frequency and are causing severe levels of property and financial damage to affected communities (O'Neil *et al.*, 2016). These disasters therefore constantly affect peoples' lives and livelihoods (UNISDR, 2007; John-nwagwu *et al*., 2014; Salam *et al*., 2017). In the recent past, the frequency and gravity of large-scale flood disasters have increased globally, resulting in casualties, destruction of property, and huge economic loss (Salami *et al.*, 2017). For instance, from 1998 to 2017, more than 55% of all fatalities worldwide occurred as a result of floods, affecting approximately 2.5 billion people (EM-DAT, 2015).

Like the rest of the world, floods are also common in Uganda (Ogwang *et al*., 2012). Besides causing death, floods destroy public health facilities and various infrastructures among others (DDPM and OPM, 2011). Between 1997 and 2007, floods affected close to one million people in Uganda (DDPM and OPM, 2011). Kasese Municipality is plagued by natural disasters, particularly floods which occur every year causing catastrophic damage to property and human lives (Jacobs *et al*., 2017; Tibara *et al.*, 2021a). The IPCC (2014) estimates that in many locations, intense and frequent extreme precipitation events, like as floods, will occur more frequently. Kasese Municipality has experienced at least three major flood disasters in the last decade. These flood disasters will continuously impact people in the area by enormously damaging property and infrastructure, substantially causing loss of lives and livelihood of people (KDLG, 2020b).

This continuous exposure to flood disasters affects household vulnerabilities which affect capacities to respond to the consequences of natural hazards. This is critical given that 97.4% of the households in Kasese are not living in decent dwellings, 44% lack clean and safe water, and 81.1% engage in crop growing (Uganda Bureau of Statistics [UBOS], 2017) which are affected more by flood disasters. Additionally, a study in Kasese revealed that extreme flooding increases the risk of the spread of malaria (Boyce *et al*., 2016), yet 73.5% of households have no access to health facilities (UBOS, 2017) which may affect their vulnerability. In 2012, Belgian Technical Cooperation (BTC) and KDLG reported that Nyamwamba and Bulembia divisions have got a majority of extremely poor households. The poor are disproportionately affected by natural disasters because they lack the resources to prepare for and deal with their effects.

Although studies on the climate change vulnerability of rural farmers, flash flood reconstruction, study of exposure impacts, weather shocks, urban livelihood alternatives, and temporal rainfall variation in Kasese (Berman *et al.*, 2015; Cooper and Wheeler, 2017; Jacobs *et al*., 2017; Akampumuza and Matsuda, 2016; Tibara *et al.,* 2021b), no study had precisely evaluated the degree of exposure, sensitivity, and ability of households in this area to deal with flood dangers. Therefore, considering the situation of floods in Kasese Municipality, research on the assessment of household vulnerability was urgently needed. Assessing households' vulnerability facilitates the implementation of adaptation measures for residents of flood-prone areas (UNISDR, 2015; Cooper and Wheeler, 2017).

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2. Materials and methods

2.1. Study area.

The research was undertaken in Kasese municipality found Kasese district, Uganda found in East Africa. The Municipality covers a land area of 93.4 square kilometers and lies on Latitude: 0^0 28′ south, Longitude: 30^0 35′East, and an average altitude of 1,441 meters. The Municipality is divided into three divisions i.e., Bulembia, Nyamwamba, and Central divisions (Figure 1). These divisions fall under the hazard-prone area where households have been ravaged by flash flood disasters (IFRC, 2013) and therefore provided a better study with households for the assessment. Kasese Municipality is bordered by Rukoki sub-county, Kilembe, Rukoki, Bugoye, Muhokya Karusandara, Kyarumba, and Hima sub-counties (Figure 1). Kasese district lies between latitudes $0^0$12′S - 0^0 26′N; longitudes 29^0 42′E - 30^0 18′E and is bordered by the districts of Bundibugyo in the North, Kabarole in the North East, Kamwenge in the South East, Rubirizi in the South and the Democratic Republic of Congo in the West (KDLG, 2016).

Kasese Municipality was chosen because it's highly plagued by natural hazards, particularly flash floods which occur every year causing catastrophic damage to property and human lives (Jacobs *et al.*, 2017). The Municipality has experienced at least three major flood disasters in the last decade that have left trail destruction of properties (IFRC, 2013; KDLG, 2020a).

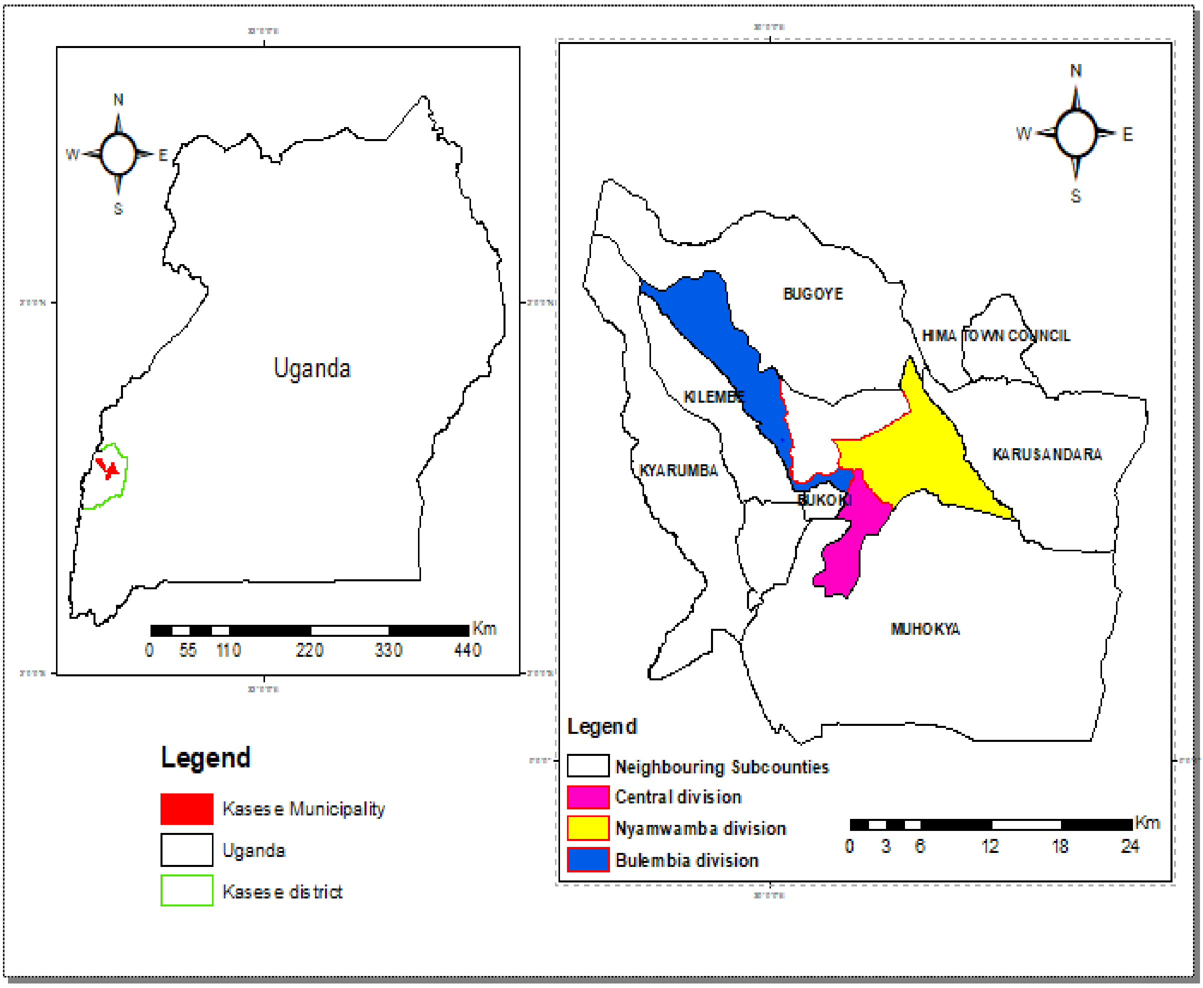

Figure 1. Map showing the study area.

Bimodal rainfall is experienced in Kasese district. The initial rains are brief but intense, falling between March and May, while the lengthy, light rains fall between August and November. The annual rainfall ranges from 800 to 1600 mm, and altitude has a significant impact.

The temperature in Nyamwamba catchment in which Kasese municipality is located changes depending on elevation, from 0 to 25^{0}C at a high altitude and from 8 to 30^{0}C at low altitudes (DWRM, 2012).

2.2. Research design

For this study, a cross-sectional survey was used. The research design for this study involved a cross-sectional survey. This was because of the limited time frame of the study which necessitated gathering information on a small sample population at a single point in time. The level of household vulnerability to flood hazards in Kasese Municipality was evaluated using an index-based technique. This approach gives a more precise overall flood vulnerability. A quantitative method was employed in the study. A quantitative method was used to collect data on the selected household indicators under exposure, sensitivity, and capacity. Using a semi-structured questionnaire uploaded on a GoSurvey app, primary data was gathered. For each division, the exposure, sensitivity, and adaptive capacity indices were calculated, and thus each division's total vulnerability indices computed.

Primary data was collected using a semi-structured questionnaire using a GoSurvey application. The exposure, sensitivity, and adaptive capacity indices were computed for each division. The overall vulnerability indices for each division were computed.

2.3. Methods of data collection

This study utilized both secondary and primary data. Secondary data was obtained through an extensive literature review. A literature review was conducted on books, scientific articles, and reports, and the combination of various literature types was vital in focusing on the study, improving the methodology, identification of the different indicators under the different components of vulnerability, and identification of knowledge among others. Primary data was obtained from the field from household respondents.

During primary data collection, before the interviews began, each respondent was informed of the objective of the study by the locally trained field assistants. The confidentiality of the research was explained to the respondents, and they received assurances that the data would only be used for research. Consent was sought before the interview. The respondents had a right to decide whether to participate and could withdraw at any stage of the interview process.

2.4. Sampling framework, Sampling technique, and Sample size

Kasese Municipality is divided into three divisions i.e., Central, Bulembia, and Nyamwamba.

At least one flood occurred in these divisions over the past ten years (KDLG, 2020a) and are therefore vulnerable to floods. Further, in 2012, BTC and KDLG reported that Kasese municipality had the majority of extremely poor households. Yet the poor suffer the brunt of natural disaster impacts due to inadequate resources to respond to the effects of the shocks (Wahab *et al*., 2013).

According to UBOS (2017), the Municipality had 25,497 households. The study's sample size was calculated using Cochran's (1977) method for determining sample size (Equation (1);

$$\text{Sample size (SS)} = \frac{Z^2(P)(1-P)}{e^2} \quad (1)$$

p is the percentage picking choice given as a decimal (0.5 is utilized for the necessary sample size), e is the precision value (0.07 = ±7), and Z is the confidence level (± 1.96 at 0.95). This method was used because since it provides a small sample size that is reliable and representative of a larger population. From Equation (1), a sample size of 196 households was obtained from the three divisions and therefore, 65.3 households from each division. For comparative purposes across the three divisions, a total of 210 samples were collected, i.e., seventy (70) households from each division. In each division, one ward was selected and from each ward, two cells were purposefully selected. These were cells that had experienced floods in the last decade according to the information by the local authority. Thirty-five (35) households were systematically randomly selected from each cell to avoid bias in the study. The household survey was undertaken using a GoSurvey application which was installed on android mobile phones. The survey was undertaken face-to-face by trained field assistants who interviewed household respondents, explaining questions for clarification as required. Since it was expected that household heads would have clear, accurate, and reliable information about their houses, the study specifically targeted them as respondents. Additionally, the questionnaire was written in English and given out by trained field workers who could translate the questions into some respondents' native tongues if they didn't understand English.

2.5. Methods of data analysis

Vulnerability is expressed in terms of exposure, sensitivity, and adaptive capacity (Rehman *et al*., 2019). Therefore, the household vulnerability to flood hazards was assessed using three components i.e. exposure, sensitivity, and capacity (Cendrero and Fischer, 1997; Nasiri *et al*., 2019). An indicator-based method was used for the assessment (Balica *et al*., 2009; De Ruiter, Ward, Daniell, and Aerts, 2017; Nasiri *et al*., 2016; Rana and Routray, 2018; Rehman *et al*., 2019). Several authors have used this method in assessing vulnerability (Balica *et al*., 2013; Bhattacharjee and Behera, 2018; Munyai *et al*., 2019; Rana and Routray, 2018; Shah *et al*., 2018; Kablan *et al*., 2017).

The indicator-based method depends on indices and therefore, the vulnerability index was based on three operational component indicators; exposure, sensitivity, and capacity (Cendrero and Fischer, 1997; Nasiri *et al*., 2019). The vulnerability index was computed from Equation 2.

$$\text{Vulnerability Index (VI)} = (E + S) - AC \quad (2)$$

Where E represents index for Exposure, S represents index for Sensitivity and AC represents index for adaptive capacity (Balica *et al*., 2009; Chombo *et al*., 2018). However, sometimes resilience is interchanged with capacity (Balica *et al*., 2012; Turner *et al*., 2003). In addition, qualitative and quantitative data were collected.

Indicators on the factors/vulnerability component are presented in Table 2, Table 3, and Table 4. The indicators under the different categories were then broken down into different classes basing on their features. The classes were developed illustrating the level of variation available in the respective variables.

The indicators were then normalized using Equation 3 to make them comparable.

$$x_{ij} = \frac{X_{ij} - MinX_{ij}}{Max\,X_{ij} - Min\,X_{ij}} \quad (3)$$

Where x_{ij} represent the value standardized for indicator *i* of the unit/household *j*; X_{ij} represent the indicator *i* value corresponding to the unit/household *j*; Min and Max represent the minimum and maximum scaled values of indicator *i*, respectively (Nhuan *et al*., 2016; Fritzsche *et al*., 2014). Weights were assigned to different indicators using Principal Component Analysis (PCA).

After well weights appropriation to classes for respective indicators, the variables normalized were multiplied with the weights assigned to develop the components of vulnerability as in Equation 4 below.

$$I_j = \sum_{i=1}^{n} b_i \left[\frac{a_{ji} - x_i}{s_i}\right] \quad (4)$$

where '*I*' represent the index value for each components, 'b' represent the loadings from the 1st component from PCA taken as weights for each indicators, 'a' represent the value of each indicator, 'x' represent the average indicator value, and 's' represent the standard deviation of the indicators (Kimani *et al*., 2015; Piya *et al*., 2016). The composite vulnerability index for the each/respective division was then determined from Equation (2)

The household survey data was processed using descriptive and inferential statistical methods, and PCA. Descriptive research accurately characterized the households and inferential statistics was used in testing the hypothesis. To test the hypothesis, a Pearson's chi square ($\chi 2$) test at a confidence level of 95% was used.

3. Results and Discussion

3.1. Socio-economic features of respondent

The household field survey was carried out in three divisions (Central, Bulembia, and Nyamwamba) in which 210 respondents were randomly selected. Table 1 presents descriptive statistics of sampled households interviewed. Out of the 210 household respondents interviewed, a majority (52.6%) were of the female gender and 78.1% were married. Most (41.0%) respondents were in the age range of 30-39 years, a majority (39.0%) of the respondents had secondary education and only 10.5% had tertiary education.

Table 1. Socio-economic features of the respondents.

Socio-economic features		Percentage (%)
Gender	Male	47.4
	Female	52.6
Marital status	Single	9.0
	Married	78.1
	Separated/Divorced	5.7
	Widowed	7.2
Age (years)	18-29	38.1
	30- 39	41.0
	40-49	14.3
	50-59	5.2
	60 and above	1.4
Highest education attained	No formal Education	13.3
	Primary Education	36.7
	Secondary Education	39.0
	Tertiary Education	10.5
	Others	0.5

Source: Fieldwork August 2020

3.2. Household's exposure to flood hazards

Table 2 presents the six indicators under exposure. The household size and the number of times households experienced floods in the last 10 years had weights of 0.534 and 0.094 respectively. The average household size for the three divisions was five persons per household, and the average household size for Central, Bulembia, and Nyamwamba were 4.8, 4.5, and 5.8 persons respectively (Table 2). Similarly, the majority (99.5%) of the households had at least experienced floods in the last ten years and most (32.4%) of these had experienced floods three times in the last decade. A majority (67.1%) of the households were in a nucleus family setting and only 14.8% were extended families. Most (58.6%) of the households in Bulembia had member(s) who had experienced injury/death in the previous flood events and was least (40.0%) in Nyamwamba. Most (96.7%) of the households across the divisions had houses constructed with brick. All the households surveyed in the Nyamwamba division were found within two kilometers of river Nyamwamba. All the indicators had a positive relationship with exposure except the type of dwelling/house structure for the households and household's that received any form of warning about previous flood events as indicated by their negative weights (Table 2). Therefore, the type of dwelling/ house structure for the household and households that received any form of warning about previous flood events reduced the level of exposure.

The household index value of exposure varied from -15.643 to 2.495 in the Central division, -2.1423 to 1.972 in the Bulembia division, and -1.371 to 2.601 in the Nyamwamba division. There was no significant difference in the level of household exposure ($\chi2$ =16.195, p=0.335). The exposure indices for each division are presented in Figure 2.

Table 2. Exposure indicators across the divisions and their respective weights.

S/n	Indicator	Classes	Weights	Aggregate n=210	Central n=70	Bulembia n=70	Nyamwamba n=70
				Percentage (%)			
1	Type of the household family	Extended family	0.510	14.8	10.0	10.0	24.3
		Nucleus family		67.1	70.0	67.1	64.3
		Single family		18.1	20.0	22.9	11.4
2	Households with member(s) who experienced any loss of person/injury in the past floods	No	0.026	50.0	48.6	41.4	60.0
		Yes		50.0	51.4	58.6	40.0
3	Type of dwelling/ house structure for the household	Brick walls with iron/tiles sheet roof	-0.137	96.7	92.9	100.0	97.1
		Mud walls with iron/tiles sheet roof		3.3	7.1	0.0	2.9
4	Households that received any form of warning about previous flood events	No	-0.168	85.2	100	100	55.7
		Yes		14.8	0	0	44.3
5	Household size		0.534				
6	Number of times households experienced floods in the last 10 years		0.094.				

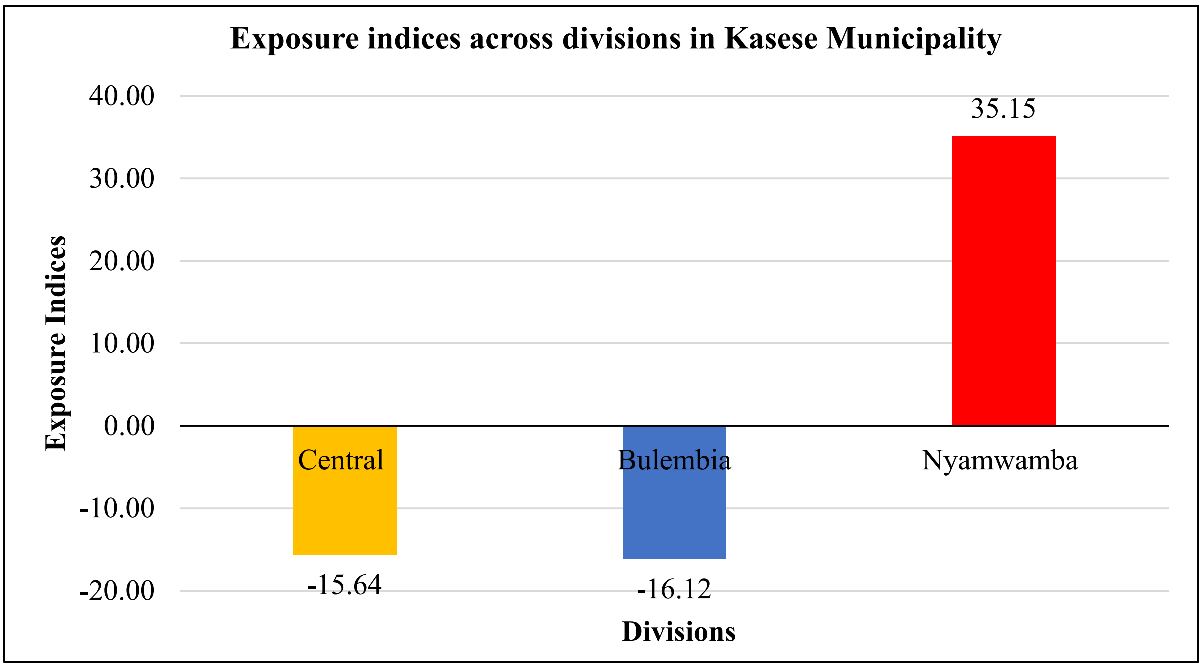

Figure 2. Exposure indices across the divisions.

The composite exposure indices varied between -16.12 and 35.15. Nyamwamba division had the highest exposure index (35.25) while the Central division had the least index (-15.64). Bulembia was ranked the second most exposed division to floods.

Therefore, the Nyamwamba division was found most exposed to flood hazards, followed by the Bulembia division, and the Central division least exposed. The higher exposure in Nyamwamba was partly due to the larger household size and the type of family. Majority of the households in Nyamwamba were under extended families and thus had higher exposure due to the larger household size associated with it. The higher household exposure to floods can also be linked to the lack of an early warning system in place. This was because 85% of the households surveyed never received any warning about the previous floods. However, in Nyamwamba, about 44.3% of the households received warnings about the previous flood events and yet were found highly exposed to flood hazards. This is contrary to a study by Rai *et al*. (2020) in which they revealed that early warning systems were found to reduce the impact of floods and thus the exposure. Further, the higher level of exposure was linked to the proximity of the households to major flooding rivers i.e., the Nyamwamba river. All the households surveyed in the Nyamwamba division were found within two kilometers of the river which increased their exposure to flood hazards. Household vulnerability is inversely related to the distance from the river to the household shelter (Hossain, 2015). For example, the effect on housing structures by floods was influenced significantly by their distance to water bodies in Grahamstown, South Africa (Dalu *et al*., 2018). Similarly, a fifth (1/5) of the Municipality of Eldoret in Kenya is highly prone to floods due to nearness to flooding rivers (Ouma and Tateishi, 2014). However, the magnitude of damages is not only determined by the level of exposure, but by the overall community vulnerability to flood disasters. Therefore, there is a need to ensure reduction of deaths and associated economic costs to minimum levels since it may not be possible to completely avoid floods and their associated effects but to manage them (Nasiri *et al*., 2016).

3.3. Household's sensitivity to flood hazards

Six indicators were selected under sensitivity (Table 3). The weights allocated to dependence ratio and length of time (in years) households had lived in the community were weights -0.528 and -0.025 respectively. About 11.4% of the households had stayed in the area for at least 15 years and 29.0% had stayed in the areas of study for over seven years. The average length of time (in years) households had lived in the Central, Bulembia, and Nyamwamba divisions were 4.1, 3.9, and 7.6 years respectively. A majority (86.7%) of the households were headed by husbands, and most (79.5%) of the households did not have family members with chronic illness/ disability. However, the majority (85.2%) of the households had their average monthly income between 50,000 and 340,000 Uganda shillings (Table 3). Household head and average monthly household head income increased susceptibility to floods as indicated by their positive weights. The dependence ratio (i.e., household size/number of infants, children, and elderly in the household) for the Nyamwamba division, Bulembia division, and Central division were 0.56, 0.48, and 0.45 respectively.

The household index value for sensitivity were from -1.023 to 3.959 in the Central division, -1.268 to 4.220 in the Bulembia division, and -1.230 to 4.220 in the Nyamwamba division. The mean value of sensitivity was 0.258 in the Central division, -0.238 in the Nyamwamba division, and -0.020 in the Bulembia division. Statistical results revealed a significant difference in the level of household sensitivity amongst the divisions (χ^2 =24.180, p=0.033). The sensitivity indices across the divisions are represented in Figure 3. Central division was the most susceptible to floods (18.070), followed by Nyamwamba (-16.670), and Bulembia was the least susceptible (-1.400). There was also a significant difference in the household sensitivity indices and the number of years households had lived in the different divisions (χ^2 =10.238, p=0.047).

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Table 3. Sensitivity indicators across the divisions and their respective weights.

S/n	Indicator	Classes	Weights	Aggregate n=210	Central n=70	Bulembia n=70	Nyamwamba n=70
				Percentage (%)			
1	Household head	Husband	0.589	86.7	87.1	87.1	85.7
		Wife		8.1	4.4	7.1	12.9
		Son		3.8	7.1	2.9	1.4
		Daughter		1.4	1.4	2.9	0
2	Number of family members in the household that had chronic illness/ disability	0	-0.006	79.5	80.0	78.6	80.0
		1		20.5	20.0	21.4	20.0
3	Average monthly household's head income (Ugx)	50,000-340,000	0.189	85.2	80.0	92.9	82.9
		350,000-640,000		14.8	20.0	7.1	17.1
4	Distance to the nearest medical facility/ center from the household	(i) <1 km	-0.130	54.8	1.4	100.0	62.9
		(ii) 1-5 km		45.2	98.6	0	37.1
5	Dependence ratio		-0.528				
6	Length of time households had lived in the community		-0.025.				

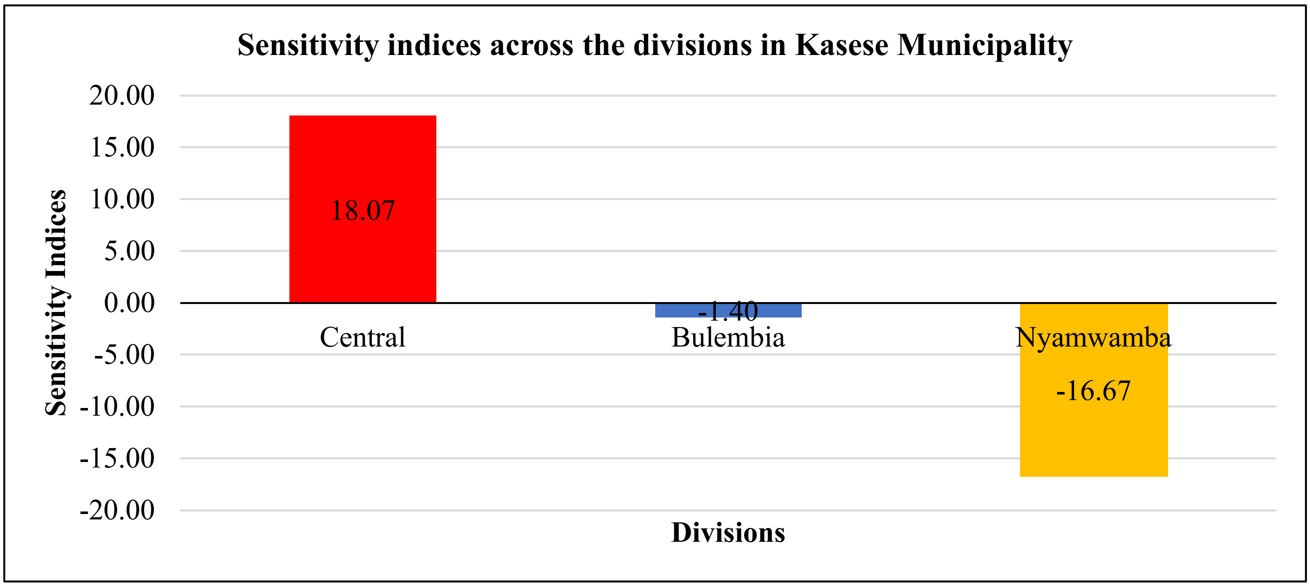

Figure 3. Sensitivity indices across the divisions.

The higher sensitivity to floods in the Central division was attributed to the length of time households had lived in the community, the household dependence ratio, and the distance from the medical facilities. The more the number of years households had lived in the community, the less was the sensitivity to floods. In the Central division, the majority (72.9%) of the households had stayed in the area for less than half-a-decade and therefore assumed to have had less experience with floods. Households that have lived in the community for a long time are more assumed aware of evacuation routes and geography and more experienced with floods (Rana and Routray, 2018; Walker *et al*., 2014).) However, the Central division had the lowest household dependence ratio. This is contrary to studies by Hamidi *et al*. (2020) and Liu and Li (2016) in which they revealed that the more the ratio of dependence, the higher the burden on the mean working-age persons and therefore the high susceptibility to floods. Similarly, the larger number of households headed by sons (7.1%) in the Central division in comparison to the 2.9% and 1.4% in Bulembia and Nyamwamba respectively contributed to the highest sensitivity. Similarly, distance to the nearest medical health facility from the household was also another factor that contributed to the higher level of sensitivity to floods since 98.6% of the households in Central were living between one and five kilometers from the nearest health facility. Yet, according to Boyce *et al*. (2016), extreme flooding increased by 30% the risk of a person getting malaria in the aftermath of flood in Kasese district. This is a challenge because, serious illness of a household member affects the morale and spirit of other household members, and in line to economic attachment, it has a less desirable and substantial effect on household income (Pham *et al.*, 2020).

3.4. Household's capacity to cope with flood hazards

Eleven indicators were selected under adaptive capacity (Table 4). The type of the main occupation of the head of household and the highest attained level of education of the household head had the highest weights 0.363 and 0.359 respectively. It was followed by the household's number of sources of income (0.229). The majority (49.0%) of the household heads across the divisions had at least secondary education and only 19.0% had tertiary education. Similarly, most (40.4%) of the households across the divisions were traders and most of the households had only one source of income (57.6%). Majority (74.8%) of the households across the divisions had two members having earnings and most (61.9%) of the households had some savings. However, their savings were as low as 50,000 to 340,000 Uganda shillings. Most (67.1%) households did not go to the government authority offices for some assistance (either in kind or money) in the past year.

The household index value under capacity ranged from -2.048 to 2.361 in the Central division, -2.121 to 1.893 in the Bulembia division, and -2.121 to 2.010 in the Nyamwamba division. The mean capacity value was 0.158 in Central, 0.049 in Bulembia, and 0.109 in Nyamwamba. There was no significant difference in the level of household capacity amongst the divisions ($\chi 2$ =26.852, p=0.190). The capacity indices across the divisions are represented in Figure 4. Central division had the highest capacity index (11.07) followed by Nyamwamba (-7.66) and the Bulembia division had the least (-3.41).

Table 4. Capacity indicators across the divisions and their respective weights.

S/n	Indicator	Classes	Weights	Aggregate n=210	Central n=70	Bulembia n=70	Nyamwamba n=70
				Percentage (%)			
1	Highest level of education of the household head	No formal education	0.359	11.5	11.4	11.4	11.4
		Primary education		20.5	20.0	14.3	27.1
		Secondary education		49.0	55.7	52.9	38.6
		Tertiary education		19.0	12.9	21.4	22.9
2	Type of main occupation of the household head	Civil/ Public service	0.363	8.6	7.1	8.6	10.0
		Trading		40.4	48.6	38.6	34.3
		Farming		24.3	20.0	24.2	28.6
		Professional/Private		26.7	24.3	28.6	27.1
3	Household's number of sources of income	1	0.229	57.6	55.7	62.9	54.3
		2		42.4	44.3	37.1	45.7
4	Number of family members having earnings in the household	>2	0.058	24.8	11.4	27.1	35.7
		2		74.8	87.1	72.9	64.3
		1		0.4	1.5	0.0	0.0
5	Households with any form of savings	Yes	0.235	61.9	82.9	71.4	31.4
		No		38.1	17.1	28.6	68.6
6	Average monthly household savings	50,000-340,000	0.074	99.5	98.6	100	100
		350,000-640,000		0.5	1.4	0.0	0.0
7	Households with land or house outside the affected areas	Yes	-0.043	43.8	50.0	38.6	42.9
		No		56.2	50.0	61.4	57.1
8	Households with relatives outside the affected area	Yes	-0.095	99.0	98.6	100	98.6
		No		1.0	1.4	0.0	1.4
9	Households with members/relatives with jobs out of the area affected	Yes	-0.041	95.7	97.1	98.6	91.4
		No		4.3	2.9	1.4	8.6
10	Households that had gone to any local authority for some assistance in the past one year	Yes	0.213	32.9	18.6	55.7	24.3
		No		67.1	81.4	44.3	75.7
11	Households that own or rent land for farming	Own	-0.094	42.9	51.4	38.6	38.6
		Rented		32.9	28.6	32.9	37.1
		Don't have		24.2	20.0	28.5	24.3

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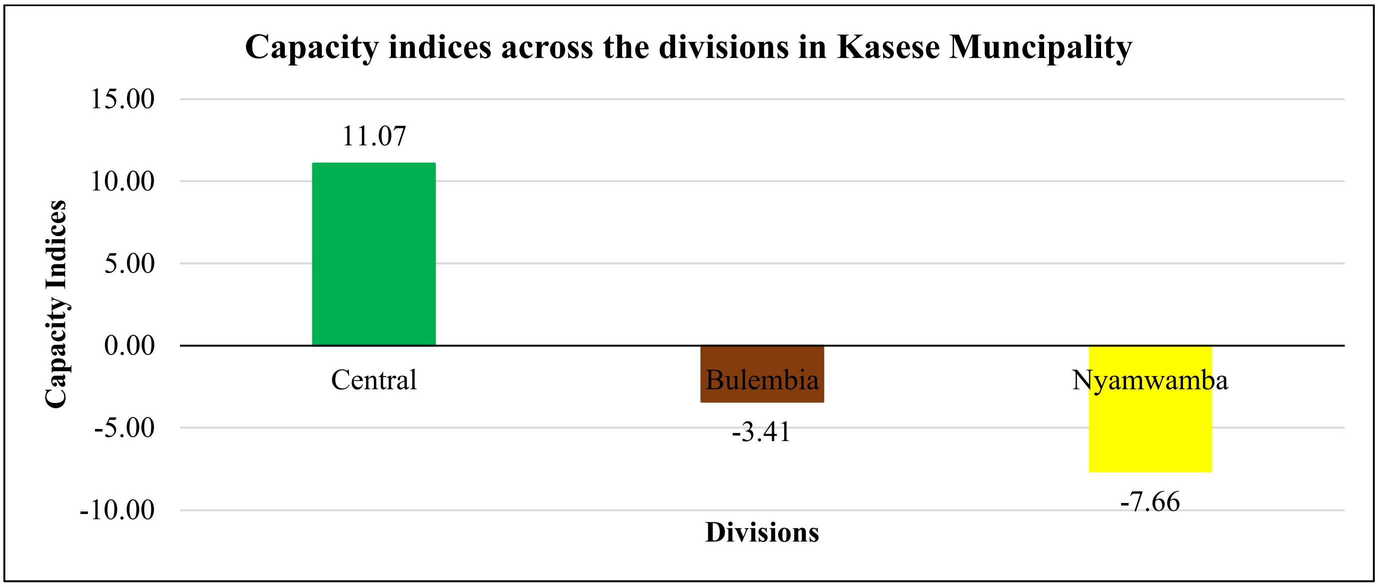

Figure 4. Capacity indices across divisions.

The higher capacity in the Central division was due to the type of the main occupation in which the majority (48.6%) of the households were traders and less in farming (Table 4). This is because farming is more vulnerable to floods (Gain *et al.*, 2015). Most households in Central (44.3%) also had two sources of income, and 87.1% of the households had at least two family members having earnings, 82.9% had some forms of savings, and 50% had land or house outside the affected community area. Households with some jobs and several sources of income are less vulnerable (Hamidi *et al.*, 2020). Households in the Central division had also a higher capacity with floods, and majority (81.4%) of these households had not sought any assistance in the past one year. The highest attained level of education of the head of household, the type of main occupation of the household head, the household's number of sources of income, and households with savings and the size of savings were the major contributors to resist, cope with and absorb the effects of flood disasters.

However, across the communities, it was revealed that 81.4% of the households had not taken measures to protect their houses against floods. This must have been because the majority (77.6%) of the households surveyed lived in rented houses and most (85.2%) of the households had their average monthly household head income very low between 50,000 and 340,000 Uganda shillings. However, a significant relationship between the highest level of education of the household head and households with relatives employed outside the community-affected areas was revealed. Reduction in household food consumption was also among the coping strategies for flood disaster effects. Majority (96.4%) of the households that had been affected by previous floods reduced food consumption in the post-disaster period as a coping strategy. This is in line with a study by Helgeson *et al.* (2013) in Oyama and Kapchorwa districts of Uganda in which households reduced food consumption to cope with the effects of natural disasters.

Similarly, a majority (71.0%) of the households had not received any information on how to respond and manage floods. This raised a serious question on the local institution's efforts toward disaster risk management and or preparedness. The more the knowledge on flood disaster risk management, the less the vulnerability (Liu and Li, 2016). However, there was a significant difference between the highest attained level of education of the household head and households that had gone to the local authority some assistance in the last one year. Households with a certain level of education are able to absorb certain levels of shocks since education levels enhance individual resilience in dealing with disaster risks (Shah *et al.*, 2019).

3.5. Vulnerability to flood hazards

The household vulnerability index value ranged from -2.664 to 3.370 in the Central division, -2.926 to 3.331 in the Bulembia division, and -2.841 to 3.765 in the Nyamwamba division. The mean value of vulnerability was 1.113 in Central, -0.201 in Bulembia, and 0.373 in Nyamwamba. There was a significant difference in the level of household vulnerability across the divisions ($\chi 2$ =60.940, p=0.025). Table 5 presents the summary of the composite exposure, sensitivity, capacity, and the respective vulnerability indices across the divisions. Nyamwamba division had the highest vulnerability index (26.139) followed by the Bulembia division (-14.104), and the Central division with the least vulnerability index (-8.642).

Table 5. Summary of index scores for vulnerability components across the divisions.

Divisions	Exposure	Sensitivity	Capacity	Vulnerability
Central	-15.643	18.072	11.072	-8.642
Bulembia	-16.118	-1.400	-3.415	-14.104
Nyamwamba	35.154	-16.672	-7.657	26.139

The highest exposure coupled with higher sensitivity and lower capacities caused the highest vulnerability of the Nyamwamba division. This is in tandem with a study (Nguyen and Van Nguyen, 2019) in which villages in Mai Hoa Commune in Vietnam with high level of vulnerability had higher exposure and susceptibility with low resilience to cope with floods. Similarly, the lower exposure coupled with the highest sensitivity and capacity made the Central division least vulnerable to flood hazards. Bulembia division on the other hand, despite having the lowest sensitivity index value ranked the second most vulnerable owing to its higher exposure index and lowest capacity index. The analysis confirmed that a significant difference existed in the households from the different divisions. However, both Central and Bulembia had the same negative sign of vulnerability index scores. About 43.8% of the households were found most vulnerable to floods in Kasese Municipality. There was also a significant difference in the household distance from the major flooding river (river Nyamwamba) and household vulnerability index levels. This is consistent with a study in which differential vulnerabilities were observed with nearer river zones being highly vulnerable (Das *et al.*, 2020). Households nearer to river Nyamwamba were found more vulnerable to flood hazards.

4. Conclusions

Given that some households had experienced floods four times in the last decade, flood hazard is a major risk in the Municipality. The study focused on the assessment of the household vulnerability to floods in the three divisions of Kasese Municipality (Central, Bulembia, and Nyamwamba divisions). Vulnerability is a factor of sensitivity, exposure and adaptive capacity. Whereas cross-tabulation of household exposure indices showed no significant difference in the household exposure level to floods, Nyamwamba division was found most exposed, followed by the Bulembia division and Central division least exposed. Households that had larger household sizes and lived within the proximity of the flooding river were found highly exposed to floods. Households that had lived long in the community were found less sensitive to floods. Statistical results showed a difference in significant in the level of household sensitivity. Central division was the most susceptible to floods. Nyamwamba and Bulembia divisions were ranked second and third respectively in terms of sensitivity to floods. Households that had lived for a lesser time in the community, and had a higher household dependence ratio, and were living long distances from the medical health facilities were found highly susceptible to floods. Central division had a better capacity to cope with floods followed by Nyamwamba, and Bulembia had the least capacity. Households with at least two sources of income, and with some form of savings had a better capacity to cope with floods. Majority of the households across the divisions had not taken measures to protect their houses against floods and this was attributed to most households living in rented houses and having a lower average monthly household income. The study further revealed a difference in significance in the level of household vulnerability amongst the divisions. The highest exposure coupled with higher sensitivity and lower capacities made the Nyamwamba division most vulnerable to floods and the Central division least vulnerable. Bulembia division on the other hand, despite having the lowest sensitivity ranked the second most vulnerable owing to its higher exposure meaning that the three components of vulnerability occur at different levels in each area. About 43.8% of the households were found vulnerable to floods in Kasese Municipality.

Given that, some aspects of disaster risk like flood hazard's frequency and its likelihood cannot change, vulnerabilities of households can be reduced through reducing exposures and sensitivities and amplifying capacities. To reduce the high levels of vulnerability of the communities affected, the local government and other stakeholders should give jobs and other related opportunities to enhance the income and savings of the households in the flood-prone areas. Households near major flooding rivers should also be relocated to safer places to reduce their exposure to floods. The individual households should at least take precautionary measures voluntarily to protect their properties from floods. This is because the government cannot alone adequately protect flood-prone households due to limited resources available. Finally, policymakers must develop unique policies and ensure climate change at the lowest levels (specifically village and sub-county) considering their unique features be addressed.

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