Int. j. adv. multidisc. res. stud. 2023; 3(3):855-863

Received: 29-04-2023
Accepted: 09-06-2023

International Journal of Advanced Multidisciplinary Research and Studies

ISSN: 2583-049X

Disaster Risk Reduction Strategies and Vulnerability by Household Level: The Case of River Shabelle, Beledweyne District, Hiiraan Region, Hirshabelle State, Somalia

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Abstract
Somalia has been powerful river floods with danger frequently when the floods reach the center of the town it causes tremendous losses. This article examines river flood risk, vulnerability and risk reduction strategies and challenges along of River Shebelle, Beledweyne District, Hiiraan Region, Hirshabelle State, Somalia. Household survey, key informant interviews, focus group discussions and field observation were employed to gather data for the study. Both descriptive and inf erential were used to analyze data. The investigations were complemented with review of past records of flooding. The main objective of this study is to examine the River flood risk, vulnerability and risk reduction strategies by rural households in River Shebelle of Beledweyne District. This study employed primary and secondary sources of data in order to achieve the stated objectives. M ixed research design was used to collect and present data collected from selected households. The results are presented using statistical package for social sciences version 20, Statistical Mann-Kendall test and Sen's Slope Estimator test using XLSTATA 2014 software and Arc GIS to produce maps were used. Using the systematic sampling technique, 335 households were selected from selected areas. The findings of the study indicated that river Shebelle flood has discharge variation, exposing the people to felt safe, awareness and participation of the community regarding to flood risk and vulnerability is different to respond effectively and which exposes to the hazard, there is the limitation of capacity to perform reduction strategies in effective way, inadequate and slow distribution of resources. Awareness creation, training and promoting Nan Governmental Organizations effort to involve in flood risk and vulnerability helps to solve the problem of flood risk and vulnerability reduction strategies in the study area.

Keywords: Flood, Flood Risk, Risk Reduction Strategies, River Shebelle, Vulnerability

1. Introduction

Flood is one of the leading natural phenomena at worldwide both in terms of the frequency of occurrence and the resulting damages to human lives, the environment, and economic assets (Doocy *et al*., 2013) [6]. River flood risk and vulnerability is one of the most widely distributed disasters in the world (Parklina, 2013) [16]. Globally, flood accounts for more than 55% of all fatalities with nearly 2.5 billion people affected and more than 30% of global economic losses from natural disasters (Hallegatte *et al*., 2013) [12]. Many African countries are threatened by the river flood risk and vulnerability, due to unexpected and overflow of the river (Ezemonye, *et al*., 2011) [8]. River flood risks occurring as a consequence of either natural factors, such as climate change and climate variability or anthropogenic factors, such as socio-economic and land-use developments (Balica, 2009). Many episodes of river flood risk have experienced in Eastern Africa (OFDA/CRED, 2008). Being one of the largest countries in East Africa, Somalia has faced to seasonal river flood risk and vulnerability (FDPPA, 2015). Somalia has experienced in flood risk and vulnerability, especially in the rainy season of the country (Wagesho, 2012) [17]. In many different years Somalia exposed to flood hazards due to the case of heavy rainfall (FDPPA, 2012). Flood risk and vulnerability exposed the people to be the supporter of government and nongovernment organs, to evacuate their home, loss of agricultural land and crops and others (Hussein, 2014) [13]. Flash flood is a common phenomenon in Somalia. In Somalia, the worst flooding flash floods happen the last decades it facing problems mostly the people who live around Shebelle and Juba rivers. The communities who live in Beledwayne town were severely affected. Over the last years, the extreme events in form floods and droughts faced the community evacuated from their living area. Consequently, the population is increasing in the town and it becomes a metropolitan area. The settlement of the community is slum and squatter during the flooding season more than

20,000 families evacuated their homes to go to the outskirts of the town without any facilities of life (Elmi, 2020). This town is susceptible to floods during the rainy season, while even the river passes with more than its bank-level when the floods come it splashes both sides of the banks. When the floods come in seasonally it eliminates a lot of agricultural and livestock, besides that it's hard to save souls and even it difficult to get several helicopters to use as aid, these floods have destroyed properties ranging from houses to personal belongings and extreme cases and loss of lives (MWES, 2019). Beledwayne has been impacted by floods dating back to the colonial era and in recent times (Abuga, 2019) [3]. There are insufficient meteorological stations and meteorological regulation supports to improve research and catastrophe management plans; as a result of this gap, it is unable to make decisions. The most factors that make the flood not managed are unknown flood characters, early warning systems, and forecasting (Abshir, 2018) [2]. As most of the river flood risk and vulnerable area of Somalia, Hirshabelle state are exposed to Shebelle River flood risk and vulnerability due to topography of the area and heavy rainfall from Ethopia. Many strategic efforts are taking place in the zone and district level that reduces the river flood risk and vulnerability. Therefore, clear understanding about river flood risk, vulnerability and risk reduction strategies helps to ensure safe of the people and to protect the life of peoples, property and agricultural land of the study area in particular and Somalia in general. Adaptation strategies have been important to reduce the impact of the river flood risk and vulnerability by taking appropriate measures before, during and in the aftermath of flood (FDPPA, 2015). Beledweyne is one of the threatened areas by the river flood risk and vulnerability, due to topography and unexpected heavy rainfall from highlands Ethiopia. Now, reduction strategies have needed to minimize river flood risk and vulnerability.

In October 2019 floods affecting a lot of people around the town economically and socially, people are victims of the floods, and flooding has become an almost annual event, according to the last event around 80% of the city was underwater as indicated in Fig 1.

Fig 1: Flash Flooding Beledwayne (2019 October by Helicopter aid)

2. Research Methodology

Description of the Study Area

Beledwayne is the capital city of the Hiiran region and located in the southern part of Somalia it lies 04°44′09″N045°12′13″E. Shebelle River passes in the midtown of the Beledwayne which starts from Ethiopian highlands most of the river is upstream of Ethiopia it passes two regions of Somalia Hiiran and Banadir. Beledwayne town covers 24 km2 of the resident of the population, characteristics Shabelle of the main gauging station of Beledwayne covers approximate 193,224 km2, the sub-basin that charges the town is 2790 km2, the area of basin Beledwayne is covered 286.7 km2 this town is the in fall of the Shebelle River basin in Somalia while the river passes other regions of Somalia and eventually met the Indian Ocean and its total length is 1500 km and total area of Shabelle Basin in Somalia is 296,972 km2. Beledwayne is above sea level 174m towards the Capital of Mogadishu.

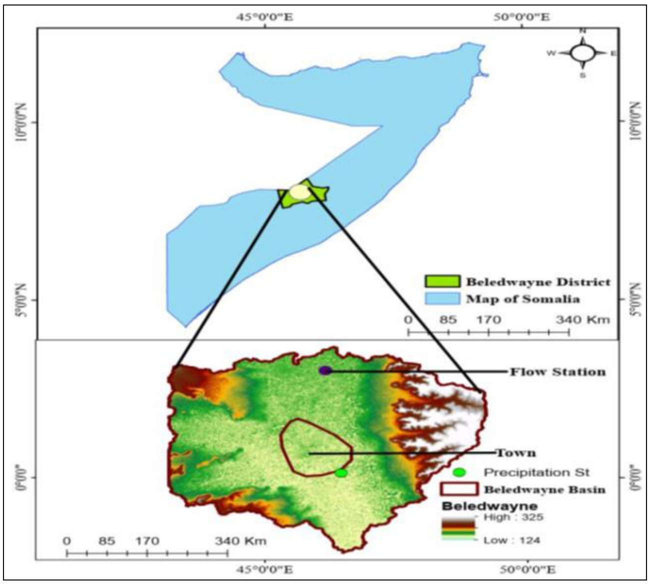


Fig 2: Location Map of the Study Area

Topography and Soil

The study area is characterized by the outcropping of the metamorphic basement complex, made up of migmatites and granites. Sedimentary rocks such as limestone, sandstones, and gypseous are present and an extensive, wide system of coastal dunes basaltic flows are present in the north western part of the study area. From a tectonic point of view, the study area is characterized by a fault system lying parallel to the coast in the alluvial part of the Area of Interest (AOI), and by a system of northwest-southeast oriented faults in the metamorphic basement complex. Some late tertiary fluvio-lagunal deposits occur on the part of the southern Shabelle, consisting of clay, sandy clay, sand, silt, and gravel. Recent fluvial deposits are common alongside the Shabelle, consisting of sand, gravel, clay, and sandy clay. A wide coastal dune system occurs along the coast (SWALIM, 2007).

Climate and Drainage

Somalia is particularly vulnerable to droughts mainly because of the country's geographical location, the fragile environments, climate, and the political instability in the country. Droughts have disastrous impacts on the communities in Somalia. The Beledweyne lies on 183m above sea level Beledweyne have a desert climate. The dry seasons of Beledweyne are January, February, and December, whereas March to June and October are rainy times of the town, the average temperate is approximately 28.6oC while most of the year Beledwayne Aggregates up to 270mm precipitation. The seasonal weather variations for Beledwayne and southern Somalia, in general, are influenced by the northward and southward movement of the intertropical convergence zone (ITCZ). More than the rainfall, the highlands upstream increased the result of the water level. The mean annual precipitation of the Shabelle basin in Somalia is almost less than 465mm and mostly comes in rainy seasons. Potential Evapotranspiration (PET) is constantly high throughout the Shebelle basin's sake of the climate variation, the highest potential occurs in Gedo, Bakool, and Hiiran regions where it exceeds > 2000mm per year, in the rest areas it is between 1500- 2000mm/yr. This climate shows that the annual rainfall is small according to the cause of the flood but its seasonal floods that come once a year and can be caused a lot of casualties that may even affect the whole area of the town (SWALIM, 2007).

Somalia has only two perennial rivers - the Jubba and the Shebelle, both of which flow through the southern part of the country. To review the hydrology of the country it is necessary to study a much broader area covering much of the Horn of Africa. A substantial proportion of Somalia's water resources originate from neighboring countries; this applies to a considerable extent to groundwater resources, and to a greater extent to surface water resources. Rainfall over the Somali parts of the catchments is generally less than 500mm per year, but in the upper reaches of the catchments in the Ethiopian highlands, it reaches 1250mm or more. With the major part of the area and generally higher rainfall, it is not surprising that most of the river flow originates outside Somalia. The virtual absence of tributaries or other drainage channels in Somalia reinforces this position because very little of the rainfall within Somalia reaches either river. The flows are seasonal and are dependent on the rainfall in Ethiopia which is largely related to the northwards and southwards movement of the Intertropical Front (ITF) and the Intertropical Convergence Zone (ITCZ). During the first half of the year, the ITCZ moves northwards (in line with, though slightly lagging, the apparent movement of the sun) and in the second half of the year, it returns southwards. This movement of the ITF and ITCZ is the main cause of the seasonal weather patterns in tropical areas. A detailed explanation of the atmospheric circulation and its effect on the climate of Somalia is presented by Hutchinson and Polishchouk (1989); many of their comments on the seasonal variation in climate also apply to the Ethiopian portions of the Jubba and Shebelle catchments. The main rains occur behind the Front in April and May, and consequently, the first flood season in Somalia (rainy season) is between April and June. The return movement of the ITF (roughly south-westwards) first affects the northern part of the Shebelle catchment in October, and it passes over the southern part of the Jubba catchment in December. The second flood season (known as the Der) occurs between September and November. The period between January and March is generally dry, and in this low-flow season known as the Dry, the flow into Somalia in each river has virtually ceased on several occasions since records began in 1951. Differences in the flow patterns are also caused by the occurrence of some pre-frontal rainfall ahead of the ITF; in March this sometimes leads to early floods in the Jubba, and in August/September it results in the Deyr flood in the Shebelle usually starting somewhat before that in the Jubba (Houghton-Carr, 2011).

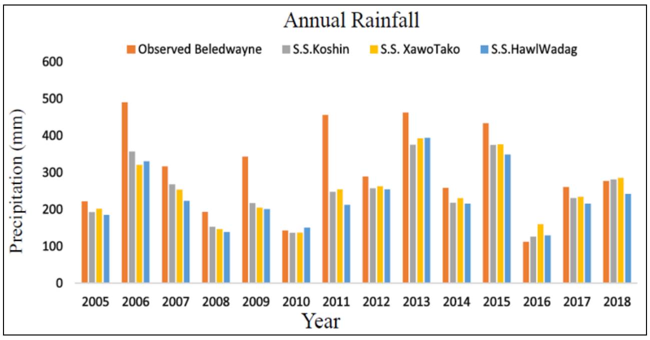


Fig 3: Annual yearly precipitation of the observed and satellite Stations

Sample Size and Sampling Techniques

The study employed both purposive and probability sampling techniques in order to get reliable data. Purposive sampling used to obtain more information about the problem of the study area and probability sampling techniques used to select respondents from the target population. There are a total of 4 villages in Beledweyne District, of all are urban villages. But the investigator selected three rural villages; namely, Howlwadag, Hawo Tako and Kooshin. The selection was based on the status of flood risk, vulnerability and risk reduction strategies practices as criteria. 335 households were selected for data collection using sample determination formula developed by Yorkshire (2009). The study first established that the confidence level required in the study was 95%, while the confidence interval allowed for this study was placed at 5%. The Standard Error (SE) was also then calculated by dividing the confidence interval by 1.96. Following the pilot study conducted, the estimated percentage (P) was placed at 68%.

The formula used for sample size determination was:

$$N = \frac{P\ (100\% - P)}{(SE)^{2n}}$$

Where;

N = Sample size

P = Estimated Percentage of respondents who was give similar responses

SE = Standard Error

Calculation:

$$N = \frac{P\ (100\% - P)}{(SE)^{2}}$$

$$N = 68\% \frac{(100\% - 68\%)}{(5/1.96)^{2}}$$

$$N = 68 \frac{(100-68)}{(5/1.96)^{2}}$$

$$N = \frac{2176}{6.50}$$

N = 334.76 = 335

Based on the above formula the investigator selected 335 sample sizes.

Table 1: Sample size distribution

S. No	Villages	Total Households	Total Sample size	Sample size in %	Sampling Techniques
1.	Howlwadag	753	137	18.19	purposive
2.	Hawo Tako	575	100	17.39	purposive
3.	Kooshin	465	98	21.07	purposive
4	Total	1793	335	18.68	purposive

Source: Local Authority (2022)

Data Collection Instruments

The most important techniques employed to generate relevant information were questionnaires, key informants, interview, field observation and FGDs as well as formal and informal discussions with households, and GIS outputs to show flood vulnerable area were included.

Questionnaire

The investigator used questionnaire for all sample respondents of the sample and collect data from the SHHs using both open ended and close ended questionnaire. The questionnaire were primarily prepared in English languages and translated in to local language (Somali), for avoiding ambiguous of respondents and as the majority of the respondents are Somali speakers. Finally, the collections of data were based on coding.

Interview Methods

Interview method allows the investigator and respondents to ask and respond freely (Kothari, 2004). The investigator used semi-structured interview because of its flexibility and makes clear anything when there is ambiguity. The informant‟s interview were conducted from representatives of different stake holders, local leaders of the village, farmers and three experts from Humatarians Office. In general 26 (twenty six) interviewers were involved in the process of interview (Table 2).

Table 2: Distribution of key informants f or interview by respective sample villages

S. No	Names	Number of informants									Total	Sampling Techniques
		Local leaders			Farmers			DAs				
		M	F	T	M	F	T	M	F	T		
1	Howlwadag	2	1	3	2	1	3	2	1	3	9	purposive
2	Hawo Tako	1	1	2	2	1	3	2	1	3	8	purposive
3	Kooshin	2	1	3	2	1	3	2	1	3	9	purposive
	Total	5	3	8	6	3	9	6	3	9	26	purposive

Source: Field Survey, 2022

Focus Group Discussions (FGDs)

In addition to the above data gathering tools, FGDs were carried out to collect qualitative information from the selected three villages. The Participants of each FGDs were purposively selected because they have best experience on flood risk and vulnerability in the study area and in each village two FGDs were conducted. The total participants of FGDs in the study village were about 8-10 household heads.

Hydro-Meteorological Data

In general, the meteorological stations of Somalia are insufficient in quality and quantity. Data for most of the stations are incomplete and limited due to poor facilities and previous civil war. There is one meteorological station in Beledweyne district which has limited information on the aspects of flew streams in the study area. Therefore, 6 percent missing climate station data. To get a complete study period of data, it was taken the missing data from a website.

Method of Data Analysis

The raw data collected through households survey, FGDs and Key Informants were processed (coded, edited, ordered and organized) to generate relevant information. To accomplish the analysis of the data for better understanding of the issues, the investigator analyzed using descriptive statistical techniques like (frequency, mean, and percentage) by using statistical package for social sciences (SPSS) version 20, Statistical Mann-Kendall test and Sen‟s Slope Estimator test were performed using Addinsoft‟s XLSTATA 2014 software, Arc GIS to produce maps and Iyengar and Sudarshan methods to calculate weight of each indicators and Weibull's formula were used. Furthermore, qualitative information was analyzed using interpretation and categorization of ideas based on themes. Finally, the findings of the study were being summarized and presented using tables and figures.

3. Results and Discussion

Background Characteristics of the Sample Respondents

Sex, Age and Educational Structure

The survey data on Table 3 shows that, from the total household heads 211 (63%) were males while the remaining 124 (37%) were females. Age of the respondents is considered as one variable that influences variation on flood risk, vulnerability and risk reduction strategies within the communities. Age is also assumed to have correlation with people‟s better preparedness towards responding to flood risk vulnerability and risk reduction strategies. Table 3 shows the sex and age category of respondents. Age of the sample respondent households ranged from 19 to over 60 years.

Table 3: Sex and age composition of the respondents

Sex	Age	Frequency	Percentage
Male	19-29	44	13
211	30-39	84	25
Female	40-49	140	42
124	50-59	57	17
	>60	10	3
Total		335	100

Source: Field Survey, 2022

Educational level is assumed to have correlation with the way how to people identify the major features of flood risk, vulnerability and risk reduction strategies. Well educated people have an ability to identify the strategies to reduce the adverse impact of flood risk and vulnerability in the study area. Table 4 shows the educational level of the majority of respondents or both male and females accounts (48.4) are unable to read and write, 13.3% of the respondents have informal education, 14% have elementary school level or less and 11% have attended secondary school level. Only 13.5% of respondents had attended education up to technical/ vocational college and university level.

Table 4: Respondents educational attainment

	Educational Level (In grade levels)	Number of the respondents	Percentage
Sex			
Male	Unable to Read and write	92	27.4
	Informal education	28	8.3
	Up to grade 8	34	10
	Up to grade 12	24	7
	Technical/ Vocational	12	3.5
	College/University	20	6
		211	62.2
Female	Unable to Read and write	70	21
	Informal education	16	5
	Up to grade 8	14	4
	Up to grade 12	11	4
	Technical/ Vocational	9	3
	College/University	4	1
		124	38
	Total	335	100

Source: Field Survey, 2022

Marital Status and Family Size of Sample Households

The marital status of the households shows that, married respondents share the largest portion which accounts 216 (64%), followed by 20% single, 10% widowed, 6 % were divorced respectively (Table 5). Marital status has a good contribution to identify flood risk, vulnerability and risk reduction strategies, from these; married respondents have better experience on flood risk, vulnerability and risk reduction strategies than others due to maturation and life experience.

Table 5: Distribution of marital status of the sample respondents

Marital Status	Frequency	Percentage (%)
Married	216	64
Single	67	20
Widowed	34	10
Divorced	18	6
Total	335	100

Source: Field Survey, 2022

The family size of the respondents that majority (44%) were found in the range between 5- 8 family size, followed by 9-12 family size which accounts 37%, and while only 12% of the respondents have family size of 1- 4 or less than five (Table 6). Therefore, family size contributes to reduce the adverse impact of flood risk and vulnerability even before, during and after the event of the disaster. Number of family size helps during the flood event to help one with the other and to reduce the problem in a short period of time through cooperation.

Table 6: Household size of the respondents

Family Size	Frequency	Percentage (%)
1-4	41	12
5-8	149	44
9-12	124	37
>12	21	7
Total	335	100

Source: Field Survey, 2022

Occupation and Farm Land Size

Table 7: shows that from the total household heads 71% over farmers while traders accounted for 18%, teachers 4% and others 7%. Many respondents were farmers and they are living near to the River Shebelle because of the availability of agricultural land there than other places, due to this they are the victims to the river flood risk and vulnerability.

Table 7: Respondents‟ occupation

Occupation	frequency	Percentage (%)
Farmers	212	71
Traders	72	18
Teachers	20	4
Others	31	7
Total	335	100

Source: Field survey, 2022

The majority of sample respondents (37%) have more than one hectare of farm land size, while 0.5ha accounted 33%, less than 0.5ha accounted 24% and greater than 1ha accounted only 6%. These farm land sizes frequently affected by flood risk and vulnerability for the past many years due to the proximity of the farm land to the river Shebelle.

Table 8: Respondents‟ farm land size

Farm land size	Frequency	Percentage (%)
<0.5ha	80	24
0.5ha	112	33
< 1 ha	20	6
>1ha	123	37
Total	335	100

Source: Field survey, 2022

3.1 Major Features of the River Flood

Discharge Trend of the River Shebelle

In this study, discharge trend analysis has been done by using non parametric Man- Kendall test together with the Sen‟s Slope Estimator (Qi) for the determination of trend and slope magnitude to find out the monthly, seasonal and annual variability of discharge data over the Lower Shebelle river basin.

The null hypothesis is tested at 95% confidence level for discharge data. If the probability of occurrence (p) value is less than the significance level α (alpha) = 0.05, H0 is rejected. Rejecting H0 indicates that there is a trend in the time series, while accepting H0 indicates no trend was obtained.

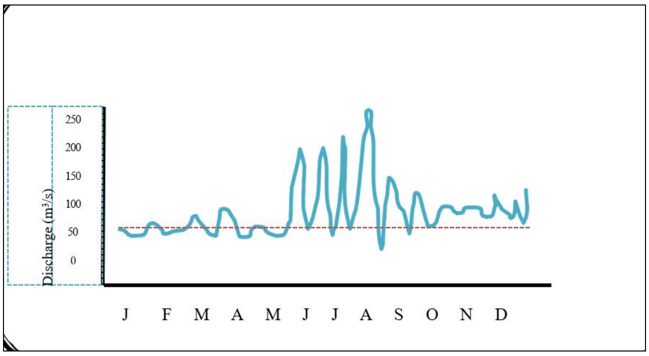
Positive value of Sen‟s Slope Estimator (Qi) indicates an upward or increasing trend and a negative value of Slope Estimator (Qi) gives a downward or decreasing trend in the time series. Statistical Mann-Kendall test and Sen‟s Slope Estimator test were performed.

Trend analysis discharge data of River Shebelle were collected from the ministry of water resources of Somalia (MoWR) of hydrology department during the field work. The available discharge data was in the unit of m^3/s. Trend analysis of River Shebelle basin has been done also with 40 years of river discharge data from 1980 to 2020. Statistical properties of the annual and monthly flow series were tested. The results shows positive skewness which means the data was normally distributed. According to the results, all the individual months show the largest CV representing different variation during the study period. The annual average discharge for these 40 years is $114.985m^3/s$. During the record period, the maximum discharge occurred in the year 2006 with the total discharge of $262.408m^3/s$ approximately and a minimum discharge in the year 1996 with the total of around 19.09 m^3/s.

Monthly Discharge Trends

Non-parametric Mann-Kendall test was used to analyze monthly trends of river flow for 40 years have been calculated for each month individually together with the Sen‟s magnitude of slope (Q).

The Sen‟s slope reveals the trend of the series for 40 years for individual 12 months from January to December which are 2.653, 2.13, 2.233, 2.031, 2.289, 0.047, 2.295, 3.433 -0.910, -1.354, -3.391, and -4.697, respectively. While June, July, August and September show an evidence of negative trend, the others months show evidence of positive trend. The Null hypothesis was rejected for June, July, August, and September months and accepted for the others months.

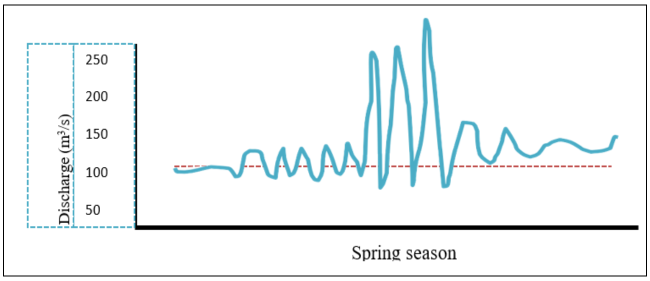


Source: Ministry of Water Resource (2022)

Fig 4: Hydrograph of river Shebelle monthly average discharge (1980-2020)

Seasonal Discharge Trends

Non-parametric Mann-Kendall test was used to analyze seasonal trends of river flow for 40 years have been calculated for each season of summer and spring or dry and rainy seasons individually. The Sen‟s slope reveals the trend of the series for 40 years for individual seasons of summer and spring (rainy and dry season). The seasonal river flood discharge has direct relation with the rainfall and it shows seasonal variability especially in May, June, July and August the seasonal average discharge rate was high while in spring season the river discharge rate was relatively low because of the variability of the seasons. This variability trend of the river flood discharge especially in summer season exposes the people to flood risk and vulnerability in the study area.

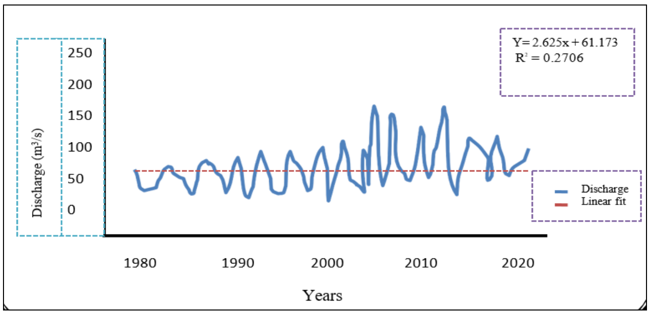


Source: Ministry of Water Resource, 2022

Fig 5: Hydrograph of seasonal discharge of river Shebelle River (1980-2020)

Annual Discharge Trends

Mann-Kendall test and Sen's slope on river discharge data shows an evidence of a positive trend in annual series. The rate of annual rainfall change is about 2.462m^3/s/year. The result indicates that the null hypothesis was rejected for the annual discharge trend (p-value=0.002). Thus, statistically significant positive trend is found for annual river discharge over the time period of (1980-2020). Below in Fig 4 shows the linear trend line for the 40 years annual river Shebelle sub basin discharge data. Therefore, this discharge trend shows the fluctuation of the trend and there is a high probability of flood risk and vulnerability in the study area, due to this the communities were the first victims on the disaster, so that reduction strategy was expected from all the concerned bodies in the area particularly from the residents.



Source: Ministry of Water Resource, 2022

Fig 6: Average annual discharge variation (1980-2020)

Let to conclude monthly, seasonal and annual discharge of river Shebelle River, Mann-Kendall test with the Sen‟s magnitude of slope (Q) was used to analyze each trends of river discharge or flow for 40 years (1980-2020) have been calculated. Monthly, seasonal and annual discharge trend shows an evidence of both negative and positive trend over the river. The river flood discharge has relation with the climate variability and it shows variability in between summer and spring (rainy and dry) seasons. The annual discharge result indicates that the null hypothesis was rejected for the annual discharge trend, which indicates there is a trend. Therefore, there is a flood risk and vulnerability in the study area due to the variation of the discharge trend of the sub river Shebelle basin in Beledweyne district.

Frequency of Flooding

According to MoWR (2021), Shebelle River maximum instantaneous flow of 736.70 m^3/s was recorded at Beledweyne station during the 2006 hydrological year while the lowest flood flow of 69.16m^3/s was recorded in 1996 hydrological year. The 40-years mean instantaneous maximum flood flow is 372.34m^3/s with a CV of 40.6% and a standard variant of 182.757m^3/s. The coefficient of variation was applied to measure the consistency and the steepness for the frequency curves in the river flow data. The CV value obtained indicated that the distribution of flood flows was not highly variable.

Table 8: Annual Maximum flow basic statistics

Basic statistics	Values
Mean	372.34
Maximum	736.70
Minimum	69.16
Std. Deviation	182.757
Coef. of Variation (CV)	0.491
Skewness	0.406
Return period	41 years

Source: Ministry of Water Resource, 2022

The return period and the probability of occurrence for each observation of the River Shebelle River sub basin have been computed, using Weibull's formula, for the period 1980-2020 which generally starts to peak in the month of July with the maximum in the month of August.

According to the MoWR (2021), Shebelle river discharge at the sub basin reveals that the study area has been affected 22 times by low intensity of flood with return periods of 1 and 2 years with high probability of occurrence. The low intensity is ranged between (69.16-372.33m^3/s). The study area experienced nine times moderate intensity of flood with return period of 2, 3 and 4 years with probability of occurrence less than 50% and magnitude between (372.34-549.64 m^3/s). The study area was challenged with high flood event nine times ranging between (549.65-736.70 m^3/s). The latest more severe flood for the sub basin part of River Shebelle is the one that occurred in 2018. Its return period is 41 years and the probability of occurrence of the 2006 flood (as a same magnitude) would be once in forty-one (41) years (Probability=0.22). During the period, the recurrence interval of high flood based on the 2006 flood magnitude has ranged from 5 to 41 years. There are eight recurrence intervals covering a total period of 40 years between the first and the last occurrence of high flood events (MoWR, 2021).

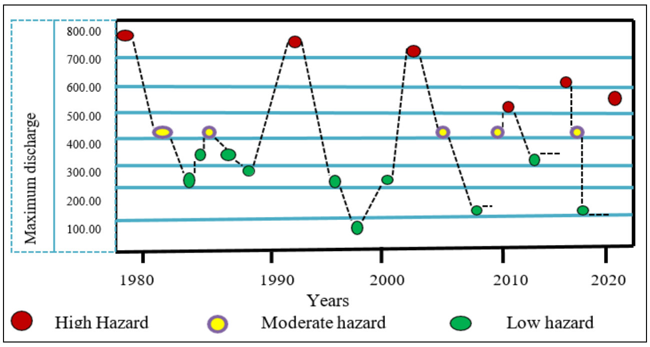


Fig 7: Frequency of River Shebelle flooding Source: Ministry of Water Resource, 2021

Table 9: Magnitude of River Shebelle River sub basin flood from the years (1980-2020)

Discharge	Frequency	Magnitude of flood
549.65-736.70	9	High
372.34-549.64	9	Moderate
69.16-372.33	22	Low

Source: Ministry of Water Resource, 2022

3.2 Flood Risk and Vulnerability

Household respondents were required to indicate whether they felt safe from floods. A majority (69%) of household heads indicated that they were not safe from flood.

This shows that within the community there is a risk of flood. Awareness can easily play role in providing knowledge to the community that minimize flood risk caused by devastating flood events. This knowledge is based on the appreciation that floods occur and pre-disaster activities (that is, flood preparedness) are intended to equip the community on what to do before, during and after floods. Studies show that families that move back after floods subside remain a concern due to their exposure to future events of flooding in the same areas.

Flood Vulnerability

Flood vulnerability in the study area was common disaster near the sub basin of River Shebelle River. According to the respondents and documents, about 70% were more vulnerable during summer season than other season. This is because of the increasing of heavy rainfall and the Joining of different streams come together with strong speed and the area was valley in its nature, because of this people were vulnerable to the river flood.

In the study area about 75% of the sample respondents stated that they left their area until the hazard come over, they left the area after they ensure the serious nature of the problem. Therefore, many people were vulnerable to flood hazard in the study area, this is because of the lack of awareness.

Figure shows flood vulnerability areas or hazard zone in Beledweyne near the sub Basin of Shebelle River. These particular villages were highly vulnerable to the river flood. During focus group discussion, some of the household heads suggested that, „"the area is vulnerable to flood hazards, but why not the government gives as concern to reduce the problem because this is beyond our capacity"". Therefore, to solve or at least to reduce the level of flood risk and vulnerability from the study area will need concern from all over the community who live the sub basin of the river, government and nongovernmental organs as a whole to reduce the sensitive problem of the study area.

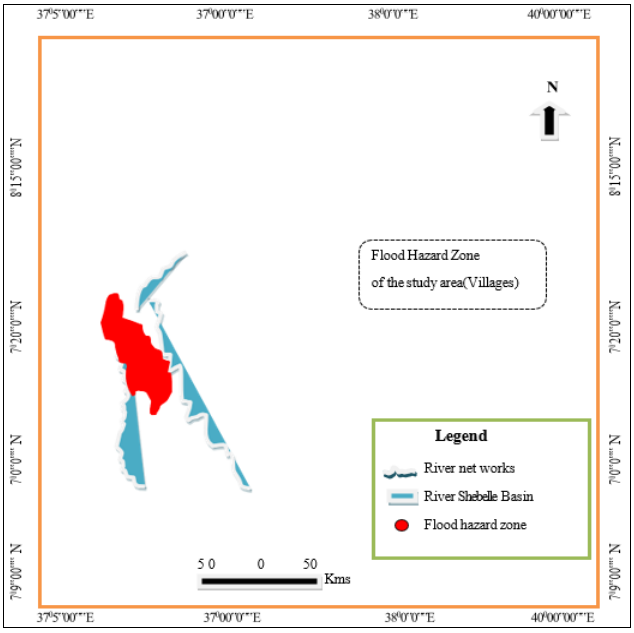


Fig 8: Flood vulnerability area in Beledweyne, Shebelle river sub-basin Source: Developed by the investigator using Arc GIS (2022)

3.3 Awareness and Participation

Household Heads' Awareness

Awareness to flood hazards may raise the attention of population on how to reduce flood risks and vulnerability. According to the key informants, the occurrence of flood in the area does not take the residents by surprise, because even though it was a natural phenomenon, the residents know when the river may overflow and they received information from the upper stream communities. Therefore, they became more or less aware of river flood risk and vulnerability in the area. Their awareness in flood risk and vulnerability reduction strategies in the study area was likely.

Table 10: Household heads" awareness in flood risk and vulnerability reduction strategy

S. No	Household heads' Awareness	Frequency	Percentage
1	Gabion construction	142	42.3
2	Watershed management	63	18.8
3	Diversion of river for flood irrigation	130	38.8
4	Total	335	100

Source: Field Survey, 2022

Most of the respondents or 42.3% have awareness about flood risk and vulnerability reduction strategies in the area on gabion construction, 18.8% on watershed management and 38.8% on diversion of river for flood irrigation respectively. However, the awareness by itself has not reduce the problem of flood risk and vulnerability in the study area, because of the shortage of concern about the problem and considering it as the only responsibility of the government and nongovernment and few of think as the responsibility of all citizens.

Household Heads' Participation

Several possible reduction options were suggested by household heads in the study area. Among the most the surveyed sample respondents, they participate in different flood risk and vulnerability reduction strategy, some of they were likely:

Table 11: Household heads" participation in flood risk and vulnerability reduction strategy

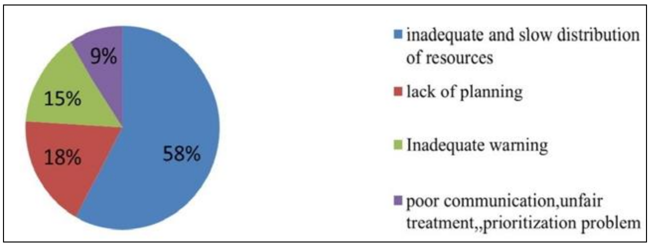
Household heads' Participation	Frequency	Percentage
Activities to divert water for flood irrigation	116	34.6
Upper catchment reduction; traditional soil and water conservation and afforestation	138	41.1
Construction of gabion and other works to stabilize River channels to contain flood water within the River bank	81	24.1
Total	335	100

Source: Field Survey, 2022

3.4 Challenges and Prospects of Flood Risk and Vulnerability Reduction Strategies

Flood risk and vulnerability was occurring in the study area to many different years. Because of this, people were enforced to left their homes, losses agricultural land, crops and other different properties. Due to this, from the total sample survey of the respondents, over 68% were responding that the government and other concerned bodies were not give concern as expected.

Observations, interview of institutions such as disaster prevention and preparedness agency (DPPA) at zonal and regional level as well as household survey results and documental information's shows that flood risk and vulnerability reduction strategies in the study area has a lot of challenges. Flood victims explained their views on the challenges and the institutions also had their say on their own problems regarding flood risk and vulnerability reduction strategy in the study area.



Source: Disaster Prevention and Preparedness Agency, 2022

Fig 9: Challenges of flood risk and vulnerability reduction strategies by institutions in the study area

Most or 58% of the respondents pointed out inadequate and slow distribution of resources such as sandbags during the flood as major institutional challenges, but 18% and 15% respectively also suggested lack of planning and inadequate warning as pressing fragility. Some respondents also have concerns that disaster prevention and preparedness agency needs assessment for financial aid was insufficient. Furthermore, 9% of inadequate notices of evacuation, unfair treatment, and poor communication regarding evacuation procedures and ethical problems during response were some of the challenges mentioned by respondents. The major institution that operates in the area of flood risk and vulnerability reduction was disaster prevention and preparedness agency. The regional, zonal and as well as district level disaster prevention and preparedness agency were interviewed and provided the challenges regarding flood risk and vulnerability reduction strategies. The challenges of flood risk reduction strategies in the study area were a lot and both respondents" and institutions mentioned mainly the lack of ample preparation due to the problem of budget and the shortage of inputs which uses to the victims during, before and after the flood event.

4. Conclusion

The research presented important information, justification and findings concerning vulnerability and risk reduction strategies by rural households in the selected villages of Beledweyne district. The findings of the study indicate that:-

- Major features of river flood discharge trend of the river Shebelle River (monthly, seasonal and annual discharge trends), and frequency of flooding, these hinders the variability or changes of the river discharge in the area from (1980-2020) and this variability or changes of the trend of the river flood in monthly, seasonal and annual discharge is the major factors of vulnerability to flood hazards in the study area.
- Flood risk and vulnerability exposing the people to felt safe. Majority of the people are not left their area until the hazard come over, they left the area after they ensure the serious nature of the problem. Due to this they fill the hazard and felt safe.
- Awareness and participation of the community regarding to flood risk and vulnerability in the study area shows a difference in between the respondents, some of the respondents consider as the only responsibility of the government, others consider as the responsibility.
- Flood risk and vulnerability adaptation strategies are taken in the district through households, communities and as well as institutions. In case of households; preventive and responsive strategies, in case of communities; catchment management, diversion of river to farm land, works for channel regulation and river bank protection and communal and traditional early warning, and in case of institutions both governmental and nongovernmental organizations are playing a significant role on the strategies of flood risk and vulnerability adaptation in the study area. This adaptation strategy helps to reduce the adverse impact of flood risk and vulnerability in the study area. However, there is the limitation of capacity to perform adaptation strategies in effective way.

The most challenging factors that affect the strategy of flood risk and vulnerability in the study area are inadequate and slow distribution of resources such as sandbags during the flood as major institutional challenges, but they also suggested lack of planning and inadequate warning as pressing fragility. Limitation of financial and material aid was insufficient. Furthermore, inadequate notices of evacuation, unfair treatment, and poor communication regarding evacuation procedures are the major strategic challenge in the study area. And, the prospect of the community was keeping everything from the government, need of external aid are the views or prospects of the community during the hazard.

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