Vol. 15(9), pp. 371-378, September 2021
DOI: 10.5897/AJEST2021.3036
Article Number: ABC942E67674
ISSN: 1996-0786

http://www.academicjournals.org/AJEST

ACADEMIC JOURNALS
expand your knowledge

African Journal of Environmental Science and Technology

Full Length Research Paper

Community views on water demands under a changing climate: The case of River Mpanga Water Catchment, Western Uganda

Isaac Mugume[1,2,3*], Ronald Semyalo[4], Peter Wasswa[1], Triphonia Ngailo[5], Ronald Inguula Odongo[1], Joyce Lunyolo[1] and Sulin Tao[6]

[1]Department of Geeography, Geo-informatics and Climatic Sciences, Makerere University, Uganda.
[2]Directorate of Forecasting Services, Uganda National Meteorological Authority, Uganda.
[3]Hub for Environmental and Atmospheric Research, Uganda.
[4]Department of Zoology, Entormology and Fisheries Sciences, Makerere University, Kampala, Uganda.
[5]Department of General Studies, Dar es Salaam Institute of Technology, Tanzania.
[6]Key Laboratory of Meteorological Disaster, Ministry of Education (KLME), Joint International Research Laboratory of Climate and Environment Change (ILCEC), Collaborative Innovation Centre on Forecast and Evaluation of Meteorological Disasters (CIC-FEMD), School of Applied Meteorology, Nanjing University of Information Science and Technology, Nanjing 210044, P. R. China.

Received 20 June, 2021; Accepted 17 August, 2021

Different sectors globally are experiencing the impacts of changing climate and water resources are among them. This study was conducted with an aim of examining the community views regarding the effect of changing climate on water demand over the River Mpanga Water Catchment. The study employed a cross-sectional survey using 111 household interviews; 14 Focus Group Discussions (FGDs) and 27 key informants interviews (KII). This study considered 14 villages and employed a mixed-methods study design. The analysis was conducted using SPSS software to derive the descriptive statistics. Qualitative information was analyzed using content analysis to conduct an in-depth analysis. The study found that the main source of water is tap water (72.1%) and the main use of water in the study area is domestic water use. This study also found that, breakage in water supply especially during the dry season (10 out of 14 FGDs) and poor quality of water especially the tap water due to chemical treatment (11 out of 14 FDGs) were the major challenges of water the community faced. Additionally, this study observed that 15 out of 27 KII considered drought as a major threat and that the area had experienced decreases in rainfall amounts over the months of January and February. Therefore, this study recommends that the providers of domestic water should invest heavily in technologies for improving water quality and amount; ensure sustainable and equitable rationing of water during scarcity; and promote incentives for water harvesting.

Key words: Community survey, water resources, River Mpanga.

INTRODUCTION

Globally, about 40% of the world's population is living under a high risk of the impacts of climate change (Nseka et al., 2021; Mukherjee and Siddique, 2019). This population, especially the population in developing countries is exposed to extreme weather events such as floods, heat waves and damaging wind among others

(Nimusiima et al., 2021; Nyakaisiki et al., 2019). Additionally, the changing climate is imposing increasing levels of economic losses and its impact to various sectors e.g. water resources, among others are becoming a great concern. For this reason, the changing climate is posing a great challenge to environmental water management (Capon et al., 2018; Murphy and Kitamirike, 2019) occasioned by unreliable rainfall (Mfitumukiza et al., 2020; Nyakaisiki et al., 2019). The main challenges relate to the demand and supply of water to the community. For example, the changing climate is driving shifts in global patterns of water and consequently affecting water security (Capon et al., 2018; Egeru et al., 2019). Therefore, the government of Uganda is examining the climate change risks into water resources and supporting integration of climate change adaption (Murphy and Kitamirike, 2019; Mwebaze, 2018).

Due to the changing climate and environment, e.g. increasing population pressure, water scarcity, loss of wetlands, and soil erosion (Amanyire, 2018; Capon et al., 2018), water management has been zoned to facilitate the implementation of catchment management zones (Egeru et al., 2019; Murphy and Kitamirike, 2019). This is further recommended by Mwebaze (2018) who opined that water allocation should be based on management zones. On the other hand, Egeru et al. (2019) advised to enhance the routine monitoring of catchment discharge. However, the development of these catchment management zones did not include climate change concerns as observed by Murphy and Kitamirike (2019). Therefore, mainstreaming climate change in catchment management plans is among the priorities of the Ministry of Water and Environment (Mfitumukiza et al., 2020; Murphy and Kitamirike, 2019). Moreover, the community over different areas in Uganda and other areas believe that the climate has changed (Mfitumukiza et al., 2020; Reta and Girum, 2019).

One of the catchments delineated by the Ministry of Water and Environment is the Mpanga catchment. This catchment is one the areas threatened by the changing climate. Additionally, it has suffered increasing land use and cover changes. These changes are also observed by Amanyire (2018) and Murphy and Kitamirike (2019) among others. The major land use/cover include cropland, forest, pasture, wetland, water body and settlement (Amanyire, 2018; Kakyo, 2019; Murphy and Kitamirike, 2019; Turyahabwe, 2019). Over the River Mpanga Catchment, the cultivated area increased by over 30% while grassland and forests decreased by about 32 and 11%, respectively over the period 1995-2015 (Amanyire, 2018). For this reason, the Ministry of Water and Environment has listed it as one of the catchments to integrate climate change in the management plans of the catchment (Amanyire, 2018; Kakyo, 2019; Murphy and Kitamirike, 2019).

The surface and ground water hydrology of River Mpanga catchment like other water catchments are highly sensitive to the altered precipitation, warming, increased evaporation, sea level rise and altered snow melt projected under many climate change scenarios (Capon et al., 2018). Egeru et al. (2019) have projected a net decrease of water resources base by 12.6% over the Nile Basin by 2040. Studies also show that small changes in climatic drivers potentially cause large changes in the flow regimes (Capon et al., 2018; Mugume et al., 2017). Additionally, the human water demands, especially for agriculture, are simultaneously expected to rise (Capon et al., 2018; Egeru et al., 2019) due to the changing climate. Freshwater ecosystems will furthermore be sensitive to climate change effects in the surrounding landscape which may exacerbate direct impact (Capon et al., 2018).

The demand of many water ecosystem goods and services are expected to increase under a changing climate (Nseka et al., 2021; Capon et al., 2018). This is likely to be worsened by human activities including siltation, eutrophication, water hardness, and toxicity (Amanyire, 2018). Overall, climate change is most likely going to reduce the availability and quality of environmental water allocations in most places as well as shifting these both spatially and temporally (Amanyire, 2018; Capon et al., 2018). In general, Amanyire (2018) recommended the population around the water catchments e.g. the River to be sensitized about the values, uses and laws regarding the sustainable use of water catchments.

MATERIALS AND METHODS

Study area

This study was carried out in mid-western Uganda. The study considered the Upper River Mpanga catchment (Figure 1) and used 111 respondents drawn from 6 sub counties (Busoro, East Division, Karambi, Kiko Town Council, South Division and West Division) which cover 14 villages (Bukwali, Busoro, Hakabale, Harakoto, Kampala Road, Karambi II, Kasojo, Kiko, Kisenyi, Mukusulya, Njara, Nkyakabale, Nyabinamba, Rwengoma) in Kabarole forming part of the Upper River Mpanga catchment.

The River Mpanga catchment is increasingly being exposed to land use/cover changes (Turyahabwe, 2019), including population pressure and changing climate (Amanyire, 2018; Tumusiime et al., 2019) yet it is the main source of water to the communities through different districts, namely Kabarole, Kyenjojo and Kamwenge (Tumusiime et al., 2019).

The catchment has an annual rainfall ranging from 600 to 1000 mm (Amanyire, 2018; Turyahabwe, 2019). The area is currently which it flows (Kakyo, 2019). This river flows over a distance of

*Corresponding author. E-mail: amooti23@gmail.com.

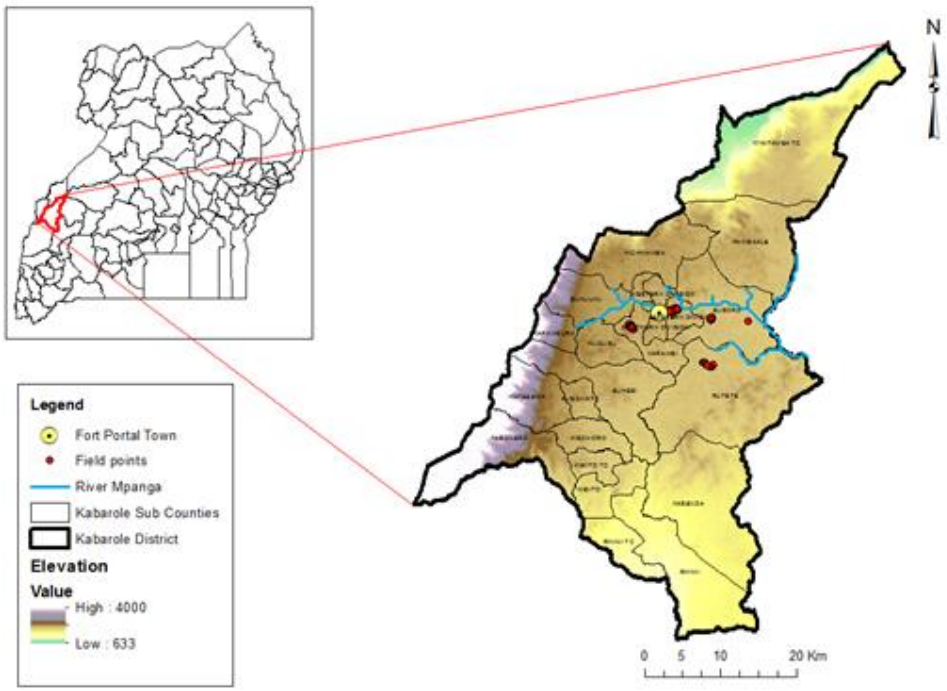

Figure 1. Map showing location of field work points obtained during the transect work through Mpanga River catchment in Kabarole district.

approximately 200 km, with an altitude ranging from 914 m (Lake George) to 2124 m (Rwenzori Mountains). It traverses three under high anthropogenic pressure due to high population growth rate and density and suffers a variety of poor land use practices such as deforestation, mining (sand, gravel and stones) by the local communities, water abstraction, poor waste disposal and agriculture (Tumusiime et al., 2019; Turyahabwe, 2019). These human activities compound to negatively affect the quality of water of River Mpanga directly and/or indirectly as it flows through Fort Portal town to rural areas. Additionally, there are large groundwater abstractions (Amanyire, 2018; Tumusiime et al., 2019) for different activities including domestic and industrial use.

Data and data sources

This study used a mixed methods approach. This approach to data collection is widely used in studies involving water demand management policies (Stavenhagen et al., 2018), and is recommended by Ransom et al. (2017). Additionally, the study employed a cross-sectional survey involving 111 household interviews (HHI). These households were randomly selected. Like Mfitumukiza et al. (2020), the study also conducted 14 gender-inclusive focus group discussions (FGDs) drawn from the 14 villages considered in the study. The participants forming the FGDs ranged from 8 to 10. Additionally, this study interviewed 27 Key Informants (KII) to cross-validate the information obtained from household surveys. The data obtained relates to demographic, household characteristics, sociological data, water availability and demand among others.

Data analysis

In this study, data analysis was done using descriptive statistics and in-depth analysis of qualitative information. Using SPSS, the descriptive statistics was carried out for the quantitative data to obtain means and frequencies for helping in drawing conclusions. The in-depth analysis was done for qualitative data. This in-depth analysis was conducted using content analysis, recommended by Mugagga et al. (2020). It included iterative forward-backward analysis of content obtained from FDGs and the household surveys to identify themes and make generalizations. This method is used in many qualitative research designs (Vaismoradi and Snelgrove, 2019).

RESULTS AND DISCUSSION

Socioeconomic characteristics of the studied sample

In order to understand the utilization of water over the study area, this study first considered the socioeconomic characteristics of the community over the study area. The study found that, on average, each household had about 5 people and that the household head had lived in the area for more than 12.6 years. Additionally, the study noted that the community appreciates that their population is increasing (75 out 111 household interviews (HHI)). The increasing population is exerting increased water abstraction. The study further found 7 out of 27 key informant interviews (KII) considered that the population is increasing polluting water while 6 out of 27 KII considered that the increasing population is destroying the available water resources.

The landholding of the household interviewed is shown

Table 1. Landholding status of the surveyed households.

Status of landholding	Frequency	
	Number	%
Acquired	66	59.5
Inherited	7	6.3
Encroached	25	22.5
Not Applicable	13	11.7
Total	111	100

Table 2. The main sources of water for the households surveyed.

Source of water	Frequency	
	Number	%
Water tap	80	72.1
Borehole	35	31.5
River	16	14.4
Water dam	4	3.6
Spring well	4	3.6
Rain harvesting	3	2.7
Total	142	127.9

in Table 1. The results show that majority of the respondents had bought and acquired the land. However, 25 out of 111 households had encroached land. Detailed analysis regarding the land encroachment showed that the sub-counties of East Division (8 out of 25), Karambi (8 out of 25) and Kiko trading center (6 out of 25) were outstanding.

Available water access points

The results showing the main sources of water are shown in Table 2. The results show that the main source of water in the surveyed areas is tap water (that is 80 households used tap water). This is supplied by the National Water and Sewerage Corporation, Fort Portal main branch (72.1%), followed by ground water abstraction using bore holes (31.5%). Our results do not show respondents using all the six sources concurrently. However detailed analysis shows that 2 respondents used borehole and water dam; 10 used borehole and tap water; 1 used borehole and river water; 1 borehole and rain harvesting; 3 borehole and spring wells; 14 tap and river; 1 tap and dam; 2 tap and rain harvesting; and 1 tap and spring wells. The results generally show that the distance to the nearest water source is largely less than a kilometer suggesting that water is within reach and since the majority of the households use tap water.

Additional analysis of the main source of livelihood (Figure 2) shows that the main sources of livelihoods for the households surveyed were carrying out small-scale business (41.4%) and crop farming (29.7%). Because of the multiple sources of water over the area and highly productive households, that is, 90.9% (Table 3) it seems that households can afford to access water, indicating that water insecurity may not be a problem.

Water uses

This study found that 98 out of 111 of the respondents considered the main use of water as domestic water use. Other water uses are shown in Table 3. Analysis of Table 3 shows that agriculture 25.2% (livestock: 18.9% and irrigation: 6.3%) is equally an area that uses water greatly. The study found industrial uses of water at 2.7%.

A related study by Adhikari et al. (2015) noted that water demand is expected to increase by the year 2040. The domestic water demand is expected to increase by 64% while livestock water demand by 44% and irrigation by 66% (Mwebaze, 2018). Adapting water resources management to climate change, however, requires integrated assessments of vulnerability across socio-ecological systems (Capon et al., 2018). This is because Mfitumukiza et al. (2020) observed that communities are now adopting drip irrigation as an adaptation strategy to the changing climate.

Challenges facing water use

The challenges regarding water use that were identified

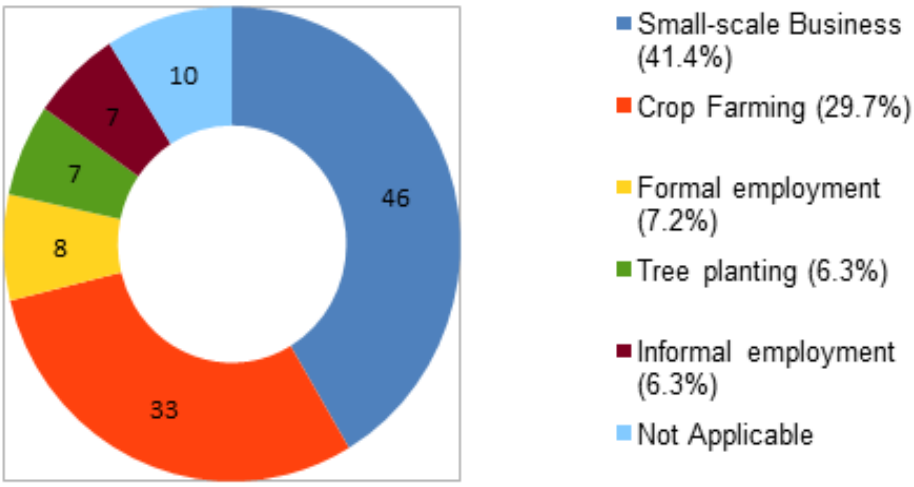

Figure 2. The main sources of livelihoods for the households surveyed.

Table 3. The main uses of water for the households surveyed.

Main use of water other than domestic	Frequency	
	Number	%
Livestock	21	18.9
Irrigation	7	6.3
Others (washing cars, recreational, water vending)	5	4.5
Industrial	3	2.7
Non response (only domestic use)	75	67.6
Total	111	100

by key informers during and the FDGs are shown in Table 4.

Analysis of the challenges facing community in accessing water shows that the leading challenges are: wells sometimes dry up (8); breakdown of boreholes (10); poor management of water sources (1); water sources not enough to many people (8); water is generally very expensive (8); on and off of tap water during dry season (10); and dirty water (11). These challenges compound to impress occasional water shortage. An investigation of households that have ever faced water shortage revealed that 53.2% experienced water shortage in the last 10 years. Of those who have ever experienced water shortage, 8.5% always suffer from water shortage; 25.5% consider that they regularly experience water shortage while 62.7% experience occasional water shortage.

Generally, in Karambi, the FGD participants pointed out that their community has fewer protected water points and analysis of the water sources in this sub-county shows that 89% of the households use the borehole as the main source of water. The urban communities generally consider that tap water is affordable but when disconnected, water becomes expensive for the case of a 20 L jerrycan. The studied communities also consider that water is becoming scarce due to increasing population. The increasing population often misuse water sources (especially the boreholes) leading to authorities to block access.

The occurrences of droughts and floods

The study found that 15 out of 27 Key Informants considered drought a threat. The study also noted that the community believes that droughts over the area increasingly occur during the months of January and February. Additionally, the community believes that there are very high chances of droughts occurring at least once a year. Flooding was also noted but it appears that flooding is not a major threat to the community compared to droughts. This is because the community considers that droughts normally reduces the supply of water (opinion of 12 out of 27 KIs); destruction of crops (opinion of 3 out of 27 KIs) among others. Additional analysis of January and February rainfall to corroborate the community views regarding rainfall in these months is as

Table 4. The main challenges the community faces in water use.

Theme	Challenge (No. of FGDs out of 14 FGDs)
General	Few protected water points (4)
	Wells sometimes dry up (8)
	Breakdown of boreholes (10)
	Poor management of water sources (1)
	Water sources not enough to many people (8)
	Water table goes down during drought (1)
Cost of water	In case it is tap water is disconnected, water is very costly (1)
	The water is expensive in terms of cost per 20 litre Jerry can
	Water is generally very expensive (8)
Supply of water	Scarcity of water especially during dry season (5)
	Road construction leading to break in supply (5)
	On and off of tap water during dry season (10)
	Low rate of water recharge (1)
	Many people served by a point source (2)
Quality of water	Dirty water (11)
	Usually not good for drinking (1)
	Too much chemicals that is put in water (6)
	Sometimes water smells (1)
	Water becomes silty (1)

'No. of FGDs presents the total number of FGD that held the same challenge. The challenges were grouped in themes for comprehensive analysis.

shown in Figures 3 and 4. The analysis confirms that indeed January (Figure 3) and February (Figure 4) rainfall over the study area has been decreasing. This is evident for January (from 2000) and February (from 2003) at about 1.509 mm per year (Figure 3) and 1.858 mm per year (Figure 4, respectively.

The decreasing rainfall amounts present high chances of drought occurrences. Climatologically, the period December to February is normally a dry season over the study area (Amanyire, 2018; Turyahabwe, 2019; Nyakaisiki et al., 2019). The decreasing monthly rainfall during the month of January (Figure 3) and February (Figure 4) will likely cause water shortages. This situation poses increasing uncertainties in patterns of water supply and the associated demand (Capon et al., 2018) and can likely lead to environmental violence described by Branch (2018), especially if it is persistent. Additionally, studies show that East Africa experienced persistent droughts in 2016 and 2017 (Branch, 2018) which is evident in Figures 3 and 4.

Conclusions

This study was about community views on water demand under a changing climate and was carried out over the River Mpanga catchment in Western Uganda. The study shows that majority of the households have access to tap water (72.1%). Unfortunately, rainfall harvesting is still limited at about 3% suggesting that the kind of technology and equipment used could be expensive. This study also probably considers that the terrain of the study area is rugged thus limiting the application of rain water harvesting technologies. Additionally, households opt for other sources of water rather than rain water harvesting due to challenges associated with it. For example, the initial cost and installation of a rain water harvesting system is expensive for instance water tank of 100 L costs 50000 shillings and above which is costly to a low income earner, inadequate volume of roof runoff, unpredictable rain, poor quality water and difficulty to store it for a longer period.

The main use of water is for domestic purposes, but other than domestic, water is usually used for irrigation (18.9%). This implies that domestic water providers like the national water and sewage corporation should invest highly in providing high quality water. Regarding water quality, this study found that dirty and smelling water due to chemicals were the main challenge regarding using water over the area. One of the FDGs noted that the water is not normally good for drinking and strongly recommended that tap water should be boiled prior to

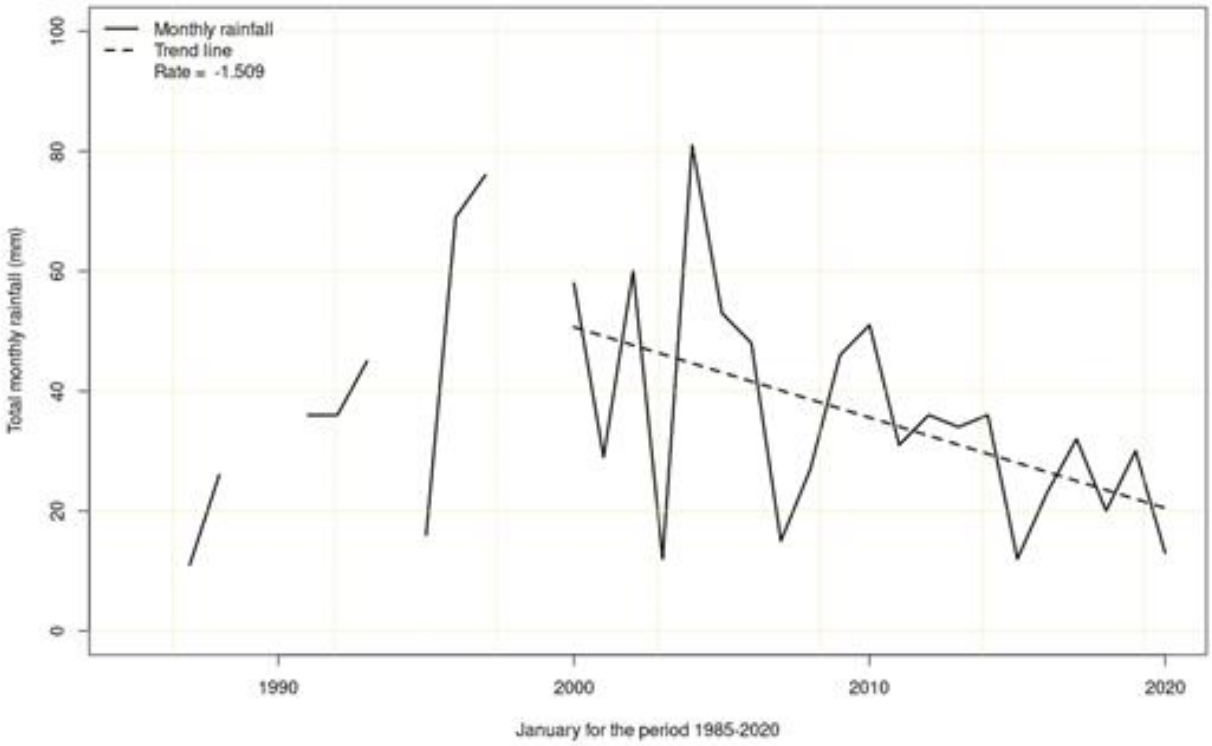

Figure 3. Monthly rainfall trends for the month of January.

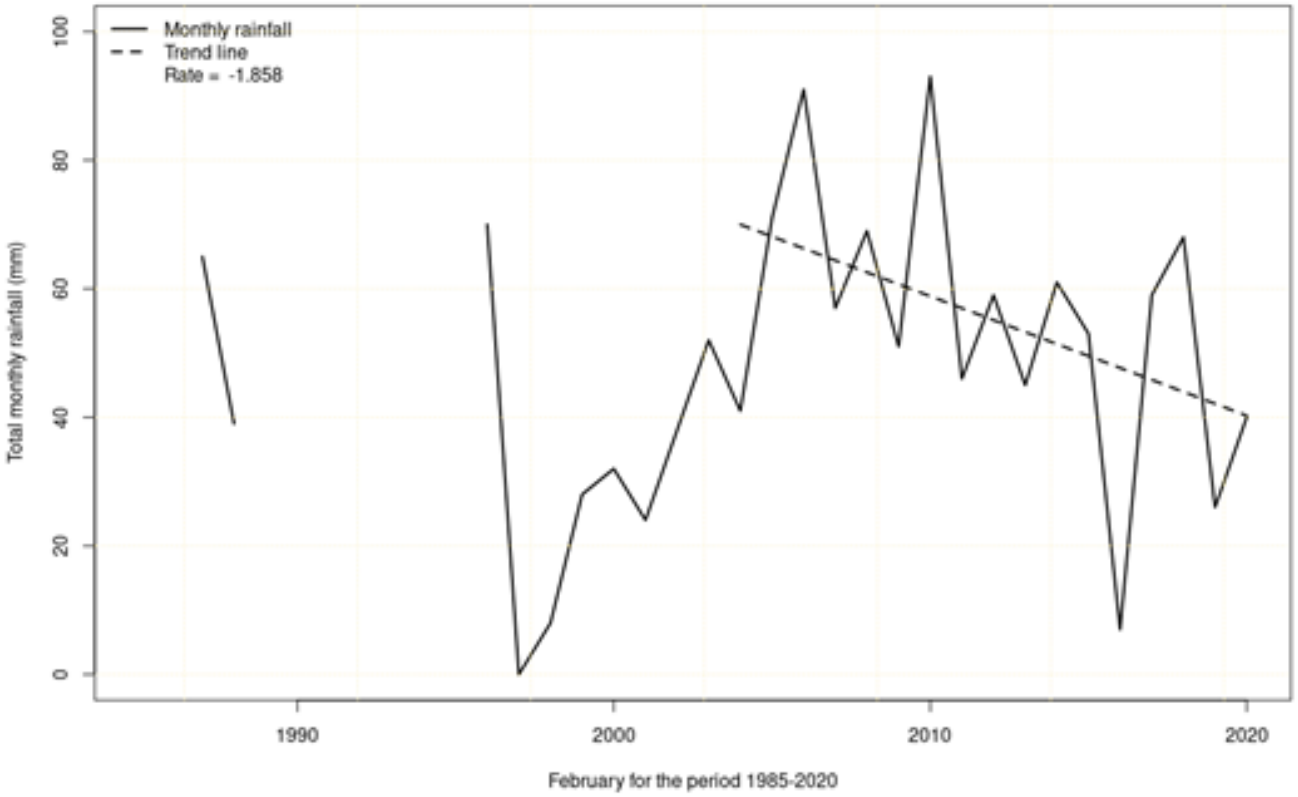

Figure 4. Monthly rainfall trends for the month of February.

drinking.

This study also observed that the community considers the climate to be changing and that this is evidenced by the declining rainfall amounts for the months of January and February. Empirical analysis also revealed that the total rainfall amounts in the months of January and February were largely decreasing at a rate of about 1.509 and 1.858 mm/year, respectively which validates the community views.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

ACKNOWLEDGEMENTS

The authors appreciate the Ministry of Water and Environment and local authorities of Kabarole district for the technical support; Prof. Robert Marcant of University of York for the scientific guidance; and the African Academy of Science (AAS) for the financial support in data collection. The authors further express sincere appreciation to the project “Towards a Food Secure Future under a Changing Climate”, granted by the Government of Uganda through the program of Research and Innovations Fund of Makerere University for financing the publication of this study.

REFERENCES

Adhikari U, Nejadhashemi AP, Herman MR (2015). A review of climate change impacts on water resources in East Africa. Transactions of the ASABE 58(6):1493-1507.

Amanyire S (2018). Urban River Pollution: A Case Study of River Mpanga in Fortportal City, Kabarole District (Doctoral dissertation, Makerere University).

Branch A (2018). From disaster to devastation: drought as war in northern Uganda. Disasters 42:S306-S327.

Capon SJ, Leigh C, Hadwen WL, George A, McMahon JM, Linke S, Arthington AH (2018). Transforming environmental water management to adapt to a changing climate. Frontiers in Environmental Science 6:80.

Egeru A, Bernard B, Geofrey G, George OL (2019). Projected water resource dynamics in the sub-humid Upper Nile Water Management Zone of Uganda, East Africa. African Journal of Rural Development 3(2):753-760.

Kakyo M (2019). Examination of the water quality of river Mpanga. Doctoral dissertation, Makerere University.

Mfitumukiza D, Barasa B, Kiggundu N, Nyarwaya A, Muzei JP (2020). Smallholder farmers’ perceived evaluation of agricultural drought adaptation technologies used in Uganda: Constraints and opportunities. Journal of Arid Environments 177:104137.

Mugagga F, Nakanjakko N, Nakileza B, Nseka D (2020). Vulnerability of smallholder sorghum farmers to climate variability in a heterogeneous landscape of south-western Uganda. Jàmbá: Journal of Disaster Risk Studies 12(1).

Mugume I, Basalirwa CPK, Waiswa D, Ngailo T (2017). Spatial variation of WRF model rainfall prediction over Uganda. International Journal of Environmental, Chemical, Ecological, Geological and Geophysical Engineering 11(7).

Mukherjee N, Siddique G (2019). Assessment of climatic variability risks with application of livelihood vulnerability indices. Environment, Development and Sustainability pp. 1-27.

Murphy D, Kitamirike J (2019). Integrating Climate Adaptation in Water Catchment Planning in Uganda. International Institute for Sustainable Development (IISD). https://www.jstor.org/stable/resrep21969, accessed 29-04-2020 21:34 UTC

Mwebaze CE (2018). Sustainable water use in Lake Edward-George Basin: A case study of River Mubuku-Sebwe sub catchments. Doctoral dissertation, Makerere University.

Nimusiima A, Nalwanga F, Mugume I, Ogwang BA, Waswa P (2021). A community perspective of flood occurrence and weather forecasting over Kampala City. African Journal of Environmental Science and Technology 15(5):188-201.

Nseka D, Mugagga F, Opedes H, Wasswa H, Mugume I, Nimusiima A, Nalwanga F, Ayesiga P (2021). The damage caused by landslides in socio-economic spheres within the Kigezi highlands of South Western Uganda. Environmental and Socio-economic Studies 9(1):23-34.

Nyakaisiki K, Mugume I, Ngailo T, Nakabugo R (2019). The Use of Indigenous Knowledge in Predicting Changes in Seasonal Rainfall by Smallholder Farmers of Ruteete Subcounty, Kabarole District. Journal of Geoscience and Environment Protection 7(1):13-22.

Ransom E, Bain C, Bal H, Shannon N (2017). Cattle as technological interventions: The gender effects of water demand in dairy production in Uganda. FACETS 2(2):715-732.

Reta Z, Girum T (2019). Assessment of Community Perception on Climate Change in Selected Areas of Arbaminch District, Southern Ethopia. Assessment 9(1).

Stavenhagen M, Buurman J, Tortajada C (2018). Saving water in cities: Assessing policies for residential water demand management in four cities in Europe. Cities 79:187-195.

Tumusiime J, Tolo CU, Dusabe MC, Albrecht C (2019). Reliability of the Tanzania river scoring system (TARISS) macroinvertebrate index of water quality: a case study of the river Mpanga system, Uganda. Journal of Freshwater Ecology 34(1):541-557.

Turyahabwe C (2019). Assessment of Impacts of Land Use Changes on Water Resources of River Mpanga Catchment. Doctoral dissertation, Kyambogo.

Vaismoradi M, Snelgrove S (2019). Theme in qualitative content analysis and thematic analysis. In Forum Qualitative Sozialforschung/Forum: Qualitative Social Research 20(3).