Original Research Article

The Environmental Conservation Strategies used in Secondary Schools Align with Guidelines of United Nations Environmental Program: Evidence from a cross-sectional study in a City Setting

ABSTRACT

The climate change crisis might soon be the biggest threat to global human existence if immediate action is not taken to overpower it. In Eastern Uganda, Mbale city is among the most affected areas, and the burden manifests in form of disasters such as long dry spells and floods. One of such floods in this city recently destroyed 5,000 acres of crops and homes of 5,600 people, killed over 30- and cut off clean water for 400,000 people. Schools can create environmentally responsible communities that are able to address this threat, but persistence of the burden in this area depicts unclear gaps in the roles played by these academic institutions. This study therefore examined the environmental conservation strategies used in addressing climate change and related calamities by students and staff of secondary schools in Mbale city, to unravel intervention-gaps and guide the way forward.

Conservation strategies, plus factors promoting their adoption and challenges, as well as the perceptions, attitudes, awareness, and knowledge about environmental conservation and climate change were examined in a random sample of 384 secondary school students and staff. Pre-tested, semi-structured questionnaires and Key Informant Interviews (KIIs) were used under the guidelines of the United Nations Environment Programme (UNEP), supplemented with observational surveys and photography. Data was analyzed with descriptive and inferential statistics using STATA version-15.0. Graphs were plottedwithGraphPad Prism® version 9.0.0.

Conservation strategies in schools were found to be diverse, involving mainly tree planting (N=339, 91.2%), preservation of green spaces (N=310, 83.3%), harvesting rain water and not damping wastes in water resources (N= 372, 100% each). Reuse of waste plastic bottles to fabricate dustbins was a novel observation. KIIs showed that the use of the school curriculum to support environmental conservation and climate change action was also prominent (N=12, 100%), but was not significantly different from other key strategic approaches such as incentives (χ^2 = 0.992, p = 0.319), and aid from some agencies (χ^2 = 3.200, p = 0.074). Interventions against air pollution were scarce. Determinants of choice of conservation measures were mostly; the school curriculum (N=381, 99.2%), costs (N= 381, 99.2%), land size (N= 352, 91.7%) and education level (N=250, 65.1%). Commonest perceptions on why conservation is vital were; to avert ecological threats (N=372, 100%), and the urge for a clean environment (N=372, 100%). Good attitudes towards conservation were in 269 (70.1%) of the participants; 48.4%, 7.8%, and 7.1% were not aware about biodiversity loss, climate change, and pollution respectively. 58.1% lacked sufficient conservation knowledge. Long dry seasons (100%), financial scarcities (94.8%**),** and high population (98.9%) were the commonest barriers, while low political will (N=12, 3.1%), was minimal.

In conclusion, environmental conservation strategies in secondary schools in Mbale city are diverse, largely align with guidelines of UNEP, and are based on the geography, resources, policies, and sociodemographic factors. The commonest challenges were; long dry spells, financial scarcities,population pressure. Redress to these anomalies is desired to enhance the use of secondary schools as hubs for environmentally responsible communities that can address environmental crises like climate change sustainably.

Key words: Climate change, environment, conservation, Schools, Mbale city, Eastern Uganda

1.INTRODUCTION

It is believed that climate change will soon be the greatest threat to human existence on Earth, making action against it urgently necessary(World Health Organisation (WHO), 2023; World Meteorological Organization (WMO), 2020).It is projected that over 216 million people will be displaced by climate change by 2050 if decisive and swift concerted action is not taken(World Bank Group, 2021; Ehui & Rigaud, 2022). As the world's food systems strain to feed a growing population and water supplies become more vulnerable, climate change is putting lives and livelihoods in jeopardy (World Bank Group, 2021). The term "climate change" refers to the long-term alterations in temperature and weather patterns. These alterations can be natural, but since the 1800s, human activities have been the primary cause of climate change(United Nations (UN), 2023,164).Such human activities include the burning of fossil fuels like coal, oil, and gas (Goniewicz et al., 2023). Fossil fuel combustion releases greenhouse gases into the atmosphere, which encircle the planet like a blanket and trap solar heat, causing the earth’s temperatures to rise, a phenomenon technically called global warming(Dieveney, 2023). Carbon dioxide and methane are the primary greenhouse gases responsible for climate change (Dilanchiev et al., 2023). These result from using coal to heat a building or gasoline to operate a vehicle, for instance. Carbon dioxide can also be released by clearing land and destroying forests. Methane emissions are mostly produced by the oil and gas industry and agriculture (Dieveney, 2023;World Health Organisation (WHO), 2023).

Research indicates that for the past 200 years, almost all global warming has been caused by humans’ activities (United Nations (UN), 2023). The Earth's surface currently has an average temperature that is 1.1°C higher than it was during the late 1800s (prior to the industrial revolution) and higher than it has ever been in the previous 100,000 years (World Meteorological Organization (WMO), 2020). The last four decades have all been warmer than any other decade since 1850, with the most recent decade (2011–2020) being the warmest on record (UN, 2023; WHO, 2023). Besides

global warming, the pressing consequences of climate change range from escalation of human diseases and deaths(Edelson et al., 2023), to devastating calamities like intense droughts, water scarcity, severe fires, rising sea levels, flooding(Dieveney, 2023), catastrophic storms,and declining biodiversity among others (United Nations (UN), 2023).

Currently, 25% of annual global human deaths are caused by preventable environmental risks and climate change exacerbates these risks(World Health Organisation (WHO), 2023). The consequences of climate change and the associated environmental disasters are more severe in resource-poor settings, especially Sub-Saharan Africa(Ehui & Rigaud, 2022). This may partly be attributed to the fact that the vulnerable populations in low-income settings are already afflicted by resource constraints and other socioeconomic factors such as illiteracy and technology shortfalls which hinder climate change adaptation and mitigation initiatives. One of the areas of the African continent where environmental threats are most prevalent is East Africa. For example, according to the State of the Climate in Africa 2020 report of the World Meteorological Organization (WMO), 1.2 million additional people in East Africa were displaced due to climate change and its related environmental disasters, primarily; floods, storms, and droughts(World Meteorological Organization (WMO), 2020).These tragedies are frequently observed in Uganda, particularly in the Eastern districts of the nation, mostly Mbale (Matembu, 2019). For instance, the catastrophic July 2022 floods at rivers including Nabuyonga, which claimed over 30 lives and destroyed thousands of dollars' worth of property, are some of the frequent occurrences of such environmental tragedies in Mbale district(New Vision News Paper, 2023b).The floods destroyed over 2,000 hectares (5,000 acres) of crops, submerged homes, businesses, and roads, and uprooted water pipes, leaving over 400,000 people without access to clean water and over 5,600 people displaced (Nakate Vanessa, 2022). Therefore, Eastern Uganda, particularly the areas in Mbale district, such as Mable city, are among the most critical parts of Uganda, where the country’s targeted interventions against climate change and the associated and its related environmental cruises need to be tailored.

In order to efficiently address climate change and other environmental emergences which are matters of urgent concern, the World Health Organization (WHO) has already recommended that the world decarbonize its energy systems and cut emissions by at least 43% over the next seven years, primarily by stepping up environmental conservation initiatives (World Health Organisation (WHO), 2023).For Uganda to effectively respond to this recommendation, particularly in Mbale city, academic institutions such as secondary schools need to be given considerable attention. This

is because the schools are not only affected by consequences of environmental disasters, such as devastation of information resources, school-gardens and infrastructure by floods (Härtel et al., 2023; Mongar, 2023; Nakate Vanessa, 2022), but have also traditionally been considered as essential centers for developing environmentally knowledgeable and competent people with a pro-environmental attitude, able to effectively address environmental threats (Aruta, 2023; Christ & Dreesmann, 2023; Härtel et al., 2023; Syvertsen et al., 2023). Nonetheless, there is a scarcity of information regarding environmental conservation strategies employed in Eastern Ugandan schools and the difficulties that come with them. This evidence deficit deters the optimal use of schools in addressing climate change and its related environmental threats, partly contributing to the escalation of these catastrophes.Therefore, the aim of this research was to examine the environmental conservation initiatives implemented as a way of addressing climate change, by students and staff of secondary schools in Mbale city, because the skills instilled in school communities in such initiatives are otherwise supposed to cause positive impacts in the general community. To achieve this, the environmental conservation strategies, factors influencing the adoption of these strategies, and the associated barriers, among secondary school students and staff were determined. This was followed by a comprehensive examination of the perceptions, attitudes, awareness, and knowledge about environmental conservation and climate change, in order to unraveled the potential gaps in school based environmental conservation strategies and pave way for the bridging of these gaps, hence advancing the capacity of schools to create environmentally responsible communities.

2. MATERIALS AND METHODS

2.1Research Design

In order to successfully address the research objectives and achieve the goals of the study, a mixed-methods research strategy wasutilized. According to Creswell & Creswell, (2017), mixed-methods research is a research approach that combines both quantitative and qualitative research methods in order to provide a more comprehensive and nuanced understanding of a research problem.Qualitative research examines people's perspectives, cultures, and experiences to reveal how they shape the outcome variable(Poth, 2020), which is environmental conservation in the context of the proposed study. In the proposed study, a cross sectional design with a qualitative approach was adopted, to subject secondary students' and staff to pre-tested semi-structured questionnaires and interviews. The findings revealed how the staff and students'perceptions, attitudes, awareness, and knowledge about environmental conservation and climate change, and the

prevailing challenges influence the adoption of different environmental conservation interventions in secondary schools in Mbale City.

In contrast, quantitative research utilizes numerical data to examine patterns, relationships, and statistical significance(Creswell & Creswell, 2017). The collection of quantitative data in thisresearch was done using a descriptive cross sectional survey design, with semi-structured pre-tested questionnaires. This enabled the unraveling of the extent to which various environmental conservation techniques are being adopted in schools, and how the qualitative variables described above influence the choice of these techniques. The collected data was subjected to suitable statistical techniques in order to identify trends on how the qualitative variable such as perceptions, knowledge and attitudes relate to the environmental conservation methods adopted in different schools.

2.2 Conceptual framework

The study context in this research was been conceptualized as follows.

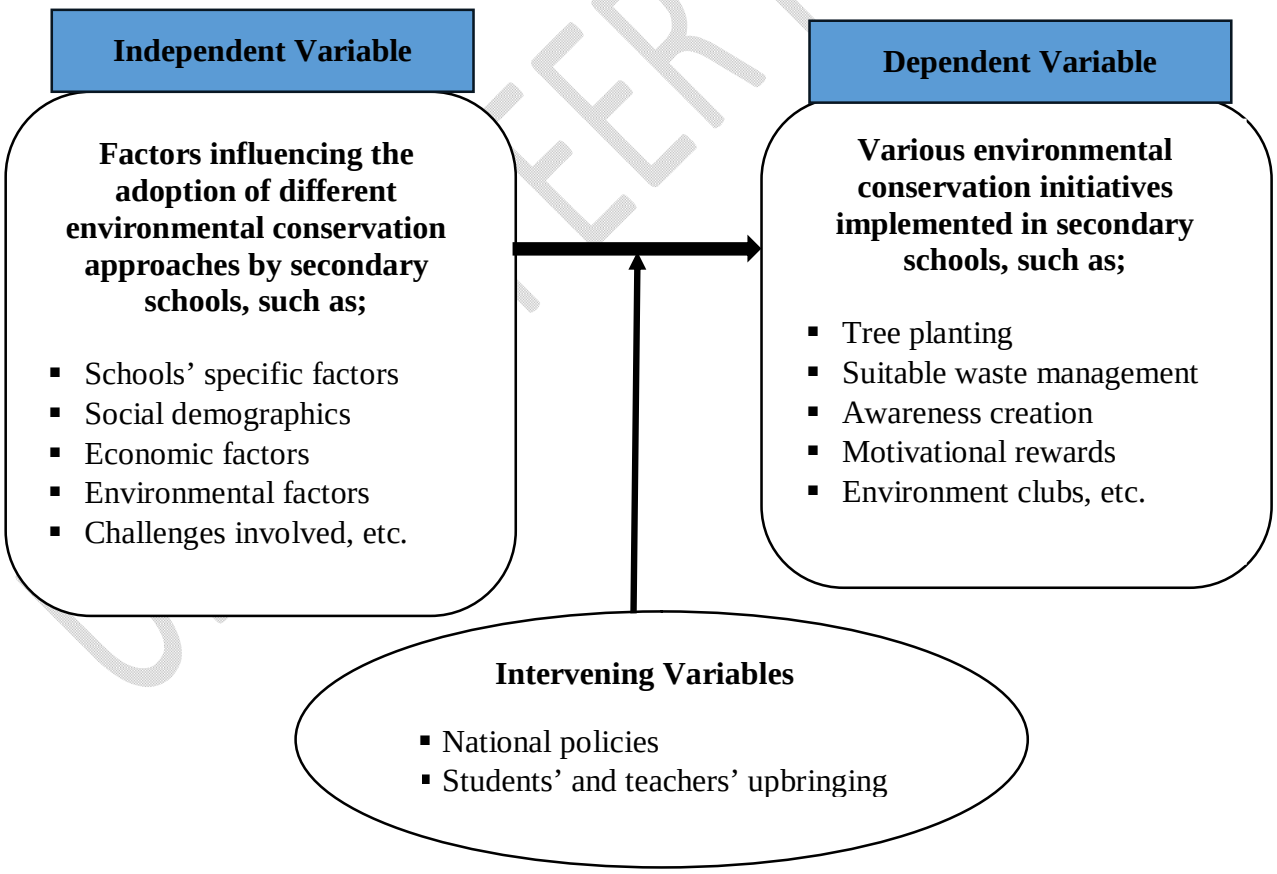

Figure 1: Conceptual framework of this research

2.3Study Area

The study was conducted in Mbale City, located in Mbale district, with a particular emphasis on the secondary schools located there. Mbale district is located in Eastern Uganda, about 225 kilometers northeast of Kampala, the main commercial and capital city of Uganda (Fig. 1). The coordinates of the Mbale district are 1°04'50.0"N, 34°10'30.0"E (latitude: 1.080556; longitude: 34.175000), with an average elevation of 1,156 meters (3,793 feet) above sea level(Warsame et al., 2021). Given its natural richness and the difficulties it possibly encounters in preserving the environment, which culminate in the frequent outbreaks of natural calamities like floods and long dry spells, Mbale distinct is a perfect site for the proposed study.

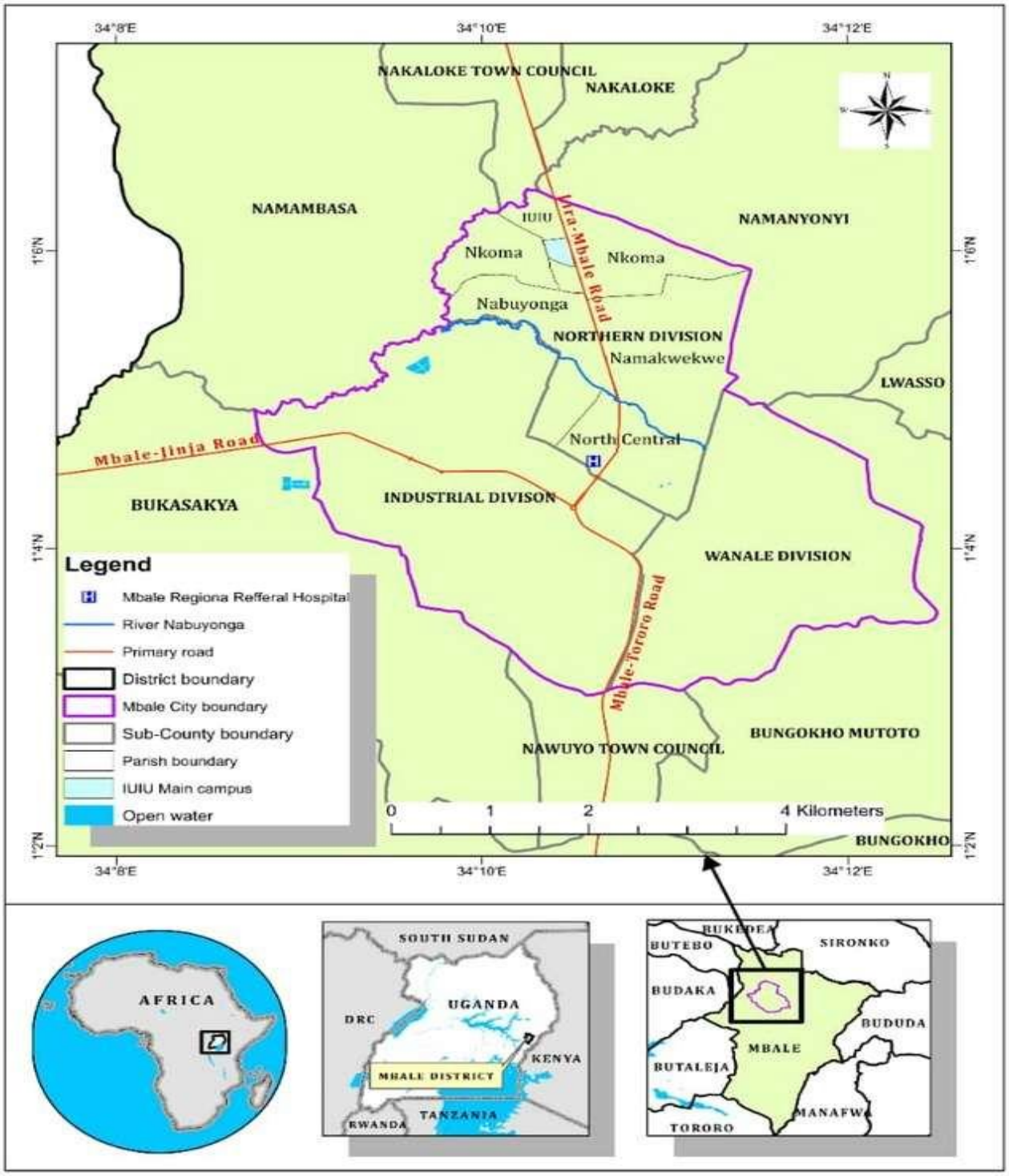

Figure 2: Map showing the study sites

2.4Study Population

According to Cohen et al., (2002), a study population refers to the total number of individuals that are eligible for inclusion into the study because they are assumed to have information concerning the research problem at hand. It is from this group that the study sample can be obtained. The research population includes Secondary school students,teachers, school administrators, and other

staff who have a stake in environmental activities such as academic programs, cleaning and tree planting activities among others.

2.5 Sample Size Determination

The sample size for this research has been determined using a published formula(Fischer et al., 2018).

$$n = \frac{[Z^2Pq]}{d^2}$$

n = required sample size

Z = confidence level at 95% (standard value of 1.96)

P = estimated proportion of secondary school communities that are involved in environmental conservation in Mbale city, or similar settings (a 50% ≈ 0.5 is adopted if such evidence is not available), hence ≈ 0.50 has been adopted in the case of this research.

q = 1-P (estimated prevalence of eligible members of the study population that decline to participate in environmental conservation programs ≈ 0.50)

d = accepted error of 5% (standard value of 0.05)

$$n = \frac{[(1.96)^2\ x\ (0.50)x(0.50)]}{(0.05)^2} \approx 384$$

Sample size (n) = 384 participants was adopted in this research

2.5.1Sampling Techniques

A stratified random sampling technique was used where the schools were divided into two strata namely; (i) The government aided secondary schools, and (ii) the privately owned secondary schools. The study recruited a proportionate number of respondents from each stratum based on its size, in order to provide equal opportunities for participation among the various participant groups.

2.6Data Collection Methods and Instruments

For objective 1, the researchers used pre-tested semi-structured questionnaires to document the methods adopted, and the frequency of usage, and the procedures for these methods. Such methods may include the implementation of environmental education programs, school's involvement in community conservation initiatives, waste management, tree planting and maintenance among others. The conservation methods and practices were also evaluated using a standardized observation checklist and photography with a digital camera.

For objectives 2 and 3, researchers used pre-validated, self-administered questionnaire to a sample of secondary school students and staff to collect data on their knowledge, perceptions, attitudes, and awareness on environmental conservation and climate change.The questionnaire assessed knowledge onclimate change and environmental hazards, plus the associated conservation measures; attitudes towards conservation; and perceptions on the importance of environmental conservation and climate change mitigation.The policy makers (Key Informants), such as headteachers, directors of studies, directors of schools, matrons and wardens; plus, the support staff that are closely involved in waste management and compound maintenance were subjected to Key Informant Interviews (KII), using a standardized interview guide.

2.7 Data Analysis Plan

Data was first checked for completeness and accuracy using Microsoft excel 2016 to remove outliers, and address any cases of missing data before analysis, as a way of assuring data quality. The qualitative data gathered from Key Informant Interviews was transcribed, coded, and then analyzed using thematic synthesis (Castleberry & Nolen, 2018), to identify recurring patterns, themes, and insights related to the perceptions, attitudes and knowledge of environmental conservation and climate change and the challenges associated with the adoption of different conservations interventions. The themes that may arise could include; policy factors, curriculum factors, resource factors, and environmental factors among others.

For the quantitative variables, the data was entered in MS-Excel and exported to STATA version 15.0 software. The data was tested for normality by using D'Agostino-Pearson test with normal distribution accepted at (p>0.05). Data was analyzed using descriptive statistics such as frequencies, mean, mode, and percentages, and inferential statistics (Pearson's Chi-squareat 0.05 significancy level).

3.8Ethical Considerations

The higher degrees research committee of the Faculty of Science at Islamic University in Uganda (IUIU) granted permission to conduct research. Additionally, the local government of Mbale city, and the administer

ators of the respective schools under study were requested for permission to access and use the research sites.Further, the studyupheld among others the following ethical principles of scientific research as described by Kumar, (2013). Informed consent:the researcher took the prospective participants through the consenting process(Chatterjee et al., 2015), and support the intersected

participants to sign the informed consent forms. Confidentiality: the researcher did not disclose the identities of respondents (instead used assigned codes), and did not use participants' feedback for purposes other than for this study.Integrity: the researcher endeavored to report the research outcomes objectively in a manner that did not change them to serve personal interests since this can be very unethical. The researcher thus reported the findings in a clear, unbiased, accurate, and objective ways possible.

3.0 RESULTS AND DISCUSSION

3. 1RESULTS

3.1.1 Sociodemographic characteristics of the participants

Of the 384 participants in this research, the majority werefemales (N=203, 52.9%), and youths (N=302, 78.6%), and had stayed in the respective schools for 1≤4 years (N=286, 74.5%). Most of the participants were students (N=319, 83.1%), followed by the staff who are not teachers and administrators, that is the compound maintainers, cooks and medical personnel (N=30, 7.8%). Most schools spent< UGX750,000 on environmental conservation monthly (N=04, 66.6%)(Table 1).

Table 1: Socio-demographic characteristics of the participants (n=384)

Variable		Number (%)
Gender	Male	181 (47.1%)
	Female	203 (52.9%)
Age (years)	18-24(Youths)	302 (78.6%)
	25-63 (Middle aged)	82 (21.4)
	≥ 64 (Elderly)	0 (0.00%)
Nationality	Ugandan	384 (100%)
	Non-Ugandan	0 (0.0%)
Marital status	Married	65 (16.9%)
	Single	319 (83.1%)
Highest level of education attained	None	20 (5.2%)
	PLE	251 (65.4%)
	UCE	68 (17.7%)
	UACE	4 (1.0%)
	Tertiary	41 (10.7%)
Time spent in this school (Years)	1≤4	286 (74.5)
	≥5	98 (25.5%)
School's estimated monthly expenditure on environmental conservation / UGX ($) (N=6)	Not specified	01 (16.7%)
	< 750,000 (200)	04 (66.6%)
	750,000 ≤ 1,500,000 (400)	01 (16.7%)
Category of respondents	Students	319 (83.1%)

	Teachers	23 (6.0%)
	School administrators	12 (3.1%)
	Others	30 (7.8%)
Total of people in the school (N=6)	300 ≤ 500	1 (16.7%)
	501 ≥700	2 (33.3%)
	>700	3 (50.0%)

Key;UGX: Uganda Shillings, $: United States Dollar, PLE: Primary Leaving Exams, UCE: Uganda Certificate of Education, UACE: Uganda Advanced Certificate of Education, Others: Cleaners/compound maintainers, Cooks, Medical staff.

3.1.2Environmental Conservation Strategies used by Secondary School Students and Staff in Mbale City

The environmental conservation strategies that were most predominantlyused by secondary school students and staff in Mbale city as revealed in the current study are shown in figure 3, and subsequently demonstrated (Supplemental files 1-12).These conservation strategies were conceptualized into four themes as stipulated inthe international guidelines of theUnited Nations Environment Programme / UNEP, (2020). As such, the majority of the conservation strategies adopted by the schools under study were in the category of interventions supportingconservation of the entire environment in general (land, water, and air),mostly tree planting (N=339, 91.2%) (Supplemental files 1 and 2), and preservation of green spaces (N=310, 83.3%) (Supplemental file 3). This was followed by the strategies aimed at conserving water resources, mostly the harvesting of rain water to ease pressure on depletable water resources, not dumping wastes in water bodies(N= 372, 100% each),and not pouring chemicals in water-ways (N=362, 97.3%). Thescarceststrategies were those used formitigating airpollution, of which, the commonest was the use of fume cupboards in laboratories (N=77, 20.7%), and minimization of wood and other fuel combustions (N=70, 18.8).The other, remarkably infrequent, environmental conservation strategiesthat were revealed in the observational survey in this researchwere; installationof kitchen-fume outlet pipes (Supplemental file 4), getting rid of solid wastes by combustion (Supplemental file 5), mixed cropping and mulching (Supplemental file 6), establishment of shallow wells (Supplemental file 7), agroforestry and incineration (Supplemental file 8), and innovative re-use of plastic waste bottles (Supplemental file 9).

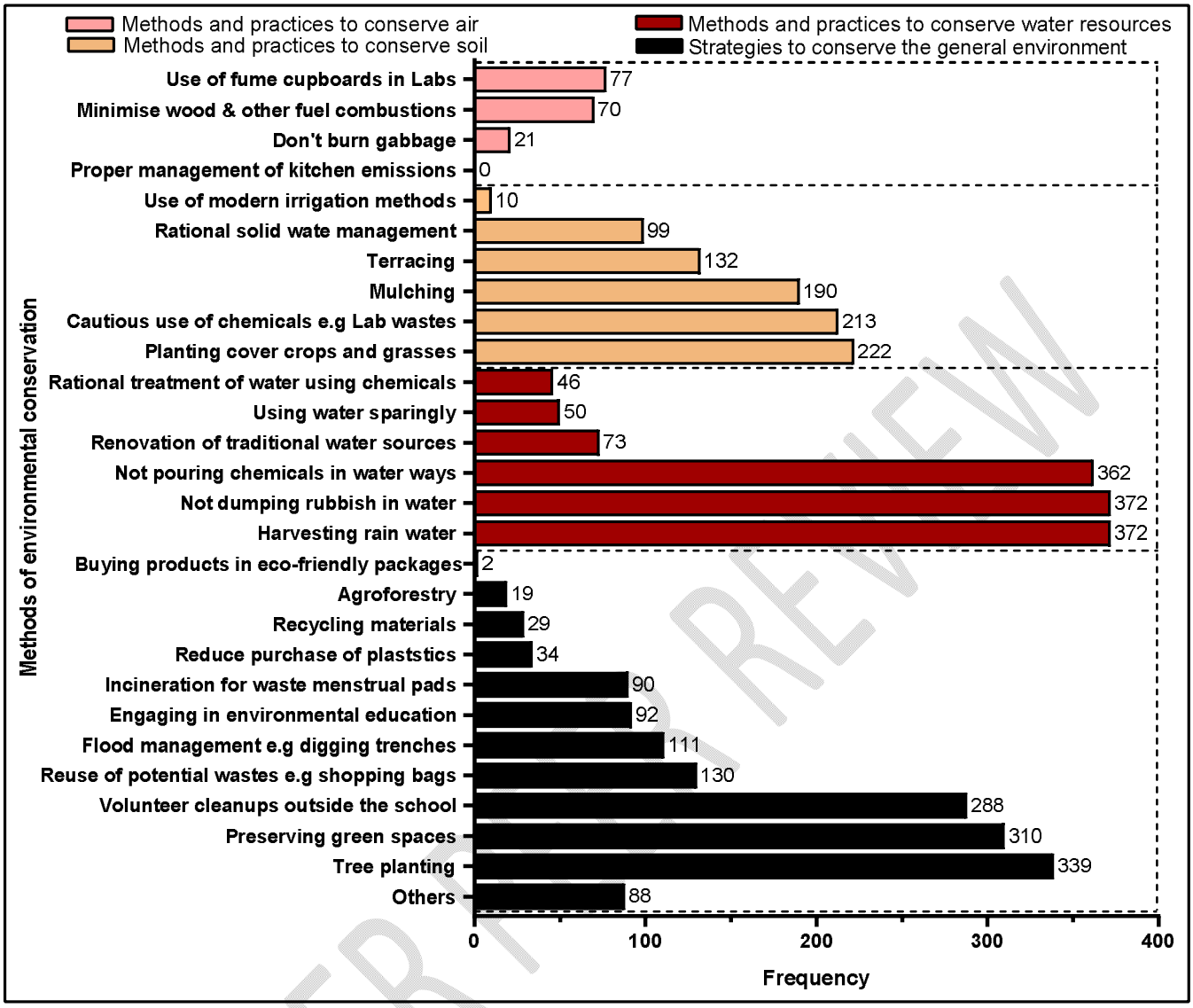

Figure 3: Environmental conservation strategies used by secondary school students and staff in Mbale city (N=372). Labs: Laboratories, E.g: Example given, Others: Routine general cleaning of the school, engaging in school environmental clubs, Effective management of toilet facilities and sewage.

For the management of medical wastes, all the school medical officers (N=09, 100%), indicated that they collected the combustible medical wastes in plastic waste baskets, sometimes together with the non-medical wastes(Supplemental file 10).Following considerable accumulation, these wastes were finally burnt together with other solid wastes such as papers and polythene bags that were generated in the general school community. However, the medical wastes that are commonly referred to as sharps (non-combustible solidwastes such as syringes and broken pharmaceutical glass bottles),were reported to be collected in hard paper containers (Supplemental file 10), and eventually deposited in school toilets.

Results from the Key Informant Interviewsrevealed that all the school administrators (N=12, 100%), acknowledged the use of environmentally relevant contents integrated into the teaching curriculum of some subjects, especially, Biology, Agriculture, and Geography, as a tool to promote and support environmental conservation in their schools. The frequency of mention of the use of formal education curriculum to support environmental conservation and climate change mitigation was not significantly different from other key strategic approaches such as the use of incentives (N=11, χ^2 = 0.992, p = 0.319, 95%CI=-16.92% to 36.8%) (Figure 4), andmobilization ofresources from government and Non-governmentalOrganizations (NGOs) (N=9, χ^2 = 3.200, p = 0.074, 95%CI=-4.80% to 57.30%)(Table 2). Such NGOs included Nature Uganda, WaterAid, SOMA Foundation, and the United Nations International Childrens Emergency Fund (UNICEF)(Supplemental file 11, and 12). On the other hand, the frequency of citation of the adoption of formal education curriculum was significantly less than some informal approaches such as the "promotion of students' community outreach activities", including environmental cleanups (N=4, χ^2 = 9.005, p = 0.003, 95%CI=18.06% to 92.50%),and awareness creation through music, poems, and plays (N=6, χ^2 = 6.800, p = 0.009, 10.50% to 81.20%). None of the key informants confirmed the use of environmental policy instruments developed by their schools, nor the adoption of the guidelines established by national institutions such as Uganda National Environmental Management Authority (NEMA), and internationalframeworks like the United Nations Environment Program (UNEP).The results from Key Informants are shown inTable 2, Figure 4 and Supplemental files11 and 12.

Table 2: Strategies used to promote and support environmental conservation and climate change mitigation by secondary school administrator in Mbale city (N=12)

Variable	f (%)	χ^2	p-value	95%CI
Relevant contents integrated in the teaching curriculum	12 (100) REF			
Giving incentives to enhance stakeholder engagement	11 (91.7)	0.992	0.319	-16.92% to 36.8%
Budgetary allocation on environmental conservation	10 (83.3)	2.070	0.150	-10.57% to 47.66%
Capacity building through teaching, seminars and workshops	10 (83.3)	2.070	0.150	-10.57% to 47.66%
Resource mobilization from NGOs and government agencies	9 (75.0)	3.200	0.074	-4.80% to 57.30%
Use energy-efficient light bulbs to reduce greenhouse gasses	9 (75.0)	3.200	0.074	-4.80% to 57.30%
Promotion of students' environment clubs	9 (75.0)	3.200	0.074	-4.80% to 57.30%
Participation in international environment celebrations	8 (66.7)	4.380	**0.036**	0.58% to 66.10%
Relevant activities integrated in informal curriculum	7 (58.3)	5.601	**0.018**	5.74% to 74.14%
Awareness creation through music, poems, and plays	6 (50.0)	6.800	**0.009**	10.50% to 81.20%
Promotion of students' community outreach activities	4 (33.3)	9.005	**0.003**	18.06% to 92.50%
Relevant policy instruments developed/adopted and used	0 (0.00)	NA	NA	NA

χ^2: Chi-square, f = Frequency of mention,NGOs: Non-governmental Organizations, REF: Reference value,NA:Not application, Bold p-values are significant.

Among the incentives offered by school administrators (Key Informants), to the members of the school communities that are championing environmental conservation and the fight against climate change, the three most frequently cited approaches were; verbal public recognition was, award of certificates of appreciation, and access of environment prefects to the students' leaders' privileges such as; special meals, free school uniforms, and consumable items like sugar (Figure 4). The least cited was recognition of the leading environmental conservation champions in the schools' periodical publications such as magazines (N=3, 25%)(Figure 4).

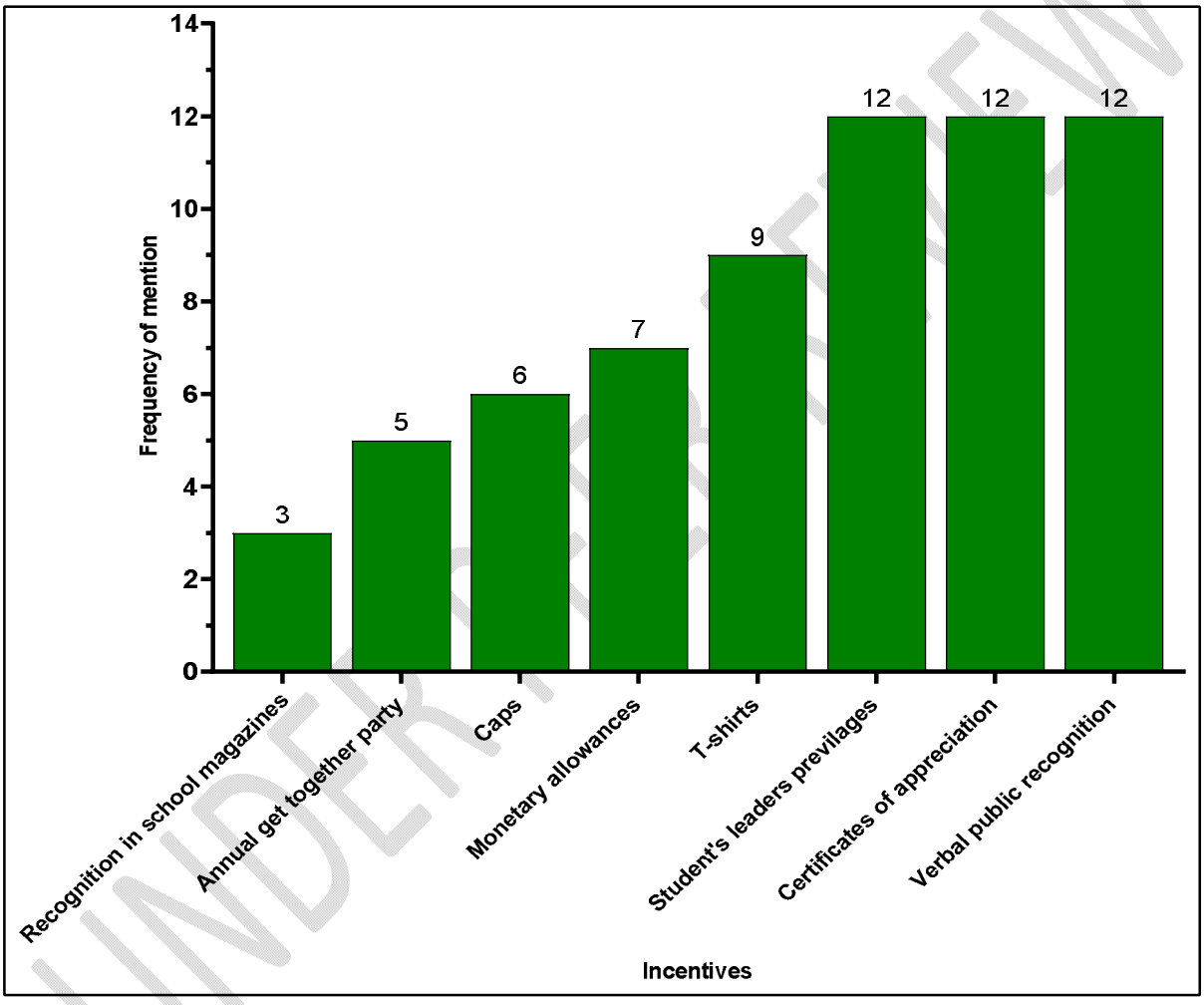

Figure 4: Incentives offered by school administrators to staff and students to promote and support the participation of secondary school communities in environmental conservation and climate change mitigation programs in Mbale city (N=12)

Pertaining to the preference ranking on the scale of 5, for the top six methods that can be most effective in promoting environmental conservation and climate change mitigation in Mbale city, the Key Informants (school administrators), ranked "tree planting" (Score=48, Rank=1st), as the most effectiveapproach for environmental conservation and climate change mitigation in the ecological context of Mbale city. This was followed by "planting of cover grasses"(Score=40,

Rank=2nd).Terracingwas ranked as the least effective among the top six intervention measures (Table 3).

Table 3: Preference ranking of the effectiveness of the top sixenvironmental conservation methods by secondary school administratorsin Mbale city (N=12)

Variable	Respondents												Score	Rank
	R_1	R_2	R_3	R_4	R_5	R_6	R_7	R_8	R_9	R_{10}	R_{11}	R_{12}		
Tree planting	4	5	5	5	3	3	4	4	5	3	3	4	48	1st
Recycling wastes	2	5	3	3	2	3	5	2	3	3	2	5	38	3rd
Burning rubbish	3	3	4	2	5	3	2	3	2	3	5	2	37	4th
Mulching	3	4	3	2	2	3	4	3	2	3	2	4	35	5th
Planting cover grasses	3	3	3	4	4	4	2	3	4	4	4	2	40	2nd
Terracing	3	2	2	3	4	3	2	3	3	3	4	2	34	6th

3.1.3 Factors Underpinning the Adoption of Environmental Conservation Strategies among Secondary School Students and Staff in Mbale City

The most commonly cited reasons for using the above environmental conservation and climate change mitigation strategies fell under three themes namely; resources, policies, and the nature of the environment (figure 5).Particularly, the most commonly stated reasons were; the fact that the environmentally sensitive contents (environmental education), are incorporated into the national teaching curriculum hence schools are obliged to implementit (N=381, 99.2%), the cost of the interventions (N= 381, 99.2%), the existing soil erosion types and severity (N= 371, 96.6%), and the size of the land owned by the school (N= 352, 91.7%) (Figure 5). A representative image of the deep scars of eroded soil that would influence the choice of intervention strategies, as observed in this study (Supplemental file 13). The least cited factors were in the category of social demographics, particularly, theschool community's level of expertise on environmental matters (N=32, 8.3%), followed by the category of resources, that is, the financial capacity of the schools (N=41, 10.7%).

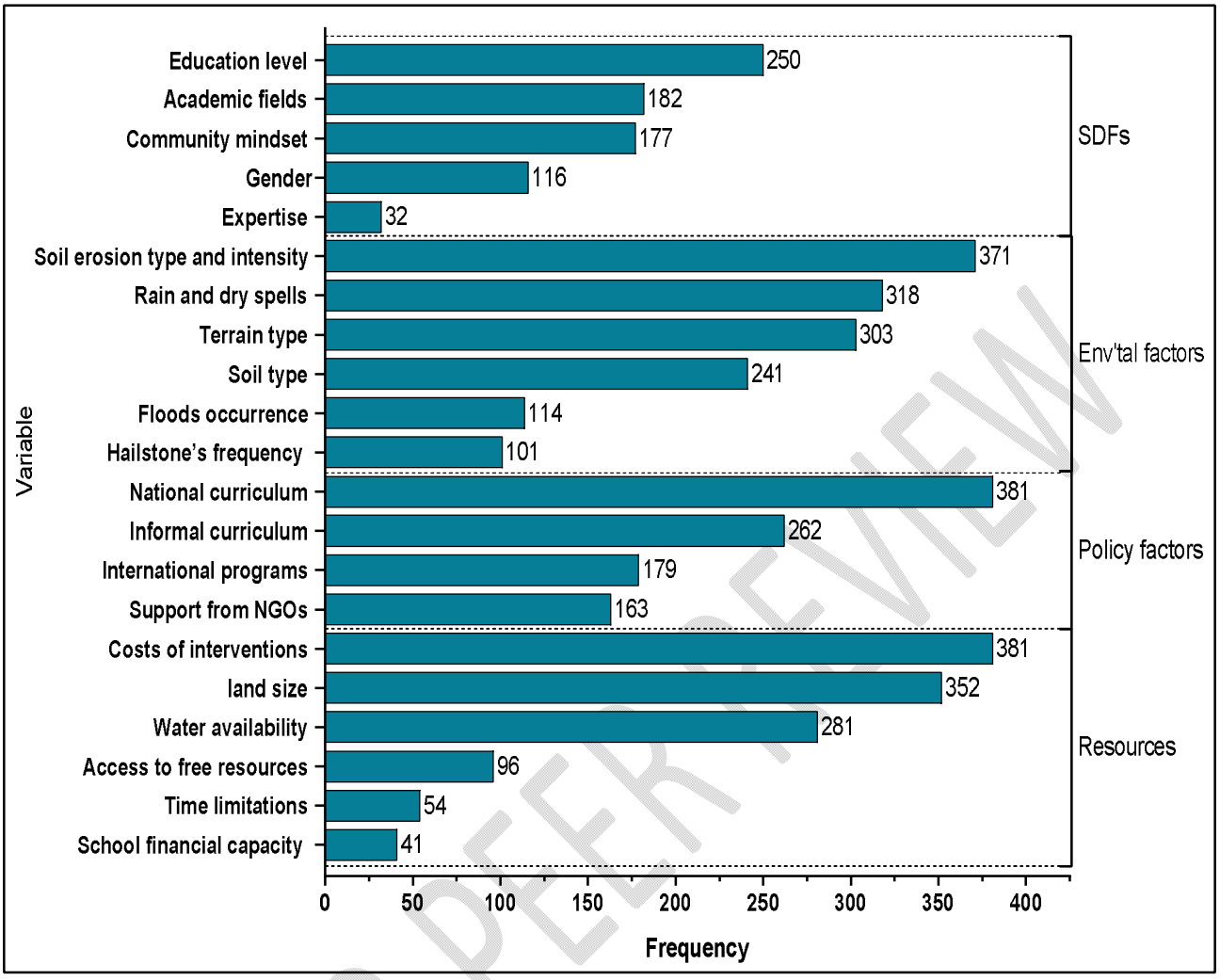

Figure 5: Factors underpinning the adoption of environmental conservation strategies among secondary school students and staff in Mbale City (N= 384). The factorswere conceptualized into four themes;Socio-demographic Factors (SDFs), environmental factors, policy factors, and then resources

3.1.4 Perceptions, attitudes, awareness, and knowledge about environmental conservationand climate change among secondary school students and staff in Mbale City.

To investigate the perceptions about environmental conservation and climate change,the respondents were asked to give their opinions with regards to why they thought conserving the environment and fightingclimate change is an important venture.The perceived desire to avert ecological threats like global warming and floods was the most frequently cited reason for conserving the environment (N=372, 100%). This was followed by the need of a clean environment for human and wildlife health (N=362, 97.3%), and to sustain essential natural resources such as lakes (Fig. 6). The perceived reasons for conserving the environment that were least stated by the respondents were; to pave way for practical environmental education (N=22, 5.9%), to promote an

ideal environment for recreation (N=26, 7%), and to earn income, e.g. from trade in seedlings (N=38, 10.2%).

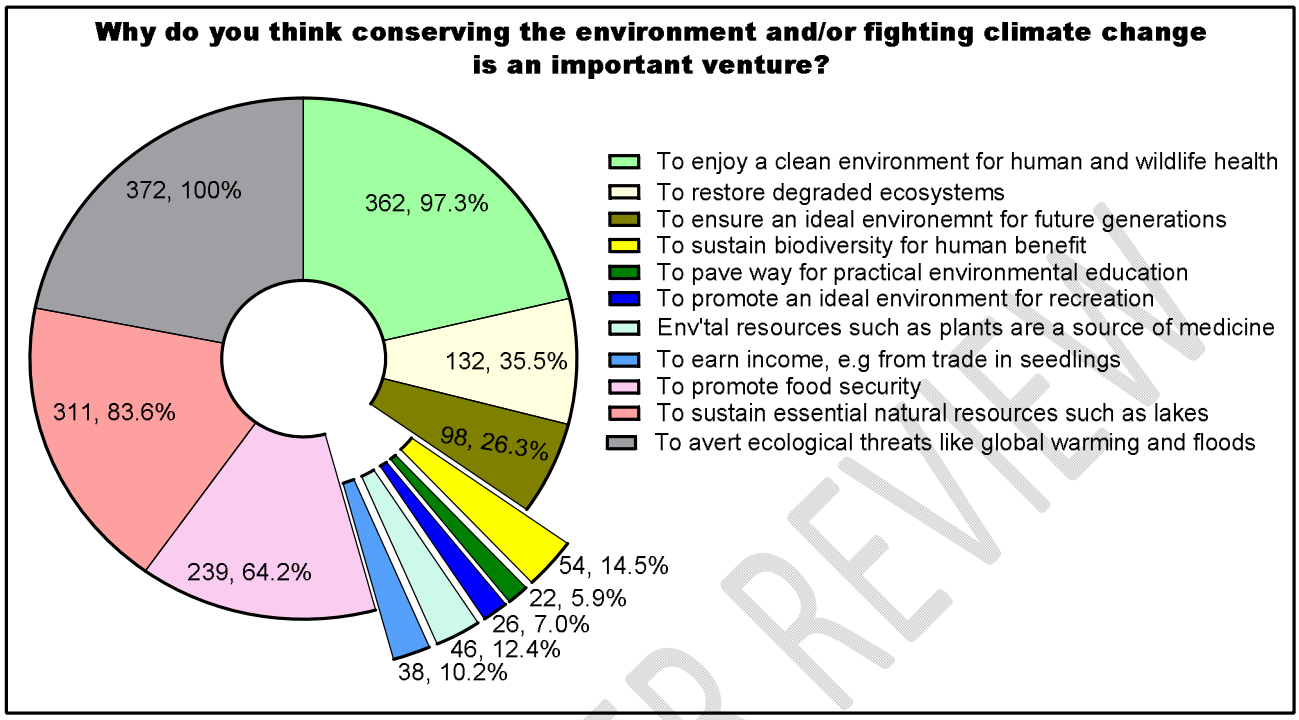

Figure 6: Perceptions on why conserving the environment and fighting climate change are important in the opinion of secondary school students and staff in Mbale City

Further, when asked to highlight their perceptions on whether they thought environmental conservation is adequately integrated into the national school curriculum, the most widespread perception wasthat the integration wasat a moderate level (N=218, 58.6%), while none of the participants (N=0, 0.0%), believed that the curriculum did not address the environmental conservationaspects at all (Table4).

Table4: Perceptions of students and staff of secondary schools in Mbale city on whether environmental conservation is adequately integrated into the national school curriculum (N=372)

Do you think environmental conservation is adequately integrated into the school curriculum?	
Variable	**Frequency (%)**
Not at all	0 (0.0%)
Slightly	19 (5.1%)
Moderately	218 (58.6%)
Very much	71 (19.1%)
Extremely	64 (17.2%)

Pertaining to the attitudes about environmental conservation and climate change, when asked, "*If you are neither obliged nor motivated to conserve the environment, would you consider abandoning your current roles as an actor in environmental conservation?*", 269 (70.1%) of the 384 participants said "No", 16 (4.2%) said yes, while 99 (25.7%) were undecided.With regard to the awareness about environmental conservation and climate change issues, 180 (48.4%), 29 (7.8%), and 26 (7.1%) of the respondents were not aware at all about biodiversity loss, climate change, pollution respectively, and their linkages to environmental crises, while the majority were extremely aware about deforestation (N=207, 55.6%) and water scarcity (N=144, 38.7%) (Table 5).

Table 5: Awareness of students and staff of secondary schools in Mbale city on critical environmental conservation and climate change issues (N=372)

How aware are you of the following environmental conservation and climate change issues, on a scale of 1 to 5, where 1 = Not at all aware and 5 = Extremely aware?

Environmental conservation issues	Awareness Level	N, (%)
Climate change	1	29 (7.8%)
	2	193 (51.9%)
	3	41 (11.0%)
	4	55 (14.8%)
	5	54 (14.5)
Biodiversity loss	1	180 (48.4%)
	2	13 (3.5%)
	3	62 (16.7%)
	4	39 (10.5%)
	5	78 (20.9%)
Pollution	1	26 (7.1%)
	2	60 (16.1)
	3	21 (5.6%)
	4	66 (17.7%)
	5	199 (53.5)
Deforestation	1	17 (4.6%)
	2	59 (15.9)
	3	31 (8.3%)
	4	58 (15.6%)
	5	207 (55.6%)
Water scarcity	1	27 (7.3%)
	2	92 (24.7%)
	3	98 (26.3%)
	4	11 (3.0%)
	5	144 (38.7%)

Further, the majority of the respondents believed that the students and staff in the schools under study were moderately—(N=179, 46.6%), and very much— (92, 24.0%) aware about the

importance of environmental conservation in schools, while only three (0.8%), stated that the school communities were not aware at all (Figure 7 A).Similarly, the majority of the respondents indicated that the students and staff in the schools under study were only moderately— (N=160, 41.7%), and very much— (109, 28.4%) aware of the dangers of climate change and the need to address it, while only six (1.6%), stated that the school communities were not aware at all. The results are demonstrated in figure 7 (B).

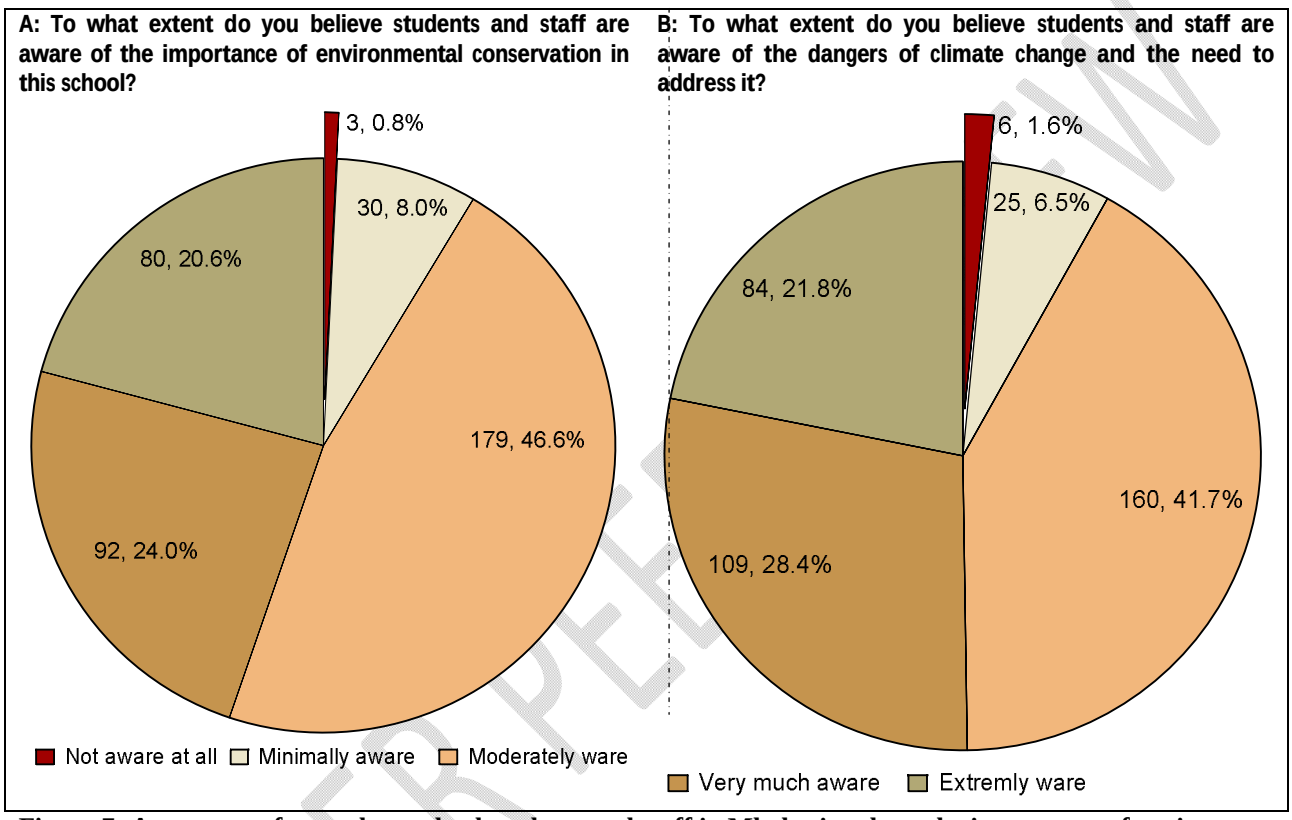

Figure 7: Awareness of secondary school students and staff in Mbale city about the importance of environmental conservation (A), and climate change action to mitigate itsdangers (B).The presence of individuals that are only minimally aware, or not aware at all about the importance of environmental conservation, and the dangers of climate change and the need to address it is a matter of critical concern, because the lack of awareness among such individuals can promote their participation in environmentally harmful behaviors such as pollution.

3.1.5Barriers Hindering the Effective Utilization of Environmental Conservation Strategies among Secondary School Students and Staff in Mbale City

The majority of the barriers were in the category of environmental factors, followed by resources, and anthropogenic issues, while policy factors were minimal (Figure 8). Overall, the most frequently cited challenges were; the long dry spells (N=384, 100%), high population (N=372, 98.9%%), Inadequatefunding (N=364, 94.8%%), and the high cost of alternatives to wood fuel (N=360, 93.8%). Supplemental file 14 (A), shows a school compound with its vegetation depleted, largely due to the high student's population that tramples on the grass. Supplemental file 14 (B)

shows the masses of wood adopted for cooking due to the high cost of climate-smart alternative fuels such as gas. Supplemental file 15(A) shows dilapidated waste buckets persistently used and Supplemental file 15 (B) shows a waste basket filled beyond the desired capacity, largely due to the scarcity of such garbage collection resources, or lack of finances to purchase enough resources in the schools. The least cited hinderance was the inadequacy of environment experts (N=8, 2.1%). This was followed by inadequate cooperation from school staff (N=10, 2.6%), and low political will and limited support from stakeholdersbeyond the school communities (N=12, 3.1%) (Figure 8).

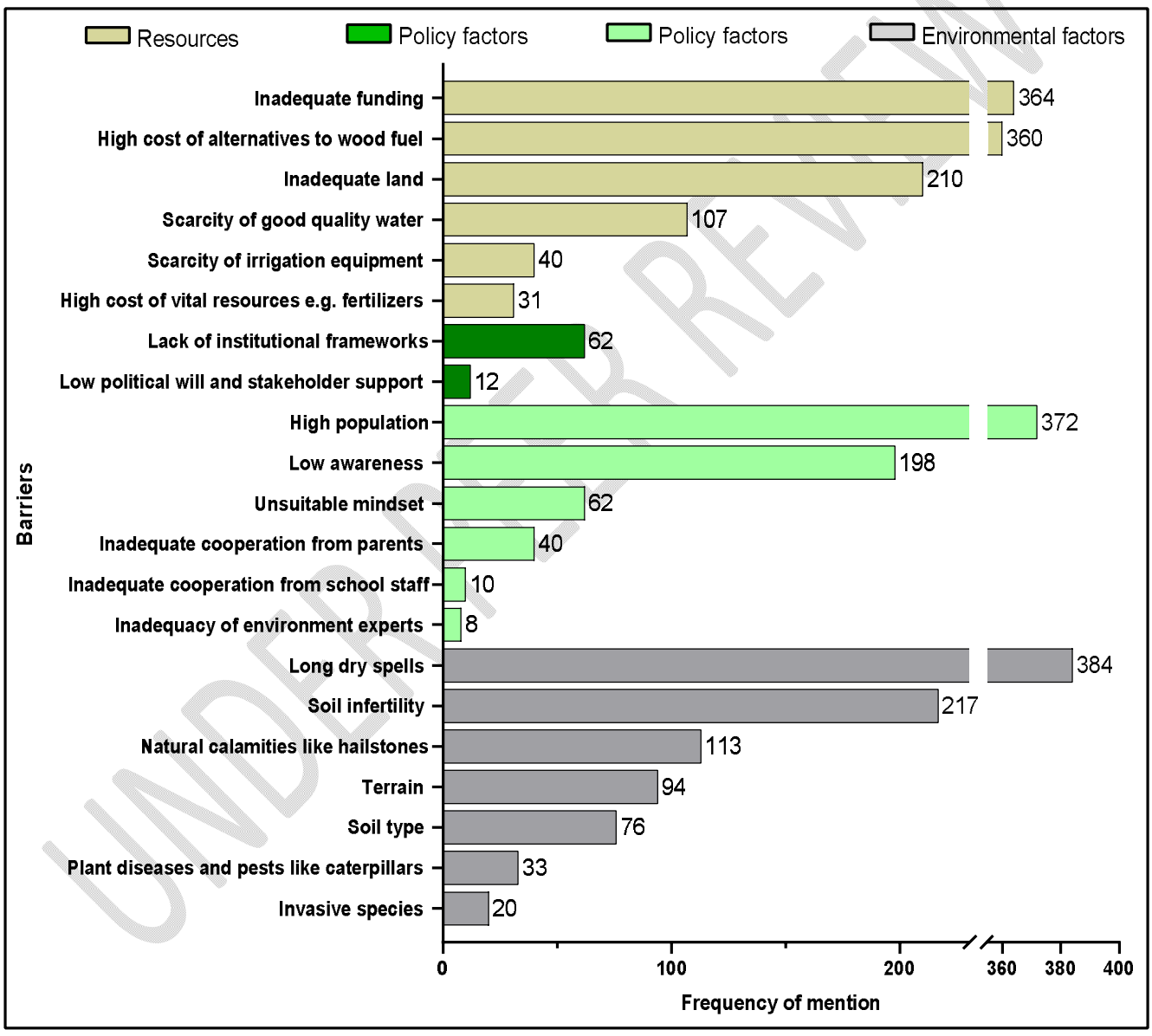

Figure 8: Barriers hindering the effective utilization of environmental conservation strategies among secondary school students and staff in Mbale City. These barriers impede the effective preservation of the environment, hence escalating the environmental hazards such as floods, land degradation, pollution, and climate change

3.2 DISCUSSION

The majority of the respondents were females but the difference with males was marginal. Similarly, prior reports from Italy (Piras et al., 2023), Central America (Moody-Marshall, 2023), Kenya (Moody-Marshall, 2023), and some parts of South Africa (Matsekoleng et al., 2024; Moody-Marshall, 2023), indicated that females constituted slightly more participants in environmental conservation initiatives in schools. Also, some studies conducted both in schools and in non-academic communities elsewhere have reported the greater participation of females in championing environmental conservation and the climate change advocacies elsewhere (Reiners et al., 2013; Ssenku et al., 2022; Unay-Gailhard & Bojnec, 2021). On the other hand, in Kenya and Tanzania, the male gender constituted the majority of the participants in a study which assessed the factors associated with the effectives of environmental conservation projects in secondary schools (Gikonyo et al., 2022; Shemdoe, 2015).The minor difference, in which the female participants slightly outnumbered the males in the current study may be attributed to the fact that in the recent years, the population of female students in secondary and tertiary schools in Uganda has slightly outnumbered the males (Catherine et al., 2023; Nafula, 2022). And this trend is likely to heighten since there is reliable evidence that in Uganda, the females arenow more likely to be enrolled in secondary schools compared to their male counterparts (Kakuba et al., 2021), overturning the documented trend in the previous few years (Catherine et al., 2023; Kakuba, 2015; UBOS, 2016).

On the global landscape as well, the percentage of boys and girls enrolled in primary and secondary education is reported to be approaching parity in almost all parts of the world, with a minor disparities in a few countries(The World Bank, 2024). The involvement of more females than males in environmental conservation ventures is commendable. This is because mothers commonly exert greater influence on child development and shaping of behaviors (Seraj Shirvan et al., 2024), hence the females are more likely to propagate their environmentally sensitive knowledge and behaviors to the future generations. Most participants in the current study were in the age bracket of 18-24. Therefore, it is inferred that most of them were youths, since the youthful age-group is defined as individuals between 15 to 48 years old (Lin et al., 2020). Given that the majority of respondents in this study were students in the highly active age group (youths), the environmental conservation initiatives and climate change advocacies reported in the current study have room to grow in future generations, because schools are critical hotspots for shaping societal behaviors (Hendricks &

Mutongoza, 2024). This study revealed that most schools spent less than 750,000 Uganda Shillings on environmental conservation monthly, but this is considerably small in the face of the ever mounting concerns about the high cost of sustaining impactful community enterprises including environmental conservation and climate change mitigation projects and activities such as massive cultivation of vegetation, irrigation, waste management, awareness creation among others (Shinyekwa et al., 2023).

Regarding the environmental conservation strategies used in the secondary schools in Mbale city, the study has revealed that, to a great extent these align with the international guidelines of the United Nations Environment Programme / UNEP, (2020). The majority of the conservation strategies were in the category of interventions that support conservation of the entire environment in general (land, water, and air), mostly tree planting and preservation of green spaces. Consequently, tree planting is one of the most widespread ecosystem conservation approaches across the world (Duguma et al., 2020). This approach is very critical because of its proven capacity to facilitate numerous ecological and biodiversity developments. For example, tree planting has capacity to promote the; preservation of soil(Brancalion & Holl, 2020; Hamilton, 2013), conservation of birds (Douglas et al., 2014), lowering of environmental temperatures by over 7.4^{o}C, raising humidity by close to 3.9%, (Hidayat, 2010), enable nutrient cycles, ecological regimes, carbon sequestration and many other ecosystem processes (Lindenmayer & Laurance, 2017). In the school settings particularly, the widespread prevalence of use of tree planting as a means of achieving environmental conservation and climate change mitigation could be additionally attributed to the socioeconomic benefits which trees offer to the students and staff, such as shelter, fruits (for feeding, teaching, and selling), and ornamentation (Scott et al., 2018). Also, the greenness offered by trees and other vegetation has been linked to improvement in academic achievement especially in urban, high-poverty schools (Kuo et al., 2018; Sivarajah et al., 2018). Also, most of the agencies of government and NGOs that are championing environmental conservation in academic and non-academic communities in Uganda mainly prioritize their focus towards tree planting among the many potentially viable interventions (Child, 2009; Ngome & Yeom, 2024; Omeja et al., 2011).

The other category of strategies that were somewhat predominantly reported by the respondents during this study were those that are aimed at conserving water resources, mostly the harvesting of rain water, avoiding dumping wastes in water bodies, and not pouring chemicals in water-ways. As far as the literature review in this research project is concerned, acknowledgement by the school

communities in Uganda, that “the harvesting of rain water is a way of conserving the environment” is novel. Massive harvesting of rain water minimizes over dependency on depletable water resources such as surface wells hence facilitating conservative utilization of the latter and avoidance of the ill effects water scarcity(Kirkby et al., 2023; Soto et al., 2017). The report of avoidance of dumping of wastes in water bodies as a way of conserving the water resources is precedented (Ochuko, 2024), and is one of the priority recommendations of the United Nations (United Nations Environment Programme (UNEP), 2020). Though the avoidance of dumping of wastes in water bodies as a way of conserving the water resources was to some extent widely acknowledged to be practiced by the school communities in Mbale city, the burden of solid wastes in water bodies especially rivers in this city continues to be a formidable environmental threat (Fred Wambede, 2020). For example, the solid waste pollution crisis in Mbale city has been linked to the prospectives extinction of all the major rivers such as river Manafwa and river Nabuyonga (New Vision News Paper, 2023a, 2023b; Valle Jr et al., 2019).

The solid waste crisis in Mbale city and Mbale district at large has also been reported as a major enabler of the rampant eco-disasters such as floods, droughts, and climate change, which are increasingly deterring food security, human health and the economy, a trend that is somewhat similar to the entire East African region (Busingye, 2022; Kintunzi, 2019; Nabusoba & Nampala Moses, 2018; Nations Office for the Coordination of Humanitarian Affairs (OCHA), 2022; The East African Community (EAC), 2023; United Nations Office for the Coordination of Humanitarian Affairs (OCHA), 2018). Therefore, since the results of this study revealed that schools may not be considerable drivers of the solid waste water pollution burden because of their widespread report of avoiding dumpingwastes in water bodies, there is need to upscale this tendency, and to transpose it to the wider communities beyond schools, as a part of the urgently desired action against the already alarming solid waste water pollution crisis in Mbale.

In the current study, the scarcest environmental conservation strategies were those used for mitigating air pollution, of which, the commonest was the use of fume cupboards in laboratories. Despite the observed deficiency of considerable remedies against air pollution, there was evidence that all the schools ratified essential operations with potential to pollute the air. For example, all the schools that were sampled in this research were found to be burning massive volumes wood to cook food to suffice the daily nutritional demands of their large populations. Massive institutional and domestic wood combustion has long been acknowledged as a significant source ofair pollution in Uganda and

the entire Africa at large, commonly driven by the scarcity and costly nature of climate-smart alternative fuels such as electricity, and Liquified Petroleum Gas (LPG), also known as cooking gas (Etchie et al., 2020; Faisal et al., 2021). The wood burning vice is frequently associated with critical environmental issues such as deforestation (Ludwig et al., 2003). There is also worry about the detrimental effects on community health, such as onset of chronic coughs and respiratory tract cancers, that come from being around high levels of pollution brought on by massive wood combustion (Ding et al., 2015). Historically, respiratory tract illnesses potentially associated with air pollution, including lung cancer, constitute a significant health threat in Uganda (Bogere et al., 2022; Kakande et al., 2001; Kirenga et al., 2013). It has also been shown that trace aerosols and gases such as carbon dioxide and carbon monoxide that are released during the burning of wood fuel have a grave impacts on the climate and biogeochemical cycles (Ludwig et al., 2003).

Warningly, it was observed that some schools involved in the current study got rid of solid wastes by burning them near crops and other vegetation. This action is regrettable since the damages incurred are not limited to air pollution but also deterrence of microhabitats and biodiversity (Canedo-Júnior et al., 2016). On the other hand, some other rare environmental conservation approaches observed in this research, such as agroforestry, raising of seedlings, incineration of menstrual pad wastes, and innovative re-use of plastic waste bottles to fabricate dustbins are highly commendable because they inculcate into the students, transferable innovative life skills that are helpfulnot only to the environment but also to the economic and livelihood wellbeing, food security, and health. The beauty is that the school communities can transfer such vital skills to the general community even many years after leaving school, culminating into an environmentally sustainable society.

The most commonly cited reason for adopting the above environmental conservation and climate change mitigation strategies reported in this research was the fact that the environmentally sensitive contents (environmental education), were already incorporated into the national teaching curriculum hence schools are obliged to implement it. The implication is that schools inevitably, are hubs for incubation of environmentally responsible behaviors in communities, and therefore majority of the individuals who have attained secondary school education in Uganda have received some enlightenment on environmental conservation concepts and are environmentally productive. This report aligns with suggestions of earlier investigators, who have indicated that individuals who have attained a certain level of formal education are more likely to care for the natural environment and to address environmental threats such as climate change than the illiterate (Gallagher et al., 2024; Gifford, 2011).

The monetary costs associated with the intervention approaches were also prominent determinants of choice of the conservation options. The adoption of environmental conservation technologies basing on their price could be vital because it enables different actors to use the intervention options that they can afford. Moreover, some schools that were enrolled in this research were found to choose the conservation strategies that suited the generally limited financial capacity of these particular institutions. However, the sole consideration of the finances as a basis for selecting the environmental conservation and climate change mitigation strategies may not be optimally helpful in case the affordable, low-cost interventions are not scientifically suitable enough to address the environmental threats at hand. The observed participation of NGOs such as WaterAid, SOMA foundation Limited, and UNICEF in environmental conservation and climate mitigation advocacies in this research is commendable. This is because climate action is generally an expensive enterprise hence governments and the local communities in low-resource countries like Uganda may not effectively potentiate it without support from NGOs and/or other development partners. Also, the use of waste plastic bottles to innovate solid waste collection baskets that was observed in some schools in this research is an exciting intuitive. Such solid waste re-use projects that warrant to be scaled up in other schools across the country, and the world at large to address the already alarming global solid waste crisis (Mahadevan & Prakash, 2020; Okot-Okumu, 2021; World Bank Group, 2020; World Health Organization (WHO), 2021).

Pertaining to the knowledge about environmental conservation and climate change mitigation, the 384 respondents were subjected to ten knowledge questions concerning the aspects of environmental conservation and climate change mitigation. The possession of satisfactory knowledge about the subject at hand was inferred if a respondent correctly answered $\geq 70\%$ of the questions. Only41.9% of the respondents demonstrated satisfactory knowledge about environmental conservation and climate change mitigation, while the 58.1%, had inadequate knowledge. The desire to avert ecological threats like global warming and floods was the commonest perceived reason for conserving the environment, followed by the need of a clean environment for human and wildlife health, and for sustaining essential natural resources such as lakes. These results are in tandem with some previous reports in both academic and non-academic settings (Dhanya & Pankajam, 2017; Díaz-López et al., 2023; Marpa, 2020; Mizan-Rahman, 2024).

Pertaining to the integration of environmental conservation into the national school curriculum, the most widespread perception was that the integration level was moderate, while none of the

participants, believed that the curriculum did not address the environmental conservation aspects at all. This further ascertains the important roles schools play in nurturing environmental conservation efforts, and the school communities acknowledge and embrace this duty. A good attitude towards environmental conservation and climate change mitigation was evident since a great majority of the participants asserted that they would not consider abandoning your current roles as an actor in environmental conservation even in situations where they are neither obliged nor motivated to conserve the environment. Though the majority of the respondents were extremely aware about some of the current critical environmental concerns such as deforestation and water scarcity, a great minority were unfortunately not aware at all about biodiversity loss, climate change, pollution and their linkages to environmental crises. Despite the minimal community awareness about them, biodiversity loss, climate change, and pollution are some of the topmost environmental problems present in Mbale city and Mbale district at large (https://www.unhabitat.org, 2024).The lack of awareness about essential environmental concerns such as biodiversity loss, and climate change that were observed in the current study needs to be addressed, because low awareness levels have been implicated in promoting environmentally unfriendly actions globally (Abbass et al., 2022; Ferronato & Torretta, 2019).

The majority of the respondents indicated that the students and staff in the schools under study were only moderatelyaware of the dangers of climate change and the need to address it. This implies that much as there was widespread perception that environmental conservation aspects were an integral part of the secondary school curriculum, it was implied that this integration was not optimally facilitating environmental awareness among the school communities. This was in alignment with further observations that only 41.9% of the respondents demonstrated satisfactory knowledge about environmental conservation and climate change mitigation (correctly answered $\geq$ 70% of the questions), while the majority had inadequate knowledge. Therefore, there is need to refocus the school curriculum-implementation in the study area, so as to achieve enhance the outcomes and potential positive impacts of schools on students' communities as far as environmental conservation and its linkages are concerned.

Finally, our results have shown that the majority of the challenges hindering the effective utilization of environmental conservation strategies in secondary schools in Mbale city were environmental factors such as long dry spells, followed by financial resource scarcities and anthropogenic matters especially the high population. These hindrances generally align with the findings of Shamimu, (2018), who reported poverty, population growth, and devastations caused by natura calamites, as some of the commonest challenges impeding the attainment of a sustainable environment in Bugishu sub-region where Mbale city is situated.

The lack of financial resources can incur profound negative influence on the majority of the conservation initiatives. For example, money is required for the purchasing of sufficient and high-quality technologies and resources such as garbage baskets and hiring of waste pickers for rational solid waste management (United Nations Environment Programme (UNEP), 2020), seedlings, land, and irrigation apparatus for propagation and preservation of plant resources in the face of long dry spells (Gedikoglu & McCann, 2022; Guo et al., 2019), communication equipment and media services for awareness creation and skilling of communities (Moody-Marshall, 2023), solar panels, energy saving stoves, and biodigesters environmentally friendly energy sources (Etchie et al., 2020), research investment and oversight monitoring and supervision of environmental conservation projects (Gedikoglu & McCann, 2022; Marpa, 2020), among others. Therefore, financial resource mobilization should be treated as a matter of critical importance by all stakeholders given its widespread influence on other conservation determinants.

Likewise, rigorous adaptation programs in response to the devastating effects of common eco-disasters such as hailstones and floods need to be accorded reasonable attention owing to the severs frustration which these calamities incur to the subsequent conservation initiatives. Such frustrations include the destruction of resources that have a bearing on conservation, such as plants, infrastructural establishments such as schools and roads, human resources, and equipment among others. Though low political will and limited support from stakeholders beyond the school communities was minimally reported, there is a need to address it because political actors are fundamental influencers of environmentally relevant affairs that have profound effects on conservation, for example, supervision and monitoring of environmental development programs (Government of the Republic of Uganda, 2020), policy formulation (Uganda National Environmental Management Authority (NEMA), 2018), budgetary allocations and community mindset change (Government of Uganda, 2019), among others.

4.CONCLUSION

The environmental conservation strategies used in secondary school communities in Mbale city are multifaceted, predominantly tree planting, harvesting of rain water to mitigate over dependance of depletable sources such as shallow wells, and avoidance of damping wastes in water resources. Interventions against air pollution were profoundly missing. The factors underlying the adoption of those environmental conservation strategies were predominantly geographical events, mostly the existing soil erosion type and intensity, plus the occurrence of rain and dry spells.The perceived desire to avert ecological threats like global warming and floods was the most frequently cited reason for conserving the environment, followed by the need of a clean environment for human and wildlife health, and to sustain the already threatened natural resources such as rivers.The majority of the challenges hindering the effective utilization of environmental conservation strategies were environmental events such as long dry spells, and followed by financial resource scarcities, and anthropogenic factors especially the high population.

5.RECOMMENDATION

The diverse environmental conservation strategies observed in this research, whichaligned withguidelines of the United Nations Environment Programme, such astree planting, harvesting of rain water to mitigate depletion ofwater other water sources, should be scaled up in the general non-academic communities to avert the persistence environmental disasters in Mbale city and the entire Eastern Uganda at large.

Ethical Approval:

As per international standards or university standards written ethical approval has been collected and preserved by the author(s).

Consent

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

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Details of the AI usage are given below:

1.

2.

3.

6.LIST OF ABBREVIATIONS

UNESCO	United Nations Educational, Scientific and Cultural Organization
UNEP	United Nations Environment Programme
EE	Environmental Education
UNCED	United Nations Conference on Environment and Development
NGO	Non-governmental Organization
IPPC	Intergovernmental Panel on Climate Change
WMO	World Meteorological Organization
WHO	World Health Organisation
UN	United Nations
NEMA	National Environment Management Authority
CBOs	Community Based Organizations

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