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UGANDA WATER AND ENVIRONMENT WEEK 2025 (UWEWK2025)

BOOK OF ABSTRACTS

ABSTRACTS FOR APPLIED RESEARCH IN WATER, ENVIRONMENT AND CLIMATE CHANGE:

POLICY | PRACTICE | SCIENCE

Overall Theme

Water and Environment Resources for Enhanced Resilience and Improved Incomes and Livelihoods

17th to 21st March, 2025
Kampala, Uganda

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FOREWORD

The Ministry of Water and Environment (MWE) was established in 2007 with the overall responsibility for development, management and regulation of water and environment resources in Uganda. The vision of having 'sound management and sustainable utilization of water and environment resources for betterment of Uganda's population inspires the Ministry to promote rational and sustainable utilization, development, and effective management of water and environment resources for socio-economic development. The MWE has been organizing the Water and Environment Week for the last seven years. This year, the 8th Uganda Water and Environment Week will take place from 17th to 21st March 2025. During the week, oral and poster presentations are made after a rigorous process of selecting and identifying relevant works from abstracts submitted. A Book of Abstracts of Applied Research in resonance with Water and Environment Week theme is usually compiled and published. A hybrid approach comprising physical and online presentations allows presenters to share applied research outputs to the audience of relevant stakeholders.

This year, a Book of Abstracts- Issue UWEWK2025 has been published and presents a summary of oral presentations on applied research pertinent to water and environment policy, practice, and science that aligns with the overall theme for UWEWK2025: ***Water and environment resources for enhanced resilience and improved incomes and livelihoods.*** The UWEWK2025 abstracts cover emerging issues in water and environment under the following four (4) sub-themes:
1. *Water and environment for a peaceful and sustainable future*;
2. *Water and environment for climate action*;
3. *Equitable and sustainable use of water and environment resources for improved incomes and livelihoods;*
4. *Water and environment innovations, knowledge, and capacity for empowering a new generation.*

These subthemes attracted abstracts related to policy, practice and science. The policy mainly includes papers that analyse the current state of policies (local, national regional and international policies) but also proposed policies from research findings to guide water and environment conservation, and sustainable development. Science component targets research papers with an underlying problem addressed from existing gaps, with clear approaches and methodologies deployed and with key scientific or field-based findings. On practice, this targets programs, innovations, projects and studies that provide community impact from interventions. The practice component offers an opportunity for partners to share progress and future plans.

For this book, each abstract is a concise summary on mainly highlights of key water and environment problems or issues at hand, methods applied, key results, conclusions and key take-away messages to inform stakeholders. Abstracts in this Issue UWEWK2025 are believed to contribute to the knowledge required for addressing topical issues and informing decisions for sustainable development of the water and environment sector.

Special thanks to the Technical sub-committee committee, Communication and Publication committee and the entire National Organizing Committee of UWEWK2025 for supporting the processes from the call of Abstracts, reviewing, technical guidance, training of to Authors and compiling of this Book of Abstracts.

Dr. Alfred Okot Okidi
Permanent Secretary
Ministry of Water and Environment

ABOUT UWEWK 2025 THEMES

The 8th Uganda Water and Environment Week held from Monday 17th March to Friday 21st March 2025, is an annual event of Ministry of Water and Environment under auspices of the Water Resources Institute (WRI). A Call for Abstracts was published on November 30th, 2024 and this ended on 2nd February 2025. This call attracted interested researchers, practitioners and policy makers to share their research findings and practical work, findings based on experiences in line with the theme and sub themes of the water week. The theme and sub themes were as follows:

Theme: *"Water and environment resources for enhanced resilience and improved incomes and livelihoods."*

Sub- themes:

1)   Water and environment for a peaceful and sustainable future

The call for abstracts under this sub-theme raised awareness on the complex inter-linkages between threats to the natural world, human security, and sustainable future. It explored the relationship between water, environment, and peace, especially in fragile contexts. The call was intended to obtain information on linkages between water, environment, climate change, and foreign policy for peace in trans-boundary water and environment resources management/ development. The sharing of information on the benefits of cooperation over shared water resources, the role of improved water and environment management in fragile contexts, and how water diplomacy can be a powerful tool for conflict prevention and peacebuilding were encouraged. The sub-theme also emphasized the role of security agencies, cultural and religious institutions, and media (among others) in promoting peace, risk reduction, and conflict resolution.

2)   Water and environment for climate action

The call for abstracts under this sub-theme explored innovative water and environment innovative technologies and ways for adapting to and mitigating the impacts of climate change to address water scarcity, equity, accessibility, environmental conservation, and ecosystem protection. The W&E innovations that were targeted among others include roads for rain harvesting, flood control through water storage mechanisms, water supply innovations amidst prolonged droughts, Triple Rs (Reduce, Recycle, and Reuse) technologies to improve resource-use efficiency and pollution control approaches. Innovations for transitioning away from the use of oil and gas towards clean, safe, and renewable energy were encouraged. Other cross-cutting innovations such as those involving transition to zero-carbon mechanisms with an emphasis on carbon-reduction service systems were also encouraged.

3)   Equitable and sustainable use of water and environment resources for improved incomes and livelihoods

The call under this sub-theme targeted abstracts that highlighted the centrality of water and environment resources for socio-economic development, employment creation, and improved incomes and livelihoods. All research or field programs that explored approaches, practices, and policy issues in sustainable investments in water infrastructure; equitable water and environment governance; and explored the links between water-related skills, innovation, and job creation were

encouraged for submission. The sub-theme also covered aspects that address building national capacity to leverage green financing for climate change-responsive infrastructure, catchment-based integrated management of water and environment resources, and water and environment cooperative societies for improved household income and livelihoods.

4) Water and environment innovations, knowledge and capacity for empowering a new generation

This sub-theme explored the potential for investing in the education and empowerment of new the future generation with green skills that can nurture a population that is prepared to lead the way towards a more sustainable future. The call under this sub-theme also targeted submissions on opportunities for technological advancements and cultivating an environmentally literate and empowered youthful future generation. Abstracts that addressed the crucial role of organizations in building a sustainable future by breaking down barriers, collaborating on educational resources by offering support to schools and communities were encouraged. Studies on environmental literacy for shaping future leaders and citizens who drive positive change for our planet were also targeted under this sub-theme.

1

WATER AND ENVIRONMENT FOR A PEACEFUL AND SUSTAINABLE FUTURE

1.1 Suitability analysis for landfill site selection: A case study on Kamuli district

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Abstract

A landfill is one of the most cost-effective methods for solid waste management, yet its improper siting and management can cause environmental and health risks. This study aimed at identifying sites with a low risk of pollution, easy accessibility, cheap land acquisition, and effective operation that can serve as landfill locations in Kamuli District. Ten factors, including soil type, water bodies, wetlands, gazetted areas, lineament, roads, slope, built-up area, price of land, and land use were used for selecting suitable areas for a landfill. Geographical Information System (GIS) based multicriteria decision-making method was used to perform the spatial decision-making process by grouping the factors into environmental, socio-economic, and geographical criteria. Analytical Hierarchy Process (AHP) of pairwise comparison was used to estimate the percentage weights that denote the relevance of each factor to the overall suitability. Input layers for the factors were processed and combined in ArcGIS 10.8 software using Weighted Linear combination to obtain an overall landfill suitability map. Results show that 474 km^2 (30.42%), 6.7 km^2 (0.43%), 0.6 km^2 (0.04%), 249.2 km^2 (15.99%), 778.9 km^2 (49.99%), and 48.7 km^2 (3.13%) of the total district area are unavailable, unsuitable, slightly suitable, moderately suitable, suitable and highly suitable, respectively. In addition to the ten factors considered in the analysis, highly suitable areas had to be more than 20 ha in acreage and considered usable for at least 25 years. Candidate landfill sites with the shortest haul distances, that is, 4.2 km, 6.0 km, and 8.0 km from the biggest waste-generating Kamili town were chosen. While environmental factors are crucial, haul distances significantly influence landfill siting decisions.

Keywords: Landfill Siting, Solid Waste Management, Multicriteria Decision Analysis, Environmental Impact

1.2 Flood risk prediction using machine learning: A Case study on River Nyamwamba in Uganda

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Abstract

River Nyamwamba in Kasese District floods 3 to 4 times a year. The occurrence displaces over 10,000 people annually, causes poor livelihoods, and destroys thousands of infrastructures. Several conventional machine learning (ML) flood prediction models, such as logistic regression, ARIMA, SVM, and random forest, have been implemented before. However, they do not accurately correlate the different environmental variables in predicting flood occurrences in Kasese; hence, they have not yet been deployed for use. Therefore, the study aimed to implement a hybrid ML-based prediction system and compare it with conventional models to determine which model could be deployed in early flood warning systems on the Nyamwamba River. The study utilised ensemble learning using python language to combine Convolutional Neural Network (CNNs) and Recurrent Neural Networks (RNN) models into a hybrid CNN-RNN model. The hybrid model was then used to analyse dataset on rainfall patterns from Uganda National Meteorological Authority, soil moisture data, and satellite imagery from the Landsat repository. The dataset was extracted and cleaned up to reduce redundancy and bias, considering only data from 1980 to 2023. Data augmentation techniques were then applied to the dataset to mitigate the risk of overfitting of data. The augmented data was then trained using logistic regression, ARIMA, SVM, random forest, and CNN-RNN models, and the model performances were evaluated using accuracy and F1 score metrics. The results from the different models showed an accuracy of 68%, 72%, 78%, and 81%, 91%, respectively, and F1-score results of 0.65, 0.68, 0.72, 0.79, and 0.89, respectively. The findings show that for all the cases, the proposed CNN-RNN model outperforms the other ML models in flood prediction. The study recommends implementing the model in early warning systems to improve disaster preparedness and climate adaptation strategies in Uganda.

Keywords: Flood Prediction, Nyamwamba, Ensemble learning, Disaster Preparedness, Machine Learning

1.3 Vulnerabilities and preparedness of communities around Kiteezi Landfill to Disaster Risks

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Abstract

Nearly 95% of municipal solid waste is disposed through landfilling worldwide. While cost-effective, landfilling poses significant environmental and community risks, particularly in disaster-prone areas. These risks threaten human security by disrupting livelihoods and undermining stability. Despite recurring landfill-related disasters, insufficient attention has been given to how landfill management practices contribute to these events, especially in vulnerable urban settings like Kampala. Conducted shortly before the August 2024 collapse of the Kiteezi landfill, this study examines community risk perceptions, vulnerabilities, and preparedness, highlighting the implications of landfill-related disasters for human security and sustainable development. Using a mixed-methods approach, the study incorporates field observations, a survey of 172 households (63% female, 37% male), a focus group discussion with 61 participants (community leaders, CBO representatives, informal waste pickers), nine key informant interviews, and GIS analysis. It assesses landfill management, residents' risk perceptions, and social vulnerabilities across 16 indicators. Findings reveal regulatory non-compliance, including inadequate leachate treatment and waste segregation, exacerbating disaster risks and environmental degradation. Communities near the landfill, such as Lusanja and Kitetika, show higher Social Vulnerability Index (SVI) scores (0.50 and 0.48) due to proximity, reliance on waste-related livelihoods, and limited disaster preparedness. In contrast, areas farther away, including Bumbu-Kiteezi, Masooli, and Lubatu, have lower SVI values (0.45, 0.43, and 0.39), reflecting reduced exposure and diversified livelihoods. Notably, 83.14% of respondents acknowledge landfill risks, with 40% of nearby households highly concerned, 37% of informal waste workers moderately concerned, 18% dismissing risks, and 5% indifferent due to distance. Governance failures, poor risk communication, and inadequate community preparedness were identified as key barriers to resilience. This study underscores the need for integrated disaster risk reduction (DRR) frameworks, community-centered preparedness plans, stricter regulatory enforcement, and sustainable waste management, including properly engineered regional landfills. Aligning with the Sendai Framework for DRR, these insights support urban resilience and socio-environmental sustainability in vulnerable communities across the Global South.

Keywords: Disaster Risk Reduction, Municipal Solid Waste Landfill Management, Vulnerability, Kiteezi Landfill, Community resilience, Sustainable development

1.4 Enhancing water management for sustainable development in Uganda

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Abstract

Water resource management remains a critical challenge in Uganda, impacting livelihoods, food security, and climate resilience. Despite ongoing efforts, many communities still face water scarcity, poor sanitation, and environmental degradation. This study explores innovative and community-driven approaches to sustainable water management, focusing on capacity building, stakeholder collaboration, and technology adoption. Through case studies in Kasese and Mukono Districts, we highlight the effectiveness of rainwater harvesting systems. The methods include participatory community engagement, stakeholder consultations, and the application of technology-driven solutions, such as mobile applications for real-time water quality monitoring. Results show that rainwater-harvesting systems increased water accessibility by 40% and enhanced agricultural productivity. Additionally, water conservation initiatives in local schools reduced water wastage by 25%, demonstrating the importance of education in behavioral change. Findings indicate that by integrating household knowledge with modern water management techniques this would strengthen resilience against climate shocks and enhance sustainability in water management. The study recommends for policy frameworks that promote community-led water governance and multi-sectoral partnerships between government agencies, NGOs, and local communities. Furthermore, leveraging digital innovations can improve monitoring, data collection, and informed decision-making in water resource management. By presenting these insights at UWEWK 2025, we aim to foster knowledge exchange, influence policy, and promote sustainable water management strategies that align with national and global development goals.

Keywords: Water management, environmental sustainability, community participation, stakeholder collaboration, Uganda, UWEWK 2025

1.5 Groundwater quality and health risk assessment in Imvepi and Rhino Refugee Camps

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Abstract

Groundwater is the primary drinking water source in the Rhino and Imvepi refugee camps, but its quality is threatened by both anthropogenic and geogenic pollution sources. Steel and metal pipelines commonly used in borehole installation and general water supply pipe work often suffer corrosion, silt build-up, and microbial growth hence introducing pollutants to the drinking water. The refugee camps are characterised by inadequate solid waste management practises, unsustainable agricultural practises that increase the risk of contamination risks by leachates, fertilizers and pesticides. Additionally, widespread use of pit latrines poses a risk of microbial contamination. Given these factors, there is an urgent need to assess groundwater quality and associated health risks to ensure safe drinking water for the communities. This study assessed groundwater quality from 50 sources in Rhino and Imvepi refugee camps, and identified likely contamination sources to inform water quality improvements the fragile context. Groundwater sources, including handpumps and motorized boreholes, were assessed through water sampling and sanitary inspections. Samples were analysed for physical, chemical, heavy metal, and microbiological parameters. The WHO sanitary survey methodology was used to evaluate infrastructure integrity and contamination risks. Findings revealed significant contamination risks, with 44% of water sources classified as medium-risk level of contamination. E. coli levels exceeded WHO standards in 22% of samples, while lead concentrations surpassed the 0.01 mg/L threshold in all tested sources. The analysis of total iron levels across all samples yielded results with a range, from 0.01 to 16.05 mg/l. Sanitary inspections identified inadequate fencing, poor drainage, and proximity to pit latrines as key risk factors. Urgent interventions, including routine monitoring, source protection, infrastructure rehabilitation, and community education, are essential to improving water safety. These measures will reduce health risks, enhance social stability, and support sustainable water management in refugee settlements.

Keywords: Groundwater Quality, Refugee Camps, Public Health, Water Conflict Prevention

1.6 Sustainable ecosystem services for food security and resilient livelihoods around Lake Bunyonyi sub-catchment, Kigezi Sub-Region.

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Abstract

Kigezi sub-region is hilly area blessed with natural forests harbouring various flora and fauna species supporting livelihoods and food security through agriculture and tourism. However, increasing population has exerted pressure on land for agriculture and human settlement causing clearing of vegetation, resulting into massive soil depletion. Consequently, the communities have resorted to unsustainable utilisation of fragile ecosystems leading to biodiversity loss- with the sub-region now contributing to Uganda's record of 41.6% forest cover loss in the last 100 years (1921-2021). The sub-region's wetland encroachment estimated at 97% and 60% for Rubanda and Kabale district respectively-with buffer zones of Lake Bunyonyi declining to 20m thus affecting sustainable ecosystem services. Self-Help Africa implemented an initiative for promoting inclusive, equitable landscape management systems for biodiversity restoration, sustainable utilization of natural resources to ensure food security and resilient livelihoods. The intervention approach included training communities on terracing, field-trenching, organic farming, agroforestry, nutrition-sensitive agriculture, eco-enterprise promotion, public-private sector engagement targeting 5,000 households in 32 villages of Kabale and Rubanda. As a result, a Sub-catchment Management Plan was developed which guided the formation of a 65-members' Functional Multistakeholder Platform to spearhead nature conservation, subsequently 731 acres of land restored with 215,355 trees. Additionally, smallholder farmers' production increased by 30%, food security was increased among 46% of households, 81% Eco enterprise households accessed new markets. Ensuring Sustainable Ecosystem Services for food security and Resilient Livelihoods in the Kigezi region calls for capable multisectoral players to spearhead natural resources management.

Key words: Ecosystem, Multi-stakeholder Platforms, Natural resources, resilient livelihoods

1.7 Anaerobic co-digestion of sewage sludge with slaughterhouse waste for improved waste management in Kampala City Uganda

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Abstract

In Uganda, untreated domestic and industrial waste is often discharged into the environment, polluting surface waters with organic matter and nutrients. Anaerobic digestion provides a decentralized, low-cost waste management solution, producing both biogas and organic manure. This study examined the co-digestion of mixed sewage sludge (CS) from wastewater treatment at National Water and Sewerage Corporation (NWSC) Nakivubo biogas plant with slaughterhouse waste (SHW) to enhance biogas yields. The characteristics of CS and SHW were assessed for anaerobic digestion suitability, and their biochemical methane potentials (BMPs) evaluated using 250-mL anaerobic reactors and 14gVS/L loading rate at 37°C for 30 days. Five substrate-mixing ratios of CS and SHW were tested, and biogas was measured using the water displacement method. Results indicated that SHW had higher characteristics, and biodegradability than CS, with a BMP of 0.987 m^3kgVS^{-1} compared to 0.219 m^3kgVS^{-1} for CS. The highest biogas production (1349 mL) was recorded when the substrate-mixing ratio was 50:50, and nutrient content increased by 36% (nitrogen), 70% (phosphorus), 88% (potassium), and 123% (organic carbon) in the co-digestion slurry, with acceptable levels of total coliforms, *E. coli*, and helminth eggs for use in agriculture. Therefore, co-digestion of CS with SHW in the ratio of 50:50 is recommended for NWSC to improve biogas yields, and additionally generate a nutrient-rich slurry that is more suitable for public reuse as an organic manure.

Key words: Anaerobic co-digestion, Biochemical methane potential, Biogas yield

1.8 JENGU unit effectiveness on soap-handwashing behaviour in crisis-affected populations: Lessons from Kyangwali refugee settlement, Uganda

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Abstract

Hand washing with soap (HWWS) is fundamental to reducing the risk of diseases such as diarrhoea and upper respiratory infections that are associated with poor hand hygiene. However, limitations related to access to hand washing facilities that are desirable, and with water and soap present still limit the performance of HWWS especially in crisis-affected populations. We share lessons from community-testing of the Jengu hand washing unit in Kyangwali refugee settlement. A randomized control study was conducted between March and July 2024, involving 300 households from four villages. Data was collected through surveys, structured observations, spot checks, in-depth interviews, focus group discussions. After baseline, 150 households were randomly allocated to receive the JENGU units which comprise of a 20-litre jerry can for water supply to the household unit, and soap (Intervention group), and the other half received only soap in the same quantity as the intervention group (control). Each household unit received four half bars of soap of 250 grams per piece at start of the intervention, two months after and end line. Compared to other hand washing facilities in the community, over 90% of participants expressed behavioural preference for Jengu unit. There was a 40% increase observed in HWWS actions in the intervention group (180 compared to 43 behavioural actions) and increase in soap availability at or near the hand washing station (6%-27%). Most performed moments were before eating, after eating, and after using the toilet. In terms of functionality, 71% Jengu units had all features fully functioning at end line, with 29% having issues that were largely related to basins. The type of locally sourced plastic basins proved less resilient to breaking (90%). Nevertheless, the findings show that availability of desirable fixed hand washing units with water and soap at key locations has potential to increase HWWS behaviour. It also shows the import testing and field-testing the handwashing innovations for suitability and resilience to enable adoption within the local contexts.

Key words: Jengu unit, Hand washing with soap, Refugees, Uganda

1.9 Monitoring and evaluation enhancement for sustainable water resources management and improved livelihoods in Albert Water Management Zone

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Abstract

Monitoring and Evaluation (M&E) is critical in ensuring effective, efficient, and sustainable implementation of water resources management projects in Uganda, particularly in the Albert Water Management Zone (AWMZ). This study evaluates the role of M&E in guiding decision-making for catchment restoration, stakeholder engagement, and sustainable livelihoods. Data was collected through monthly field monitoring, quarterly progress reports, and participatory evaluations in Ruhezamyenda, Nyamwamba, and Nkusi catchments. Statistical analysis, including trend analysis, correlation assessments, and impact evaluations, was conducted to assess environmental and socio-economic changes. Findings reveal that riverbank stabilization efforts reduced soil erosion by 35%, afforestation programs increased vegetation cover by 40%, and water retention strategies improved groundwater recharge by 25% in targeted areas. Additionally, over 2,439 households benefited from tree planting, soil conservation, and income-generating activities under the Integrated Water Management and Development Project (IWMDP) in Nyamwamba Catchment. Stakeholder engagement significantly contributed to project success, fostering community ownership and a 60% increase in the adoption of sustainable practices. However, challenges such as resource constraints, climate variability, and weak policy enforcement hinder long-term sustainability. Strengthening M&E through digital monitoring tools, community-based tracking systems, and capacity-building initiatives is essential to improve outcomes. This study concludes that a robust, adaptive M&E system enhances transparency, supports evidence-based decision-making, and strengthens resilience to environmental changes. The findings inform recommendations for scaling up successful interventions and improving sustainability in water resource management.

Keywords: Monitoring and Evaluation, Catchment Management, Climate Resilience, Sustainable Livelihoods, Water Resource Conservation, Stakeholder Engagement

1.10 An Integrated modeling framework for water accounting assessment in the Lake Tana sub-basin, Ethiopia

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Abstract

The Lake Tana sub-basin is recognized as a vital area for hydropower and irrigation development, both of which significantly contribute to Ethiopia's economic growth. However, increased development activities in the subbasin have resulted in growing water scarcity and environmental challenges for Lake Tana. Therefore, understanding the lake's water balance is crucial for planning and implementing sustainable water management strategies. This study aims to assess water use and supply in the Lake Tana sub-basin from 2010 to 2020. We utilize a hydrological model, a lake water balance model, and the Water Accounting (WA+) framework to estimate the sub-basin's water accounts, incorporating both in-situ and remotely sensed data. The inflows to the lake from gauged and ungauged catchments were estimated using the HBV-light model, combined with a regionalization approach. The lake's outflow at both the natural and hydropower outlets was determined using the Lake Water Balance model. WA+ was applied to estimate water use across various landscapes. The water balance analysis reveals that the lake's outflow at the hydropower outlet exceeds the outflow at the natural outlet, with a water balance closure error of 53 mm/year. Rain fed and irrigated croplands consume approximately 6.6 km³ and 0.4 km³ of water, respectively. Overall, this study provides critical insights for sustainable water management in the Lake Tana sub-basin, emphasizing the importance of balancing the lake's outflows at both outlets.

Keywords: Lake Tana, Water Balance, Lake Outflow, Rain fed Cropland, Irrigated Cropland

1.11 Quality of water from Lake Kyoga and remediation of heavy metals using Nymphaea Alb Leaves in Bugondo sub-county, Serere District, Uganda

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Abstract

Increasing global pollution of water resources by anthropogenic activities undermines water quality and the efforts invested in the realization of sustainable development goals. The study investigated the levels of physico-chemical and biological parameters and concentrations of heavy metals of surface water from a stretch of Lake Kyoga covering Bugondo Sub-county in Serere District, Uganda. The study followed purposive sampling method. The parameters of water were determined as follow pH by pH meter, temperature by mercury thermometer, turbidity by turbidity meter, electrical conductivity by electrical conductivity meter, total dissolved solids by an evaporation method, dissolved oxygen by dissolved oxygen meter, magnesium, calcium, and total hardness by EDTA titrimetric method, odour by olfactometer, phosphates by vanadomolybdophosphoric acids, nitrates and Sulphates by spectrophotometer, potassium by flame photometer, sodium by omega sodium ion electrode, Lead, cadmium, copper, iron and zinc by flame atomic absorption spectrophotometer, fecal coliform, escherichia coli and total coliform by membrane filtration method . The results obtained indicated that the mean pH, magnesium, dissolved oxygen, turbidity, colour, sulphates, nitrates, sodium, potassium, fecal coliform, Escherichia coli and total coliforms occurred at levels that were above the permissible limits as per Ministry of Water and Environment guidelines for drinking water. The heavy metals that were above the maximum permissible levels (Pb, 4.08 ± 0.08-5.56 ± 0.04 and Cd, 0.92 ± 0.03-1.1 ± 0.01) were remediated using white water lily leaf powder (WWLLP). Findings indicate exposure of humans to waterborne diseases thus the need to emphasize the urgency to restrict the occurrence of anthropogenic activities around the lakes. Further studies should conducted for routine monitoring of the water quality for Lake Kyoga during both dry and wet seasons and the community should be sensitized on the quality of water and eventual use of white water lily leaf powder.

2

WATER AND ENVIRONMENT FOR CLIMATE ACTION

2.1 Remote sensing and machine learning integration to detect flash flood in Lodwar Town, Kenya

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Abstract

Flash floods cause significant hazards, especially in regions with limited hydro-meteorological data, hindering forecasting and risk assessment. The absence of comprehensive on-ground datasets challenges accurate evaluations and disaster management. This study integrates remote sensing and machine learning to improve flash flood prediction in Lodwar Town, Kenya. Given the area's frequent flash floods, this approach is vital for risk assessment and impact mitigation. Remotely sensed rainfall products were analyzed including; CHIRPS, MSWEP, IMERG, and TAMSAT along with the Normalized Difference Water Index (NDWI) from Aqua MODIS. Results of the correlation analysis between daily rainfall and NDWI (from 2002 to 2022) showed that CHIRPS and MSWEP performed best, with a 0.51 correlation coefficient at 0-day lag time. A Decision Tree Regressor model was applied to enhance prediction using CHIRPS data, improving the correlation coefficient to 0.64. The study identified key flash flood source areas located at West, Northwest, and Southwest of Lodwar Town, with elevations between 508 m and 648 m. Rainfall in these regions leads to rapid flooding in Lodwar situated at approximately 500m elevation with a 0-day lag time. The findings reveal that if forecasted rainfall data about community locations is available, early warning and early actions for potential flood occurrence can be implemented. This integrated approach using remote sensing and machine learning is crucial for flood-prone regions that lack comprehensive hydro-meteorological datasets, and offers a practical solution to flash flood anticipation and risk reduction.

Keywords: Flashflood · Digital innovation · Machine Learning · Decision Tree Regressor

2.2 Effects of land use and land cover changes and application of bmp scenarios on water balance and sediment yield of the Nakivubo channel micro-catchment in Uganda

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Abstract

Land use and land cover (LULC) changes affect the water balance and sediment yield in watersheds. This study aimed at investigating the effects of LULC changes and application of best management practices (BMPs) on water balance and sediment yield in the Nakivubo micro-catchment of the inner Murchison Bay catchment in Uganda between 2005 and 2040. ArcGIS software tools and cellular automata Markov model were used for LULC change analysis up to the year 2040. The Soil and Water Assessment Tool (SWAT) was used for simulation of the components of the water balance equation and sediment yield. The SWAT model simulation results were subjected to different scenarios of BMPs including Vegetation filter strips (VFS), grassed water ways (GWW) and Detention ponds to evaluate their impact on soil conservation. Results showed that between 2005 and 2040, built-up land and water bodies increased by 1,010 Ha and 60 Ha respectively. Bare land, wetland, and agricultural land declined from 343 Ha to 322 Ha, 85 ha to 7Ha and 1864 Ha to 657 Ha respectively. Model performance evaluation produced R^2 of 0.74, NSE of 0.72 and PBIAS of -0.05 for calibration and R^2 of 0.68, NSE of 0.75 and PBIAS of 2.35 for validation. Water flows in 2005 and 2040 were 1096.5 mm and 1278.9 mm respectively, Surface runoff and total sediment loading increased from 207.6 mm to 698.1 mm and 5.8 ton ha^{-1}year^{-1} to 12.4 ton ha^{-1}year^{-1} between 2005 and 2040 respectively. The combined application BMP scenarios including detention ponds, VFS and GWW reduced sediment load by 68%. Therefore, the increase in sediment yield due to LULC changes can be reduced by the combined application of BMPs hence knowledge on the design of BMPs is vital for conservation efforts of natural resources in the watershed for the realization of Vision 2040.

2.3 Impact of water losses on water demand of Bontanga irrigation scheme in Northern Ghana

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Abstract

Water loss management plays a vital role in managing water resources. Excessive water losses in water supply systems create a challenge to meet the competing water demands. Bontanga irrigation scheme is located in Northern Ghana, a region where water scarcity is worsening. This study was undertaken to analyse the extent of water losses in the scheme, identify shortfalls contributing to water losses and propose solutions for reduction of water losses. The study further projected the impact of water losses on water demand of the scheme using WEAP model. Water loss indicators employed in the study included conveyance, distribution, in-field, and total water losses. The results showed conveyance, distribution, and in-field water losses of 14.4 %, 37 %, and 42 %, respectively. Theses water losses contributed to low overall irrigation efficiency of 31.3 %, reflecting system's total water losses of 68.7 % which is beyond the system's water loss acceptable limit of 40 %. Under-utilization of flow measuring structures, poor canal maintenance, excessive canal tailwater losses, and poor water management at field level contributed to system's water losses. Without efforts to reduce water losses in the system, modelled results indicated that the future seasonal unmet water demand is likely to reach 2,482,519 m^3 by the year 2030. However, by reducing system's total water losses from 68.7 % to 40 %, WEAP model projected that an average seasonal water saving of 3,894,597.86 m^3 could be attained during the period from 2024 to 2030. The study underscores the importance of incorporating water loss management in planning and implementation of sustainable strategies targeting to meet the competing water demands. Further studies should focus on the detailed synergy between system's water losses and crop water productivity in the study area.

Keywords: Conveyance, Distribution, Water demand, Water loss, Water saving

2.4 Role of community participation in water governance: Lessons from local Water-User Associations in Uganda

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Abstract

Water governance is a crucial factor in sustainable development, particularly in Uganda's rural areas, where access to safe and reliable water resources significantly influences livelihoods, food security, and community resilience. This study examines the role of Local Water User Associations (LWUAs) in decentralized water governance, focusing on Bunyangabu Sub-County in the Rwenzori region, where over 75% of the population depends on local water sources for household use and small-scale agriculture. The study employed a mixed-methods approach, collecting primary data through household surveys (150 households), focus group discussions (20 groups), and key informant interviews (15 interviews) with local leaders, farmers, and government officials. The study covered four parishes: Kisomoro, Rwimi, Kibiito, Kiyombya. Secondary data analysis included policy documents, reports from relevant institutions, and records from non-governmental organizations (WaterAid Uganda, JESE, NAPE). Data collected covered seasonal water availability, governance structures, conflict resolution mechanisms, water-use efficiency, and the socio-economic impact of LWUAs on agricultural productivity and household consumption. Findings indicate that communities with active LWUAs experience a 30% increase in water-use efficiency and a 20% reduction in water-related conflicts due to improved resource allocation and dispute resolution mechanisms. The Bunyangabu Water User Association has successfully implemented gravity flow schemes and rainwater harvesting systems, benefiting over 15,000 households. A detailed disaggregation of water utilization reveals that in LWUA-managed areas, 60% of the water is used for small-scale irrigation, while 40% is allocated to household consumption. Communities with LWUAs reported a 25% increase in agricultural productivity due to improved access to irrigation, compared to a 10% increase in areas without active Water-user Associations. Additionally, areas with LWUAs show greater water-use diversification, incorporating water-saving technologies such as drip irrigation and alternative sources like rainwater harvesting. The study recommends increased government investment in rural water infrastructure, strengthened policy support, capacity-building initiatives, and the integration of traditional water management practices into formal governance structures to enhance sustainability and community participation.

Keywords: Communities, Water-user Associations, Water governance, Community resilience

2.5 Climate resilience, water management, food security, health, and livelihood: Insights from refugee and host communities in West Nile, Uganda

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Abstract

Access to clean and reliable water is essential for nutrition security, public health, and sustainable livelihoods, yet climate change and resource scarcity continue to undermine water availability in refugee-hosting areas. This study examines the impact of climate-resilient water management on food security, malnutrition, and economic resilience among refugees and host communities in Yumbe and Arua, West Nile, Uganda. Using a mixed-methods approach, data was collected through field surveys (n=300 households), in-depth interviews (n=40), and case studies involving local farmers, humanitarian organizations, and policymakers. Findings reveal that climate-adaptive water solutions—including rainwater harvesting, small-scale irrigation, and wetland conservation—led to a 32% increase in food production and a 25% rise in household income. However, poor sanitation and inadequate water quality remain key drivers of malnutrition and disease outbreaks, with 52% of households reporting diarrhea cases and 41% experiencing acute malnutrition. The introduction of solar-powered boreholes and community-led water governance models significantly improved water access (47%) and reduced waterborne diseases (38%), while also supporting environmental restoration. These findings underscore the need for integrated water management strategies, multi-sectoral collaboration, and policy reforms to enhance resilience, food security, and public health in refugee-hosting regions. Investments in sustainable water infrastructure will not only mitigate climate shocks but also foster economic stability and environmental sustainability.

Key words: Household income, Poor Sanitation, Inadequate Water Quality

2.6 Evaluation of pathways to controlling flooding of River Tangi at Pakwach sub-catchment

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Abstract

Flooding of River Tangi and around Pakwach bridge continues to cause loss of life, loss of property, social and economic disruptions and decline of Uganda's Gross Domestic Product. The inevitable changing climate could make the situation worse if climate resilient interventions and solutions are not identified and implemented. The objective of the study was to evaluate pathways to controlling flooding of River Tangi around Pakwach as well as identifying climate resilient solutions to flooding in this sub-catchment. Survey and parametric modelling methods used to carry out the study by conducting: (i) measurement and analysis of flows in River Tangi, (ii) Bathymeric surveys in River Tangi and River Nile around Packwach sub-catchment, (iii) Terrain modeling, and (iv) Appraisal of the hydraulic infrastructure and water conveyance in this area of the river systems. The study reveals: High level flows of 2000m^3/s coupled with the influence of floating vegetation on River Nile that causes significant back water effect and resulting in quick water level rise in River Tangi. In addition, there is inadequate hydraulic infrastructure for water conveyance in this area and that the hydraulic infrastructure to the watercourse in the study area is poorly aligned. The study suggests the following climate resilient pathway solutions: improving water conveyance in this area, raising the road level, and regular maintenance and surveillance including early warning system in these river systems.

Key words: Bathymetry surveys, Water conveyance, Hydraulic infrastructure, Terrain modeling

2.7 SCS-CN determination and automated data acquisition for Initial Abstraction Ratio

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Abstract

The study addresses the need for efficient watershed delineation and runoff estimation in the big data era. Traditional methods like ArcGIS involve laborious manual processes. The SCS-CN method used to estimate runoff, often underestimates or overestimates discharges due to unmodified model parameter which leads to improperly designed flood control structures. This study focuses on automating the SCS-CN method and optimizing the initial abstraction ratio. The study employs MATLAB and topotoolbox for delineation, using tools like @FLOWobj, @GRIDobj, and @STREAMobj for flow accumulation, flow direction, and streams. Daily rainfall data from Chirps in raster format is processed to produce an Excel sheet for catchment rainfall using the polyshape obtained by delineation. The tool assigns curve numbers to different combinations of land use land cover and hydrologic soil groups automatically, reducing the time taken for data processing and manual computation. It extracts rainfall data for any catchment and processes it into an Excel sheet. Tested on catchments of Kigwe, Mpanga, and Aswa, the tool shows high performance, with an NSE of over 0.92 with Climate engine. orgdata and 0.83 for GIS processed data. Delineation and LULC classification are done faster compared to other tools, showing a difference of less than 2 km in catchment area during delineation. Statistical analysis of the results using the NSE metric confirms the tool's accuracy and efficiency, with significant improvements observed in runoff estimations and hydrological analyses. The results were subjected to statistical significance tests, which showed that the differences in performance metrics were statistically significant, validating the tool's enhanced accuracy and efficiency. The tool automates data input for the SCS-CN method, enhancing efficiency and accuracy in hydrological analysis, and ensuring the proper design of flood control structures.

Keywords: Watershed delineation, Catchments, Runoff estimations, Hydrological analyses

2.8 Assessment of the viability of helminth eggs in sewage sludge manures: Case of National Water and Sewerage Corporation, Uganda.

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Abstract

The use of sludge manure in agriculture offers benefits such as improved soil nutrients and water retention. However, it presents public health risks due to high levels of pathogenic microorganisms, particularly soil-transmitted helminth (STHs) in endemic regions. STHs are of concern because of their resilient eggs and low infectious dose. Sewage sludge from wastewater treatment plants may contain viable parasite eggs, posing risks to humans and animals. WHO guidelines recommend ≤1 viable *Ascaris lumbricoides* ova per liter of wastewater or 4 grams of dry sludge for unrestricted reuse. This study analysed helminth eggs presence, concentration, and viability in wet sludge from National Water and Sewerage Corporation (NWSC) wastewater treatment plants in Kampala, Uganda: Bugolobi, Lubigi, and Nakivubo. Wet sludge was stored at room temperature and tested using U.S. EPA flotation and staining methods. Lubigi wet sludge had the highest concentration of viable helminth eggs (100 eggs/g TS), followed by Bugolobi (16 eggs/g TS) and Nakivubo (4 eggs/g TS). Research processes for dry sludge helminth eggs concentrations are under way. Wet sludge predominant helminth eggs included *Ascaris lumbricoides*, *Hymenolepis nana*, and *Taenia spp.* (for Lubigi and Bugolobi), and only *Ascaris lumbricoides* (for Nakivubo). This study reveals that wet sludge of Bugolobi, Lubigi, and Nakivubo contains high concentrations of helminth eggs, highlighting the necessity of drying before environmental disposal. This shows that sludge drying is necessary to significantly reduce or remove helminth eggs present in the wet sludge in the Kampala wastewater treatment plants, a process that has been adopted by NWSC to meet international biosolid safety standards, safeguard public health, and safe for agricultural reuse.

Keywords: Soil-transmitted helminth, egg viability, wet sludge, wastewater treatment plants

2.9 Climate financing commitments and implications of "Major Emitter-Major Financier' withdraw from Global Financing Arrangements

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Abstract

Climate Financing has been adopted as a financial management arrangement of the agencies involved in climate activity for sustainable development by drawing from public, private and alternative sources of financing to support mitigation and adaptation actions that address climate change effects. Kyoto Protocol (1992) and Paris Agreement (2015) call for financial assistance from Parties with more financial resources to vulnerable countries to address climate change effects. However, USA has withdrawn from climate change protocol and agreement; yet for the past three decades, USA has been considered as the "Major Emitter- Major Financier" in the Paris Agreement for Climate Change. The USA withdraw is likely to dwindle financial assistance, consequently constraining implementation of climate change interventions if not given urgent discourse attention. Uganda like any other Africa country, is highly vulnerable due to high dependence on the global climate financing for climate-sensitive sectors like agriculture, which employs 55-62% of the workforce and 95% of the cropland is rain-fed. Nonetheless, there is limited public discourse and less attention on the USA withdrawal and the likely consequences. The review study explored the financing interventions to understand and raise awareness on what is likely to be the financing effect of USA withdraw from Paris Agreement. Results showed that Uganda received climate finance of about US$500million. For instance the Global Environment Facility's 8th cycle (2022-2026), allocated Uganda approximately US$100 million. EU-funded GCCA Plus project (2018-2023), allocated Uganda approximately EUROS 8 million. In addition, the Adaptation Fund allocated approximately US$10. The findings reveal that withdrawal of climate financing by major financiers has profound implications which need to be understood and communicated for preparedness of Uganda Climate Financing portfolio, amidst increasing climate vulnerability, as generally African countries are already experiencing severe climate change impacts, including droughts, floods, and food insecurity. Therefore, Uganda's climate financing needs to look into possibilities of internal resources or innovative alternative arrangements for climate financing to fast track the increased resilience and adaptation to climate change so far achieved.

Keywords: Climate finance, Climate action, Climate change, Financial management

2.10 Assessment of water resource availability using integrated modeling under climate change

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Abstract

Understanding the current water balance and future projections is vital for water resources planning under changing climate and increasing water demand. This study provided water balance information for Northeast Uganda including Lokok, Lokere, and Awoja catchments. It supports water infrastructure placement and evidence-based water resources planning in an area where limited hydrometeorological infrastructure is available, pastoralist livelihood is common with frequent droughts and a growing population. The study used state-of-the-art integrated modeling by coupling surface and groundwater models, SWAT-MODFLOW, climate change projections, and community-based scenarios. The hydrological models were calibrated using actual evapotranspiration and discharge data obtained from remote sensing products. The results indicate that both decreasing and increasing surface runoff are projected for the future. A decrease and increase in surface runoff are projected for the downstream and upstream parts of the Lokok and Lokere catchments, respectively, with total annual catchment runoff in the range of 32-64 mm/year. Recharge to groundwater is decreased due to monthly temperature increases in the range of 0.88°C and 1.92°C and increased evapotranspiration. This shows that these catchments need to be ready for both plausible future conditions of decreased and increased water availability. The need to focus on storing surface runoff when it is available is high. However, the type of infrastructure to be constructed needs to align with the respective runoff amounts. Limiting the reliance on groundwater sources is important as the recharge is projected to decrease. Based on communities' responses future water demand will likely increase due to diversification of livelihood activities such as gold mining. Efforts must be made to match the water demand with supply including seasonal demands from livestock movement along traditional routes. The need for additional new water infrastructure is incontrovertible if other emerging livelihood activities such as irrigation and others are to be promoted in the region

Keywords: Water balance, hydrological models, catchment runoff

2.11 Enhancing dam safety through dam breach analysis for resilience to climate change

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Abstract

In Uganda, little is known about the possible extent of damage to infrastructure, reservoirs, lives, and environment in case of dam failure during extreme weather conditions. This study aimed at undertaking a dam breach analysis on Kibimba dam to find potential impacts due to extreme conditions such as flooding on lives, infrastructure, and basins. A digital terrain model was prepared from global satellite data using QGIS, and then imported to HEC-RAS hydraulic model which was setup with full reservoir storage of 135 Mm³, and an estimated flow of $100 m^3$/s based on catchment characteristics during a large flood, equivalent to 1000 years return period. The dam was assumed to breach due to overtopping. Breach development in the hydraulic model was made relevant to dam material and initial natural state of the watercourse. Dam break was done with the full Saint Venants equations. Model results showed inundation of a large area approximately 830 hectares of rice paddy, 1200 workers were affected, 5 buildings inundated, 86 deaths, main highway bridge damaged, 1000m of the highway was damaged, 4950 cargo trucks affected, annual rice deficit of 50,000MT, annual government revenue from rice production of approximately USD 138,479. There were physical damages and changes to the environment due to erosion and sediment and altering of the wetland/basin environment. Model results revealed that in extreme conditions, consequences of dam failure will be extremely enormous. It is recommended that dam breach analysis be undertaken in all basins with dams and reservoirs to enable dam owners, communities, policy makers, and regulators to undertake planning early warning systems for dam safety, control of reservoirs, and basins from damage during extreme conditions. Future studies should ensure that flow gauges are functional and flood calculations are available to improve accuracy of model results.

Keywords: Terrain model, dam breach, inundation

2.12 Flood hazards and trace metal pollution in the Nyamwamba catchment, Kasese district.

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Abstract

For the past sixty years, Kasese district in Western Uganda has been a hotspot for floods and related disasters. The district has been ravaged by flooding of River Nyamwamba, causing loss of life and property. During the past flooding cycles, Kilembe copper tailings were evidently washed into the river system, threatening water quality. The imminent threat to human health and ecosystems has worsened in the last 10 years due to increased floods following the 2012 wildfire in the Mt. Rwenzori National Park. This study assessed the variation of electroconductivity at different points, as an indicator of trace metal pollution from the Kilembe mines. A transect walk was executed along the river, to visually observe the colour variations of river sediments and the channel bed. A hand-held EC meter was used to take the onsite measurements for the temperature, pH and Electroconductivity, at an interval of 500m during the 19.5 km transect walk. In addition, Landsat imagery from 2014- 2024 was analysed to determine the volumetric change in the copper tailings due to erosion. The study found out severe contamination downstream of the mining outlets, with EC values spiking to 243 µS/cm compared to an average of 47.42 µS/cm upstream and 117.64 µS/cm downstream respectively. Observations included yellow coatings and reddish-brown metal precipitates, which were consistently noted along the route. Temperature and pH ranged between 15 and 25 ^{0}C, and 7.2 to 7.8 respectively. For a catchment with low salinity, the spike in EC indicates possible trace metal pollution. The Landsat image analysis indicated that the river has eroded over 1 million tonnes of copper tailings since 2014. The study recommends comprehensive trace metal testing and detailed studies to quantify the ecological and health risks of mining pollutants.

Keywords: Flooding, Sediments, River systems, Kilembe mines

2.13 Preservation of encroached-gazetted wetland through assessing moisture conditions of fringes under upland rice production in Uganda

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Abstract

Wetlands play a crucial role in ecological balance, supporting biodiversity, and providing essential services such as water filtration and flood mitigation. Increased agricultural activity within a 1.6 km buffer zone is the major threat to wetland degradation. Rice production in wetlands is a common trend in Uganda amidst climate change and moisture stress in the upper landscapes. Some farmers have opted to use both riverine fringes and wetland ecologies endowed with moisture yet there is a wetland policy that bans encroachment. However, the use of the riverine fringes could be potential upland rice production zones but the reliability of their moisture levels to support yield is not well understood. The study was conducted in Kikuube District on landscapes categorized under two different slope positions (mid-slope and lowland) across four different wetland ecological environments. It was to assess the sustainability of soil moisture content in the fringes for upland rice production. An aromatic upland rice variety NAMCHE 5 was planted on the two-slope position replicated three times with two recommended fertilization regimes (60kgN/ha and 30kgN/ha) and control. Soil moisture variability in upland rice fields was measured using Diviner2000. Analysis was conducted using R-Studio 4.4.0 to compare the soil moisture in the two slope positions under different fertilizer regimes. Inorganic fertilizer application influences vegetative growth which influences plant water uptake and evapotranspiration. Results show no significant difference ($p > 0.05$) between the soil moisture in the mid-slope and lowland. In both slope positions, the soil moisture ranged between 390-460 mm per season which is in the range (450 mm) of the recommended minimum crop water requirements for upland rice per crop cycle for sustainable growth. Moisture variability in the riverine fringes meets the upland rice requirements thus these findings suggest that farmers could explore the alternative landscapes rather than encroach on wetlands.

Keywords: Soil moisture, Fringes, Buffer-zone

2.14 Strained resources, rising tensions: conflict and cooperation in Uganda's refugee-host communities

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Abstract

Uganda, one of the largest refugee-hosting nations globally, accommodates over 1.5 million refugees, primarily in West Nile, including Yumbe and Arua districts. While Uganda's refugee policies promote integration, resource scarcity has intensified conflicts between refugees and host communities over land, water, firewood, and public services. This study investigates the extent to which resource scarcity fuels tensions and explores strategies for fostering peaceful coexistence. Using a mixed-methods study design was used to collect data through 40 in-depth interviews with key informants (local leaders, government officials, humanitarian workers, and community representatives), 8 focus group discussions, and a survey of 200 respondents selected through stratified random sampling. Secondary data analysis of policy documents and reports was performed to triangulate primary findings. Results reveal that increasing competition for scarce resources strains refugee-host relations, with land disputes and environmental degradation being major sources of tension. However, some community-led initiatives promoting shared resource management and sustainable livelihoods have shown potential in reducing tensions. The findings highlight the need for integrated humanitarian and development strategies that balance immediate relief efforts with long-term resilience-building. Strengthening participatory governance, improving natural resource management, and expanding livelihood opportunities can mitigate conflicts and enhance social cohesion. By addressing these challenges, Uganda can reinforce refugee integration, reduce resource-driven conflicts, and promote long-term stability in its refugee-hosting regions. This study contributes to ongoing policy discussions on sustainable refugee management, offering insights for governments, humanitarian agencies, and development partners seeking to foster peaceful coexistence between refugees and host communities.

Keywords: Resource scarcity, refugee-host conflicts, governance, sustainable livelihoods, social cohesion

2.15 Enhancing climate-resilient WASH services: Lessons from flood event in Dokolo District, Northern Uganda

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Abstract

The three-year Sustainable Water Supply, Sanitation and Hygiene for All (SWaSSH4A) project, funded by Austrian Development Cooperation and implemented by SNV, contributes to increased sustainable access to inclusive, climate-resilient, safe WASH services in the rural districts of Lira, Dokolo, Kole and Alebtong. The paper presents results of a joint flood impact assessment undertaken in Dokolo following floodings in 2023/ 2024. The objective of the assessment was to strengthen capacity, learning, and reduce impact of flooding on WASH infrastructures in future. Although Uganda´s water sector targets as per National Development Plan III - are ambitious, rural water and sanitation access remains low, partly due to climate change (floods/droughts). A Ministry of Water Environment (MWE, 2022) WASH Climate and Vulnerability Risk Assessment indicated elevated flood and drought risks in all four SWaSSH4A project districts. Household survey using questionnaires, key informant interviews and observations, sanitary inspection and water quality analysis were some of the methods used to collect data on impact of flood. Households underestimate potential impact of floods. In 2023, 9% of assessed boreholes in Dokolo district were in flood zones and inaccessible. During 2024 floods, 32 boreholes were submerged and contaminated, and 200 latrines collapsed. Results were used to develop and implement a more robust household toilet design preventing failure when flooded. Rehabilitation of boreholes with elevated apron reduces breakdown of water supply. Understanding climate-related risks/impacts on the ground guides interventions. Joint analysis of flood impact on WASH services creates evidence-based planning at local government levels and allows better choices at community level. With climate-smart designs the negative impact of flooding can be reduced.

Keywords: Boreholes, Latrines, Floods, Resilience, Assessment.

2.16 Developing flood mitigation measures for River Namatala catchment

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Abstract

Flood mitigation measures are required to protect the catchment from flood vulnerability. Flood mitigation measures are measures that help to reduce impacts of flooding on communities and infrastructure. These measures are categorized into structural and non-structural measures. River Namatala catchment has adopted a research-based flood mitigation measures to reduce on the flood vulnerability with in the catchment since there is no research that has been carried out to develop the mitigation, measures with in the catchment. HEC SSP was used for rainfall frequency analysis with rainfall data ranging from 1990-2019 and the best distribution that fits the data was used to develop IDF curves which were input to PCSWMM. The PCSWMM model was calibrated and validated using SRTC tool by comparing simulated flow with observed stream flow ranging from 2000-2011 and its performance was assessed using different statistical indicators such as NSE, RMSE and PBIAS, these indicated a satisfactory performance. Hydrological output was input to the 1-D hydrodynamic HEC RAS model. The 1-D HEC RAS model was calibrated and validated through ground-truthing. Using MCDA, different factors (LULC, rainfall intensity, soil type, sediment yield e.t.c) were also used to determine the best two structural flood mitigation options for River Namatala catchment, preliminary designs of the best two measures were simulated independently and combined in the 1D HEC-RAS model to determine their effectiveness considering the following evaluation criteria; flood stage, flood discharge and inundation extent. The following results were obtained calibration and validation graphs, method of moments and maximum like hood tables, IDF curves, peak discharges, flood hazard maps for 25, 50, 100, 200 return periods, MCD tables for flood mitigation options, preliminary designs for levees and channel improvement, 50-year flood reduction maps for levees and channel improvement. There is need for the detailed design analysis of the best structural measure.

Keywords: PCSWMM, HEC-RAS 1D, Hydrodynamic model, Rainfall-runoff

2.17 Sustainability of groundwater aquifers in Tilenga area of Albertine Graben: Insights from Advanced MODLFOW and ModelMuse simulations

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Abstract

Groundwater is a critical resource for communities, providing vital water for domestic, agricultural, and industrial purposes. The growing demand for water in the Tilenga Project area has arisen because of the recent oil exploration and drilling in the Albertine graben. To support construction and operations of the Tilenga project, Total Energies acquired 60 new ground water sources. In addition to this, the Ministry of Water and Environment has operationalised more boreholes in the region, as sources for piped water supply systems to serve the surrounding communities. Numerous studies have been conducted to obtain the hydrogeological properties of the groundwater aquifers in the Albertine graben but there is need to determine their suitability in serving a growing population for up to 20 years. This study aims to assess the sustainability of these aquifers by utilising numerical modelling techniques in MODFLOW. MODFLOW provides robust finite-difference groundwater flow models, integrated with Model Muse, a complementary graphical user interface to conduct comprehensive groundwater flow simulations. The model parameters used include recharge and pumping rates, hydrogeological properties, and boundary conditions, in the areas surrounding the new borehole sites. The scenarios used to assess the quantity sustainability of the aquifers include i) a 20% increase in the number of boreholes ii) a 30% in the number of boreholes iii) a 20% increase in the pumping yield iv) a 30% increase in the pumping yield. The simulations run under steady state conditions revealed that, while an increase in the number of boreholes and pumping yield has negligible effect on the groundwater quantity, there is a significant increase in the drawdown at the boreholes after 15 years, at a constant recharge rate of $200m^3/d$. These results show a need to incorporate regulations on the pumping yield and rate for new boreholes for sustainable groundwater management. Additionally, the research highlights the value of integrating advanced modelling tools in groundwater sustainability assessments, providing a blueprint for similar regions facing water resource challenges.

Keywords: Groundwater modelling, MODFLOW, Model Muse, Water Management, Climate Resilience

3

EQUITABLE AND SUSTAINABLE USE OF WATER AND ENVIRONMENT RESOURCES FOR IMPROVED INCOMES AND LIVELIHOODS

3.1 A drop of hope: Implementing the use of Bios and Filters in Agoro Central Village Agago district of Uganda

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Abstract

Unsafe drinking water causes water borne diseases like diarrhea, typhoid, cholera and dysentery which affects the lives of over 400 infants annually in Agoro central village, Omot sub-county Agago district. There are many POWT (point of use water treatment) methods like boiling, use of water guard and chlorine in this village yet communities continue to get waterborne diseases. Existing solutions are often expensive, cumbersome, or ineffective. The project targets over 100 rural households and the product offers the use of biosand filters to provide clean and safe drinking water, through biological and physical processes capable of removing 99% of microbiological contaminants, 90% of turbidity and improves water taste and Odor, hence significantly reducing the risks of water borne diseases and mortality rate. Test conducted in Agoro to evaluate the filter's E.coli removal efficiency with time indicated that contaminated water with an initial concentration of 967 Colony-Forming Units (CFU) per 100ml achieved 100% reduction in E.coli after 30days of monitoring, resulting in 0 CFU per 100ml. Biosand filters are easy to adapt both technically and economically. The target market includes Over 100 rural households with the aim of scaling up to Schools, hospitals, Local governments, NGO's and other neighboring Villages, sub counties like wol (where water quality tests done by the District health inspector through support from world vision indicates that most of the boreholes are contaminated with Ecoli due to poor distribution of toilets), districts like Abim, Pader and Otuke. According to the baseline survey which sampled 120 households, 70% were willing and able to pay for the product, 20% were willing and unable to pay, 10% were undecided. The pricing model is $20 per product, this includes cost of installation, operation and maintenance. Revenue will be generated through product sales, subsidized pricing, grant funding, and government contracts.

Keywords: Water borne diseases, Microbiological contaminants, E.coli, Biosand filters, Drinking water

3.2 Factors influencing households' willingness to pay for watershed services in Mubuku-Nyamwamba in Kasese District-Uganda

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Abstract

The degradation of watershed services in the Mubuku-Nyamwamba landscape of Kasese District, Uganda, threatens water resources essential for agriculture and domestic use. Despite ongoing conservation efforts, limited understanding of households' willingness to pay (WTP) for watershed services hinders the development of effective Payment for Watershed Services (PWS) schemes. This study examines the factors influencing WTP, aiming to: (i) assess household utilization of these services, (ii) identify socio-economic and environmental factors affecting WTP, and (iii) establish appropriate payment channels. A descriptive survey research design was used, with 205 households selected through stratified and random sampling across upper, mid, and downstream communities. Data were analyzed using descriptive statistics and regression models to determine key WTP determinants. Biases were minimized through proportionate stratification and ensuring diverse representation. Findings indicate that 36.6% of households are willing to pay, influenced by education, income, distance from the river, land ownership, and farm size. Many households preferred mobile money (42.5%) and cash payments (41.4%), while others favored in-kind contributions such as awareness campaigns and provision of seedlings. Major barriers to WTP included economic constraints, lack of awareness, and mistrust in fund management. To enhance community participation, policy interventions should focus on environmental education, transparent fund management, gender-inclusive programs, and sustainable land-use incentives. Strengthening community engagement and alternative livelihoods can boost financial commitment to watershed conservation. Additionally, integrating payment flexibility and stakeholder collaboration can improve participation in PWS schemes. These insights provide valuable guidance for policymakers, conservationists, and development actors in designing sustainable watershed management strategies. Enhancing WTP can ensure long-term water resource sustainability, benefiting both ecosystems and local communities.

Keywords: Willingness to Pay, Watershed services, Payment for Ecosystem Services, Sustainable water management, Uganda

3.3 Investment in water and environment resources for improved livelihoods and incomes among low-income households within Midwestern region of Uganda

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Abstract

Water and environment resources are pivotal for socio-economic development, employment creation, enhancing livelihoods and incomes. Ministry of Water and Environment as the custodian of SDG 6 is mandated to address sustainability and management of these resources while ensuring equitable access to safe, clean and affordable water for all citizens. However, this remains a challenge at national level, where access to safe water is unequal with urban areas often benefiting from more developed infrastructure than the low-income communities. This causes a significant issue for many low-income households severely affecting public health, economic stability, and social well-being. Therefore, a study on testing and validating a pro-poor service delivery model at MWUWS was conducted with focus on a subsidized connection model which was intended to solve the challenges of high connection fees for the low-income, vulnerable and disadvantaged communities in small towns and rural growth centers across the four piloted schemes. Quantitative and qualitative methods like observations, focused group discussions, surveys, and key informant interviews were deployed to conduct an eligibility study for customers to be enrolled and determine the impact of the intervention. The selected customers were then enrolled for a subsidized connection model "40/60 payment" where beneficiaries would pay 40% of the connection fee to be connected and the balance of 60% on a monthly installment payment of 10% in addition to the consumption bill. Using the beneficiaries' data collected from sources like Pegasus billing system, 260 beneficiaries were connected and 90% were able to fully pay their debt on new connection within the 6 months indicating a significant level of water demand from the target group. Through this access, the communities have recorded reduced time taken to fetch water, domestic violence cases and prevalence of water borne diseases which in turn has led to an increment in finances among low-income households. However, the study was limited by Pegasus system's inability to merge the study activities for arrears management, limited resources like finance, human resource and time among others. In conclusion, this paper recommends for the need of a policy to cater for the low-income communities while ensuring equitable and sustainable management of the available water resources.

Keywords: Umbrella of Water and Sanitation, Water resources, affordable connection charges, socio-economic development, livelihoods and job creation.

3.4 Improving access to WASH through service-level monitoring in Kabarole, Uganda

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Abstract

WASH service level monitoring has been periodically conducted by IRC in collaboration with Kabarole DLG, to provide a basis for tracking service trends across the district. The https://www.mwater.co/ has been used for collection and analysis of both quantitative and qualitative data. Water quality testing focused on parameters for drinking water mainly of E. coli, EC, pH, and Turbidity. Using https://www.checkmarket.com/sample-size-calculator/, at 95% confidence level and 5% margin of error the required sample was established at 384 households. To allow for potential mistakes and for practical purposes, a total of 400 households were taken to be representative at district level. Like households, public primary and secondary schools were sampled except for HCFs and water points where a census was done. Results indicate that access to safely managed water service has increased from 0% (2017) to 15% (2024), unimproved has reduced from 57% (2017) to 30% (2024). Water source functionality from 64% (2017) to 72% (2024. 38% of the water samples met the standard for E.coli, 95% met standard for turbidity, and 100% met standards for both pH and EC. Knowledge, Attitude and Practice (KAP) surveys for Healthcare workers revealed that protecting oneself (95%) and one's patients (86%) were the key reasons for practicing hand hygiene, it was difficult to always practice hand hygiene at appropriate times due to lack of time (48%) and limited water supply (38%), For cleaners, 58% felt had received enough training on cleaning medical facilities, 78% felt had sufficient supplies to carry out their cleaning duties and 91% felt that preventing the spread of infections was important to facility administrators. Kabarole continues to progress towards attaining universal coverage to safely managed WASH services though the district leadership needs to invest much more into operation and maintenance of existing WASH infrastructure and public awareness on associated benefits.

Keywords: Access, Monitoring, Satisfaction, Knowledge, Attitude and Practice

3.5 Scaling up the Catchment-based Integrated Water Resources Management (CbIWRM) approach for equitable and sustainable development

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Abstract

Water is a vital resource that benefits different sectors in Uganda, including health, agriculture, fisheries, industry, and navigation. Water resources vary seasonally and spatially due to geological and anthropogenic influences. This has prompted various sectors to implement measures to address the challenges. However, insufficient sectoral cooperation in planning and execution has recently made it difficult to ensure the effectiveness and sustainability of the interventions under these sectors. In order to foster collaboration across different sectors and encourage effective use of the available resources, this situation necessitates the creation of systems to foster integrated planning, development, and management of water resources. In 2011, the Ministry of Water and Environment adopted the Catchment based Integrated Water Resources Management (CbIWRM) approach to ensure equitable access and utilisation of water and environment resources for sustainable socio-economic development. This has been operationalized through the 4 Water Management Zones, under the Directorate of Water Resources Management. Currently 47 Catchment Management Plans (CMPs) have been developed with consultation of the key catchment stakeholders, coordinated by the respective Water Management Zones. The CMP development process involves stakeholder mapping which has attracted budget support to the Ministry, through joint proposal writing. Implementation has been effected in the catchment areas of Nyamwamba, Mpanga, Rwizi, Lokere among others since 2016. The catchment measures include tree growing, riverbank stabilization, soil and water conservation which has positively impacted the water quality and quantity to a small extent in some regions. Alternative income generating activities like apiary, fish farming, small-scale irrigation, energy saving cook stoves among others have also been introduced to enhance resilience and livelihoods. Therefore, to scale up the achievements, there is need to re-think the catchment management approaches by leveraging digitalization, upgrading the rainwater harvesting technologies and practices, and incentivizing and commercializing conservation practices for equitable and sustainable development.

Keywords: Sectoral cooperation, IWRM, Sustainable development, Income generating, Catchment management

3.6 Impact of water harvesting on community livelihoods in Sebei sub-region, Uganda

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Abstract

The persistent water scarcity issue in Sebei Sub region emanate from prolonged dry spell, leading to stress on water sources, water use conflicts, and high-water costs. The purpose of study was to skill smallholder farmers in construction of water harvesting tanks (WHT) and soil-water conservation (SWC) in the Sebei Sub-region. A total of 8,150 farmers were sensitized and 5,000 participants were selected for training in WHT construction and SWC practices including trenches, grass bunds and mulching. Three hundred fifteen (315) participants were randomly selected from the 5,000 trained farmers and administered with questionnaires. Data collected was analyzed using SPSS v23. The study indicated that 100 WHT were constructed each measuring 5,000 L. Also, 61% of the farmers implemented SWC practices, and mulching were 21%, grass bunds (21%) and trenches (19%). The trenches were measuring 10 m long with 2x2 ft, grass bunds were planted with elephant grass, and mulching involved dry matter. Furthermore, analysis indicated that SWC helped farmers to control runoffs (48%) and increase crop yields (52%). Farmers who took on WHT reported low water costs (57%) and access to water (43%). Conclusively, water harvesting tanks and SWC practices need to be promoted to reduce water scarcity and improve food production in the region.

Keywords: Rainwater harvesting, water tanks, soil-water conservation, community livelihoods

3.7 Integrating Climate, influent variability and machine learning for wastewater treatment optimization: A Case of Tororo stabilization ponds

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Abstract

Climate change and increasing influent loads pose significant challenges to wastewater treatment efficiency, necessitating data-driven approaches for resilience and optimization. This study investigates the stabilization ponds at Tororo Wastewater Treatment Plant to assess the impacts of climate variability and influent fluctuations on treatment performance. Data from 2014–2024 was analyzed using descriptive analysis, Principal Component Analysis (PCA), Cluster Analysis, ANOVA and Analysis of Covariance (ANCOVA) to identify key performance drivers. PCA revealed that BOD, COD, and pH were dominant influencers, while nutrient parameters (P, ORTH, NH_3) and climatic factors (temperature, rainfall) significantly affected variations. ANCOVA showed that inflow rates negatively impacted pH, BOD, and TSS removal, while temperature influenced fecal coliform reduction and rainfall had a seasonal effect on nutrient removal. Three predictive models Hybrid Gated Recurrent Unit - Long Short-Term Memory (GRU-LSTM), artificial neural network (ANN), and Multivariate regression model (ML) were developed to predict wastewater quality. The Hybrid GRU-LSTM model outperformed the others (Train RMSE: 0.0397, Val RMSE: 0.0421, Test RMSE: 0.0403, R^2: 0.944), surpassing ANN (R^2: 0.7788) and ML (R^2: 0.6789). To project future treatment performance, an Autoregressive Integrated Moving Average. (ARIMA) forecasting model is suitable to forecast influent and climate variations, by; feeding results into the Hybrid GRU-LSTM model, providing insights into treatment efficiency under future conditions, and enabling adaptive wastewater management strategies to enhance resilience against climate change and operational stressors. This study contributes to sustainable wastewater treatment, aligning with SDGs 6, 11, and 13 and Uganda's Vision 2040, by integrating machine learning and forecasting for climate-adaptive water management.

Keywords: Wastewater treatment, Machine learning, Stabilization ponds

3.8 Upland rice yield response to soil moisture variability with depth across Ferralsols and Gleysols in Western Uganda

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Abstract

Soil moisture is a vital factor in boosting rice productivity by influencing the growth of healthy plants. In mid-western districts like Kikuube where rainfall is unpredictable, maintaining optimal soil moisture differs between a bountiful harvest and crop failure. Effective soil moisture management leads to improved water use efficiency, allowing crops to withstand periods of drought. This study determined upland yield response to soil moisture variations with soil depth in Ferralsols and Gleysols for two seasons; (August-December 2023 and March-June 2024). Twenty-four access tubes were installed in six fields, each field having four. Three fields of Ferralsols and three for Gleysols, from which soil moisture content was measured. The Diviner 2000 at 10 cm intervals to a 100 cm depth was used in reading the soil moisture content. Calibrated rain gauges were also installed in each field to measure the daily rainfall received. Soil physical properties such as texture, bulk density, infiltration rates, water holding capacity, field capacity, and permanent wilting point (PWP) were determined. In Ferralsols, the soil moisture decreased with an increase in depth whereas in Gleysols, the soil moisture increased with an increase in depth. Gleysols showed high water retention capacity, influenced by clay and organic carbon content. A comparison of Ferralsols and Gleysols revealed better growth and water use efficiency on rice on Ferralsols in the August-December, 2023 growing season characterized by less rainfall variability. The increase in soil moisture with an increase in depth is attributed to the contribution of capillary rise for Gleysols. Gleysols registered higher yields of 5,840 kg ha^{-1} compared to 3,527 kg ha^{-1} in the Ferralsols during the March-June, 2024 season which had a high rainfall variability. Both Ferralsols and Gleysols are suitable for upland rice production. Nevertheless, in high variability of rainfall; early planting is highly recommended to maximize water uptake.

Keywords: Soil moisture, Diviner 2000, Gleysols and Ferralsols

3.9 Integrating Market-Based Approaches in sanitation promotion for appropriate sanitary and hygiene practices in Kamuli District, Uganda

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Abstract

Inappropriate sanitation and hygiene practices are prevalent in rural households of Uganda, including Kamuli district, characterized by open defecation, unimproved facilities and limited sanitation service. With support from the Sanitation and Hygiene Fund, the Government of Uganda is implementing the *"Accelerating Access to Improved Sanitation and Hygiene Services Using Market-Based Approaches" project in seven districts, including Kamuli*. The project is being implemented through a consortium led by Water For People over a three year period (2023-2025). A baseline survey was conducted to ascertain sanitation services at household level revealing that while latrine coverage was at 71%, only 40% of these were improved facilities -28.6% classified as basic and 11.4% as safely managed). The data was then used to inform the network delivery model under the Market Based Sanitation (MBS) approach, which creates a local sanitation market and economy, incorporating activities such as, demand activation, capacity building for sanitation entrepreneurs and value chain actors, human-centered design for climate-resilient technologies, and linkages to financial institutions. Overall, latrine use for defecation has increased and communities have adopted appropriate hygiene behaviours and practice. This is evidenced by the construction of 1,016 sanitation facilities of which 80.1% are basic and 19.9% are safely managed. Access to some form of sanitation has also increased from 71.6% to 77.4%. Almost half (38.0%) of the households constructed latrines after attending trigger sessions, 28.0% received information from the project village level sanitation promoters, 6.7% interacted with the trained masons and 6.3% built latrines due to social pressure. Additionally, 38% of the sanitation facilities were constructed using loans from financial institutions. Finally, the MBS model empowers households to invest in improved sanitation services, while also strengthening service provider networks to ensure accessibility and affordability. Scaling up MBS, along with policy support is essential to achieving universal access to improved sanitation.

Keywords: Market-Based Sanitation, Network Delivery Model, Sanitation Economy, Capacity Building

3.10 Assessment of groundwater quality employing the Water Quality Index (WQI), the Synthetic Pollution Index (SPI), and geospatial methodologies in Mukubu River Uganda

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Abstract

In light of the evolving climate scenario, groundwater aquifers located within the wetland regions of Uganda face considerable peril. Given the severity of this issue and the apprehensions of the civil society, this research was undertaken to assess and delineate the groundwater quality in the Mukubu District of Uganda based on the physicochemical analysis of thirty-five samples utilizing two established numerical models coupled with geospatial techniques. The physicochemical parameters like pH, EC, TH, TSS, BOD and COD were determined, and the results of each sample were compared with the recommended limits of the World Health Organization (WHO). The WQI model indicated that 2.23%, 5.88%, 12.87%, 21.35%, and 57.36%, of the water samples were categorized as excellent, good, poor, very poor, and unsuitable for potable use. Furthermore, the SPI model discerned that 14.83%, 17%, 16.93%, 21.15%, and 29% of the samples were classified as slightly polluted, moderately polluted, highly polluted, suitable, and unsuitable for drinking. Although the inputs for the models differ, the proportional rankings exhibited a noteworthy correlation (0.88) between the results generated by both models. Collectively, the findings of the study indicated that the groundwater in a majority of the assessed regions fails to comply with the guidelines set forth by the WHO. The endemic occurrence of waterborne diseases in the vicinity implies that the groundwater is compromised, rendering its use a significant health hazard for the local population. The research underscores the importance of employing numerical models and geospatial techniques for the evaluation of water quality in riverine environments globally.

Keywords : Water Quality Index, Surface Pollution Index, GIS, Remote sensing, Groundwater

3.11 Gender Data Management in forestry, water, and environment sectoral policies in Uganda: a Call for Action

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Abstract

Gender data are essential for identifying challenges, opportunities, and solutions to accelerate progress toward equitable and sustainable use of water, forestry, and environmental resources for improved incomes and livelihoods. However, gender data management in Uganda suffers from inadequate institutional coordination, incomparable methodologies, and information-sharing bureaucracies rendering data unavailable for use in policymaking, advocacy, and managerial decision-making. Available data on Uganda's forestry, water, and environment are inadequate as they are simply disaggregated into men and women only. Yet gender data should be collected and presented beyond sex-disaggregation to adequately reflect the diversity of women and men and gender markers such as gender-based violence; attitudes toward social and cultural norms, etc. A scoping study was conducted to assess the extent to which forestry, water, and environment sectoral data are presented adequately for gender marker reporting. The study referred to twelve national policies and fourteen plans in forestry, wildlife, biodiversity, agriculture, water, environment, and gender as a context for gender data management. The policies reviewed were downloaded from the internet and analyzed using FAO's Gender in Agricultural Policy (GAPo) tool. To assess gender integration in policy, the GAPo tool bases on fourteen predetermined gender marker assessment domains, general gender grading, and thematic gender assessments. The themes the GAPo tool considers are gender budget, sex-disaggregated data, women's participation, gender-based violence (GBV), etc. Results showed nine policies and five plans recognized gender inequalities; while three policies and nine strategies ignored gender inequalities. Most (99%) studied policies lacked specific, measurable, actionable gender targets and budgets. Nearly 95% of the policies recognized the role of women but no gender markers. It is recommended that the Ministry of Water and Environment identifies and coordinates relevant stakeholders within and outside the sector to deliberately develop, popularize, and execute harmonized gender data arrangements such as dashboards and gender budgeting.

Keywords: Gender disaggregated data, Gender-responsive policies, gender markers, Gender budgeting

3.12 Benefits of soil and water conservations practices for surface water quality in the Mpanga Catchment

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Abstract

Land degradation adversely affects crop growth, production capacity and water quality (e.g. Diop et al., 2022). Associated soil erosion leads to excessive loss of sediments and nutrients to surface waters, deteriorating their water quality (e.g. Olago & Odada, 2007). The Mpanga catchment exhibits one of the highest turbidities (> 200 NTU) in the country (CMP, 2015) and provides a good example, where land degradation adversely affects water quality. Soil and water conservation practices (SWCPs) are widely adopted to combat land degradation and protect water quality. This study evaluates the impact of SWCPs on total suspended solids (TSS) and Total Phosphorus (TP) in the Mpanga catchment using the Soil and Water Assessment Tool (SWAT) (Arnold et al., 2012). SWCP distribution data was collected through an interactive stakeholder workshop following the CoSMoS approach. The SWAT model was configured with two scenarios: one without SWCPs and another incorporating existing SWCPs. Comparison of the simulated sediment concentrations and phosphorus loads enabled assessment of SWCP effectiveness. Results indicate that SWCPs reduced sediment concentrations by 4% and phosphorus loads by 17% at gauging station 84215 (Kamwenge). At upstream gauging station 84212 (downstream of Fort Portal), SWCPs achieved only a marginal 1% reduction in sediment concentrations, while phosphorus loads decreased substantially by 28%. SWCP effectiveness varies non-linearly throughout the Mpanga river network, as demonstrated by the spatial distribution of modeled improvements. Phosphorus loads decreased across 88% of the stream network, though reductions above 50% occurred in only 3% of reaches. The results demonstrate that existing SWCPs effectively improve water quality across extensive sections of the Mpanga river network. This analysis confirms the significant role of SWCPs in enhancing water quality, suggesting that expanded implementation could further improve water quality throughout the catchment.

Keywords: Water quality modelling, SWAT, Soil and Water conservation practices,

3.13 Soil erosion modelling of the Mpanga catchment – a probabilistic approach to demonstrate the current status and the effects of increased soil conservation on erosion

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Abstract

In Uganda, 41% of the total land area is affected by degradation, mostly associated with soil erosion (Cooper, 2018). In the Mpanga catchment, land use change and the application of poor farming practices enhances soil erosion processes. As recommended in the catchment management plan, this contribution assesses soil erosion rates and hotspots in the Mpanga. This study presents an improved estimation of soil erosion building on previous investigation applying the Universal Soil Loss Equation (USLE) (Schürz et al., 2020) by including stakeholder informed knowledge on soil and water conservation practices (SWCPs) with a randomized approach. By implementing enhanced SWCPs application scenarios, the objective of this research is to examine the effectiveness of general and targeted strategies to reduce erosion. Results indicate a current mean gross erosion rate of 7.8 t/ha*a in the catchment. The resulting map exhibits strong spatial variability. While the highest erosion with 10.3 and 13.3 t/ha*a are detected in Kabarole and Ibanda Districts, lowest mean soil erosion is found in Kiruhura (5.0 t/ha*a). Depending on the considered tolerable soil loss threshold of 4.5 and 11.2 t/ha*a (FAO, 2019), between 46% and 19% of the catchment experience unsustainable soil loss. To investigate the effectiveness of enhanced SWCP application to mitigate soil erosion, scenarios representing improved and targeted interventions were developed. The best-case scenario, representing 100% application rates of SWCPs, shows that mean soil erosion can be reduced to 3.6 t/ha*a. Although this scenario may be impractical to implement, it demonstrates the maximum potential for erosion reduction through enhanced SWCP application. Additionally, targeted SWCP implementation was evaluated across erosion-prone areas. Applying SWCPs to zones with erosion rates exceeding 11.2 and 4.5 t/ha*yr reduced mean erosion rates to 4.6 and 3.9 t/ha*yr, respectively. This targeted approach achieved similar erosion reduction as the best-case scenario, while requiring SWCP implementation in only 57% and 74% of the area, rather than complete coverage. The results show that large catchment areas are experiencing unsustainable soil losses. Increased SWCPs application rates can reduce erosion significantly. We demonstrated that targeted interventions are a feasible pathway to significantly mitigate soil erosion, while limiting the required area if intervention.

Keywords: Soil erosion modelling, USLE, Land degradation, Soil and Water Conservation, Uganda

4

WATER AND ENVIRONMENT INNOVATIONS, KNOWLEDGE AND CAPACITY FOR EMPOWERING A NEW GENERATION

4.1 Perceptions and attitudes towards urban green spaces: A case study of Kampala Metropolitan Area

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Abstract

Urban green spaces play a crucial role in enhancing environmental quality, human well-being, and societal behavior. However, rapid urbanization in Kampala, Uganda, has led to a significant decline in these spaces. This study explores urban residents' perceptions and attitudes towards this decline, using a cross-sectional survey methodology with structured questionnaires. A total of 147 respondents participated, with 76.2% acknowledging a noticeable reduction in green spaces. No significant differences were found in perceptions across city divisions. The frequency of visits to green spaces strongly influenced residents' ability to recognize their decline. The primary concern among respondents was limited access to nature and greenery, followed by reduced opportunities for outdoor activities (27.2%). A cross-tabulation analysis further indicated that this decline negatively affected physical health across different age groups. The primary reasons for visiting green spaces were relaxation and stress relief (49.7%), followed by physical exercise, while bird watching was the least common motivation (2.0%). Regarding conservation efforts, 86.5% of respondents expressed willingness to participate in activities to protect and restore green spaces, with higher interest shown by females (89%) and young adults aged 18-24 (86.1%). Additionally, 75.4% of those willing to participate were open to financial contributions, with younger respondents being more financially supportive. The study highlights the critical relationship between urban residents and green spaces, emphasizing their importance for health and recreation. It recommends further research on urban green space dynamics and the use of crowd-sourced geotagged data to enhance urban planning and conservation strategies.

Keywords: Environment, Urbanization, Urban green spaces, Biodiversity, Perceptions, Kampala

4.2 Predicting deforestation trends using deep learning and remote sensing: A Case study of Mabira Forest

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Abstract

Deforestation and land cover change pose significant threats to environmental sustainability, biodiversity, and global climate stability, making accurate prediction and monitoring essential for informed decision-making and policy implementation. This study developed a deep learning-based approach to analyse deforestation trends and land cover transitions using remote-sensed imagery, integrating temporal and spatial data from satellite sources such as Sentinel-2 and Landsat to capture complex patterns of environmental change. Key features, including spectral indices like NDVI and EVI, were extracted to enhance the detection of vegetation loss, while advanced convolutional neural networks (CNNs) and recurrent neural networks (RNNs) model spatial and temporal dynamics. Semantic segmentation models, such as U-Net and DeepLabv3+, classified deforested regions at a pixel level, enabling precise mapping and quantification of land cover changes, while temporal models predicted the progression of deforestation based on historical trends and climatic data. The results demonstrate high accuracy, with the segmentation models achieving an Intersection over Union (IoU) score of 89% and temporal predictions aligning closely with observed data, showing an RMSE of 5% in forecasting deforestation rates. Additionally, deforestation maps generated for a Mabira Forest region revealed a 12% increase in deforested areas over a three-year period. These findings provide an efficient framework for large-scale environmental monitoring, offering valuable insights for conservation efforts, land use planning, and mitigation of deforestation impacts. This approach underscores the potential of integrating remote sensing and deep learning to advance environmental management and achieve sustainability goals. To enhance conservation efforts, it is recommended that the findings be integrated into policy, early warning systems be developed, community engagement be strengthened, data fusion with high-resolution imagery be improved, and climate models be incorporated.

Keywords: Conservation, Deforestation, Deep learning, Remote sensing

4.3 Optimizing water treatment through dissolved air flotation technology: A Case study of Katosi Drinking Water Treatment Plant.

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Abstract

National Water and Sewerage Corporation (NWSC) uses conventional water treatment where traditional sedimentation relies on heavy flocs for settling thus becoming more costly and taking longer to achieve the required quality. NWSC introduced Dissolved Air Flotation (DAF) technology at Katosi to address cost, demand and quality. DAF uses light flocs that easily attach to gas bubbles, allowing for more efficient flotation and water clarity. Since floatation didn't require heavy flocs, there was perception that it could provide an opportunity to reduce the required dose and lower chemical costs for water treatment. With the overall objective of optimizing chemical usage and reduce water treatment costs, this hypothesis was put to test. To achieve this, the optimal Alum dose was determined through jar test experiments and applied to the plant. The dose was then gradually reduced in steps of 1 mg/L below the initial and subsequent preceding dose, with continuous monitoring and comparisons to potable water specifications. This process was repeated until further reductions could not be made without compromising water quality. As a result, the optimum jar test Alum dose was reduced by up to 50%, leading to significant operational cost savings of over 400 million shillings annually. The findings highlight the potential for reducing chemical usage without compromising water quality or treatment effectiveness. This case demonstrates the importance of experimental optimization, continuous monitoring, and adjustment to improve water treatment processes and achieve cost-effective operations. The technology serves as a model for other water treatment plants looking to optimize chemical usage and reduce costs while maintaining high water quality standards.

Key words: Optimizing water treatment, DAF, Process stability

4.4 Addressing youth unemployment through WASH business: Insights from the SWaSSH4A Project in Lango Sub region Uganda

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Abstract

Youth unemployment rates in Uganda are high, at 18.7% and 14.7% among female and male youths respectively. To avert this situation, SWASSH4A project, funded by Austrian Development Agency (ADA), and implemented by SNV, is engaging youths in WASH businesses. The project mapped 15 youth groups of 10 -15 members each in the project area who underwent intensive WASH capacity building trainings for at least 10 days. Youths trained as hand pump mechanics, masons, WASH products distributors, among other skills. During the trainings, marketing and financial management, and practical skills, were taught in borehole rehabilitations and repairs, making of sanitation products and services like liquid soap, sanitation platforms, slabs, Sato-pans, simple sand washing facilities like tippy taps, latrine construction and more. Each youth group trained under the project earned up to UGX 840,000 from June to December 2024. The groups contributed directly to construction of 274 improved sanitation facilities, and installation of 197 tippy taps; translating to access to basic sanitation for 1,644 people, and 1,182 people practicing hand washing with soap. A midline survey showed 10.5% increase in access to basic sanitation and 1.9% increase in hand washing with soap compared to the baseline. Over 150 water points were repaired by trained youths. Whilst reducing on downtime and increasing on water source functionality, youths collectively earned up to UGX 13,500,000 for their work. The skilling initiative has further empowered youths to earn through private sector linkages by selling products like Sato-pans and borehole spare parts. One group even opened up a metal fabrication workshop. Involving youths is paramount in driving the national and international strategy of achieving universal basic sanitation and hygiene access by 2030. The addition of a skilling component not only accelerates achievement of SDG 6, but also SDG 1 and 8.

Keywords: Youth unemployment, WASH businesses, Borehole rehabilitation, Sanitation products

4.5 Vandalism of water monitoring stations: causes, impacts and mitigation within the Albert Water Management Zone

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Abstract

Water resources are monitored across the country by an established network to monitor anthropogenic and geogenic factors influencing the quantity and quality of the water. Vandalism of monitoring stations hampers water resource management, leading to detrimental environmental, social and economic effects. Vandalism has led to data gaps ultimately impacting the development of models for flood forecasting and warning, water supply and drought management, and increasing costs for rehabilitation and maintenance of the stations. In the Albert Water Management Zone, 5 out of 45 of surface and 3 out of 19 ground water monitoring stations have been vandalized in a period of three years. Protecting these stations is essential to support planning for water utilization. Therefore, the study investigated the causes, impacts, and potential solutions to this issue. Data from four vandalized monitoring stations (Kafu-Hoima Road, Muzizi, Hoima and Nyabyayi) that were randomly selected was collected using mixed approaches of field observations, focused group discussion (4) and key informant interviews (20). Results show that major causes of vandalism include selling steel components to scrap dealers (40%), inquisitive community members (24%) limited community engagements (19%), and inadequate security measures to protect the stations (17%). Installing monitoring stations in secure locations, cameras and surveillance, alarm systems, enhanced community ownership and participation through sensitization, regular maintenance and inspection, promoting alternative income generating activities in hotspot areas and adopting innovative technologies are recommended in Addressing vandalism and ensuring that monitoring stations re Vandalism main intact.

Keywords: Water resources, Water Monitoring, Maintenance, Inspection

4.6 The Role of Entrepreneurs in Achieving SDG6 and Creating Green Jobs for Youths

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Abstract

The WASH Impact Accelerator Program (WAIP) empowers young entrepreneurs to launch social businesses tackling Water, Sanitation, and Hygiene (WASH) issues in their communities. Implemented by Turi Kumwe Development Foundation since 2020, WAIP's comprehensive program model involves organizing hackathons, business training, seed funding (up to €5,000), intensive coaching, and ecosystem development. Using a mixed methods approach and a sample size of 20 youth-led start-ups across four districts, WAIP has achieved significant results, impacting 50,000 people, with 2,500 direct beneficiaries per enterprise. Notably, 60% of the young entrepreneurs are actively implementing WASH projects, while 40% are working in related fields. WAIP's innovative approach has the potential for replication, making it a promising solution for achieving SDG 6 and promoting green jobs, reducing youth unemployment, and mainstreaming gender equality.

Keywords: Entrepreneurship, Innovation, WASH, Green jobs, Youth start-ups, SDG 6

4.7   Assessing Heavy metal concentration in Kiteezi landfill and the receiving environment, Wakiso district

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Abstract

Poor waste management in landfills pose environmental pollution and societal health impacts. This research focused on the analysis of selected heavy metals, namely chromium (Cr), lead (Pb), Arsenic (As), copper (Cu), and zinc (Zn) to assess their concentrations at different sampling sites in and around Kiteezi landfill used to dispose municipal solid wastes (MSW) from Kampala City. The study also analyzed the physicochemical parameters of pH, Electric Conductivity (EC), Oxidation-Reduction Potential (ORP), and temperature that affect the distribution of heavy metals both in dry and wet season. To analyze the heavy metals, Inductively Coupled Plasma-Mass Spectrometer (ICP-MS) was used. All physico-chemical parameters were analyzed *in situ*. The results showed that highest concentrations of heavy metals were found to be at the tyre burning site on landfill in dry season following the order of Cu (6741mg/Kg) > Zn > Pb >Cr >As (2.19mg/Kg). The concentrations decreased in wet season, and this could be due to leaching of the metals into the surrounding environment. The statistical analysis showed that there was a significant (p = 0.017, 0.025, 0.023 $for\ pH, EC\ and\ ORP$) difference with in the physicochemical parameter values between the two seasons (wet and dry), except temperature (p > 0.179). It was clearly shown that copper, lead and zinc pose potential ecological risk alarm that human beings and the environment are threatened by these metals. Heavy metal concentration in the landfill and the receiving environment varies with seasonality, with the dry season having concentrations above the permissible limits. It is recommended that continued monitoring of the landfill is implemented and the general management of the landfill is improved.

Keywords: Heavy metals, Mobility, Bioaccumulation, Municipal solid waste, Landfill

4.8 Purification of local salt for on-site chlorine disinfectant generation in Bombo Area.

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Abstract

Optimizing water treatment chemicals without compromising on water quality during water treatment is among Uganda's National water and sewerage corporation (NWSC) strategic direction. Water is disinfected with chlorine gas, Calcium Hypochlorite Powder or sodium chloride/ Salt through electrolysis. However, salt electrolysis requires high purity sodium chloride imported from china or India causing increased disinfection costs. In a bid to reduce on disinfection costs, local salt from lake Katwe was purified to a quality that can be used in salt electrolysis by; (i) characterising both imported and local salt using standards methods as described in APHA -4500-H+B, APHA-3111A, HACH 8051A and APHA-252OB for PH, Calcium, Magnesium, Sulphates and Salinity respectively. (ii) Local salt purification using a bio sand filter and testing the filtrate for the above parameters using similar methods. (iii) On site electrolyze chlorine production using both purified local salt and imported salt and disinfecting water with the generated chlorine. (iv) Monitoring of water quality and electrolyser performance (v) Cost Benefit Analysis of disinfecting water using imported salt and local salt. The findings were, imported salt complied with the NWSC specifications unlike local salt (moisture content (8.28 / ≤ 3.00) %, insoluble matter (0.78/ ≤ 0.15) % and pH (10.1/9.5) Units. Local salt complied with specifications upon purification. Ratio (1:3) of salt to water had the best salinity. Both imported and local salt brines registered % strength of over 99. The generated chlorine from both the purified and imported salt treated water with complying free chlorine (0.2-0.5) mg/l and (0 CFU/100ml) faecal coliform counts. Local salt was cheaper UGX (400)/kg than imported salt UGX (1980/kg). Disinfecting with purified local salt saved 1,247328 million within 18 months. In a nutshell, disinfection of raw water using purified local salt rendered the water suit for human consumption.

Keywords: Water treatment, Chlorine disinfectant, Local salt purification,

4.9 Health Profession Students and Open defecation free environment: Case study in Kabale District

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Abstract

Uganda's Community Led Total Sanitation (CLTS) strategy is based on the use of Health Extension Workers (HEWs) for its implementation at community level. However, other options of players to improve and accelerate the scaling up the CLTS intervention have not been explored. This study evaluated the effect of a Student-led CLTS interventions on Open defecation and open defecation free status outcomes. The study was conducted in two sub counties in Kabale district in south western Uganda. We used a pre-post with nonequivalent control group quasi-experimental study design to measure the effect of student led CLTS intervention on' the levels of household Open defecation (OD) and Open Defecation Free (HODF) status. A total of six parishes from two study subcounties with no main towns and having low latrine coverage according to the subcounties and district reports were selected. Fifty villages were randomly selected and assigned to the two study groups. Each study subcounty was assigned 25 villages, which received either the student CLTS intervention or the conventional CLTS. 492 respondents drown from different households participated in before and after CLTS intervention surveys. The results showed that the households in intervention group had more odds of not practicing open defecation (3.73; 95% CI: 1.01 - 13.77) compared to the households in the control. Similarly, in the intervention group, households had more odds of attaining the open defecation free status (13.20; 95% CI: 3.26- 53.55) compared to the control group. The student-led CLTS reduced open defecation from 24.7% to 14.0%. This study shows that other resource persons such as health profession students are valuable resource that can fill in the gap on sanitation promotion activities.

Keywords: Open defecation, Status ODF, Health extension works, Health profession students, Community-led total sanitation

4.10 The role of Legal innovations in reducing non-revenue water and enhancing environmental literacy in Uganda

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Abstract

A conservative estimate of the total annual cost of non- revenue water to water utilities worldwide is US$14 billion. In some low-income countries, this loss represents 50-60% of water supplied with a global average estimated at 35%. Saving just half of this amount would supply water to an additional 100 million people without further investment. Therefore, in order to enhance the livelihoods of Ugandans through access to clean water, the legal fraternity plays a critical role by reducing non- revenue water through fighting illegal water use and breaking down barriers through legal education. The data was gathered from the Utility Court and the NWSC Legal Department through one-on-one interviews and focus group discussions. Before the establishment of the utility court, on average criminal water cases used to take 3 to 5 years to complete, however, since the establishment of the court, they take 3 to 12 months. This has reduced case backlog and led to increased access to justice. Additionally, the non- revenue water reduced from 33.7 % in 2013 to 29% in 2019 after the inception of the utility court. The NWSC Legal Aid Clinics have led to increase legal knowledge of over 1000 KW staff. Additionally, over 500 customers have been reconnected to NWSC water supply thus reducing cases of illegal reconnection. NWSC has been able to collect over 1 billion shillings from this initiative. In conclusion, more funding should be provided to support the utility court and roll out of legal aid clinics across the country.

Keywords: Legal Aid clinics, Environmental literacy, Non-revenue water, Illegal water use, Utility court

4.11 Impact of artificial intelligence and big data in enhancing water literacy and climate awareness among young change-makers in Lagos, Nigeria

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Abstract

Lagos state is a web of environmental hazards owing to several environmental odds, including water scarcity, and the impacts of climate change. As these issues continue to occur, it is increasingly important to equip the younger generation with the necessary skills and knowledge to combat these odds. Water literacy and climate awareness are essential for encouraging sustainable development, especially in a fast-growing urban regions such as Lagos, Nigeria. This review investigates how Artificial Intelligence (AI) and Big Data can strengthen youth engagement in water, and climate-related challenges by providing real-time understanding, predictive analytics, and interactive learning platforms.AI-driven technologies, including machine learning, artificial neural network, remote sensing, and Internet of Things (IoT)-enabled smart water systems, improve the understanding of hydrological patterns and climate variability. The methodology used for the study involved desktop study from literatures for 10 years relevant to AI-driven water literacy programs and climate education initiatives, identifying both opportunities and challenges in integrating digital technologies into environmental education. The results showed that AI and big data play a crucial role in improving water literacy and climate awareness among young change-makers in Lagos. The rise in awareness from 32% to 78% and increased engagement with AI-powered tools indicate that digital platforms make climate information more accessible and impactful. A 40% boost in climate-related social media discussions and a 30% rise in youth advocacy participation highlight AI's ability to drive behavioral change. In conclusion, challenges such as limited access, data literacy gaps, and high costs remain barriers to broad adoption. Expanding affordable AI tools, enhancing digital literacy, and integrating AI-driven climate education into formal learning systems are essential to maximizing their long-term benefits for water literacy awareness and sustainability.

Keywords: Artificial Intelligence, Big data, Water literacy, Climate awareness, Youth engagement, Lagos, Sustainability

4.12 Walking as a science for raising awareness and action for conservation of water and environment resources

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Abstract

Awareness creation campaigns are popular policy instruments attempting to shape public attitudes, values or behavior in the hope of reaching some desirable outcome. Walking presents one of the methods of stakeholder involvement in which participants, usually local communities, are guided through a walk with experts explaining their challenges and collecting views from the participants. With increasing global water crises and environmental degradation, communities are interested in shaping their surroundings through water and environment resources conservation. Since 2018, the Ministry of Water and Environment through the Water Resources Institute collaborated with the Walkers Association of Uganda to undertake long route walks, engaging local communities and collecting their views relating to the conservation of the water and environment resources of Uganda. Communities and the public have shown enthusiasm and a positive attitude to engage with the walkers. There has been an increasing trend in the number of partners supporting the walk. In 2019, there were 12 partners compared to twenty-one (21) and twenty-two (22) partners in 2022 and 2024 respectively. Media houses including NBS, UBC, New Vision, Bukedde, T.V West, have expressed interest to support the walkers. Advocacy efforts have resulted into restoration of River Rwiizi and River Nyamwamba by Ministry of Water and Environment, CARE, WWF and Uganda Breweries Limited, the degraded hill at ST. Padre Pio, the greening of the Kingfisher oil development area. Walking has demonstrated to be an effective way of identifying community environmental challenges, advocating for solutions, and attracting localized financing for the climate actions. The Ministry of Water and Environment should therefore popularize walking, making it a routine tool for public participation in the water and environment resources conservation programs. Just like the roads and health sectors, other sectors should also adopt this tool not only for awareness creation purposes but also for improved health purposes.

Key words: Stakeholder involvement, Restoration, Walkers Association

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