UGANDA WATER AND ENVIRONMENT WEEK-2020 (UWEWK-2020)

UGANDA W&E WEEK 3rd

Online Water Week: 13th-18th September, 2020

Hosted by Water Resources Institute

Book of Abstracts

Abstracts for Applied Research in Water and Environment: Policy, Practice and Science

Forward

This UWEWK 2020 Book of Abstracts presents a summary of Applied Research works that have been carried to address the theme: ***"Water and Environment Resources for Inclusive-Growth, Employment and Wealth Creation.*** Papers have been presented under three sub-themes address of the water week. The themes are: Theme 1: Water and Environment Security for Inclusive-growth; Theme 2: Water and Environment for Employment and Wealth Creation; Theme 3: Climate change and achievement of NDP III goals. Abstracts may be drawn from research papers, case studies, topical reports, photos, videos and posters. A spectrum of topics has been covered, producing results in form of policy, practice and scientific papers. This volume for UWEWK 2020 abstracts, hopefully will inform decisions related to water and environment.

Contents

1. Overview of the Online UWEWK 2020

The online UWEWK 2020 event is a national annual event for providing a neutral platform and facilitate interface among key stakeholders within and outside the mainstream sector including the private sector, academic institutions, religious and cultural institutions, retired professionals, civil society. The online water-week event is intended to facilitate deliberating and exchange of ideas that will enhance sustainable development of water and environment sector. Participants will be exposed to key issues pertinent to the water and environment sector, vital questions on key issues affecting the sector will be addressed; as well, innovative solutions for Uganda's sustainable development challenges will be profiled.

Online UWEWK events Outlook

The online sessions were linked to the overall theme and sub-themes of the Uganda Water Environment Week 2020 which was about demonstrating ***"the centrality of water and environment resources in Sustainable Industrialization for Inclusive-growth, Employment and Wealth Creation."*** Evidence from research, practice and anecdotal experiences were used to discuss present possible alternative solutions to the current water and environment resources challenges. The dialogues and parallel sessions were moderated by seasoned professionals with extensive experience and knowledge in managing divergent discussions and creation of consensus.

Key Speakers for online UWEWK-2020 Events

Various key note speakers and panelists participated under the following thematic areas

- National Economic policy
- Water and Environment
- Investment
- Academia
- Political Economy
- Media and information management

General Presentations for Online UWEWK-2020 events

Parallel sessions, short courses and the side events were organized collaboratively with relevant stakeholders and partners working in those specific areas.

The online sessions were organised as follows:

- Each dialogue session had a coordinator, note taker, moderator, key note speaker and 5 expert panellists
- Each dialogue was preceded by a key note address delivered by an identified expert on the major theme and each of the sub-themes.
- General remarks were provided by the moderator to introduce the dialogue and panellists
- The moderator introduced and presented key questions to the panellists
- Each panelist took a turn to provide their views on the general topic about (3-5 minutes)
- The moderator opened discussion to the plenary, and panellists responded to plenary questions
- Conclusions and way forward were drawn on discussion themes
- Each short course had 1 or 2 facilitators, chair and rapporteur to guide the training

2. Compendium of abstracts for Applied Research, UWEWK-2020

Applied Research in water and environment provides standardised and open information from various districts across Uganda. Applied Research information is intended to be used by different communities of practice related to water and environment sectors including; development practitioners, scientists, and policy makers to understand and apply research-based products to attain sustainable development of the sector.

Abstracts for UWEWK-2020 comprise about 100 titles to applied research done by practitioners in water and environment sector within Uganda. These practitioners form the community of practice for applied research outputs under three thematic areas for UWEWK-2020 book of abstract publication:
Theme 1: Water and Environment Security for Inclusive growth;
Theme 2: Water and Environment for Employment and Wealth Creation;
Theme 3: Climate Change and achievement of NDP III goals.

Theme 1: Water and Environment Security for Inclusive growth

1.1. Reliability of Rural Water: A Fundamental for Inclusive Growth

Elibabeth Buhungiro

Poor maintenance of safe water infrastructure in rural Uganda is an impediment to economic growth. This issue is distinct from the problem that only 69% of the rural population have access to improved water technology. The failure of maintenance means that the 69% with infrastructure still do not enjoy access levels sufficient for health and productivity. Many studies have shown that rural water service delivery in Uganda is inadequate despite continuing investment in infrastructure. In 2011 the Ministry of Water and Environment (MWE) published a study finding that 47% of recently installed improved sources were either broken, abandoned or inadequately functional. In 2019, a 4-year study in several countries by an international consortium of universities and aid agencies (including Makerere, WaterAid Uganda, ODI, and several universities) found that in ten districts of Uganda, 76% of the 200 randomly-sampled hand-pumps were insufficient in reliability and yield. A Uganda pioneer rural water utility, Whave Solutions, found in similar results: for example, a 2019 survey of 300 hand-pumps in Mityana district showing that 73% were non-functional or inadequately functional. Although there is a government policy on maintenance of water sources, studies show that it is not working in practice. Most rural water users currently do not interact with an entity they trust, which has the necessary professional qualifications for management of technical services and accountability to its customers. In other words, rural water users do not yet interact with entities like NWSC. Consequently, they are unwilling to pay maintenance fees. As a result, preventive maintenance is not being done, and repairs are not being done quickly. The result is infrastructure failure. The money invested in new infrastructure is wasted if the infrastructure fails to work some months after it is installed. Poor health is one result. The Ugandan Ministry of Health issued a statement that 75% of the country's disease burden was linked to poor water supply and poor hygiene. Another result is slow agricultural and industrial growth, particularly impeding potential new agro-processing industries and agro-exports. Taking the maintenance problem into account, more than half Uganda's population is unserved with reliable safe water, despite money invested in infrastructure. This presentation provides a solution, developed collaboratively with rural communities in 4 districts and with local and central government. The solution is a structure for Functionality Assurance, including a detailed cost study and a sustainability strategy by which maintenance become self-financing within the next 5 years.

1.2. Citizens' perceptions on water, sanitation and hygiene service delivery impact on associated businesses and the water and environmental management for inclusive growth

Andrew Tebandeke

Citizens' perceptions about the quality of water, sanitation and Hygiene (WASH) service delivery by various service providers and duty bearers greatly affects businesses related to WASH and certainly impact on environment management. Generating these perceptions and using them for planning and as a means for feedback to duty bearers and service providers, greatly improves the quality of operation of WASH related businesses such as prepaid meter system taps; managed by focal people in various communities, garbage collection businesses and drainage of waste channels. Citizen's perceptions highlighted in several consumer perceptions studies and often packaged and summarized as score cards. This paper presents key findings from a meta-analysis of several citizen report cards conducted within several slum areas of Kampala district (i.e. Central, Makindye, Kawempe and Nakawa divisions) by Environmental Alert and Partners. A desk review following a critical issue analysis and synthesis was used to identify key perceptions that have a bearing on the delivery of water and environmental management interventions. Based on this, policy and practice recommendations are suggested targeted at improved service delivery for effective and efficient management of WASH based businesses and associated water and environment resources.

1.3. Improving Dam Surveillance and monitoring in countries with non-existent legal and regulatory dam safety frameworks – A Case of Isimba Hydropower Plant (Uganda)

G. Rwakafunjo

According to world statistics; the highest percentage of dam failures happen at impounding and then in the first 5years of operation hence a critical phase for the less developed countries. These countries are currently or in the near future will be dealing with the newly constructed dam risks. Given the non- existence on the Dam Safety Legal and Regulatory Framework in a country like Uganda, a dam owner may be reluctant to undertake dam surveillance. But this exposes the downstream communities to potential risks of loss of life, property and serious damage to the environment if a dam fails. The failure of the dam also comes with loss of the asset and revenue for the dam owner. This paper thus discusses how improved dam surveillance does not only help protect the potentially affected communities but also benefits the dam owner. It also discusses how dam owners in countries with no regulatory framework can establish and implement an improved dam surveillance. Just like Isimba Hydro Power Plant in Uganda, which was commissioned in March 2019 and is currently under Defects Liability Period. The paper discusses ways of customizing dam surveillance based on benchmarked international best practices with reference to international guidelines and use of a strategy-based approach dam Safety review toolkit.

Keywords: Dam Surveillance, Dam Safety, legal and regulatory frameworks, Isimba HPP, Uganda.

1.4. Water Source protection measures sustain water availability in Valley tanks: A Case Study of Lokok Catchment, Karamoja region

Kajimu Athamah

Catchment degradation is the loss of value over time, including the productive potential of land and water, accompanied by marked changes in the hydrological behavior of a river system resulting in inferior quality, quantity and timing of water flow. The degradation Lokok Catchment is strongly linked with destruction of vegetation cover which is caused by deforestation, wildfire or bush burning, expansion of agricultural lands, encroachment of agriculture into wetland and unsustainable land use. It can also be noted that as the population figures increase, extraction for firewood and charcoal burning increases all this culminates into catchment degradation. Lokok Catchment is characterized by reasonably but highly uncertain rainfall, with long dry spells and intense rainfall events that lead to highly eroded areas. These eroded areas show high rainfall-runoff ratios (i.e. of up to 25%). This, therefore, leads to siltation of the valley tanks which lead to poor water quality and reduction in the storage of the reservoir. The focus of study was to protect the water source and degraded areas in the Lokok Catchment to improve water availability and quality. To achieve this, restoration of degraded areas, stakeholder engagement, demarcation of buffer zones, provision of alternative livelihoods among others was undertaken thereby protecting, improving and rehabilitating valley tanks and upland watersheds thus leading to increased storage of the valley tanks with good quality water.

1.5. Ecosystem depletion attributes and cubing it in Maziba catchment

Tusiime Gilbert

Many ecosystems in the Maziba catchment including riverbanks are under increasing threat of degradation or modification in the face of population increase for livelihoods by communities. This is affecting the regulatory services of these ecosystems. Rivers and streams are heavily silted due to high erosion processes. This is highly attributed to poor land practices in the upstream like cultivation on river banks. Silt load increases after a rain downpour at any section of river. The rivers and streams are also polluted by the surrounding urban areas, direct disposal of waste by surrounding communities, poor sanitation and siting of latrines, poor farming methods and use of agrochemicals, all with potential to adversely affect water quality. This has been attributed to ignorance of users, lack of protection of water sources, lawlessness, failure to harvest water from roof-tops leading to increased run-off, cultivating very close to the water channel, bush-burning, bathing and watering of animals in the stream; destruction of terraces, indiscriminate human activities like brick making and logging; ignorance about the effects of indiscriminate dumping of wastes in water sources and bursting of sewer lines. All these have caused a reduction in access to quality water for domestic, industrial, hydropower and other uses. The high silt loads have affected the newly constructed Muvumba Hydro power dam which is operating below its maximum capacity and the high yield causing a lot of wear and tear. EURECCCA project is building capacities of extensions services and institutions by setting up demonstration centers to facilitate experience sharing activities on control of floods and landslides across agricultural landscapes. The project will promote the technologies in Maziba catchment such as ; Terraces, Contour bunds, Trenches, Grass bunds, Rehabilitation of degraded watersheds, Conservation agriculture, Agronomic practices, Small scale irrigation, water harvesting, Agroforestry and Woodlots.

1.6. Effect of Livestock Production Systems On Physio-Chemical Properties of Water in Mpigi District

Reuben Kawagga

The livestock sector is one of the fastest growing in Uganda's agricultural economy driven by the increased demand in animal products and thus putting pressure on the environment. The effect of livestock production systems on physical and chemical properties of water was assessed in four sub-counties of Mpigi district lying along the shores of Lake Victoria. Structured questionnaire interviews, focus group discussions and personal observations and secondary data from the district veterinary office were used to identify production systems and analyze trends in livestock species and numbers. Water samples were collected from piped water (control) and open water sources accessed by animals on either communal grazing, tethering or stall grazing systems. They were analyzed for heavy metal contents as well as physical and chemical properties. Data on physical and chemical properties were analyzed using the General Linear Model procedure of SAS. Livestock species kept were cattle, sheep, goats, pigs and indigenous chicken. The major livestock rearing systems used were; tethering (52%), stall feeding (26%), communal grazing (17%), fenced grazing (4%) and semi-intensive grazing (1%). The major livestock related factors affecting water quality were increasing numbers, direct access to water sources and poor waste management. Although water pH, temperature, electrical conductivity, total dissolved solids, turbidity and nitrate varied among water sources, they were below the APHA acceptable limits. However the contents (mg/l) of phosphorus (3.9), copper (0.04) and iron (2.47) were above the critical levels of 0.1, 0.03 and 0.3 respectively for the open water sources. This may have a direct effect on human and livestock health and pollution of Lake Victoria. There is need for improved waste management to reduce the runoffs that may affect water quality and the practice of directly watering animals at communal water sources should be discouraged.

1.7 The Climate Change Discourse: Where is the Media?

Rebecca Nabatanzi

A number of stakeholders have the ability to authoritatively engage in the climate change discourse but perhaps not the media in Uganda. There is poor media coverage of climate change issues with journalists frequently unable to communicate highly complex and often scientific topics in compelling and understandable ways to the general public. Climate change is often seen as a "Western" and highly complex problem far removed from the day-to-day lives of Ugandans, leaving communities unaware and vulnerable to the devastating effects of climate change that are already impacting their lives. Without knowledge of possible ways to counter activities that are increasing climate change, such as pursuing agroforestry or knowledge of solutions to mitigate the effects of climate change and disasters, such as low-cost irrigation systems, communities are left without the power to take climate action. The bigger challenge therefore is the lack of satisfactory communication about the causes, solutions and adverse effects of climate change and disasters mainly due to a lack of interest and training of journalists in the subject. To address this challenge, Office of the Prime Minister and Ministry of Water and Environment in partnership with Media Challenge Initiative embarked on training of over 500 journalism and mass communication students from 12 universities and institutions of higher learning. The objectives were: to increase informed, relatable and compelling communication about climate change and disaster risk reduction in Uganda and to equip young journalists and mainstream journalists with skills and knowledge to practice journalism that drives social change in the climate change sector. The trainings were climaxed with a 3-day climate change and disaster risk Reporting Challenge. This paper therefore seeks to highlight the lessons learned throughout the process, the challenges that exist and recommendations thereof.

1.8. Water and Environmental perspectives for refugee settlement: the case of Nyumanzi camp, Uganda

Gladys Acaya

Settlement of refugees in an area may pose an environmental risk to the host community in forms of deforestation, depletion of firewood, degradation of land, extraction of groundwater in an unsustainable manner, and pollution to water sources. The detrimental effect on the environment contributes to the poor quality of life for both refugees and the local population in hosting communities. Human waste disposal from refugees into water bodies' also may cause the spread of diseases, like cholera and other related diseases. The study objective was to examine the living condition of refugees. Methods. The area of study was in a refugee settlement in Nyumazi settlement, Adjumin district. The sample consisted of refugees in Northern Uganda. Data were collected using face-to-face interviews. The statistical method used was SPSS. The method used was a multiple regression analysis to analyze the data. Finding: Natural resources have been harvested, and all households are having to walk increasingly long distances to collect firewood. Loss of trees cut over the steep hilly terrain may also cause severe-increased soil erosion rates and could lead to a slight reduction in the availability of the game. There is increased prices of many basic commodities, with the prices of most products tripling and quadrupling in the period following the influx. However, although the prices of many commodities raise sharply, others fall equally dramatically (notably maize, cooking oil and other "refugee" goods), and it is not clear whether, overall, the refugee presence and the associated relief operation has improved or worsened the local food security situation.

1.9. Integrating Water Sanitation and Hygiene in school development plans; Experiences, lessons and recommendations based on the five schools in Kampala.

C. Kizito

This paper highlights the experience, lessons and recommendations for improving Water Sanitation and Hygiene (WASH) in schools through a systematic planning and budgeting of the WASH components into the overall school development plan. This when done and implemented would contribute towards attainment of the National schools WASH standards benchmarked using the three star Approach. This initiative and support was rendered to the five schools plans namely: Mirembe primary school and Kansanga seed secondary school in Makindye division, Railway children primary school in central, Nateete Muslim high school in Rubaga and Uganda school for the deaf in Nakawa division under the Sustainability WASH project funded by Water Aid Uganda and implemented by Environmental Alert in collaboration with the Kampala Capital City Authority. Environmental Alert conducted a survey through which school Water Sanitation and Hygiene was assessed. This survey generated various issues as baseline for the respective schools in respect to WASH. Some of these are associated to poor planning for WASH components (i.e. analyses, planning, budgeting, monitoring and evaluation) in the school plans. Through participatory approaches the 5 schools were facilitated in the development of a, 'WASH Improvement Plan.' This involved among others responsive awareness and training targeting School Management Committee and representatives from the school Parent Teacher Associations were trained on for these components. The key results from these engagements beyond enhanced knowledge and skills by the school leadership in respect to integration of WASH in school plans. Besides, key tailored action plans were developed for each school for purposes of operationalization of the plans in each school. With due consideration that the schools have meager resources to finance implementation of these plans, it's important that additional support is mobilized from the relevant Government Ministries & Authorities, Parents, Development partners.

1.10. Integrating Technology-Driven Solutions to Improve the Production and Utilization of Weather Products and Services in Uganda

Georgina Campbell Flatter

1.11. Groundwater resources management for sustainable socio-economic development in Uganda: status, challenges and prospects

Callist Tindimugaya

There is heavy reliance on groundwater in Uganda and indeed in most of Africa for rural and urban water supply due to its wide distribution and general good quality. More than half of the nearly 42 million people in Uganda rely upon groundwater for their daily water supply. Groundwater has also enabled communities in Uganda to adapt to seasonal or perennial shortages in surface water. Groundwater is indispensable when managing water scarcity. Expanding irrigation to enhance food security is a growing necessity because per capita food consumption is largely inadequate. Groundwater is therefore expected to play a very important role in food production, livelihoods improvement, and employment and wealth creation in the face of dwindling surface water resources due to climate change. Groundwater management is also fundamental to effective river basin management. Effective groundwater development and management however face a number of challenges that include hydrogeological diversity and complexity, inadequate scientific knowledge on characteristics of the aquifers, pollution, limited knowledge of the impacts of intensive abstraction on groundwater levels and storage and impact of climate change, and limited human and institutional capacity for groundwater management. A number of strategies have been put place in Uganda and are being implemented to improve groundwater development and management among which are the following: establishment of groundwater monitoring networks, instituting programs for characterization of groundwater resources, establishing regulatory and licensing systems for groundwater and integration of groundwater in catchment management planning and implementation. Prospects for groundwater to support socio-economic development and achievement of National Development Plan 3 targets in Uganda are quite good but a lot still needs to be done to ensure that groundwater resources are sustainably developed and managed.

1.12. Sustainability of water and hygiene in rural healthcare facilities in western Uganda: Preliminary findings from interviews with stakeholders and a scoping review of the literature.

Jenna Davis

Stanford's Program on Water, Health & Development in collaboration with Makerere University is studying how and why healthcare facilities (HCFs) struggle to sustain water, sanitation and hygiene (WASH) services in rural Uganda. Although WASH is crucial for delivering safe and effective healthcare, according to WHO, an alarming number of HCFs around the world lack improved water sources (38%), improved sanitation (19%), and water and soap for handwashing (35%). Scarcity of basic WASH services affects low-income countries disproportionally. Covering four districts (Mbarara, Kamwenge, Rwampara, and Kitagwenda) in western Uganda, we conducted 117 stakeholder interviews, semi-structured observations in nine rural HCFs, and a scoping review of the literature. Team members used Dedoose to code interviews, and a content analysis approach was used to identify findings. Preliminary results are presented using a framework of resources, information, and accountability. Resource constraints identified by respondents and in the reviewed literature included unavailability of water, funds, and inadequate infrastructure. Information gaps led to discrepancies in expectations of healthcare staff, government officials, and community members. Accountability systems for ensuring maintenance of resources, adherence to guidelines, and management of funds in relation to water and hygiene were overall noted to be lacking or inadequate. Based on the final analysis findings, we will generate key recommendations and design a pilot intervention to tackle the systemic barriers we identify – rather than simply providing new infrastructure – to improve sustainable access to water and hygiene services in HCFs in Uganda, and as a potential model for other locations.

1.13 Justification for monitoring of groundwater levels in town water supplies in Uganda- a case of Albert Nile Catchment

Johnson Pule

The sustainability of intensive groundwater pumping for town water supplies in Uganda is unclear. Detailed monitoring of groundwater levels in high-yielding wells supplying the towns of Wobulenzi and Rukungiri reveals interesting and very useful differences. In Rukungiri, ground water levels have fallen steadily (approx. 3m per year) since pumping commenced. In contrast, the decline in groundwater levels in Wobulenzi is less than 10% that observed in Rukungiri under a similar pumping regime over the same period. Further investigations show that the wells in Wobulenzi draw groundwater from a much wider area than those in Rukungiri where groundwater is tightly constrained by local geology. This vital knowledge not only permits pro-active, long-term planning to prevent water shortages in towns before they occur but also informs strategies for the development and management of groundwater-fed town water supplies in similar geological and hydrological conditions in Uganda. The inter-arch basins of Uganda are characterized by low relief, a thick weathered regolith, dominance of infiltration over surface runoff, broad valleys with concave slopes, and regionally extensive aquifers in the weathered overburden where as the intra-arch basins are characterized by high and undulating relief, a thin weathered mantle, dominance of surface runoff over infiltration, narrow and highly incised valleys and channels with convex slopes and localized aquifers. Abstraction in such aquifers becomes unsustainable due to continued abstraction and when the extent of the aquifers reduces due to erosion. Albert Nile catchment lies in the intra-arch basin and so most of the towns served under Water and Sanitation Development Facility-North (WSDF-N). This paper provides a justification for a detailed monitoring and assessment of the well fields supplying these towns.

1.14. Integrated Environmental Management Principles and Application: Case of NWSC

Innocent Twesigye

An exponential growth of the world's population and industrial capital leads to Environmental problems such as lack of resources and pollution. In the past, the need for water source protection in Uganda has often been neglected in the development and management of water sources. Consequently, many drinking water sources have become contaminated or dried up. Establishment of adequate water source protection has recently been recognized as the most sustainable and cost- effective way to protect drinking water sources in both developed and developing countries. Planning and implementation of water source protection requires a legal frame work and engagement of different stakeholders. As a key strategy for achieving middle income status as well as the clean water and sanitation global agenda, NWSC has undertaken a multitude of source protection/ micro-catchment restoration initiatives to control pollution of the natural environment. These interventions have been implemented in partnership with Ministry of Water and Environment, civil society, community based organizations and youth. Micro-catchment restoration activities have been undertaken under the towns of Arua and Bushenyi with the aim of improving water quality, reliability of water supply and improving the livelihood of communities within the micro-catchments used by NWSC as raw water sources. Key activities included development of water source protection plans to identify bio logical, chemical, physical pollution threats and securing funding for implementation. During the stage of implementation, the approach used was "community based" method with technical guidance provided from community based organizations in the field of Environment Management to ensure sustainability of water infrastructure investments that rely on these water sources, community sensitization and involving youth groups to actively participate in micro-catchment restoration activities. Project out comes indicated the need for environmental management in order to have sustainable natural resources. For instance, under the Arua micro-catchment restoration project for the River Enyau, positive results involving; i) provision of alternative livelihood options fo r youth groups depending on car washing activities to control pollution of the raw water from River Enyau ii) demarcation of the banks of the river Enyau, iii) afforestation using suitable fruit and tree species, iv) construction of rainwater harvesting tanks and v) construction of stone gabions for stabilisation of the collapsing banks. The Other environmental initiatives that are earmarked for implementation in the future include; i)one million tree campaign for all NWSC areas of operation ii) restoration of four micro-catchments in the towns of Mbale, Arua, Gulu, Adjumani and Bushenyi, and iii) strengthened collaboration with relevant government agencies (NEMA, NFA, DWRM, DEA) to ensure sustainable use of environmental resources. Implementation of environmental policies, frameworks and guidelines is still a big challenge in most African countries. For the case of Uganda, there are many good policies especially for use and management of the natural environment developed by the Ministry of Water and Environment through its different mandated departments, however enforcement is still a big challenge. NWSC is one of the model public utility companies in Africa and its move to embrace environmental protection and management in order to preserve natural resources and prevent environmental pollution is a good example to other utility companies in Africa.

1.15. The role of Watershed Partners in averting impacts of environmental degradation and poor water quality supply at River Mpanga Catchment

Lydia Biira

In Uganda, IRC Uganda in partnership with Caritas Fort Portal- HEWASA, Joint Effort to Save the Environment (JESE) and Uganda Water and Sanitation NGO Network (UWASNET) implement the Watershed Program which aims to deliver improvements in the governance and management of water, sanitation and hygiene services as well as of the water resources on which they draw (and to which they return). Mpanga river originates from Karangura Sub county in the Rwenzori Mountain, flowing through Fort Portal Municipality, continues through Kyenjojo to Kibale forest then to Kamwenge-Karuhura Districts and eventually pours into the River Nile. Mpanga River is an economic good in that it provides for the businesses, factories, hydro power dam, irrigation dam, agriculture and domestic water for Kabarole and three more districts. Notwithstanding it's social- economic importance, the efforts to sustainably use the river have been weak, as it faces major threats of degradation and pollution from upstream in Karangura subcounty, where stone quarrying, sand mining and poor agronomic activities at the riverbanks were the major sources of livelihood and had grossly interfered with its flow, drastic reduction of water levels, and increased river siltation. These practices upstream gradually affected water quality supply downstream, as the river water was visibly muddy, yet it is the very water that National Water would supply to households. This would lead to water shortages because National Water would shut down its plant for some hours to wait for the river water to first clear, because it was very costly for them to filter mud. These challenges led to joint efforts by WaterShed Partners to save Mpanga river as an economic good. Partners included IRC, HEWASA, JESE. Water point mapping was conducted to assess WASH Status and underlying IWRM- WASH issues. Sub county dialogue meetings were conducted to disseminate the findings. Key resolutions were reached upon, which included; mapping out household that were staying and deriving their livelihood from and along the River Banks, identifying all the existing economic activities, training in sustainable agronomic practices and awareness on environmentally friendly species and sensitization on policies for the households that were mapped out and gaining livelihood from the river. Thereafter, a subcounty byelaw was passed for sand miners and stone quarrying to stop. Community and leaders resolved to maintain a 20meter buffer zone. Moreso, with the public dialogues conducted during the 2019 UWEWK pre events in the region, like minded actors such as CSOs, private sector, MWE, Academia, National Water and most recently Tooro Kingdom with the leadership of the His Majesty the King has spearheaded campaigns in efforts to save River Mpanga, guidance of AWMZ on policy.

1.16. Enhancing waterborne toilets to reduce water usage in schools: Experience from Kampala

Byansi Zziwa Jude

Sustainable development goal 6, aims at achieving access to adequate and equitable sanitation and hygiene for all by the year 2030. This can be realized having water and sanitation infrastructure, operating and maintaining them well. Worldwide, about 620 million children lack basic sanitation service at their school and 12% of schools have facilities that are not usable. In Kampala, 07% of the waterborne toilet stances in public schools are not in use due to high cost of water resulting from the high volume of water used during flushing. Waterborne toilets use over 10 liters of water per flush. This study aimed at enhancing the waterborne toilet to reduce water for flushing and the cost for managing waterborne toilets in schools. The normal flush design toilet was modified by removing the squat pan with all its plumbing accessories and replacing them with an open channel that slops at 10% to 15% below the floor slab. The channel runs through all the stances of the toilet block and is connected to the cistern at the upper end. The toilet pan was replaced with a drop hole that directs the faecal sludge into the channel. Faecal sludge in the channel is intermittently flushed with water flowing from the reservoir tank to the septic tank. The resultant toilet was code named 'Channel-flush toilet' by Kampala Capital City Authority. Twelve toilet blocks with 14 stances each, have been constructed in Kampala Public Schools. The channel flush toilet is flushed three times a day using 60 liters per flush for a public school having 1000 pupils. This reduces water usage for toilet flushing from 30 liters to 4 liters per child per day with a sato pan and 0.18 liters per child per day without a sato-pan. A reduction of the cost for flushing of waterborne toilets in schools of 86% was realized. Flies and odor nuisance were controlled by introducing a sato-pan on drop holes and vent pipes respectively. The channel flush toilet should be promoted in institutions such as schools, markets and taxi parks to reduce cost of managing waterborne toilets.

1.17. Gendering the Design, Planning, Implementation and Operation of Sanitation-Hygiene Programs Under RWSSP in Karamoja

Prossy Nambi

This study aimed at investigating the extent of involvement of both men and women in the design, planning, implementation and operation of sanitation programs under the Rural Water Supply and Sanitation Project (RWSSP) in Karamoja guided by the objectives of establishing women and men`s knowledge of their roles and responsibilities in assigned positions and duties under RWSSP, finding out their roles and impact towards sanitation and identifying the challenges that hinder their full participation in sanitation programs under RWSSP. The study employed both quantitative and qualitative methods but qualitatively led. The quantitative method applied survey questionnaires and qualitative applied focus group discussions, observations, document review and key informant interviews. Women in Karamoja participate more in sanitation activities but men dominate in making effective decisions concerning sanitation and hygiene, poor prospects of adequate follow-up and support to sanitation and hygiene committees by Subcounty and District Local Government, poverty limits both men and women from accessing sanitary and hygiene equipment, poor sanitation and hygiene being embraced by cultural taboos and norms, unequal participation at the phase of design, selection and construction of sanitation facilities, negative attitude towards promoting hygiene and sanitation, plight of soil texture and security threats. In Rupa sub-county there is gender imbalance in the design, planning, implementation, operation and maintenance of sanitation programs. Decision making is dominated by men because of the Karamojong cultural settings. Therefore, it is recommended that there should be a need to integrate both men and women in decision making bodies as a way of reducing inequities and improving efficiency and sustainability of sanitation programs.

1.18. Lessons from the WASH Infrastructure - Age analysis in Kabarole District, Rwenzori Region.

Florence Anobe

In August 2019, the WASH asset analysis was conducted by IRC International Water and Sanitation Centre in Kabarole with the technical support of Albert Water Management Zone. The District had experienced a non-functionality of upto 43% of its water systems with a handful yield below standards. The results revealed that only 43% of the water sources tested met the required drinking water (WHO, 2004) standards. Contamination with ecoli was at 64% while total coliforms were 83% of the 128 water sources sampled. In addition to the poor water quality results water service levels were further complicated by high rates of non-functionality due to WASH asset malfunction. Hence both the quality and quantity of Water compromised. A detailed analysis of the WASH asset analysis showed trends that call for immediate action for the repair and maintenance of over 65% water points in Kabarole district. The key parameters assessed were, asset availability and value, age, quality of water, number of households served. Additional qualitative data collected focused on the physical condition, functionality, and level of satisfaction. This analysis will contribute to the body of knowledge and inform district decisions on WASH asset analysis to promote water quality management, operations and maintenance plans for sustained functionality and understanding of client satisfaction, as well as focus on the unserved populations towards attainment of the Sustainable Development Goal Six (SDG6).

1.19. Setting A Foundation for Citywide Inclusive Sanitation, Kampala City

Bernadette Kwebiiha

Globally, access to basic sanitation while 39% have access to safely managed sanitation. In Uganda, the population accessing basic sanitation in rural and urban is 16% and 26% respectively. Kampala city population accessing safely managed sanitation is at 6% and basic sanitation at 14%. Many households in Kampala share one toilet leading to unhygienic conditions, most pit latrines are unlined and unemptiable posing both health and environment risks for the people. The recent Kampala feacal sludge management program attempted to address these problems by leveraging the collection and transportation stage of the value chain to increase access to safely managed sanitation in the city. Despite collection efficiencies getting to 61%, over 42% of the population still access unimproved sanitation. City Wide Inclusive Sanitation (CWIS) programme by Kampala Capital City Authority being implemented is aimed to improve sanitation and the respective financing across the value chain. This is achieved through strategic and catalytic investments that will strengthen the regulatory environment, increase access to improved onsite sanitation services, provide equitable and inclusive sanitation services targeting gender, underserved urban poor households, public institutions and deliver integrated sanitation services such as feacal, municipal solid waste and storm water services. Successful implementation of KCCA's CWIS approach is hinged on the following key pillars; strengthening the enabling environment for citywide sanitation service delivery, development of sanitation infrastructure for both household and public spheres, strengthening the capacities of private sector to deliver sanitations services, innovative social and sanitation marketing, and financing solutions to increase demand for sanitation services especially for the urban poor, mainstreaming gender in service delivery to ensure that services reach all. Challenges that require attention for CWIS successful implementation include; ensuring that sustainable services are accessed by the urban poor, retrofitting the sanitation technologies in the city, mobilizing the required resources for implementation.

1.20. The Water Security Action and Investment Plan for Greater Kampala: Tools and approaches to promote integrated planning for Water Security at the metropolitan scale

Lydia Ngonzi

Kampala City has undergone a period of rapid urbanization during the last twenty years to enable economic growth. Nonetheless, rapid urbanization has posed challenges including degradation of the city's essential natural resources as well as affecting the water security for urban dwellers. This paper assesses the extent and magnitude of water security threats facing greater Kampala. Two multi-stage analysis processes was used. Stage one involved a rapid assessment of threats using the Driver-Pressure-State-Impact-Response (DPSIR) technique to determine key water security threats and define the water security index of Greater Kampala. In stage two five models namely; water quality, wetlands, flooding, public health and economics were generated and analyzed fortwo time periods – current (2019) and future (2040) at catchment and sub-county level. Outputs of model interactions are stored in the Scenario Planning Tool (STP). Water security index for Greater Kampala is 32%. Key water security threats facing greater Kampala are: water source pollution ecosystem loss, flooding, solid waste management, access to clean safe water and sanitation, and governance. Results show that wetland coverage has reduced by 48%. This is expected to drop to 64 square kilometers in 2040, only a third of the 1996 coverage. Reduction is wetland coverage and effects of climate change will affect flood occurrences with flood peakflows rising by 180% on average in 2040. Nearly 2.2 million people will require access to water supply and sanitation services by 2040. Water quality is expected to deteriorate further if urbanization and industrialization continue with limited consideration of environmental standards. By 2040 BOD levels across metropolitan river systems are projected to rise from 17 – 258 mg/l in 2019 to 46 – 630 mg/l in 2040. Inner Murchison Bay will be most impacted with BOD levels rising from 762 mg/l to 6443 mg/l in 2040. These challenges facing Kampala city metropolitan areas presents very difficult regulatory environment in which to make major present improvements in water security. To mitigate water security threats facing greater Kampala, investment in transformative institutions is needed.

1.21. Water Security Threats Facing Greater Kampala: Current and Future Trends and Need for Transformative Institutions

Lydia Ngonzi

Kampala City has undergone a period of rapid urbanization over the last twenty years enabling year-on-year economic growth that has sprawled to neighboring pri-urban areas. Rapid urbanization nevertheless has also posed great challenges and contributed to the degradation of the city's essential natural resource base. Proposed industrial and economic development plans for the city and surrounding metropolitan towns pose additional challenges. To address water security challenges facing Kampala and surrounding metropolitan areas, this paper presents tools and approaches to promote integrated planning for water security at the metropolitan scale. Development of the Water Security Action and Investment Plan (WSAIP) for greater Kampala utilized inclusive and highly participatory mixed methods approach. This included among others the stewardship approach to mobilize and engage stakeholders; the Driver-Pressure-State-Impact-Response (DPSIR) technique to analyze water security threats and identify potential intervention area; Integrated hydrological and socio-economic assessments to understand the causes, magnitude and likely impacts of each threat; and the Computable General Equilibrium model to determine how investment in water security in greater Kampala would affect economic growth in real GDP terms. Two novel tools have been developed namely the Water Security Scenario Planning Tool (SPT) and Water Security Action and Investment Model (WaSIM). The

SPT enables stakeholders to monitor the landscape of water security under changing social (e.g. population), economic and environmental (e.g. climate change) conditions. WaSIM on the other hand, supports the identification, selection and prioritization of investment actions as well as the quantification of the impact of each investment action. It explores the costs, benefits, and tradeoffs associated with various investment and action decisions. Preliminary results indicate that investment in water security in Greater Kampala leads to a 4.2% increase in annual GDP per capita by 2040. This translates into USD 195 in greater Kampala and USD 52 nationally. Forty six percent of the benefits will be derived from investing in water supply, sanitation and hygiene, 13% from flood risk management, 7% from forestry and wetlands, and 4% from tourism. Collective multi-stakeholder action is necessary in solving water security challenges which no single stakeholder can address in isolation. The Water Security Action and Investment Plan sets the water security agenda for Greater Kampala and surrounding metropolitan areas and opens avenues for investment to spur socio-economic growth across the Kampala – Jinja corridor.

1.22. Gender Equity in Agroforestry Resource Management in Elgon Region

Peter Fuuna

Disparity in gender equity in forestry programs is common throughout developing countries. Few socioeconomic studies have been conducted. Women's contributions to the forestry sector have not been recognized and evaluated in their full complexity. The objective of this pater was to examine gender equity I in decision-making in agroforestry practice, distribution of benefits, and utilization of forestry products. The findings indicate that forests provide monetary and non-monetary benefits to both men and women in forest communities around the world. Men and women often have different roles in managing forests, different knowledge about them, different access to forests and different ways of using forest resources. Forestry tends to be perceived as male dominated although women are heavily involved in forest work such as gathering fuel wood, medicinal plants and other non-timber forests products, collecting food for family consumption as well as for income, and in processing secondary wood products. Forestry and agroforestry systems are not gender-neutral. Women often have highly specialized knowledge of trees and forests in terms of species diversity, management, conservation and use. Compared with men, women's knowledge tends to be linked more directly to household food consumption, including collecting fuelwood for cooking and heating, and health, which is particularly important during food crises. Men tend to play a greater role than women in extracting timber for commercial purposes, although these roles are changing. Women contribute to the forest sector in many ways, both formal and informal, including through agroforestry, watershed management, tree improvement and forest protection.

1.24. Assessment of the Faecal Sludge Management Services Delivery in Mbarara Municipality, Uganda

Charles B. Niwagaba

Urban sanitation provision is a challenge for low- and middle-Income countries (Harada et al., 2016). In low and middle income urban areas, there are insufficient systems for the management of accumulated faecal sludge. However, sanitation needs in these areas is met through on-site technologies (pit latrines, unsewered public ablution blocks, septic tanks, aqua privies etc). Consequently, the need for faecal sludge management (FSM) from existing on-site sanitation systems should address sustainability of the natural resources and public health (Scott et al., 2019). Moreover, onsite sanitation with FSM is cheaper than sewerage (McConville et al., 2019). In this paper, the tools developed by the World Bank for rapidly assessing faecal sludge management (FSM) were applied to the municipality of Mbarara, Uganda. To assess FSM outcomes, we used the a faecal sludge (FS) matrix, which illustrates the different pathways FS takes from containment toilet systems through collection and transportation to treatment and reuse/end-disposal (Scott et al., 2019). The containment systems that were assessed included ventilated improved pit (VIP) latrines, traditional latrines, septic tanks and urine diverting dehydration toilets (UDDTs). Besides, an FSM service delivery assessment (SDA) tool was applied to assess the quality of the enabling environment, the level of service delivery and commitment to service sustainability. Data collected from household (one-on-one) interviews, key informant interviews and participatory approaches in workshops were applied in the tools. Findings revealed that the various stakeholders are not coordinated, participate or attend to just one or a few components of the FSM services/value chain and FS valorization is lacking. The resultant proportion of safely managed FS in Mbarara Municipality is 44%. To improve this fraction in Mbarara, the roles of the actors at each component of the FSM services value chain should be fully defined, operationalised and coordinated. Findings from the SDA revealed that sanitation planning should be inclusive, allowing participation of relevant stakeholders; dissemination and enforcement of national laws and local byelaws should be performed; more resources should be mobilized and allocated to improve FSM service delivery; and innovations in FS valorization should be pursued.

1.25. Assessing the Impact of Land Use and Land Cover Changes on the Stream Flows Case Study-Upper River Rwizi Catchment

Musimenta Pamela

Uganda's high annual population growth of above 3% has led to utilization of sensitive lands like wetlands, forests, hilltops that would leave for environmental conservation. The upper Rwizi catchment is steadily transforming into agricultural land, human settlement and industrial parks as the population seek land for development activities. The purpose of this study was to assess the impact of land use and land cover changes for 2000 and 2014 on the stream flow of river Rwizi. GIS was used to develop thematic maps of soils and landuse using spatial and hydrological datasets for the upper river Rwizi catchment and HEC-HMS model was used to simulate the impacts of scenario based land use types (forests, water, grassland, subsistence cropland, wetlands and settlement), using Classified land use maps of 2000 and 2014. Results showed that in the period between 2000 and 2014, forest cover and wetlands decreased by 1%. However, subsistence cropland increased by 24% while grass land had decreased by 18%. This implies that, a higher peak discharge of 84% in the year 2014 compared to 57% in the year 2000 and runoff volume 37.11 mm in the year 2014 as compared to 16.47mm in the year 2000 will occur. The vegetation and forest cover in the river Rwizi catchment should not decrease to less than 55% as this results into a low retention capacity of the catchment and reduced water flows.

1.26. Impacts of Climate Variability and Land Use Changes On Streamflow in Upper Rwizi Sub Catchment, Uganda

Emmanuel Arinaitwe

River Rwizi catchment experiences human threats due to expanding agricultural land and high urbanization rates with increasing demand for timber, fuel wood and charcoal that has resulted into deforestation and wetland degradation. But little is known about the impact of both climate variations and human factors on streamflow in data poor catchment like Rwizi. A systematic way to quantify the impact of climate variability and landuse/cover changes on streamflow is by integrating semi-distributed rainfall-runoff models together with GIS and remote sensing tools. In this case SWAT model with the ability to use semi-distributed model domain was applied to assess the impact of landuse/cover and climate variability on upper river Rwizi flows. Uganda meteorological Authority (UNMA) provided required climatic data and spatial data (90m- DEM, soil, landuse/cover) were obtained from other global sources. For trend analysis, Mann- Kendall and Sen's slope tests were used to detect trends in hydro-meteorological data which indicated increasing trend but not significant while evapotranspiration showed decreasing trend in the catchment. Finings for landuse and cover changes showed an increase in agricultural area of 11.09%, Urban/built up by 6.13% and bare land with 3.9%. On other side, decrease in Natural vegetation area by 17.3% was observed followed by 6.48% decreases in wetland area between 2003 and 2013. SWAT model simulated streamflow under specific landuse/cover and climate between 2000-2014 to assess the impact of both factors on Rwizi river flows after calibration and validation using observed flows. Simulated model flows show reduction in surface runoff by - 3.24%, and -33% in ground water under landuse/cover change but increased by 27.2% (surface runoff) and 85% (ground water) hence increasing river average flows under climate change scenario. The study revealed that climate variability has bigger effect on streamflow hence recommending for more efforts to climate change adaptation in planning, development and management of future water resources.

Theme 2: Water and Environment for Employment and Wealth Creation.

2.1. Assessing the water footprint of irrigated rice production for Doho rice irrigation scheme, Butalejja district

Naula Catherine

Water footprint assessment addresses the issues of freshwater scarcity and pollution. Further, water footprint assessment is limited to considering those human activities that impact upon the quantity or quality of freshwater within a catchment. Water footprint" is an indicator of water use in relation to crop yield. It generally breaks down three components depending on water resources: green, blue, grey water. The water footprint was determined using the climatic data of Mbale meteorological station (2002 to 2018).This study quantified the green, blue and grey water footprints of rice production for Doho Rice Irrigation Scheme found in Butalejja district in Eastern Uganda. Aqua crop model was used for simulating the crop water use and the yield which takes into account the daily soil water balance and climaticconditions. In addition, the water pollution associated with the useof nitrogen fertilizer in rice production is estimated. The study included two growing seasons of rice. The green water footprint was 1078 m3/ton and 922.57 m3/ton for the first and second season respectively. The blue water footprint was 141 m3/ ton and 4812.16m3/ton for the first and second season respectively. The grey water footprint was 129.87 m3/ ton and 143.39 m3/ton for the first and second season respectively. Deficit irrigation was considered majorly to policy makers in formulating water management strategies to reduce water footprint. Hence, these results are useful for paddy rice water management, specifically establishment of water saving policy.

2.2. Could the Health-Energy-Water-Agriculture Nexus be the Solution for improving African livelihoods?

Patrick Musinguzi

In Africa, the increasing complexity to satisfy health and livelihood needs of human beings requires innovative approaches that are interlinked for better leveraging of resources. The Health-Energy-Water-Agriculture Nexus (HEWAN) is one of the novel concepts that is increasingly proving appropriate for livelihood improvement while ensuring sustainable development. It entails collective engagement with a purposive use of making available resources for health, fuel, food, forage, and income while considering the inextricable connectivity of different players, such as water, agriculture, and energy for better livelihoods. The concept is proposed as an effective policy measure in resource-constrained regions, especially in Africa, that have limited access to health services and entirely depend on land for food for income. With the support of energy and water resources to optimize production, increased energy security and sanitation are achievable. These have potential impacts to ensure healthy living and improved livelihoods among urban and rural communities involved in agriculture. The nexus might be a panacea for livelihood empowerment when households understand the complete cycle of the benefits accruing from increased water harvesting, on-farm crops, product recycling, animal and woodlot productivity; that subsequently support the supply of critical resources such as biogas, manure, mulch, compost, forage, food, fuel, timber, herbal medicine and household income. The connectivity of resources working in an integrated manner is necessary for the improvement of livelihoods in Africa. The HEWAN concept is novel and is a promising approach in policy and development to improve quality of life, especially for Africa.

2.3. Better Livelihood Opportunities for Catchment Management in Maziba Sub Catchment, Kagera Catchment

Tusiime Gilbert

Uganda's forests supply 88 % of all its energy needs, provide 61% of Uganda's tourism income and provides jobs for about 1 million people. However, the rate of deforestation in Uganda is high and the country will soon become water-stressed if citizens do not pay attention to environmental management. All other organizations ought to take part in planting trees as a priority to manage the climate change challenges. Uganda's forest cover has been depleted to 8% up from 24% in 1990s, largely attributed to human encroachment for different activities such as tree cutting for charcoal and timber as well as agriculture. Through the "Enhancing Resilience of Communities to Climate Change through Catchment Based Integrated Management of Water and related Resources in Uganda (EURECCCA)" project, communities are being supported to restore deforested and degraded areas through afforestation in order to return the ecological functions of forest ecosystems that have been lost due to unsustainable forest management practices, particularly water infiltration to reduce the risk of floods and landslides. In order to deliver this, tree nurseries are supported in the sub-catchments under a Public Private Partnership arrangement to produce 342,300 seedlings of different species and distribute them to farmers and communities for growing in Maziba Catchment. The selected tree nurseries are supported with seedlings of high value tree species, soil mixtures, seed, shading material as well as tools and equipment and other nursery implements to enable them increase their production capacity so that they can be able to supply tree seedlings to the communities for restoration of deforested and degraded land at subsidized rates hence increasing the income of the tree nurseries and the communities as well as socio-economic security through better catchment management.

2.4 Challenges and opportunities for promoting private sector investment in tree seedling production in UgandaTree

Dennis B Mujuni

Seedling production in Uganda is diverse in many respects such as geography, size, level of investment, type of ownership, type of germ plasm used, promotion and marketing, to mention but a few. This diversity means that there is no single uniform position in terms of quality and quantity, costs or price in the tree seedling production and trade. This fact is exacerbated by lack of records to establish the exact number of individuals and groups involved in tree seedling production and trade. Despite this however, the story of tree seedling production and trade in Uganda is a story of remarkable success. This success has come about as a result of a vibrant private sector involvement since there is a long history of inadequate government investment in tree seedlings in the country. Tree seedling production in Uganda is predominately an activity of the private sector and there is no visible shortage of tree seedlings in the country such that tree farmers have a wide choice where to choose from depending on their abilities and requirements. The private sector plays s a critical role in providing tree seedling that contributes to national afforestation and reforestation programs as well as environmental conservation. The sector is diverse in production outcome and locality and as a result has developed skills and business processes that are unique in both technology development, and utilization of resources, both human and natural. The sector has reached this position as a result of investment over time by individuals and groups through their own resources. However, private sector involvement in tree seedling production and trade in the country is not without challenges. Those involved in this sector must face the realities of weather uncertainties, poor extension services, lack of quality control mechanisms, lack of capital, poor quality seed, low prices of seedlings and high costs of inputs especially good quality seed. This paper will therefore explore the challenges in the tree seedling business. It will also explore the opportunities and strategies that need to be employed if the private sector is to thrive and survive in the business.

2.5 Citizens' perceptions on water, sanitation and hygiene service delivery impact on associated businesses and the water and environmental management for inclusive growth

Andrew Tebandeke

Citizens' perceptions about the quality of water, sanitation and Hygiene (WASH) service delivery by various service providers and duty bearers greatly affects businesses related to WASH and certainly impact on environment management. Generating these perceptions and using them for planning and as a means for feedback to duty bearers and service providers, greatly improves the quality of operation of WASH related businesses such as prepaid meter system taps; managed by focal people in various communities, garbage collection businesses and drainage of waste channels. Citizen's perceptions highlighted in several consumer perceptions studies and often packaged and summarized as score cards. This paper presents key findings from a meta-analysis of several citizen report cards conducted within several slum areas of Kampala district (i.e. Central, Makindye, Kawempe and Nakawa divisions) by Environmental Alert and Partners. A desk review following a critical issue analysis and synthesis was used to identify key perceptions that have a bearing on the delivery of water and environmental management interventions. Based on this, policy and practice recommendations are suggested targeted at improved service delivery for effective and efficient management of WASH based businesses and associated water and environment resources.

2.6 Developing *Shea* value chain for Wealth creation in Aswa catchment, northern Uganda

Sophie Kutegeka

Shea tree *(Vitellaria paradoxa)* is among dominant tree species in northern Uganda, and is mostly cut for charcoal production. Benefits derived from the shea tree are enormous, including providing; poles for construction, shade for homesteads, fruits for food, and high quality natural oil. However, all these uses are considered to have low commercial value compared to oil extracted from processed Shea nuts. To reverse this situation, the International Union for Conservation of Nature (IUCN) supported communities in Aswa catchment of northern Uganda to process Shea oil at a commercial scale. The intervention focused on developing the Shea value chain by; mobilising producer groups, trainings and linking them to markets. As result, higher economic and financial benefits have been realised from selling Shea oil. Close to 500 households have engaged in production of Shea oil and have realised the value of protecting the Shea tree. Increase in Shea oil production has been realised at household level. For example in Alololololo and Arwotngo parishes, an increase from 5 litres to 50 litres per day has been realised with introduction of motorised Shea processing units. Improvement in quality of Shea oil was realised and a trading certificate for Shea oil acquired by the producer group to enable access national markets. The improved quality has also fetched a higher market price from UGX 7,000 ($1.85) to UGX 18,000 ($4.75) per litre which is providing significant income to producers. The communities have also registered a cooperative association for the production of Shea, which has enabled them to communally market their product and negotiate a better price for the Shea oil. The marketing association, which is the first of its kind in Aswa catchment, is motivating other community groups to organise themselves into similar arrangements in order to tap into the lucrative Shea oil market.

2.7 The relevance of WASH community initiatives in boosting livelihood

Shafiq Kakeeto

Following the 2030 Agenda for Sustainable Development Goals, the Netherlands Development Organization (SNV) with funding from Austrian Development Cooperation (ADC) is implementing a 3year project (Improving Water Supply Sustainability, IWAS) using a preventative maintenance approach to rural water facilities. The purpose of this paper is to show that working with the District Local Governments to professionalize and scale community based operation and maintenance (O&M) systems allows generating and safeguarding financial resources to upgrade from a reactive repair to a preventive maintenance model. According to a baseline survey conducted in June 2019, 15.4% of the 858 (132 /858) water sources sampled in the four districts of Lira, Kole, Alebtong and Dokolo were not functional. Through the IWAS project in a period of six months, communities understood and appreciated their roles in O&M. As a result, 27 water sources were repaired using the IWAS preventive maintenance approach where sub county based Hand Pump Mechanics (HPMs) are remunerated from community O&M funds to do repairs and maintenance. This has increased functionality by 3.1% from 84.6% to 87.7% as of December 2019. This approach no longer leaves communities with the challenges leading to inconsistent access to water supply. The formation of Sub county Water Supply and Sanitation Boards (SWSSBs) is key in the IWAS model. 783 Water User Committees (WUCs) were formed in 22 project sub counties and were linked to the SWSSB. The (HPM) Association works with the SWSSBs focusing on the entire sub-county (scale). The SWSSB designates HPMs from respective sub counties to carry out maintenance and repairs of water sources. WUCs are tasked with the responsibility of routinely collecting user fees and remitting them to the SWSSBs. These initiatives have led to 6,750 people regaining access to safe water supply. In addition, the income of the community HPMs is more predictable since they are assured of monthly income from preventive maintenance services. This has kept the HPMs more motivated and committed to provide high quality services to keep "their" water sources operational. The results demonstrates that using the IWAS preventative maintenance model to strengthen WASH structures, communities can generate financial resources that can attract professional service providers such as HPM to maintain the community water sources.

2.8 The Role of Pollution Control Task Force (PTF) in Improving Environmental Compliance -A case study of Industries in Kampala City, Uganda

Stacey Natunkunda

Uganda like many other developing countries, the rapid urban population growth and industrialization have greatly endangered the environment resources. Kampala City is experiencing rapid urbanization with a day population of 4.5 million and resident population of about 1.5 million. The City is largely reliant on Lake Victoria as its source of water which is currently polluted as a result of unregulated developments such as industries, commercials and human settlements. The non-compliance to wastewater discharge and waste management regulations by the industrial sector as well as the lack of coordination among regulatory bodies has greatly impacted the quality of the environmental assets (wetlands, Murchison Bay and Water Supply and biodiversity) in Kampala and population therein. Due to the mentioned challenges, Kampala Capital City Authority spearheaded the formulation of the Kampala Pollution Control Task Force (PTF) in 2012. The PTF is a multi- stakeholder approach with an aim of strengthening cooperation both the member regulatory agencies (Ministry of Water and Environment (MWE), National Water and Sewerage Corporation (NWSC) and National Environmental Management Authority (NEMA) as well as between the public and private sector to safeguard water and environmental resources while fostering inclusive growth, employment and wealth creation. Since its formation,

the funding for operations has majorly come from GIZ -Reform of the Urban Water and Sanitation Sector (RUWASS) and the International Water Stewardship Programme (IWaSP). The PTF activities majorly revolve around the development of joint actions and interventions that can support industries to undertake self-monitoring for environmental compliance. These range from joint industrial Assessments, capacity building, Public -Private Wastewater Dialogues, Compliance campaigns and are essentially linked to the Sustainable Development Goals (SDGs) such as Goal 3, 6, 9 and 11 (Good Health and Well-being; Clean Water and Sanitation; Industry; Innovation and Infrastructure; Sustainable Cities and Communities) respectively. The findings demonstrate that PTF multi-stakeholder approach has greatly influenced compliance to environmental standards, through technical support to industrialists in the implementation of cleaner production practices that eventually improve resource efficiency, reduce costs of production, promotes recycling (waste to wealth innovations) and reduce impact on the environment.

2.9 Moving Sanitation in Rural Growth Centres (RGCs) - A Business Opportunity

Stephen Alege

Water and Environment resources are at the core of sustainable development and are critical for socio-economic development and healthy ecosystems in Uganda. With rapid urbanisation and population growth uplifting sanitation and hygiene of households and institutions in Rural Growth Centres (RGCs) is challenging but also offers business opportunities. SNV with funding from UKaid implemented a 5 year Sustainable Sanitation and Hygiene for All (SSH4A) program to improve access to sanitation and hygiene across 33 Sub counties in nine Districts. Within the project area many RGCs developed during the project implementation. The purpose of this paper is to show that while working with the District Local Government (DLG), Rural Growth centres (RGCs) present business potential in the area of sanitation. The SSH4A program followed an areas based approach that embraced supply chain and financing aspects alongside traditional pillars of sanitation interventions such as governance, demand creation and behaviour change. RGCs require DLG lead Market based and private business approaches. The sustainability survey showed that latrines were affordable but access to sanitation products to improve latrines was a challenge. SSH4A pitched sanitation products to entrepreneurs with retail shops in RGCs. These entrepreneurs stocked these products moving them closer to the potential customers and addressing one of the key access barriers. In addition pit emptying services remain limited to a handful of individuals that use manual methods and dispose faecal material unsafely into the environment. The rapid urbanisation in RGCs across Districts in Uganda with increasing demand for RGC-appropriate solutions will require readily available and affordable sanitation services. Government and other stakeholders should purpose to grow this market and encourage private players to take full advantage of this business space.

2.10 Trace metal pollution in the surface water and bioaccumulation in the Brycinus sadleri (Sadleri robber) and Barbus altianalis (Rippon barbel) fish species from River Rwizi in Western Uganda; the risks to both human health and economic development.

Anthony Basooma

River Rwizi supports over 5 million people, of which 400,000 are from Mbarara municipality. Studies indicated that the river was polluted with trace metals but no clear sources were identified. This study was conducted to determine the trace metal concentrations in water and fish of River Rwizi and establish a pollution gradient. Physicochemical parameters, namely temperature, pH, and conductivity were measured. Fish muscle tissue samples of (*Brycinus sadleri* and *Barbus altianalis*) and surface water were collected, processed, and multi-trace metals were analysed using a High-Resolution Induced Coupled Plasma-Mass Spectrometry (HR ICP-MS). Principal component analysis and trace metal evaluation tests were performed in R. The water pH for upstream was slightly acidic (5.8±0.4) compared to downstream (6.8±0.1) $p<0.05$, which increased the bioavailability of Pb to fish. Surface water had low trace metal loads with metal evaluation indices were below 3 except for Sheema (8.7) and Kayanja (4.5). Manganese (Mn) levels at Sheema (740-831 µg/L) were above the allowed Uganda levels of 100 µg/L which could be attributed to both geological and anthropogenic sources. Both Hg (0.06-0.3 µg/L) and Au (0.003-0.007 µg/L) levels were only found in water at Katenga and Kayanja which was inclined to poor disposal of wastewater from Katenga gold mine. The lifetime risk of developing cancer from consuming ***Brycinus sadleri*** contaminated with Pb (0.0022) was greater than the USEPA acceptable levels for adults (0.001). Further, the risk-free quantity (Q) for As and Hg in ***Brycinus sadleri*** was lower than the national daily fish consumption (31.5 g/day); however, the Qs for ***Barbus altianalis*** were all above the national fish consumption. Consumption of ***Brycinus sadleri*** posed lifetime health risks but not ***Barbus altianalis.*** The trace metal loads posed high human health risks due to Mangenese toxicity. Keywords: cancer risks, heavy metal evaluation index, trace metal toxicity, River Rwizi, R-software.

2.11 Situation of Groundwater Resources in Urban Areas of Uganda-The Case of Kampala City

Julius Aheebwa

Groundwater is widely being developed for urban/town water supplies in weathered crystalline rocks of Uganda but with limited data and information on its availability hence limited borehole success rates and unsustainable groundwater sources. There is, however, an ongoing improvement of groundwater knowledge base at the Directorate of Water Resources Management through collection of data and information from licensing of borehole drillers, hydrogeologists and motorized groundwater abstractions as well as other related activities on groundwater resource development in the ministry, academic institutions, NGO's and other private partners. This paper has based on this data and information to present the current situation of groundwater resources in urban areas of Uganda with specific reference to Kampala city. The main objective of the paper is to improve understanding of the contribution of groundwater resource to urban water supply needs/ employment and wealth creation hence sustainable development. This will enable more focused protection of groundwater resource as key bankable water resource for sustainable urban development, given the fact that there is seemingly uncontrollable issues of degradation on most surface water bodies in urban areas of Uganda. The study has specifically noted that groundwater abstraction rates of up to $12m^3$/hour around Kampala city do not significantly affect the resource due enough underground storage and rainfall-fed recharge. The effects of rainfall variations due to climate change effects on groundwater resource has however not been comprehensively investigated. More studies on groundwater management are thus required in order to improve on planning **for the predicted large scale groundwater abstractions in most urban areas of the country, but mostly Kampala city.**

2.12 Safe water, Wealth and Household income among homes that harvest rainwater

David Baguma

Wealth creation has a strong influence on the safety of drinking water. We examine the relationship between the effect of safe water availability on monthly home expenditures, the dependent variable and independent variables such as background characteristics, tank size, usage instructions, and post-construction guidance, including the management of water-related sources. The sample consisted of rainwater harvesting 301 households in Uganda. Multiple regression analysis used to analyze the data using SPSS. Post-water tank construction guidance and tank size were significant variables. This study recommends the need for a follow-up to improve storage cleanliness after the installation of the water supply equipment. That is, provide information about storage cleaning among women groups, enhance reading norms, and facilitate the availability and affordability of information sources, e.g., water association subsidized newspapers and information support devices (computers and mobile information systems). Additionally, this study also shows the possibility of increased wealth partly due to possible reduction expenses on water bought from vendors and the management of water-related health risks. Overall, this study reveals two measures to enhance wealth and employment in developing countries: 1) ensure sufficient post-construction guidance for all water resources, especially among women groups, and 2) sustainable supply of adequate safe water in households.

Theme 3: Climate change and achievement of NDP III goals

3.1. What is the contribution of sustainable biomass production and utilization towards achievement of Environment and Natural Resources and Sustainable Energy Programs National Development Plan III (2020/21-2024/25)

Arafa Kamoga

This paper presents and discusses the linkages and potential contributions of sustainable biomass production and utilization towards the achievement of National Development Plan III targets under the Environment and Natural resources and the Sustainable Energy Programs. Currently, the national total primary energy is comprised of 88% biomass energy, 10% fossil fuels and 2% electricity. It is projected that the demand for biomass energy will rise higher as the population grows but also refugee influx. Over 95% of the population depends on firewood for domestic energy. The National Development Plan III targets for the Environment and Natural Resources and Sustainable Energy Programs are: For example, restoration of forest cover from 9.5% to 18% of the total land area; and increasing access to electricity from 21 to 60% of the national population. This paper therefore, underpins the key emerging issues (challenges and opportunities) in respect to sustainable biomass production and utilization along the value chain. Thus, in this respect it suggests policy and practices' recommendations for addressing the emerging issues for consideration during the implementation of the National Development Plan III to contribute towards delivery of the targets under the Environment and Natural Resources and Sustainable Energy Programs. The paper is generated largely through literature review and gap analysis and synthesis. Several constraints to sustainable biomass production including information gap, low priority, inadequate capacity of players, limited investment, lack of biomass energy standards, land tenure system, weak governance arrangements, lack of clear financing mechanisms. Changes to improve sustainable biomass energy production are suggested including: increased funding, access to information, decentralized planning, integrated and coordinated implementation, adequate regulation and law enforcement, institutional capacity, investment, research and development. The promotion of sustainable biomass production and utilization will certainly contribute to delivery of the National Development Plan targets under the Environment and Natural resources and the Sustainable Energy Programs.

3.2. Excessive deforestation in Uganda

Simon Peter Okello

In the past 29 years (1990-2019) Uganda has lost over 63 percent of its forest cover due to tree-cutting for firewood, timber and charcoal, as well as the growth of farms and towns. The country's forest cover has reduced from 24 per cent of the total land area in 1990 to less than 9 per cent in 2019. Northern Uganda has many of the trees most in demand, including; ***Yaa*** (Shea-butter tree), ***Ogali*** (Camel's foot leaf tree), ***Okechu*** (Velvet-leafed combretum), ***Beyo*** (Lucky bean tree), ***Awok*** (Large-leafed albizia) and ***Cwaa*** (Tamarind). Since 2013 to date, villagers in northern Uganda are paid Shs 500,000 for over 15 acres of mostly indigenous and endangered tree species. Deforestation has added to climate change and scrambled local weather patterns. More than 73,000 hectares of private forest are cleared every year across the country and over 7,000ha of protected forest reserves are destroyed annually for timber and charcoal. However, the charcoal sector earns $38m (sh144b) annually as majority of the households depend on charcoal. There is temporary ban on felling Afzelia Africana and Shea nut trees, the two species considered "vulnerable" by the International Union for Conservation of Nature. In the past 25 years Uganda has lost 63 percent of its forest cover due to tree-cutting for firewood, timber and charcoal, as well

as the growth of farms and towns. A policy that prohibits cutting of tree species such as Afzelia Africana commonly known as ***Beyo,*** and Shea nut that are rare and take long to grow, has been established but leaders and dealers have ever connived to violate the policies. Dire poverty has pushed northern Uganda communities that are recovering from war to massive cutting down of trees for charcoal, this is rapidly depleting native forests and posing environmental threats to the rural communities and the greater Uganda. Ethnographic research methods were used triangulating in-depth interviews, focus group discussions, informal conversations and participant observation, for an understanding of the various stakeholders' perceptions of deforestation and how these perceptions impact future interventions for prevention, treatment and disease control. If deforestation continues at the present rate, Uganda will have lost all its forested land by 2050. People can solve these challenges by integrating charcoal in agriculture with trees inform of agroforestry; intercropping trees meant for charcoal with crops in the gardens like in Western Kenya, where farmers are planting trees purposely for charcoal, or use organic waste; in towns, from farms, charcoal dust and saw dust to make organic charcoal briquettes to reduce the demand for fire woods. The alternative technology like char kiln to make briquettes out of biomass waste uses a simple mechanical process that gives a cleaner burning, more environmentally friendly fuel for personal consumption or sale rather than earth kiln**s.**

3.3. Nodding Syndrome illness infections in northern Uganda

Simon Peter Okello

Nodding syndrome, is a disease commonly occuring around water bodies in northern Uganda. It was first documented in Tanzania in the 1960's, then later in the present Republic of South Sudan during the 1990's, and in northern Uganda in 2007. The disease has affected over 3000 children in northern Uganda where the epidemic emerged at the time of the civil war. Generally, it's not clearly known what causes the disease, but it is believed to be connected to infestations of the parasitic worm Onchocerca volvulus. Nodding Syndrome has been politicized in northern Uganda, which has greatly affected health interventions including research and dissemination. Distrust towards the government has developed in northern Uganda over several decades of war and was particularly linked to political control and ethnic divisions in the region. Disease perceptions revolved around rumour that the entire ethnic groups of north would be annihilated by government, or that international researchers were making money by stealing study samples. Such rumour and distrust led to suspicions concerning the integrity of the disseminated research results. Ethnographic research methods were used by triangulating with in-depth interviews, focus group discussions, informal conversations and participant observation, to understand stakeholders' perceptions of Nodding Syndrome and how these perceptions may impact future interventions for prevention, treatment and disease control. Findings reveal Black Fly to be causing nodding syndrome, which through its bites transmits a worm called onchocerca volvulus which causes river blindness or onchocerchiasis. RThe recent thinking that the disease is caused by onchocerciasis has also increased the; relevance of onchocerciasis control, bi- annual ground river dosing in the affected districts and Bi- annual distribution of Ivemectin to kill the baby worms that causes River Blindness. Trust must be built gradually through transparency and by de-politicizing interventions. This can be done by engaging the community at regular intervals during research and data collection and the dissemination of results in addition to involvement during service delivery for prevention and treatment.

3.4. Examination of use of agro-ecologically based management strategies for resiliency to climate disasters as an approach to achievement of NDP III

Nakayemba Allen

The threat of global climate change has caused concerns among nations because crop production has been affected severely by changes in climatic conditions that have compromised food security both globally and locally. Uganda too, has not been spared as changes in the climatic conditions have had devastating impacts on the society and undermining Uganda's social and economic growth. The key impacts have been on agriculture (crop failures due to drought and destruction by flooding) with severe impact on small farmers. This paper develops a typology of adaptation to systematically classify and characterize agricultural adaptation options to climate change, drawing primarily on the Ugandan situation. A synthesis of research on adaptation options in Uganda, especially in the agriculture sector identified four main factors deemed necessary to stimulate adaptation initiatives, which were: technological developments; information provision, government programs and insurance; farm production practices, farm financial management. The study suggested that rescuing traditional management systems combined with the use of agro-ecologically based management strategies may represent the only viable and robust path to increase the productivity, sustainability and resilience of peasant-based agricultural production under predicted climate scenarios. The paper explores a number of ways in which three key traditional agro-ecological strategies (bio-diversification, water harvesting, and soil management) can be implemented in the design and management of agro-ecosystems allowing farmers to adopt a strategy that both increases resilience and provides economic benefits, including mitigation of global warming. Observations of agricultural performance after extreme climatic events have revealed that resiliency to climate disasters is closely linked to the high level of on-farm biodiversity, a typical feature of traditional farming systems. The results also reveal that most adaptation options are modifications to on-going farm practices and public policy decision making processes.

3.5. Technology Needs Assessment for Climate Change Adaptation in the Forestry Sector in Uganda.

Joshua Zake

This paper reflects on the on-going Technology Needs Assessment process for advancing climate change adaptation in the forestry sector in Uganda. Technology Needs Assessments fall within the framework of United Nations Framework Convention on Climate Change and the Paris Agreement. They enable identification of national needs for equipment, techniques, practical knowledge & skills in respect to climate change mitigation and adaptation. Technology development and transfer contributes to climate change mitigation and adaptation at different scales. This paper focuses on phase 1 of the technology needs assessment ***(i.e. Identification & prioritization of sectors & technologies)*** as applied to the forestry sector climate change adaptation. The methodology and approach included: literature review & synthesis in the identification of the existing technologies; related prioritization of the technologies through multi-criteria analyses; and key stakeholders consultations for technical inputs and validation. As a result, the prioritized technologies for advancing forestry sector climate change adaption are: ***i) Promotion of Farmer Managed Natural Regeneration for forest landscape restoration; ii) Integrated pest management in forest plantations; and iii) Promoting Forest based enterprises e.g. apiary, butterfly farming, fruit trees production & ecotourism.*** This initiative is implemented with support from Global Technology Needs

Assessment project. It's funded by the Global Environment Facility and executed by United Nations Environment, in collaboration with the UN Environment - Technical University of Denmark, Partnership Centre on Energy, Climate and Sustainable Development through coordination by the Uganda National Council for Science and Technology and the Ministry of Science, Technology and Innovation.

3.6. Farmers' Adaptation to Climate Variability Using Mobile Phones A Case of Kasangombe Sub-County, Nakaseke District, Uganda

Rashid Lukwago

Mobile phones have the potential to enhance agro-meteorology extension to smallholder farmers to address climate variability impacts. A study aimed at establishing the ownership and use mobile phones to access climate variability information and use of climate variability information for adaptation by farmers was conducted. A mixed method approach was used to collect quantitative data from randomly select 155 smallholder crop farmers. Qualitative data were collected from key informants and Focus Group Discussions. The study revealed that farmers demanded early warning information because the agriculture practiced was mostly rain-fed. Overall, 60% of the farmers used phones to receive climate and weather-related information of which 91% was for early warning, daily weather updates (88%), monthly climate outlook (85%), seasonal forecast (77%) and other climate related information (61%). The adaptation practices that farmers developed included; intercropping (90%), soil fertilizer application (67%), early planting (43%), drought resilient seeds (32%) and rain water harvesting at (72%) although much of the harvested water was not meant for irrigation. Although smallholder crop farmers received climate variability information, little did they base their adaptation practices on the information they received. Therefore, the meteorology department and other development organizations in agriculture, need to design farmer tailored information that addresses the specific challenges encountered as a result of climate variability.

3.7. Using the Impact based forecasting methodology (IBF) to reduce anticipated risks

Irene Amuron

Uganda is considered the most vulnerable countries to Climate Change and the frequency and magnitude of extreme events is projected to increase. The impact of these events can be reduced or avoided if weather and climate forecasts, together with in depth knowledge of risk, are systematically used for anticipatory early action. However, forecasts are not always used to take early action, with governments and humanitarian organizations often starting their response operations after a disaster has occurred. To address this challenge, the Red Cross Red Crescent movement and its partners are proposing the use of IBF to help identify when and where these events are forecasted to occur as well as the anticipated risks. This approach aims at supporting early actions to those anticipated to be affected prior to the occurrence of the event. Impact Based Forecasting (IBF) focuses on the impacts of the hazards and this requires linking forecasts with vulnerability and exposure data. To achieve this, it is essential to work with the national meteorological and hydrological services and other relevant stakeholders. The IBF translates climate hazards into potential sector & context specific impacts which can lead to the development of efficient sectoral responses to mitigate the anticipated impacts. By focusing on impacts, it is expected the population at risk and other humanitarian actors will have a better understanding of risks which can be used in the development of triggers to identify when and

where to take appropriate early action. Steps taken to develop the impact-based forecasts include; Risk Analysis, Inventory of Forecasts, Define hazard magnitudes, develop impact forecast through composite index approach, elementary or statistical modelling and generate the impact based forecasting intervention map. This methodology developed by the Red Cross is currently being developed in Uganda in partnership with hydrology department and Uganda National Meteorological Authority.

3.8. National-Scale impact-based forecasting of flood risk in Uganda (NIMFRU)

Tumusiime D Moses

Floods can be of many different types and scales and this drives differences in the architecture and implementation of flood forecasting systems. For example, flood forecasting systems have been implemented at global (Alfieri et al. 2013), continental (Thiemeg et al. 2015), basin (Hopson and Webster 2010), and community scales. The purpose of a flood forecasting and warning system (FFWS) is to alert the general public and concerned authorities of an impending flood as much in advance, and with as much reliability, as possible. The National-Scale Impact Based Forecasting of Flood Risk in Uganda (NIMFRU) project aims to help communities in the Katakwi District in the Eastern Region of Uganda to become more resilient to flooding by ensuring they, and the local and national DRR (Disaster Risk Reduction) services have access to the right information at the right time. To facilitate this, two information integrated exchange platforms have been set up by UNMA to operate in research mode during the NIMFRU project. These are: the Uganda National Meteorological Authority (UNMA) led Farmer Agri-Met Village Advisory Clinics (FAMVACs); and the Listening Groups (LGs) for understanding the specific vulnerabilities of communities at different seasons, and their exposure to different types of flood threat is key to improving physical and livelihood risk assessment, preparedness, communication and response. The already well established Farmer LG and novel FAMVAC methodologies have been integrated to create an open and inclusive conversation space involving district and LG officials and over 50 farmers. They aim to bring together scientific data with indigenous knowledge to solve local climate and weather-related problems. We have run one FAMVAC week every month over the past six months. Each FAMVAC week engaged 3 different communities in the Katakwi district. There was an average participation of 150 farmers per FAMVAC in each community with a well distributed attendance of men and women. These amount to total of 450 farmers a month participating in the FAMVACs. There have been 20 listening programs which have been broadcast on ETOP radio based on varying topics chosen by the 12 listening group members who represented different wealth groups and genders from each community. These programs are estimated to have reached 67,000 listeners across the region. We have also developed an open source step by step field guide (available at https://zenodo.org/record/3369280#.XmkEjaj7TRY) to support the sustainability of the FAMVACs and LGs. Responses from the communities of Katakwi District indicated that livelihoods have been improved through FAMVACS and, because of this, UNMA recommends the extension of these to other parts of the country. The Rainwatch Platform (http://walker.ac.uk/rw/) has also been developed and integrated into the FAMVAC and LG methodologies. Rainwatch aims to overcome limitations in climate services over Africa by providing a stable and open source platform for rainfall monitoring in near real time for timely and effective decision-making by relevant stakeholders and users. Rainwatch has been designed to be used by multiple actors, and has an open source User Manual to support users of varying skill(available at https://zenodo.org/record/3366368#.XnD1H6j7RhE). Uganda therefore drives the need for a new approach that synthesizes evidence from different disciplines including climate science, hydrology, and livelihoods. The NIMFRU project responds to this need, through a new approach that will provide comprehensive flood impact assessments for FbF across all

areas of Uganda, complementing the SHEAR-FATHUM project's outputs on forecast skill with basic household economy/socio-economic information, to guide preparedness, protection and response. *Key words: NIMFRU, FAMVAC, Community, and Flood forecast.*

3.9. Drought Assessment (1987-2017) And Adaptive Capacity of Households to Water Scarcity in Kasali Sub-County, Kyotera District, Uganda

Joseph Mukasa

The world is experiencing reduced precipitation, increased temperature, drought frequencies and intensities. Globally, approximately 4 billion individuals experience water scarcity due to drought. About 10% of the population in the south and north-eastern parts of Uganda experience drought related water scarcity annually. This study aimed at assessing drought and households' adaptive capacity to water scarcity during drought in Kasali, SW Uganda. This was done through determining drought trends from 1987 to 2017, assessing the impact of drought on water availability and indicators of adaptive capacity of households to water scarcity. Annual and seasonal (MAM, JJA, SOND and JF) temperature and rainfall components were analysed using regression analysis. Drought values per year were assessed using RDI calculated using Drought Index Calculator (DrinC). Results show a decrease in the average annual rainfall, MAM and JF seasons, while SOND and JJA seasons show an increase in rainfall trend. The average maximum and minimum annual temperature, MAM, JJA, SOND and JF seasons skyrocketed. Average minimum temperature increased more than the average maximum temperature. Kasali experienced one extreme dry year (1991-1992) and four moderate ones (1988-1989, 1999-2000, 2008-2009, 2016-2017). Households spend longer hours collecting water during dry years than wet years. Adaptive capacity of households to water scarcity was moderate and drought negatively impacted water availability. The study recommends provision of early warning information and more water points. There is also need for households to adopt a variety of adaptation strategies in order to increase their adaptive capacity.

3.10. Low Flow Analysis in Lake Albert, Edward and Victoria Basins

Sylvia Nanyunja Ndahura

Low flow is a seasonal phenomenon, and an integral component of a flow regime of any river. There is shortage of water due to drought as rivers dry up and the volume reduces significantly. This can affect water supply for domestic and livestock especially in the dry areas of the country yet most parts of the country depend on surface water. The major objective of this study is to carry out low flow analyses for Lakes Albert, Edward and Victoria Basins in Uganda. And the specific objectives are: to identify catchments with similar hydrological and physical characteristics, and delineate homogenous regions, to generate low flow series from a given time series of input flow data using Water Engineering Time series Processing tool (WETSPRO) and Extreme Value Analysis tool (ECQ) and to identify the most suitable probability distribution for analysing the extreme low flows. From the extreme value analysis, the results showed that Weibull distribution provided the best fit for the low flows in the catchments of Albert, Victoria and Edward. Nyakijumba and Nkusi stations were seen to follow heavy tails of the Weibull distribution for the inverse discharge implying lower probabilities of low flows; while Ruizi, Muzizi, Chambura and Mpanga rivers showed light tail behaviour and higher probability of low flows.

3.11. Comparative Suitability of the Global Hydrological Model GLOFAS against a Catchment-Based Model to Simulate and Predict Floods in Uganda

Mulangwa Douglas

The frequency and magnitude of flood events in Uganda have increased in the past few decades, with a total of 1363 flood events reported in Uganda over the period 2000-2016 and this can be attributed to anthropogenic activities like development in the flood prone areas. To better prepare for floods and reduce their impacts in Uganda, the Red Cross Red Crescent Climate Centre, the Ugandan and German Red Cross have piloted the Forecast-based Financing (FbF) approach in North Eastern Uganda from 2013 to 2018. Forecast-based Financing is an approach recently developed by the Red Cross Red Crescent Climate Centre to automatically trigger preventative actions based on climate and hydro-meteorological forecasts or real-time observations, before potential disasters, such as floods, strike. There are some different global hydrological models and large-scale flood forecasting systems like the African Flood and Drought Monitor tool (AFDM), Eastern Nile Flood and Drought Monitor tool (EN-FDM), Drought and Flood Mitigation Service (DFMS) and the Copernicus-EMS Global Flood Awareness System (GloFAS) among others. This research study is focusing on the Global Flood Awareness System (GloFAS) which is an operational, web-based and freely available system for global flood monitoring and forecasting and is part of the Copernicus Emergency Management Service funded by the European Commission. This study therefore seeks to assess the comparative suitability of GloFAS against a catchment-based model as possible alternative or complementary flood forecasting tools to be used in Uganda The aim is to assess whether forecasts produced by the global forecasting model, GloFAS, can be relied on by local relevant authorities as one of the tools to inform flood-preparedness actions or whether other ready-to-use hydrological models that can be set up at the catchment scale would provide better results. This research will also contribute to a better understanding of the performance of GloFAS to forecast floods in tropical areas and Uganda in particular and this will aid better decision making for humanitarian actions for flood-preparedness in Uganda in the context of the ongoing Forecast-based Financing project led by the Red Cross. This study is being undertaken following three specific objectives: (i) to estimate the biases in the rainfall reanalysis (ERA5) using local observed data available at some rain gauges in Uganda; (ii) to simulate river flows and floods in some Ugandan catchments using a lumped catchment-based model and the meteorological reanalysis ERA5 as input; (iii) to evaluate GloFAS hindcasts to determine the ability of GloFAS to forecast the duration and timing of the flood, as well as its magnitude estimated in terms of return period. Four catchments were selected for this study but the whole country will be covered in subsequent studies. So far, an analysis of the precipitation has been done using locally observed precipitation from UNMA and ERA5 reanalysis over a 38-year period (1981 to 2018). The parameters considered include the annual and interannual monthly statistics like total precipitation, monthly mean and daily precipitation bias and correlation. The results show that the seasonality of rainfall is well reproduced by the reanalysis for Uganda. However, there is a significant bias between the observed and ERA5 datasets in most catchments. Our current analysis is investigating whether this bias is propagated into the hydrological model outputs. Currently, evaluation of GloFAS hindcasts to determine the ability of GloFAS to forecast the duration of the flood, as well as the magnitude of the flood peak and its timing is ongoing. The results will contribute to inform the development of the Early Action Protocol for Uganda led by the Red Cross. If GloFAS forecasts are found reliable in Uganda, the system will be tested by the Ministry of Water and Environment and Department of Water Resources Monitoring and Assessment to provide flood forecasting information while the modelling unit is operationalized for possible dissemination of the forecasts to several government agencies and the private sector.

Table 1: Compendium of abstracts for Online-Uganda Water and Environment Week 2020

Applied Research Abstracts for Online-Uganda Water and Environment Week 2020				
S/n	Title of Abstract	Theme for UWEWK 2020	Category of applied research	Authors (Name & Contact)
1