



Ministry of Water and Environment

Uganda Water and Environment Week 2019 Abstracts

**Water and Environment a Strategic Driver in Attainment
of Sustainable Development Goals 2030.**



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INTRODUCTION

Uganda Water and Environment Week (UWEWK) is a weeklong event that is organized annually by Ministry of Water and Environment (MWE), spearheaded by Water Resources Institute (WRI). Since its initiation in 2018, the event seeks to contribute towards the attainment of Sustainable Socio-economic Transformation in collaboration with various partners and stakeholders. It provides an interface for sector actors and other stakeholders for knowledge exchange and improvement of Uganda's water and environment resources. This year the focus of UWEWK 2019 is on the centrality of water and environment in achieving Sustainable Development Goals (SDGs) by 2030.

1.1 BACKGROUND

The Ministry of Water and Environment (MWE) in collaboration with key partners held the first ever UWEWK in March 2018. The event attracted high-level political participation including the Vice President and the Prime Minister, and enabled stakeholders to deliberate on pertinent sector issues. In addition, the private sector and academic communities presented information, exchanged knowledge and built relationships.

Based on the success of the first UWEWK, the MWE through the Water Resources Institute (WRI) will hold the second UWEWK at the Water Resource Institute in Entebbe from Monday 18 – Friday 22, March 2019. The event will conclude with the annual commemoration of three important International Environmental Days: World Forest Day (March 21st), World Water Day (March 22nd) and World Meteorological Day (March 23rd).

The UWEWK 2019 is intrinsically linked to: Sustainable Development Goals (SDGs); achievement of economic goals such as reaching middle income status by 2020; and to Uganda's National Development Plan II (NDP II), which focuses on achieving structural transformation through increased industrial activity, with emphasis on manufacturing, including value addition in agro-processing. As Uganda seeks to industrialize and meet national development goals, development and management of water and environment resources will be critical to ensuring steady growth of the manufacturing, agricultural and service sectors.

1.2 WATER AND ENVIRONMENT A STRATEGIC DRIVER IN ATTAINMENT OF SUSTAINABLE DEVELOPMENT GOALS 2030.

Water and environment resources are strategic natural resources crucial for sustenance of life, agricultural production and industrialization, provides vital input for production, key to socio-economic transformation of society. The increasing pressures on water and environment resources coupled with challenges of climate variability and climate change compromise the natural resource base and absorptive capacity of ecosystems. Consequently, these affect the quality of life, national economies, and sustainable progress. Therefore, sustainable management and use of water and environment resources is vital in creating social economic transformation.

KEY NOTE ADDRESS

Peter Bjornsen

Director of the UNEP-DHI

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Fresh water, in sufficient quantity and quality, is essential for all aspects of life and sustainable development. The 2030 Agenda lists rising inequalities, natural resource depletion, environmental degradation and climate change among the greatest challenges of our time. It recognizes that social development and economic prosperity depend on the sustainable management of freshwater resources and ecosystems and it highlights the integrated nature of Agenda 2030. The establishment of SDG 6, *Ensure availability and sustainable management of water and sanitation for all*, reflects the increased attention on water and sanitation issues in the global political agenda.

Achieving SDG 6 is essential for making progress on all other SDGs and vice versa. Sustainable management of water and sanitation for example underpins wider efforts to end poverty, provide food, energy and improved health while at the same time maintaining the integrity of the environment. Countries' baseline reporting in 2017 showed that the World at large is not on track to achieve SDG6. Billions of people still lack access to safe water and sanitation; water pollution is increasing; agriculture places increasing stress on water resources; governance and capacity are generally weak; and ecosystems and their water services are in decline.

Uganda has devoted significant effort to furnish its population with safe water and sanitation services and to strengthen water resources management in the country. Still major challenges remain unresolved. For example, the pollution of Lake Victoria from multiple sources is continuing and is changing the lake from a natural eutrophic (nutrient-rich) state towards a dysfunctional hypertrophic state, affecting fisheries yields. Water hyacinth is again invading the lake affecting ports and maritime transport. The water level is sensitive to climatic changes, potentially affecting hydropower production. Wetlands provide important services to secure clean water resources and need better protection.

On the positive side, information on water is improving rapidly with new technologies providing global data and with increased awareness, participation and capacities at the national levels. Complemented with regional and national indicators, such as the ones being used for the sector performance review in Uganda, national governments and water managers alike are much better placed to assess what is working well and where there is a need to direct further efforts to ensure availability and sustainable management of water and sanitation for all.

WATER-FOOD-ENERGY-ECOSYSTEM NEXUS

This theme will focus on the inseparable link among security of water, energy, food and ecosystems which underpins sustainable economies and human well-being. It will explore means of addressing concerns about the availability, distribution, access and sustainability of water, food and energy and the resultant stress on natural resources due to increased climate variability and change and as more people migrate to cities and join the middle class. Special attention will be given to key cross-sectoral issues of policymaking, conflicts and conflict management, interdependencies (water, food- energy and ecosystems) in shared basins, water security and scarcity and nexus financing.

REGULATORY AND POLICY OPTIONS FOR PROMOTING THE DEVELOPMENT OF SUSTAINABLE RENEWABLE ENERGY USE IN UGANDA

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Renewable sources of energy are those sources that are replenished continuously by natural processes. Uganda is richly endowed with renewable energy resources for energy production and the provision of energy services. The most common sources of renewable energy include: solar wind, biogas and geothermal biomass. There are several environmental and social benefits associated with development and use of renewable energy. The major ones are that the renewable sources are eco-friendly, renewable, boost public health, create jobs and can be easily installed in rural areas. The impediments that may compromise the development and use of renewable energy in Uganda are: the subsidies on fossil fuel-based energy, access to affordable and sustainable financing to develop and use renewable energy in its early stage, inadequate regulatory and institutional environment at national, regional and international levels and insufficient stakeholder participation in the planning and implementation of renewable energy projects. The success of promoting the development and use of sustainable renewable energy depends on the existence of an effective regulatory framework for their sustainability. Such a regulatory framework should integrate economic, social and environmental objectives in a way that improves the wellbeing of the current generation whilst safeguarding the wellbeing of future generations. Regulation through law and policy has the potential to address many of the impediments decisions into renewable energy. While Uganda has developed energy and environmental law and policy to regulate the development of energy and use, there are impediments that need to be addressed through different options. The main purpose of this paper is to analyze regulatory and policy options for promoting the development of sustainable renewable energy use in Uganda.

EAST AFRICA FUTURE WATER SCENARIOS TO 2050

Sylvia Tramberend, Robert Burtscher, Peter Burek, Taher Kahil, Simon Langan

A key goal of integrated water resources management is to balance “supply” and “demand” for all water users across the water-food-energy-ecosystem nexus (WFEE Nexus), at different spatial and temporal scales in terms of quantity and quality of available water resources. Water scarcity intensifies when water demand increases and water availability (supply) in terms of quantity and/or quality decreases. This study attempts to understand the future water balance under a WFEE Nexus toward the year 2050 using an integrated modeling framework combining the hydrological model (CWATM) and the hydro-economic model (ECHO), under two future development scenarios. Based on the East Africa Vision 2050 and development visions of the EAC member countries, we develop an “*East Africa Regional Vision Scenario*”. The second scenario “*Business as Usual*” is based on the Shared Socio-Economic Pathway (SSP2). These scenarios inform the setting of modeling parameters. The study area includes the Lake Victoria Basin, the basins of the Victoria and Albert Nile, and all Nile tributaries upstream of the river gauging station of Laropi/Uganda. Sharp economic development and population growth expected through to the 2050 will lead to high increase of water demand across the WFEE Nexus. Much of it is expected to be offset with an increase of water availability due to climate change effects which will result in change of the flow regime of the Nile at Laropi. The results of the two scenarios show moderate water scarcity when measured using the Water Exploitation Index and

high-water scarcity when measured using the Water Crowding Index. Uncertainties of the modeling results are mainly attributed to the projection of various drivers such as irrigation area expansion, future water use efficiency parameters, and climate change effects resulting from the use of General Circulation Models.

SAFE WATER, WOOD FUEL, AND ENVIRONMENTAL IMPLICATION FOR DEVELOPING COUNTRIES:

A case of Uganda

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Energy is an engine of economic growth supporting industrial development and improving the safety of drinkable water at household level. Multivariate regression was used to analyse the data. The data included rainfall at six long-term stations, energy sources used to improve domestic household water and a survey of 90 households. The availability of a water-storage facility was found significant (< 0.05). Also, 87.0% of the household members used wood fuel as a source of energy to improve domestic water. Water-quality improvement measures that use wood fuel as an energy source affect the environment and human health as deforestation and greenhouse gas emissions are linked to climate variability and health risks (respiratory illnesses). Unsustainable consumption of wood for fuel and inadequate regulation of forests destroy woodlands, disrupts the ecosystem and causes environmental hazards. Policy makers and agencies in the energy and environment sector could increase information of energy efficient and usage in households to improve the safety of drinking water and climate change adaptation. Energy policies, such as emphasis of controlling and monitoring deforestation and increasing energy efficiency and conservation could minimise emissions and health impacts.

THE ROLE OF THE SERVICE MODEL IN SUSTAINABLE DEVELOPMENT CASE OF DROUGHT AND FLOOD MITIGATION SERVICE

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Throughout Africa, farmers are affected by the intensity, timing and length of both dry and rainy seasons becoming more and more unpredictable due to Climate Change. Although the Uganda National Meteorology Authority (UNMA) has registered improvements in weather predictions in the recent past, the situation in Uganda is no different: reliable and actionable weather and crop data is often not (known to be) available or inaccessible and of varying quality which leads to underperforming agricultural production and food insecurity. Access to robust meteorological, hydrological, and other Earth Observation (based) information enables informed decisions to be taken, risks and their associated humanitarian and financial losses to be reduced, and the effects of climate change to be mitigated. Whilst in the coming years and decades Uganda's National Meteorological and Hydrological Services continue to increase their capacity to provide such information, the Drought and Flood Mitigation Service (DFMS) Project is taking an innovative approach to allow decision-makers to benefit from robust information now. Working in cooperation with relevant Ugandan Ministries, Departments and Agencies under the leadership of the Ministry of Water and Environment (MWE), a consortium led by the RHEA Group has created a suite of agricultural, environmental, and water management information products that are provided as a subscription-based service. DFMS will support MWE with reliable satellite data for monitoring of SDG 6 and 13. By delivering DFMS as a service rather than a system to be operated by e.g. MWE, the need for infrastructure investment and operating the underlying platform is removed. Moreover, the service must continuously develop and meet changing user needs to stay competitive with drives sustainability.

EXPERIENCES AND LESSONS FROM STRENGTHENING TRANSBOUNDARY WATER GOVERNANCE AND COOPERATION IN THE IGAD REGION

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Intergovernmental Authority on Development (IGAD) region comprises a number of international watercourses and trans-boundary aquifers, though over 60% of the region is made up of arid or semi-arid lands that are among the most vulnerable areas to climate variability and drought in Africa. The IGAD Member States recognize that central to the well-being of the population is access to reliable quantities of water of sound quality and predictable availability. In January 2015, IGAD endorsed a Regional Water Resources Policy with the overall objective to promote closer cooperation among member States in the equitable, sustainable and coordinated utilization, protection and management of trans-boundary water resources in the region for poverty eradication, regional integration, environmental sustenance and peaceful coexistence. Some of the experiences and lessons gained from this process include the following: capacity building is necessary to improve skills and understanding in transboundary water governance and cooperation; legal and institutional framework at various levels are necessary for transboundary water governance and cooperation; transboundary water governance and cooperation is multi-stakeholder and multi-level process; transboundary cooperation is only possible when there is trust; in most cases, riparian countries are interdependent and rely on one another either through a common heritage, trade and to build cooperation it is essential to understand these interdependencies and connectedness between countries; stakeholders have strong attachment to the traditional volumetric water sharing; limited capacity and understanding and application among stakeholders of the international frameworks.

POTENTIAL ROLE OF THE WATER RESOURCES INSTITUTE IN HELPING UGANDA ACHIEVE SUSTAINABLE DEVELOPMENT GOALS BY 2030

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The Ministry of Water and Environment established the Water Resources Institute (WRI) in March 2018 to address the current and emerging water resources related issues in the country and globally. The Institute will be a centre of excellence that provides cutting edge applied research and training; delivers continuous professional skills development across all levels in water resources management and development, and serves as a neutral place for dialogue and outreach on water resources related issues. Its major functions will among others include (i) developing policy, legal, social, technological, and scientific expertise in the water resources sector; (ii) planning, facilitating, and conducting research responsive to national and regional needs; (iii) promoting technology transfer and the dissemination and application of research results to appropriate users; (iv) providing for education and training of scientists, engineers, and students as water resources professionals through their participation in research; (v) assisting public and private interests in the planning, regulation, conservation, development, and utilization of water resources through outreach program; and (vi) providing opportunities for research grants to be awarded by organizations under national, bilateral, multilateral, and international arrangements. Although the WRI is still young it has demonstrated potential to revolutionize the sector through applied training with over 15 short courses involving over 600 participants held since March 2018. To ensure that the institute is well positioned to contribute to the socio-economic development of Uganda through sustainable development and management of water and environment resources, priority has been given to preparation of a strategy and business plan. This paper will therefore explore the potential role of the WRI in helping Uganda achieve Sustainable Development Goals by 2030. It will also explore the mechanisms and strategies that need to be employed if the institute is to make the expected contributions.

ANALYSIS OF THE ONSET, CESSATION OF RAINFALL AND LENGTH OF THE GROWING SEASON OVER WESTERN, CENTRAL AND EASTERN LAKE VICTORIA BASIN IN UGANDA.

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As it is in most tropical countries including Uganda, rainfall is a critical climate factor for agriculture production. The important rainfall features critical in determining the crop growth, farming system, and sequence and timing of farming operations are the rainfall onsets, cessation and the length of the rainy season. The main objective of the study was to establish the onset, cessation dates and the durations of seasonal rainfall over Western, Central and Eastern Lake Victoria Basin. The pentad analysis showed; an early onset of the rains for both MAM and SOND and late cessation of rains in the Western, Central and Eastern Lake Victoria Basin with durations of the growing season of 14 weeks, 12 weeks and 12 weeks in MAM and 17 weeks, 18 weeks and 16 weeks in SOND respectively. The spatial analysis gave a mean MAM onset date of March 10th for both the Western and Eastern Lake Victoria Basin and March 23rd for Central Lake Victoria Basin; cessation date of July 1st, June 13th and June 19th; and the length of the growing season of 17 weeks, 14 weeks and 15 weeks for Western Lake Victoria Basin, Central and Eastern Lake Victoria Basin respectively. During strong El Nino and La Nina years rains started early and ended so late leading to long growing seasons for MAM. Conclusively; there is an inter – annual variability of seasonal onset, cessation and the length of the growing season for MAM in the study area.

THE INFLUENCE OF ALTERNATIVE LIVELIHOODS ON FISHERIES AND NATURAL RESOURCES REGENERATION; A GENDERED SOCIOLOGICAL INTEGRATED NATURAL RESOURCES MANAGEMENT (INRM) PERSPECTIVE.

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Worldwide, livelihood enhancement is associated with Improving livelihoods and promoting economic growth particularly of poor people dependent on single livelihood options such as women in the marginal fisher communities as they are more directly exposed to the risks of livelihood shocks as a result of mismanagement of natural resources which are not limited to fisheries and water resources. Few implementation activities however focus on the strategic relevant supportive alternative livelihood options that are sustainable in diversifying income of the women in fisher communities. This is an important omission as it limits the ability of the women to meet their Practical and Strategic needs and performing their productive, reproductive and community roles that transform into access and control of resources. In order to address this problem, the Multi National Lakes Edward and Albert Integrated Fisheries and Water Resources (LEAF II) Project under the Ministry of Water and Environment has used an innovative approach of Alternative livelihood programme at Mahyoro landing site in Kamwenge district. A total of 584 women were trained in environmentally friendly alternative options including making bar soap, school chalk, Vaseline, jazzy, liquid soap, cake and hair shampoo thereby diversifying the income sources and easing pressure on the fisheries resources and the natural resource environment at large. An assessment of performance of the trained groups was carried out and findings indicated that the women were producing and making sales of the items in which they were trained. By resolving the livelihood monotony, LEAF II Project is able to empower the most marginalized and isolated vulnerable fisher women with livelihood security through training in various alternative livelihood initiatives.

IMPACT OF CLIMATE AND LANDUSE/COVER CHANGES ON THE SURFACE AREA OF LAKE WAMALA, UGANDA

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The surface area of Lake Wamala, one of the significant small (about 180km²) fresh water lakes in central Uganda, has been shrinking since 1990. However, there is no significant water abstraction for irrigation or hydro-power

generation, implying that the reduction could be due to land cover change and climate variations. This study evaluated the impact of climate and land cover change on Lake Wamala surface area. Modified Normalized Difference Water Index (MNDWI) was employed to delineate the lake area from Landsat Enhanced Thematic Mapper (ETM+) images for the period of 1990-2017. Land use maps were developed from Landsat images using maximum likelihood classifier, while a Mann-Kendal test was used to determine the trends in surface area, rainfall, temperature and land cover change. Results show a no trend in rainfall, a slight increase in temperature and an increase in agricultural and built-up land for the period of 1990-2017. The lake's surface area significantly shrunk between 1990-1995, while the period 1995-2017 is marked with a rebound in the lake. The fluctuations in the surface area are attributed more to land cover change rather than climate variations.

RAINWATER HARVESTING KNOWLEDGE AND PRACTICE FOR AGRICULTURAL PRODUCTION IN A CHANGING CLIMATE: A REVIEW FROM UGANDA'S PERSPECTIVE

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With Uganda's changing climate, rainfall distribution patterns have become more irregular over time and space. Excess water during rainy season is causing runoff, soil erosion, nutrient depletion and crop damage which reduces the productive capacity of land. It thus remains difficult to achieve the agricultural development targets identified in the National Development Plan for Uganda, without addressing regular incidences of adverse impacts of climate change. The overarching objective of this paper was to carry out an assessment of the status, performance, and scope for improving rainwater harvesting (RWH) for small-scale agriculture under local conditions. Accordingly, research gaps in RWH technologies were identified and documented to inform future studies. The research was carried out in the semi-arid areas of Nakasongola, Rakai, and Hoima Districts characterized by crop-livestock dependent livelihoods. Findings show that RWH technologies could enable smallholder farmers and agro-pastoralists to become more resilient to increasing climate variability and climate change by conserving soil and water thus increasing food production. Small-scale irrigation systems have enabled farmers to adapt to drought challenges by enhancing crop yields and allowed farmers to target for higher market prices. However, there are challenges including threats to sustainability of such established systems because of lack of community participation in systems' monitoring and maintenances, vandalism, and some systems require high investment costs.

APPROPRIATE HYDRO POWER TECHNOLOGY FOR UGANDA IN ATTAINMENT OF SUSTAINABLE DEVELOPMENT

David Kataratambi

This study examined river-run hydro power technology in rivers of Uganda. The focus was on answering the question "are river-run hydro power plants the future of electricity in Uganda" River- run hydropower technology continues to dominate on rivers in Uganda and this is posing a threat to access and use of waters in rivers. The aim of this study was to: assess water reliability in rivers; assess actual performance of river-run hydro plants against planned power generation; analyse various water demands; and evaluate environmental concerns to get a broader view of water stress and the likely water conflicts. The methods used involved reviewing and analysing of: (i) Hydro power Feasibility studies, (ii) Reports from water permit holders and water permits, (iii) Environmental Impact assessment reports, (iv) Hydrological data from data bases, (v) meetings with stake holders, (vi) Internet, (vii) minutes of Water Policy Committee.

The findings revealed There is low water reliability at high/medium flows in most river systems and thus, most hydro power plants are designed at flow rates of less than 40% reliability. Optimal design flows are available for very short

periods in a year! (ii) River –run systems lack the capacity to store energy generated thus not easily adapting to electricity demand. (iii) Increasing water demand for Agriculture, Industries, etc. (iv) Potential to generate power that may not be needed and Lack of potential to generate power when it may be needed (v) conflicts in water use by various users including the hydropower users on the same river system. Due to low water reliability, increasing water demand for various uses and changing climate, river-run plants cannot be the long-term solution for electricity in Uganda. Therefore it is recommended to: limit number of river run hydropower plants, Explore other renewable energy sources, Ensure thorough Environmental Impact Assessments, Consider multipurpose reservoirs, and avoid plants on river with flows less than 50% Reliability.

WATER-FOOD-ENERGY-ECOSYSTEM NEXUS: A CASE STUDY OF IMPLEMENTATION OF SIPI INTEGRATED WATER MANAGEMENT AND DEVELOPMENT PROJECT

Louis Mugisha and Muhammad Badaza

In Uganda before the adoption of the Catchment based Integrated Water Resources Management framework, water and other related interventions were implemented without considering the interrelatedness and inter-linkages of the environmental resources. This led challenges of declining of water quantity and quality thereby threatening water supplies and ecosystems. In 2011, the Ministry of Water and Environment adopted Catchment based Integrated Water Resources Management as a comprehensive, holistic and integrated approach management of water resources. It creates synergy among various sectors and promotes efficiency in the utilization of water and other related resources. At the heart of this framework is preparation of Catchment Management Plan (CMP) for each catchment Currently a number of Catchment Management Plans (CMPs) have been prepared for a number of catchments in the country which include Awoja Catchment in Kyoga WMZ. As part of implementation of this plan a project called Sipi Integrated Management and Development Project is implemented the project is made of three components which are being implemented in tandem. These components are: Water Supply, Irrigation and Catchment Restoration activities This paper tries show how the Water-Food-Energy-Ecosystem approach was used to implement one of the ongoing project- Sipi Integrated Water Resources Management and Development Project and in Awoja Catchment, Sipi sub catchment and what has been achieved so far. It also highlights some of the challenges faced and suggest solutions

RURAL DEVELOPMENT WITHIN THE FRAMEWORK OF IWRM IN KARAMOJA

Isaiah Ndongu,

GIZ ENWASS Moroto

Semi-arid Karamoja is the least developed region in Uganda, subdivided into three livelihood zones that correspond to annual rainfall pastoralism, agro-pastoralism, agriculture. Karamoja is one of the most vulnerable regions to climate risks in Uganda. Drought, flooding, water scarcity and crop failure are recurrent climate-related disasters. Although Karamoja receives relatively high rainfall, the absorption capacity of its soils is extremely low. A consequence of the exploitation of nature reinforced by climate change is the destruction of catchments resulting in: high levels of soil erosion and sedimentation; high speed of water run-off and evaporation rates; loss of surface and ground water reservoirs and increased nutrient depletion leading to low productivity. There is considerable potential to adapt to climate change, particularly through improved land and water management, appropriate policies and capacity building. it is essential to reduce surface water run-off and evaporation as well as to store water. This can be achieved through: hard-ware (construction and rehabilitation of large-scale and spatially well distributed water storage infrastructure) and Soft-ware (Soil and water conservation to reduce erosion and run-off Water can be used for livestock production, agro-pastoral production and irrigation of fruit plantations). The main purpose of GIZ Climate Change Adaptation Project was to improve the resilience of ecosystems through community-based disaster preparedness, climate-smart agriculture and sustainable resource management. Additionally, IWRM and source protection was implemented within Lokere Catchment to demonstrate the nexus between natural resource restoration and water for production infrastructure. This reduced erosion, decreased run-off and increased the infiltration rate of water in the soil. These technologies have diversified and improved agro-pastoral production/ food security whilst demonstrating appropriate and resource-friendly use of micro-catchments.

FOREST REFERENCE EMISSION LEVELS A KEY FACTOR IN WATER-FOOD-ENERGY-ECOSYSTEM NEXUS IN UGANDA

John Diis

Forests are a key factor in the environment and for that reason they are cross cutting across several themes. Forests play a big role in the water cycle and they ensure stable supply of water. For that reason, they are vital in ensuring food security for humans and wildlife. They also provide biomass energy for domestic and industrial purposes especially in developing countries. Efforts to ensure sustainable forest existence are important in the water-food-energy-ecosystem nexus. This is what is being done under the strategy to reduce emissions from deforestation and forest degradation (REDD). One important step in REDD is to establish a forest reference against which implementation efforts can be measured. Uganda produced its final Forest reference emission levels (FREL) in January 2018 and submitted to UNFCCC. FRELS are expressed as tonnes of CO₂ equivalent per year for a reference period against which the emissions and removals from a results period will be compared. It is a baseline for assessing each country's performance in implementing REDD+ activities. Uganda's FREL was produced by a combined effort of the REDD+ Secretariat, FSSD and NFA under the guidance of the Climate Change Department in the Ministry of Water and Environment. Currently, emissions from deforestation are estimated at 8.255 million tonnes of carbon per year. Efforts are underway to develop capacity to improve Uganda's FREL to include other activities such as: Forest Degradation; Conservation of carbon stocks; Sustainable management of forest carbon stocks; Enhancement of forest carbon stocks.

SUSTAINING THE LAST OASIS: AN ECOSYSTEM APPROACH

Margaret Aharikundira

Watershed management is about protecting and improving the water sources as part of a multiple barrier approach to ensure the delivery of safe drinking water. Provision and accessibility of adequate, safe supplies of water is a major source of concern, expense and even international tension. This is not because water supplies are insufficient but rather due to the inability to organize supply properly to meet demand. Until recently, the main focus of efforts to improve urban water supply has been within the cities themselves, including better distribution systems, treatment plants and sewage disposal. It is however clear in recent times that while forests are less able to control some contaminants (for example the human parasite *Giardia lamblia*), forests can substantially reduce the need to treatment for drinking water and thus radically reduce the costs of supplying water. The concern remains on how to bridge the gap to replenish forest services and rescue the inner forest patches from illegalities? This paper analyses efforts to alleviate pressure on forests and interventions to provide alternative energy sources to the charcoal burning community in Kyegegwa District.

SUSTAINABLE RESTORATION OF WATER AND RELATED RESOURCES

Annette Kezia Nantongo

Uncoordinated development of water and related resources has led to their gradual deterioration ultimately leading to negative socioeconomic and environmental impacts thereby requiring proper planning to achieve effective and sustainable management and development of these resources. This planning is best achieved at the lowest appropriate level and based on hydrological catchments, thus Catchment Management Planning. Being a stakeholder driven process, this planning provides a mechanism for knowing the catchment physical, socioeconomic and environmental conditions, catchment characteristics, people's aspirations and needs, potential development opportunities, challenges, risks and threats that need to be addressed. The results of this process is a Catchment Management Plan (CMP) which is a strategic tool for managing water and related resources on a catchment scale consisting of a list of investments (both management and infrastructure) that need to be implemented in the catchment based on the identified challenges and opportunities. Through this process, a CMP for Aswa catchment was developed and implementation of the identified interventions is ongoing in Kochi and Aswa II sub catchments. In order to ensure sustainability of these interventions, identification and confirmation of priority catchment management measures in the sub catchments was done through collection of relevant data from the CMP and various

stakeholders including the Ministry of Water and Environment, District and lower Local Governments, Catchment Management Committees, local communities, among others. Together with the stakeholders and building from the previous work during the development of the CMPs, hotspot areas with high incidence and/or risk of soil erosion or loss, vegetation loss, flooding and drought were identified and confirmed. Participatory field resource assessments were done for each identified hotspot, and an agreement of the key issues, catchment management measures/interventions and responsibilities of each stakeholder during implementation for sustainable management of the resource and the potential livelihood options was reached. Environmental project briefs and bills of quantities were also produced making it ready for the next stage of implementation of concrete adaptation measures on ground.

CASE OF AWOJA CATCHMENT, KYOGA WATER MANAGEMENT ZONE.

Mohammed Badaza and Louis Mugisha

In Awoja Catchment, water scarcity stands at the forefront, and unsustainable consumption and over-abstraction of surface and groundwater resources contribute to water shortages and threaten long-term sustainable development. Options being adopted to enhance water supplies include water harvesting for multipurpose uses, conjunctive use of surface and groundwater. Currently, only 5 percent of the Awoja Catchment potential water resources are developed and less than 1 percent of catchment's cultivated land is irrigated and less than 1 percent of hydropower potential is being developed for electricity generation. Awoja catchment also has other renewable energy potentials, such as solar and biomass. The Awoja catchment is one of the Uganda's most food insecure regions and majorly an agrarian region with agriculture, both crop production and livestock as the backbone of the local economy, employing an overwhelming majority of the population. The opportunity for the expansion of agricultural products and livestock remains untapped. With an estimated livestock population of millions, the Awoja catchment has not adequately made use of its resources. Most water-related interventions are short term and target a single problem, rather than the entire complex set of problems that communities face. This paper explores state of energy, food, water and environmental security in Awoja, main strategic goals, development policies, challenges as well as related intersectoral issues and highlights solutions and benefits.

EXPERIENCES ON THE IMPLEMENTATION OF CATCHMENT INVESTMENT PLANNING IN UPPER NILE WATER MANAGEMENT ZONE

A Case Study of Kochi Sub-catchment in Northern Uganda

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Integrated catchment management plans (ICMPS) identify the catchment issues and strategic management measures, defines a range of management options and preferred management approaches (Catchment Investments) for avoiding, remedying environment risks and effects, it sets out roles, responsibilities and tools for implementation and review. Kochi Sub Catchment is one of the 12 sub catchments that form the Albert Nile Catchment in Upper Nile Water Management Zone (UNWMZ). Its area covers almost 1600 km² with a total population of 376.975 people in 76.105 households. Ninety Percent of the population depends on subsistence agriculture. Crops grown include cotton, sunflower, simsim, cassava, millet, sorghum, potatoes, soybean and pigeon peas. Crop production is largely rain fed with high risks of exposure to flood and drought, and therefore loss of yields. There is a high dependency on the natural resources (land, vegetation and water resources) for agricultural and livestock production, daily household activities like cooking and cleaning, and additional income generating activities like charcoal and timber production hence increasing the pressures exerted on the Natural resources in addition to the impacts of climate change. To break this vicious circle, ICMP for the Albert Nile Catchment have been prepared and currently the implementation of catchment management measures, including soil and water conservation, river bank protection and restoration; and providing alternative livelihoods for affected communities (catchment investments) are under implementation. This paper examines the catchment investment planning in UNWMZ, approaches used in identification of the investment measures, challenges encountered and recommendations

GENDER AND WATER RESOURCES MANAGEMENT

Namwanje Robinah Olga

In Uganda, 85% of Uganda's 34 million people depend on rural water sources such as boreholes and swallow wells. In most instances, water in the rural areas is provided by the government or NGOs who later hand it over to the community to manage through the establishment of Community Based Management System (CBMCs) which form the Water User Committees (WUCs) whose responsibility is to ensure the continuity of the functioning of water resources. As a limited resource, water supply sometimes suffers challenges. Some of these challenges include; Non-functionality of the management of water sources, breakdown of the water sources, Poor Operation and maintenance of rural water sources because of unwillingness of the water users to own and manage the water facility, and inadequate funds to maintain the water facilities. In creating the CBMC and the WUCs the challenge has always remained on gender consideration. Poor management affects mainly women and it is right to empower them through greater and more effective participation (United Nations 2005). Well as women are the most affected when it comes to water use, they were always left aside on the WUCs and the management of the water sources.

In response to the gender challenge in water resource management several approaches have been put in place to demonstrate the importance of gender equality at the core of inclusiveness and human capital development. Policy-frame works mandate all development Institutions to promote gender equality and women empowerment while executing programs and activities to guide gender equality and women empowerment effort in their respective Sectors. Much as these efforts have been made and these policies have been put in place, Women are still less involved in Water Resources Management Issues. It is not clear why women are less involved in the Management of Water Resources. This study focused on gender and water resources management among water user committees in Nakasongola District. It assessed the contribution of women participation in water resource management through Water User Committees (WUCs), how they understood and performed their roles, the positions they occupied, the associated challenges to their participation and impact of their participation on water resources sustainable operation and maintenance or functioning. A qualitative methodology was used and comprised of interviews with various stakeholders including the Ministry of Water and Environment, district technical and political staff WUC, Local Councils.

ASSESSMENT OF THE POTENTIAL IMPACTS OF OIL AND GAS DEVELOPMENT AND ASSOCIATED ACTIVITIES ON WATER RESOURCES IN THE ALBERTINE GRABEN

Anthelem Iragena

The emerging petroleum sector has a high potential to contribute significantly to alleviating poverty and improving living standards in Uganda, as envisioned in national oil and gas policy. This prospect can potentially accelerate development, as anything before, and drive Uganda to become an important economic player in the region. However, oil exploration may impact negatively if appropriate mitigation measures are not put in place. Both direct and indirect effects might occur in the environment including national parks, bodies of water, forest reserves and to the economy. It is envisaged that the oil development activities will involve heavy abstraction of water resources for injection in wells to maintain underground pressure and avoid collapse of the ground. More-so, the water generated in the production process needs to be treated and disposed before being discharged. The Strategic Environmental Assessment (SEA) for the Albertine Graben in 2013 clearly indicated how the environmental issues associated with oil and gas development must be implemented in the legal framework, regulations, Policies, Plans and Programs (PPPs) and any specific strategic aspects related to petroleum activities. The SEA identified several issues such as; discharges and Emissions from the Petroleum Industry, waste Management, water Management, and oil spill preparedness on land and in surface Waters. Therefore, a comprehensive impact assessment that considers the water resource availability, needs, and associated environmental concerns posed by the oil and gas development is a necessity. This shall be a basis for a holistic management planning for the transboundary water resources in the Graben. The findings from the assessment later guide oil companies in taking the Final Investment Decisions (FID) and also allow Uganda Government to formally notify to the Nile Basin countries of the beginning of oil development activities seeking their no objections.

ASSESSMENT OF IMPACTS OF CLIMATE CHANGE ON HYDRO-METEOROLOGICAL ECOSYSTEM SERVICES AND WATER STRESS IN LAKE KYOGA CATCHMENT.

Tumusiime D. Moses

Climate change is predicted to increase the frequency of climatic extremes that can lead to loss of life and property. Basing on climate change studies the sensitivity of water resources to climate change over Lake Kyoga catchment was investigated. This study analyzed the water stress from the impacts of climate change on hydro-meteorological ecosystem services. The methodology involved analysis of available meteorological and hydrological observations, analysis of Global Weather Data for ArcGIS/SWAT output data and finally the seasonal performance of precipitation and temperature using Climate Predictability Tool (CPT) outputs. The Correlation Percentage change was used to estimate the rate of change of flow and water levels under a changing climate. The outputs for different stations showed that climate change has already affected water resources in Lake Kyoga catchment with continuous reduction in water levels of 6%. The results of the study revealed that climate change is likely to increase precipitation by 10-20% received during the wet seasons resulting in higher stream flow and a reduction of 20-40% of precipitation during the dry seasons. The GCMs also demonstrated an increase in maximum and minimum temperatures of 1 to 30C by 2065 with minimum temperatures increasing more rapidly compared to the maximum temperatures for the two scenarios (RCP4.5 and RCP8.5). The strategies for adaptation and mitigation measures have been identified

POTENTIAL OF WIND ENERGY DEVELOPMENT FOR WATER ABSTRACTION SYSTEMS IN DEVELOPING COUNTRY CONTEXT: A CASE OF TESO SUB-REGION OF UGANDA

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Wind energy powered pumps could be an alternative to conventional fuel powered pumps for water abstraction because they rely on a free energy and they are environmentally friendly. The objective of this study was to assess the potential of wind energy to operate water abstraction systems in Teso sub-region of Uganda for livestock watering. Daily mean wind speeds recorded at a height of 10 m for a period of ten years (2005-2015) were collected from Amuria and Soroti Meteorological stations in the study area. Data were analyzed using Weibull distribution to evaluate the annual wind speed frequency distributions and consequently assess their potential for water abstraction. The results indicated that warmer months (January, February and March) have higher mean wind speeds than the cold months (August, September and October). High wind speeds in the dry seasons corresponded to the periods of high water demand. The highest shape parameter (k) of 3.07 was registered in 2009 and scale parameter (c) of 3.78 in 2012. The highest wind power density of 43 W/m² was obtained the year 2012 while the lowest wind power density of 15.47 W/m² was obtained for Soroti district in the year 2009. The maximum power extractable in Amuria in 2012 was 324 W/m² which is potentially enough for water abstraction. Maximum discharges of 1.86 m³/s and 1.52 m³/s were obtained for Amuria and Soroti districts respectively at mean wind speeds of 5 m/s. Therefore, Teso sub region winds have potential for water abstraction and Amuria district has better sites for livestock watering using wind energy.

RAINWATER HARVESTING BALANCES LAND USE ACTIVITIES OF FOOD-PRODUCTION AND ELECTRICITY-PRODUCTION,

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The term nexus in the perspective of water, food and energy signifies that these aspects are intimately linked to the extent that actions in one aspect affect all the others, as well as on ecosystems. Natural resources are facing increased pressure due to population growth, and economic development. These result in increased energy and food needs which automatically lead to increased pressures on natural resources. Such needs have to be met in a

sustainable way, without compromising the functioning of ecosystems. During the planning and decision making processes, Energy, land management and water resources have to be given due and adequate attention to enhance water, energy and food security. Because water, energy and food are interrelated, there is need to draw a lot of attention towards increasing them. Water–energy–food nexus can support food security and sustainable agriculture. Population growth, rapid urbanization, changing diets and economic development are some of the factors driving increased demand for water, energy and food. Agriculture is the largest consumer of the world's freshwater resources, and more than one-quarter of the energy used globally is expended on food production and supply. Feeding a global population expected to reach 9 billion people by 2050 will require an increase in food production. In this paper, URWA will focus on promotion of Rainwater harvesting as one best practice that will increase the availability, distribution, access and sustainability of water, food and energy, since it greatly addresses issues of climate change, and improves energy and food security. This paper shows how rainwater harvesting balances land use activities of food-production, electricity-production, and solar panels. Activities in the food-energy-water nexus require ecosystem services to maintain productivity and prevent ecological degradation, and this is addressed through practising rainwater harvesting.

FACTORING SPATIAL VARIABILITY OF RAINFALL IN THE DESIGN OF OPTIMUM RAINGAUGE NETWORK FOR UGANDA

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Director Station Networks and Observations

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Weather and climate monitoring is a strategic undertaking by the global community for purposes of understanding and planning with the climate natural resource. The challenge of climate change calls for accurate meteorological data, information and/or advisories especially while undertaking climate trend analysis for planning purposes. For rainfall, a well-designed rain gauge network addressing spatial variability is critical for accurate and reliable estimates of the areal or point average rainfall estimates at any desired location. This study therefore sought to assess the current rain gauge network and design a feasible optimum rain gauge network for Uganda. Basing on the 16 Homogeneous Climatological Zones (HCZs) and quality-controlled data for 136 stations from previous studies, the WMO recommended formula was applied to determine the 'Feasible Optimum Rain gauge Network' (FORN) for each Climatological Zone (CZ) through suitability analysis using ArcGIS V10.3 software. A 7% maximum allowable error (ϵ) for rainfall estimation, was subjected to the coefficient of variation of every CZ to keep the error as low as possible but also to factor in affordability and sustainability. Results indicated a very low functionality of 5.2% for the current rain gauge network compared to the colonial time coverage of 1075 stations. The buffer analysis yielded the land area left for locating rain gauges, which when divided by the number of stations in a HCZ, gives the pixel size, translating to the gauge density per that particular zone. The 7% rainfall estimation error therefore resulted in 1,057 rain gauges (including the 136 baseline stations), which is close to 1,075 rain gauges that have ever been operated though with subjective distribution and hence the term 'Feasible'. Once the resultant network design is fully implemented, poor coverage and generation of adequate rainfall data shall be addressed, which will further help in comprehensive hydrological analyses to support water resources management plans, to boost the national climate change adaptation and mitigation efforts especially within the agriculture and energy sectors.

RETHINKING EXTENSION SERVICES ON CLIMATE CHANGE RELATED INFORMATION TO SMALLHOLDER FARMERS IN KASANGOMBE SUB COUNTY, NAKASEKE DISTRICT

Lukwago Rashid

Smallholder farmers are more vulnerable to climatic change variability and impacts. Access to climate change related information underscores the challenge among such farmers under the conventional farming extension service system especially in hard to reach areas like rural areas of Nakaseke district. The study demonstrates that the penetration of mobile phones among smallholder farmers provides a unique opportunity to reach out to such farmers with relevant and timely climate change mitigation related information. Through the cross-sectional survey involving 155 smallholder farmers, this study focused at the use of mobile phones by smallholder crop farmers to access climate

change related information. Study findings show that 63% of the farmers were receiving climate change related information using different mobile phone applications. Study findings indicate that mobile phones have enhanced the speed and mode of relaying climate change related information amongst farmers. Farmer to farmer extension through the SMS easily enables farmers to share climate change related information. Study findings further revealed that the mobile phone inbuilt radio was the most used application to access climate change related information at 49%, voice call at 32% and SMS at 19%. This was attributed to zero costs incurred by farmers as a result of using the phone inbuilt radio. Climate change related information was identified as critical in farm level decisions in all the villages in Kasangombe Sub County, Nakaseke district. Among modern ICT tools, mobile telephony has been most recent and widely accepted mode of delivering information not only in rural areas, but also in other areas in Uganda. However, the limited capacity of farmers in the use of mobile phones is only destined to benefit a few literate farmers

SEASONAL VARIATION IN CHEMICAL CONSTITUENTS OF ALESTES BAREMOZE (PEBBLY FISH) IN LAKE ALBERT, UGANDA

Amal Magga

The main objective of this study is to determine the Seasonal Variation on Chemical Constituents of *Alestes baremoze*. From the dry salted and fresh fish sample. The Specific Objectives .to determine the chemical composition of *A.baremoze* (Amino acid, fatty acid, moisture content, crude protein, fat Content, vitamin A, gross Energy, Ash content and minerals). Three size of the sample Fish in three different size groups (small, medium and large) will be collected from Lake Albert during the dry season is in the lab to analysed for chemical composition (Amino acid, fatty acid, moisture content, crude protein, fat Content, vitamin A, gross Energy, Ash content and minerals) using different methods. all the procedures and the principles will be applied and the sample will be analysed from analytical Lab Kyambogo university, objective two and three include water quality analysis using laboratory methods, sensory evaluation which was done by panellist members of Kawanda research centre, Rigor mortis that was done on site. And Post-harvest losses of processed *Alestes baremoze* along the value chain of salted fish are also being documented. For this objective the batch of 40 fish sample were processed and collect from three different points to determine the loss from processing point at the landsite, Kampala market and the last quantity sold from Kampala market and at each stage, the samples will be used to determine the physical, economical and nutritional loss. All data will be subjected to duplicate. Statistical Analyses will be performed using (ANOVA) Significance level will be at 0.05. including Analysis of Variance. Descriptive statistics will be used to calculate the mean and standard deviation values of the water and parameters and Pearson correlation will be used to determine the relationship between the causes of loss (Damage factor).

CONDITIONS FOR SUCCESSFUL COMMUNITY-BASED WATER MANAGEMENT: PERSPECTIVES FROM RURAL UGANDA

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Operation and maintenance of communally managed water infrastructure is still an uphill task despite over a decade of implementing community-based water management system in rural water provision in Uganda. Using mixed methods and Ostrom's eight design principles as an analytical framework, this article examines the relevance of the design principles in explaining the success and failure of collective self-management institutions in determining sustainable access to safe water in Uganda. The findings show that, to a large extent, the differences in water infrastructure management effectiveness in the two study communities are explained by the existence or absence of the organizational characteristics prescribed by the design principles. The results further highlight additional factors that are critical for successful community-based water management which are not explicitly covered by the design principles. This implies, therefore, that the design principles should not be used as a 'blueprint' on resource management regimes especially in developing countries.

THE CONTRIBUTION OF ALTERNATIVE NO-REGRET LIVELIHOOD ENTERPRISES FOR BUILDING RESILIENT COMMUNITIES, ECOSYSTEMS AND ASSOCIATED CATCHMENT IN UGANDA

A case of communities within Nyarunzinga, Kandekye—Ruhorobero and Nyamuhizi-Kagogo wetland systems catchments in South Western Uganda.

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Environmental Alert

The concept of promoting alternative No-Regret enterprises (e.g. apiary, mushroom production, crafts making, piggery, and fish-farming) has been tested in Uganda and several other countries and found to positively contribute to building the resilience communities, environment and natural resources. This is being up scaled by the Government of Uganda in collaboration with the United Nations Development Programme and the Green Climate Fund through the project titled, 'Building Resilient Communities, Wetland Ecosystems and Associated Catchments in Uganda.' It's being implemented in eastern & southwestern Uganda targeting 20 districts. Environmental Alert on behalf of the Ministry of water and Environment facilitated processes for promotion of promoting alternative No-Regret enterprises in selected wetland systems and associated catchments in south western Uganda. This involved highly consultative stakeholder participation at the national, local and community level. This was through key informant interviews and targeted stakeholder group consultations through meetings and focus group discussions. The information generated was synthesized through content analyses and the results were validated during the regional stakeholders meeting that paved way for implementation of actual interventions for promotion of the selected alternative No-Regret enterprises. The following interventions were implemented: capacity needs assessment for the beneficiary groups in respect to their technical and institutional status in respect to the selected enterprises using a value chain approach; targeted and responsive practical trainings based on the needs assessment; participatory monitoring and backstopping to ensure that the beneficiary groups & individuals are ready to receive the support; discussions with beneficiary groups & individuals on the terms and conditions for the support as detailed in memorandum of understanding to ensure sustainability of the initiative; procurement and delivery of the required inputs (i.e. tools, improved breeds and technologies) to the beneficiary groups as a way of boosting productivity of the enterprises. Six wetlands community based organizations benefited from this initiative. Were as for starters individuals within each group have benefited on behalf of the group members, as proceeds from the enterprise are realized each group agreed on framework for sharing them with other group members until the time when all the group members have benefited. Within this framework the group members, the sub-county leadership and the district have a role of regular monitoring and backstopping to ensure the group's and projects objectives are achieved. Furthermore, the groups and community should be targeted for improved access to others development services to address their needs which may not be delivered within the project framework.

TREES ON FARMS: FARMER CHOICES FOR ENHANCED ECOSYSTEM BENEFITS

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Species abound in every habitat, but when those habitats are destroyed the biodiversity disappears with them. Uganda is losing 200,000 ha of forest cover annually due to agricultural expansion and increased demand for tree products. More forest land will continue to be destroyed due to agricultural expansion to feed the growing population. Biodiversity loss is therefore predicted to continue and yet these resources are essential for food, energy and general ecosystem health. Studies elsewhere have shown that using the land-sharing model, agricultural lands can be sustainably managed to conserve biodiversity and provide critical ecosystem services for the benefit of the growing population. This however needs to be managed while considering the needs and choices of individual farmers. Using a mix of choice experiments among farming households in Mt Elgon sub-region in Uganda, the World Agroforestry Centre (ICRAF) in collaboration with other partners are seeking to understand the factors that influence the retention and establishment of trees on farms (agroforestry) for enhanced ecosystem services and landscape restoration. This is intended to farmers' willingness to integrate trees on their farms, estimate the 'demand' for the

new technologies and ascertaining their key determinants; ascertaining the characteristics of farmers who are likely to adopt agroforestry practices and investigating the attributes agroforestry practices impact upon farmers' prospective adoption decisions. This paper will explore the methodologies for assessing farmers' decision-making processes for adopting integration of trees on farms to meet livelihood needs and ecosystem services. With such information, policy makers and practitioners will be informed on the best choice species to promote in a given landscape for enhanced ecosystem services.

ANALYSIS OF NDVI AND RAINFALL VARIABILITY TO DETERMINE THE PLANT GROWING SEASON IN KARAMOJA REGION

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Uganda's climate is naturally dynamic with high temporal and spatial rainfall variability, some of which can be explained by large-scale oscillations in atmospheric and ocean circulation. This vulnerability emanates from the high dependence on Agriculture, which employs approximately 72% of the population. It is estimated that 80% of the country's population is engaged in Agriculture in one way or another. In the rural areas, 90% of the households are engaged in Agriculture. In Uganda, agriculture is heavily reliant on rainfall due to limited irrigation. Studies have shown that rainfall and temperature variability have a significant impact on the crop growing season and hence food security. The impact of rainfall variability on crop growing season is exacerbated by limited investments in irrigation within the region. This study sought to utilise GIS as a tool to spatially characterise the interactions between rainfall and the Net Difference Vegetation Index (NDVI) variability in order to determine an appropriate plant growing season in Karamoja region. Rainfall variability was analysed using the rainfall data from the Uganda National Meteorological authority while NDI data for Uganda was downloaded from online sources. Statistical applications SPSS was used to carry out predictive modelling of the growing period with rainfall and NDVI variability as Geographical Information Systems (GIS) was used to identify the spatial relationships. The resulting maps helped generate recommendations for interventions that can be implemented by governments and development partners in order to mitigate the negative impacts of rainfall variability on food security in the region

GEOSPATIAL ASSESSMENT OF LAND AND WATER MANAGEMENT OPTIONS FOR ENHANCED LAND PRODUCTIVITY IN MT. ELGON SUB-REGION, UGANDA

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Most households in Mt. Elgon sub-region in eastern Uganda are vulnerable to land degradation and food insecurity resulting from vegetation clearing, soil erosion and nutrient depletion. Over 80% of the population are smallholder farmers depending on rain-fed agriculture. To address this challenge, the World Agroforestry Centre (ICRAF) in collaboration with partners are implementing a four-year "trees for food security project" in the Mt. Elgon sub-region. The project aims to improve food security and livelihoods of smallholder farmers through widespread adoption of appropriate and locally adapted farming practices. Given that water availability is a constraint, one of the project objectives focusses on the integration of appropriate water management technologies to enhance adoption of agroforestry interventions. Six sub-counties in Mbale district including; Busiu, Buta, Nakatsi, Nalwanza, Namabya and Namanyonyi were mapped using satellite imagery and ground truthing. Up to 63 maps were produced and of these 42 are base maps depicting the digital elevation model, land use, soil, rainfall, slope and temperature. The rest are thematic maps showing appropriate land and water management options, potential run-off that can be harvested and potential soil loss if no conservation is practiced. The findings indicate that the area with closed forest is 10.5%, a proportion acceptable but at a marginal tipping point towards degradation. The rainfed agriculture area requiring soil and water conservation and agroforestry is 299.7Km² (22%) of the district. Given that 36% of Mbale district has slopes exceeding 60%, authorities need to carefully monitor encroachment of agriculture into these sensitive areas to avoid further degradation and potential landslides. The findings also indicate that 23% of the district requires terraces and agroforestry systems to be implemented reverse land degradation. We conclude that the Government of Uganda

needs to embrace geospatial assessment and other similar planning approaches which provide context-based solutions to natural resources management

SUSTAINABLE UTILIZATION OF WASTE

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Value addition in agro-processing in Uganda is mostly carried out in towns where processing units are located far away from the points of production. The process of value addition is associated with generation of waste. During peak seasons of production, waste generation is highest due to lack of appropriate storing capacities and preservation techniques and long distances between production areas and potential consumption centers. Management of solid waste is a public health and environmental concern in most of the developing countries in the world especially in the cities. In Kampala, about 28,000 tons of waste are collected and delivered to landfill every month. Kampala Capital City Authority records show that this represents approximately 40 % of the waste generated in the city. The remaining uncollected waste is normally burnt and/or dumped in unauthorized sites. KCCA reports that 90% of the 1,300 tons of waste delivered at the final disposal point in Kiteezi is landfilled. This contributes to 12% of global methane emissions being generated by landfills, which is greatly damage the environment. In an effort to explore opportunities for achieving green growth through sustainable development and management of water and environment resources, special focus will be given to Sustainable utilization of waste. Empowering locals where production takes place with small processing units to utilize waste as a source of energy (biogas) for processing combined with solar energy (renewable source) would reduce on the quantity of waste generated in cities/towns. This will help in reducing the effects caused to the environment through contribution to mitigation of greenhouse gas emissions and also contribute to sustainable production.

EVALUATION OF SPATIAL VARIABILITY OF SUSPENDED SEDIMENT YIELD IN MEDIUM-SIZED TROPICAL CATCHMENTS OF SOUTHWESTERN UGANDA

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Suspended sediment yield (SSY) data for tropical regions are very scarce, yet these data are highly needed to assess land-use/cover changes and their ecological effect on water resources. Measurements of SSY of eight medium-sized sub catchments (100-500 km²) of the upper Rwizi were conducted for two consecutive hydrological years from 1st June 2009 to 31st May 2011. At the outlet of the sub catchments, depth-integrated samples were taken on a flow proportional basis. River flow depth was measured every 30-min using pressure transducers throughout the year. Rating curves were established to estimate river discharge and SSY. The results show the average SSY for the sub catchments ranges between 40 and 1152 t km⁻² yr⁻¹. Considering upper Rwizi catchment, the average SSY is 465 t km⁻² yr⁻¹. The magnitude and spatial variation of SSY is influenced by the spatial pattern of land-use/cover change. The average SSY for the sub catchments with intact, moderately and heavily encroached riverine papyrus swamp respectively is 93, 371 and 638 t km⁻² yr⁻¹. Owing to encroachment of riverine papyrus swamps, the valley bottoms composed of alluvium, become sediment sources rather than sinks through remobilization of the unconsolidated sediment. River bank erosion is accelerated by removal of riverine papyrus vegetation and by livestock trampling. The sediment generated by riverbank erosion and cultivation in swamps is readily available for transport hence, the high SSY downstream. Hence, it is crucial to maintain and protect these papyrus swamps since, they have a significant buffering effect on sediment fluxes from the upland areas in the catchment towards the rivers.

RISK MANAGEMENT OF NEW HYDROPOWER DAMS ON THE WHITE NILE CASCADE A CASE STUDY OF ISIMBA & KARUMA HYDROPOWER DAMS IN UGANDA)

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The development of dams is undoubtedly vital for the Uganda's socio-economic development; however, such dams could pose a high potential risk to the downstream communities. A proactive dam risk management is therefore required to mitigate impacts of potential downstream injury and property damage, as well as catastrophic and long-lasting environmental impacts. This paper presents an integrated decision-making framework for analyzing risks and uncertainties for Hydropower Dams development which takes into account dam design, construction, impoundment and the long term operation. The paper also proposes strategies for mitigating risks that could be caused to property, human life and the environment. The framework uses an integrated Potential Failure Mode Analysis to identify and develop a risk matrix, risk mitigation measures, and Emergency Preparedness Plan. The framework and approach is illustrated on Isimba & Karuma Hydropower Dams, currently under construction on the Victoria and Kyoga Nile Cascade in Uganda. Results indicate that the framework can be used to rank and prioritize risks amidst data scarce scenarios. The approach will help dam managers to rank prioritize dam risk mitigation interventions and investments amidst budget limitations.

HYDRAULIC MODELLING AND ASSESSMENT OF IMPACTS OF HYDROPEAKING: A CASE STUDY OF 48MW MUZIZI HYDROPOWER POWER PROJECT - UGANDA

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Unsteady flow phenomena caused by hydropeaking operations, power surges and intermittent or rapid changes in environment flow releases typically affect river morphology, aquatic habitats, and often livelihoods and public safety. The analysis conducted for the 48 MW Muzizi Hydropower Project in Western Uganda encompassed the retention effects of the tailrace channel and the River Muzizi, and impacts of flow fluctuations on the aquatic ecosystem in the reduced flow section of the river and downstream the tailrace. The analysis is based on an analytical approach and a 2D numerical simulation using HEC-RAS, Version 5.0.3 which was used to simulate flow characteristics during passage of the rising limb of an observed hydropeaking event in the tailrace channel downstream of the powerhouse of Muzizi HPP. The effect of hydropeaking was estimated taking into account the retention of the tailrace channel itself and the River Muzizi. Baseline conditions in the Muzizi river system have been determined and effects of fluctuating flows predicted. This paper presents these findings and proposed mitigation measures including alternatives to hydropeaking such as a solar hybrid, river bed modification, flood protection and adequate design of outflow into the Muzizi river.

WATER AND ENVIRONMENT: WIS A STRATEGIC TOOL IN THE ATTAINMENT OF THE SUSTAINABLE DEVELOPMENT GOALS 2030

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The Water Information System (WIS) of Ministry of Water and Environment is a web based customized solution that was developed based on a server-client model of a distributed system architecture. The WIS was designed and developed to address issues of fragmented data sets, poor quality of data, data that are not readily accessible nor readily usable; and non-transparent policies, standards and protocols to a new paradigm of effective data collection,

integrated, harmonized data warehouse and dissemination to users. WIS aims at providing a central access point for water information and putting a halt to data fragmentation by providing a single-entry point that shows the user clearly what information is available and where to get it. It is comprised of independent but interlinked databases for the Hydrological Information System (HIS), Spatial Data System (SDS), Information Management System (IMS), Knowledge Management System (KMS) and the data dissemination system (DDS). This paper therefore is to highlight operational structure of the fragmented databases under the various Directorates and Departments of MWE; the operational structure and processes after the implementation of WIS phase I; and as well the proposed operational structure and processes after the upgrade and implementation of the second phase of the WIS.

SCRAMBLE FOR WATER IN STRUGGLE OF TRANSFORMATION IN UGANDA: NEITHER TOO MUCH NOR TOO LESS WATER TO AID THIS DESIRED TRANSFORMATION

Food Rights Alliance

Uganda's development trajectory is buttressed on industrialization and commercialization of agriculture, sectors which depend on water resources. Uganda's Vision 2040 recognizes how critical water resource is to development of hydropower, agricultural development, tourism, industrialization and mitigation of climate change. Uganda receives total annual rainfall of 500 - 2000mm. However, 80% of Uganda experiences rain deficit with total rainfall far less than the evaporation. Renewable fresh waters are declining at 34% in the past 16 years and the total water resource base estimated at 66.6bn m³ in 1995 had declined to 43.3bn m³ by 2011. There is little attention paid to how much water is required to produce how much produce. The desire for increased adoption of water for production equally collides with celebration of extractive industry and industrialization drive whose transformation trajectory is hinged on increased exploitation of water resources a central factor of this transformation with little attention is paid to it. The desk review looked at National Development frameworks, specific Sector Investment Plans as well as specific studies already conducted. 10 gallons of water are required to produce a gallon of beer, 480 gallons of water to refine a barrel of crude oil, 18litres to produce 1kg of meat, 1500 - 2000litrs of water to produce 1kg of sugar and 2500 – 3400litrs of water to produce 1kg of rice. Bringing the realities of these findings into policy development will allow conscious and targeted interventions to improve sustainable use of water resources among all sectors, strengthen governance and contribute to sustainable development.

WATER, SANITATION, ENVIRONMENT AND SOCIETY

This theme will focus on how water and environment contribute to society and how society can enhance its stewardship role and contribute effectively to achievement of SDGs related to water and environment. Focus will be given to the role of faith-based organisations, cultural institutions, the private sector, children and youth, community based organizations etc. It will look into issues of inclusive Water supply, Sanitation and hygiene services, politics and governance of water and ecosystems, sustainable urbanization, irrigation, industry water and environment innovations, water and environment businesses, waste water management

KEY NOTE ADDRESS

Water, Sanitation, Environment and Society in an age of Disruptive Technology

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The world is facing a number of challenges both traditional and new as governments seek to better manage their water and other natural resources and provide a range of water, sanitation, irrigation, and environmental services to their growing populations with increasing climate risks and in an increasingly complex global, regional, national, and sub-national stakeholder environment. Today, no community is content to live with poor service quality and degrading ecosystems around them and no agency content with a culture of “data-free analysis and analysis-free decision making” using outmoded ways of working. We are also now entering an era of “disruptive” technologies that are changing the fundamentals of how we make decisions (with data from modern sensors, earth observation, cloud analytics, machine learning, and apps/portals/dashboards), produce things (with 3D printing, robotics, nanotech, etc.), and interact with each other (with crowdsourcing, crowdfunding, social media, and the sharing economy).

This keynote will set the global context for the need for stewardship on water and environment and how the role of emerging technologies can help us completely rethink our work on resource planning and management and service delivery. What if we could estimate reservoir levels or river flows from space? What if we could forecast the flow in any river segment anywhere in the world 15 days in advance? What if we could enable farmers and dam operators to have customized early alerts on their smartphones to help make more informed decisions? Can we think of 3-D printed weather or flow monitoring stations? Can we unleash the power of free open data and analytics to help unleash the creativity in Uganda? ...All these are not science fiction but all proven technologies that are harbingers of much more to come from the accelerated pace of technological change. This will help us rethink the information, institutional, and investment framework to better manage our natural resources and service delivery and change our ability to rapidly access and contribute to global good practices.

STRENGTHENING TRANSBOUNDARY WATER GOVERNANCE AND COOPERATION: CASE OF SIO-MALABA-MALAKISI SUB BASIN OF THE NILE

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In many basins or countries, demand for water resources for food, energy, ecosystem is increasing while its supply is declining or becoming scarce. Nevertheless, the scarce water resources are shared between different stakeholders for multiple uses. These stakeholders often represent varied interests, drawn from different sectors and a wide variety of ecosystems including lakes, rivers, and national parks that are home to a rich variety of fauna and flora of high tourism value. Despite this potential, the sub-basin faces constraints primarily from increasing water scarcity and deteriorating water quality from poor land use practices, catchment degradation and river bank destruction. Therefore, strengthening transboundary cooperation in the SMM basin has the potential to accelerate socio-economic development and reverse environmental degradation. Cooperation among the two SMM riparian countries has evolved to a formal establishment of a Memorandum of Understanding (MoU). In addition, the two SMM riparian

countries have agreed on an SMM Basin Investment and Development Framework whose objectives are: (1) to support the identification and preparation of investment projects with transboundary implications; (2) to support the prioritization and sequencing of investment projects in the basin; (3) to facilitate the mobilization of funding to implement investment projects in the basin; and (4) to support the implementation of the investment projects in the basin by enhancing the monitoring and evaluation of their implementation from local to national to regional scales in transboundary settings. The question we should therefore ask is: how can transboundary water governance and cooperation be strengthened to yield better and more sustainable benefits across these different scales and stakeholders? To answer this question, this paper presents a case study on the joint decision making and planning process in the Sio-Malaba-Malakisi (SMM) sub-basin of the Nile, shared between Kenya and Uganda.

MONITORING AND EVALUATION SYSTEMS IN THE WATER AND ENVIRONMENT SECTOR

A case study of Uganda

Daphine Ann Abeinemukama, Charity Kansiime, Judith Orishaba

By 2030, universal and equitable access to safe and affordable drinking water for all should be achieved. Safe water has become one of the most important issues of our time and will continue to be well into the future. The challenge is to find approaches to water management that give people the quality of life they seek while protecting the water systems that are also the foundations of our wellbeing. In order to understand water and environment endowments in relation to its contribution to society and to use it as a means towards reaching a wider goal of attaining the SDGs, policy makers need to be able to assess how the policies that are put in place are performing and what outcomes have been achieved. To this effect, a coherent system of Monitoring and Evaluation (M&E) should be developed. Indicators are the basic building blocks of such a system. It helps to answer key questions such as: where are we now, where do we want to go, are we taking the right path to get there, and, finally, are we there yet? An appropriate and comprehensive M&E system provides insights into effective and efficient management of water and environment programs and helps to reformulate policies, reallocate resources. It also supports transparency and gives civil society, cultural institutions and governments a way to assess the performance and impact of their interventions. This way, it also serves advocacy and communication purposes.

IMPACT OF IMPLEMENTATION OF DEMAND SIDE MANAGEMENT OF WATER USE IN A BEVERAGE INDUSTRY

A case study of Century Bottling Company Ltd Mbarara Branch

Bashir Kamulegeya

Century Bottling Company Ltd - Mbarara Plant was established in 1998 as a franchise of Coca Cola International Ltd to manufacture and distribute a range of Coca Cola products within the south-western region of Uganda. Century Bottling Co. Ltd decided to participate in the pilot project on Demand Side Management of water use in MSMEs through adoption of water efficient techniques and practices under SWITCH Africa Green in order to support its goal of reducing its water consumption indicator to a standard set by Coca Cola International. With technical support from Uganda Cleaner Production Centre and Directorate of Water Resources Management, the company was able to implement a number of water saving initiatives including: sealing off all water leakages, installation of a contactor to synchronize the flow of water in bottle washer final rinse with the machine dive, eliminating overflow of tanks in the bottle washer and leakages in the final rinse, channeling RO reject water for re-clarification, revising the re-use-frequency for clarifier blow down as opposed to just draining the water to environment and installation of float valves on the storage tanks and pressure relief valve on the supply line. Implementation of such initiatives has resulted in social, economic and environmental benefits including: 17% reduction in water demand by the company despite a 7% growth in Production volume during the implementation period, reduced water bills by more than 15%, improved water productivity i.e from 3.06 L of water/ L of beverage processed to 2.3 L of water/ L of beverage processed and reduced volume of effluent.

OPERATIONALIZATION OF CATCHMENT BASED WATER RESOURCES MANAGEMENT IN KARAMOJA

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The Integrated Water Resources Management (IWRM) project was an addendum to the “Enhancing Resilience in Karamoja Programme (ERKP)”, funded by DFID. The goal of ERKP was to increase resilience to extreme climate and weather events in semi-arid Karamoja through strengthening nutrition programmes, livelihoods and food security for vulnerable communities. The project objective was to improve coordination of water resources management at local, district, zonal and central level. With support from this project, the CbWRM approach was initiated and operationalized in Lokok and Lokere catchments that covers parts of Karamoja and Teso regions. The planning framework for water resources had not been operationalized in Karamoja region thereby leading to uncoordinated development and management of water resources in Lokok and Lokere catchments. In addition, the CbWRM was not clearly known by key stakeholders in the catchments and the linkage between human activities was not well understood. The development of the Lokok and Lokere CMPs as planning frameworks has given rise to several projects as part of the implementation of the plans. Under the same project, stakeholder platforms called the Lokok and Lokere CMOs were established for the two catchments and have been instrumental in bringing together stakeholders during development of catchment management plans. The GIZ ENWASS project co-funded by European Union under DINU is one such project that aims to increase the climate resilience of communities and enhance local level water governance in Karamoja aimed at consolidating stability in Northern Uganda, eradicate poverty and under nutrition. The project will contribute to increased production of diversified food and strengthen the capacity of local governments to deliver services to the communities.

WATER CONTAMINATION WITH HEAVY METALS AND TRACE ELEMENTS FROM KILEMBE COPPER MINE AND TAILING SITES IN WESTERN UGANDA: IMPLICATIONS FOR DOMESTIC WATER QUALITY

Abraham R. Mwesigye

Mining and processing of copper in Kilembe, Western Uganda, from 1956 to 1982 left over 15 Mt of cupriferous and cobaltiferous pyrite dumped within a mountain river valley, in addition to mine water which is pumped to the land surface. This study was conducted to assess the sources and concentrations of heavy metals and trace elements in Kilembe mine catchment water. Multi-element analysis of trace elements from point sources and sinks was conducted which included mine tailings, mine water, mine leachate, Nyamwamba River water, public water sources and domestic water samples using ICP-MS. The study found that mean concentrations (mg kg⁻¹) of Co (112), Cu (3320), Ni (131), As (8.6) in mine tailings were significantly higher than world average crust and were being eroded and discharged into water bodies within the catchment. Underground mine water and leachate contained higher mean concentrations (mg L⁻¹) of Cu (9470), Co (3430) and Ni (590) compared with background concentrations (mg L⁻¹) in un contaminated water of 1.9, 0.21 and 0.67 for Cu, Co and Ni respectively. Over 25% of household water samples exceeded UK drinking water thresholds for Al of 200 mg L⁻¹, Co exceeded Winsconsin (USA drinking) water thresholds of 40 mg L⁻¹ in 40% of samples while Fe in 42% of samples exceeded UK thresholds of 200 mg L⁻¹. The study however found that besides mining activities, natural processes of geological weathering also contributed to Al, Fe, and Mn water contamination in a number of public water sources.

ENVIRONMENTAL CONCERNS ON RIVER NILE AND IMPLICATIONS FOR UGANDA'S ENVIRONMENT MANAGEMENT ASPIRATIONS

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River Nile remains a lifeline of both lower and upper Nile countries but in different perspectives. While lower Nile countries of Sudan and Egypt primarily rely on the river for domestic, commercial and national water needs other countries that generate the water use the resource in equally similar but different context and approach. These ways

including agriculture, transportation, and energy among others are associated with differing environmental pressures and consequences particularly where they are not properly managed. Over time, the use of the river has generated a number of concerns both; environmental and strategic. The paper highlights the different environmental concerns and the related consequences on the riparian countries. Spatial, political and strategic concerns including rights over use of the river and related sharing agreements, water volume and national development aspirations are attached an environmental perspective. The paper discusses the key environmental concerns including, pollution, sedimentation, evaporation and water quantity and quality issues in general. It further synthesizes the underlying causes and effects and provides a way forward. While the focus is on Uganda, all the river's riparian countries are included. It is hoped that exposition of the different environmental concerns will keep the river's concerns on both the policy and operational agenda of Uganda and neighboring countries and result into fair and sustainable use of the river for a sustainable environment.

CYANOBACTERIA AND SOCIETY

Olokotum Mark, Veronica Mitroi, Marc Troussellier, Jean-François Humbert, Ronald Semyalo, Catherine Quiblier, Bernard Cécile, William Okello

Lake Victoria (LV) is a good example of the huge challenge facing the South countries concerning the sustainable management, monitoring and protection of their surface water resources. Although the lake remains a vital resource, this increasing eutrophication is a major threat to its ecological functioning and support to the growing populations. Several surveillance programmes have collected water quality data in the framework of the Lake Victoria Environmental Management Projects (LVEMP I and II) in addition to other research programs in the past 20 years. Based on this extensive literature, we aim to present a review of the direct and indirect relationships between socioeconomic factors and cyanobacterial blooms (and more globally eutrophication). On one side, an analysis of the history of eutrophication in LV and the current available knowledge on cyanobacterial toxins. The demographic data of populations in the LV watershed will be related to land use changes, and to eutrophication process of the main lake as well as the consequences of growing urbanization near B&Gs, which lead to the hyper eutrophication of these sub-ecosystems. The last part of the presentation will concern (i) the potential impact of these cyanobacterial blooms on the ecosystem services provided by the lake; including the economic costs of cyanobacterial blooms for the water supply, and (ii) a global analysis of the efficiency of the numerous actions that have been undertaken with the goal to reduce nutrient loads and consequently cyanobacterial blooms in the main lake and in B&Gs. In conclusion, we will discuss the importance of the B&Gs for the human populations but also for the functioning of the main lake. These highly polluted areas that collect wastewater originated from large urban areas appears to constitute buffer areas and probably limiting the pollution of the main lake.

THE ROLE OF THE TECHNICAL SUPPORT UNITS IN THE PROVISION OF DECENTRALIZED WASH SERVICE DELIVERY IN UGANDA

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Following the decentralization policy and supported by the Local Governments Act 1997, the Ministry of Water & Environment in 2001 established eight Technical Support Units (TSUs) to provide specialized support to District Local Governments. In April 2017, the number of Units increased to ten. The main aim for setting up TSUs was to improve performance in the water and sanitation sector by ensuring efficient and effective provision of sustainable services throughout the country. The TSUs were the first de-concentrated structures of MWE and because of their success other departments followed suit and regional offices have been set up. Since their creation, the funding for operations has majorly come through the Joint Water & Environment Sector Support Program (JWESSP). Also, the Development Partners continue to support provision of WASH services to the rural communities in Uganda. With changing trends in the sector, aimed at providing safe and sustainable WASH services in line with Sustainable Development Goal (SDG) No 6 and Vision 2040, the need for technical support to Districts and other stakeholders remains very high; since the sector is dynamic with new developments in WASH service delivery targeted at achieving SDG Goal No 6 and Vision 2040 that include sustainable development of water resources, use of nature

based green technologies, improving service levels, adaptation to climate change and sustainable sanitation solutions. This paper highlights key roles played by the TSUs. It also provides a justification for their continued existence in order to provide specialized technical support to districts and eventual attainment of SDG 6 by 2030.

HYDROGEOCHEMICAL EVOLUTION OF GROUNDWATER RESOURCES IN THE ALBERTINE GRABEN

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Rural communities in the Albertine Graben (Uganda) where recent oil discoveries are undergoing development has one of the highest population growth rates in the country and world, and yet it depends on groundwater as its only source of potable water. Hydrogeochemical evolution and insights to contamination of water resources arising from petroleum activities in the Albertine Graben was primarily determined by data collected under the current study and archived/historical data. Interpretation of the hydrochemical data for 6 surface; 55 groundwater samples; and 1 rainfall sample for the wet season; and 6 surface; 57 groundwater samples for dry season under the current study reveals weathering of silicate rocks that entails reverse cation exchange, precipitation and evaporation as the significant processes influencing ionic concentrations. Multivariate statistical analyses of the hydrochemistry, trace and heavy metal data attributes high concentrations of Hg, Fe and Mn to possible anthropogenic sources associated with oil exploration in the Albertine Graben. Geogenic sources related to terrigenous input have been suggested for the major cations and anions as well and possibly some trace and heavy metals that include: As, Al, Cu, Cd, Cr and Zn in the sampled water sources.

APPLICATION OF INTEGRATED ENVIRONMENT MANAGEMENT STRATEGIES TOWARDS SUSTAINABLE WATER AND SANITATION SERVICES DELIVERY: CASE OF NATIONAL WATER AND SEWERAGE CORPORATION

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In the past, the need for water source protection has often been neglected in the development and management of water sources. Consequently, many drinking water sources have become contaminated or dried up. As a key strategy for achieving as the clean water and sanitation global agenda, NWSC has undertaken a multitude of source protection/ micro-catchment restoration initiatives. These are being implemented in partnership with Ministry of Water and Environment, civil society, community- based organizations and youth. Micro-catchment restoration projects undertaken under the towns of Arua and Bushenyi were mainly aimed at improving water quality, reliability of water supply and improving the livelihood of communities within the micro-catchments used by NWSC as raw water sources. The approach used was “community based” method to ensure sustainability of water infrastructure investments that rely on these water sources and youth groups. In addition, NWSC through the young water professionals’ programme, launched the “one million tree campaign” to ensure that at least one million trees are planted within the catchments serving as water sources in all areas of operation. NWSC embarked on climate change adaptation projects including the; Nakivubo waste water treatment plant with a treatment capacity of 45,000 m³/d. 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 however their 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 is a good example to other utility companies in Africa.

DISTRICT WATER, SANITATION AND HYGIENE (WASH) MASTER PLAN; A TOOL TO FOCUS LOCAL GOVERNMENTS TO ACHIEVING SDG6

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Kabarole District has developed a comprehensive WASH master Plan 2018-2030 to ensure universal access to improved WASH and IWRM to all by 2030. The District WASH Master Plan provides the roadmap for Planning, Coordination and Implementation of the strategic actions required to ensure that everyone in Kabarole has access to Water and Sanitation services by 2030. The biggest reality is that it will be a tool to mobilize resources needed to fund SDG6 in Kabarole District. Under the decentralized framework, a district is a water authority that should ensure policies, strategies and approaches are actualized into access to Improved WASH and implementation of IWRM. Without a clear analysis of the access gap, funding needs, and funding strategies, it will be difficult for any district in Uganda to achieve SDG6. It is these challenges that prompted IRC to support Kabarole district Local Government to develop a comprehensive WASH Master Plan. The District WASH master Plan was developed through several reflection meetings, compressive data collection and wide stakeholder consultations. This has been aligned to the National Vision 2040 and National Development Plan. Already, in the process of Developing the WASH Master Plan, an enlighten and awareness raising of stakeholders involved has been created. The WASH Master plan is a tool for engagement with the private sector players' investments in water and sanitation services for achievement of SDG WASH. To maximize benefits, there should be massive dissemination of the WASH master plan, ensuring periodic reviews and modification to suit the economic changes. Other district could adopt the approach of the Master planning to create a critical mass of districts from which lessons can be harnessed.

ROLE OF CENTRAL GOVERNMENT IN FOSTERING COLLABORATION AMONG VARIOUS CIVIL SOCIETY ORGANISATIONS. CASE STUDY OF MPANGA, KABAROLE DISTRICT.

Jackson Kitamirike

Albert Water Management Zone

The civil society organisations in Uganda had always worked in isolation towards creating awareness and implementing Catchment Based Water Resources Management in the local communities in the Albert Water Management Zone. Duplication and lack of accountability had since emanated from the various players in the catchment that were trying to implementing remedial measures of the highly degraded hotspot areas highlighted in the developed Catchment Management Plan. An all-inclusive social structure with the various players has since adopted the Albert Water Management Zone. This has, therefore, led to the increment of geographical scope in implementing catchment-based water resources activities by the various actors in the catchment and fostered collaboration of the different player's in efficient optimisation of the available merge financial resources. The model used in Mpanga can be adopted and rolled out to other catchments in the zone and country. This would lead to increased accountability from the civil society and Central Government in trying to serve the local populace

GROUNDWATER CHARACTERIZATION OF LAKE BASINS IN UGANDA

A case of the Kyoga Basin in Eastern Uganda

Nancy Mary Nahabo

Groundwater is a more reliable and principal source of drinking water in Uganda, due to its relatively good quality and wide distribution. Uganda embarked on groundwater development through drilling boreholes, to increase the safe water accessibility by 2020. Nonetheless, the characteristics of most basins in Uganda, including the Kyoga basin are not well understood a limitation to the sustainable development of the resource. This study utilized data on 5120 out of 9769 boreholes located in Kyoga basin, to examine the characteristics of the basin underlying aquifers. Inverse

distance weighted technique was used to interpolate main water strikes, overburden depths, static water level and borehole depths. Results indicate that static water level, first and main water strikes are generally shallow in central parts of the basin and the overburden depth varied across the basin. This implies that in areas with thicker regolith and deeper main water strikes for example around L. Kyoga, there is need to drill and install casings up-to total aquifer depths, implying higher costs for aquifer development. Shallow regolith with deeper main water strikes imply few casings and open hole design. The study results are useful in guiding local groundwater developers, decision makers and district planners on borehole designs, the estimated pump installation depths and the suitable technological options across the Basin.

IMPROVING ENVIRONMENTAL MANAGEMENT GOVERNANCE IN UGANDA

Nathan Mununuzi

The Environment and Natural Resources are the foundation and main building blocks for Uganda's economy. They are also the primary source of livelihood for millions of Ugandans in rural and low-income urban areas. However, the ENR sector is under threat and with it, the economic and livelihood opportunities are at risk and our national security is being compromised. Recent studies have highlighted worrying trends that suggest reversals in the achievements made in the ENR sector. The consistent conclusions from these studies point to the failures in governance as the primary reason for the apparent reversals. Over the last two decades, Government has put in place a robust policy, legal and institutional framework for the management of the sector as part of the strategy to address the decline in environmental parameters. However, it has not been possible to attain the levels of good governance envisaged under these reforms.

Recognizing the urgent need to address governance issues in the ENR subsector, the Ministry of Water and Environment constituted a Good Governance Working Group to spearhead implementation of governance actions in the sub sector. The working group prepared a Good Governance Action Plan for 2013- 2016 and this has since been reviewed and a revised action plan for 2017- 2020 has been finalized. The Environment and Natural Resources Good Governance Action Plan comprises a set of actions and interventions of the Government of Uganda designed to address the current governance challenges in the Environment and Natural Resources (ENR) Sector. The overall goal of the actions set out in this Action Plan is to improve the governance of the ENR sector as a strategy to enhance the sustainability and productivity of Uganda's natural resources capital. Good governance of the sector will also increase predictability and certainty in the policy environment.

THE GENDER COMPOSITION STATUS OF THE EXECUTIVES OF CATCHMENT MANAGEMENT ORGANIZATIONS IN THE WATER MANAGEMENT ZONES OF UGANDA.

C. Niwagaba, R. Musota, N. Waiswa
Directorate of Water Resources Management

Catchment Based Water Resources Management (CBWRM) following principles of Integrated Water Resources Management is an approach being used by the ministry of water and environment (MWE) to manage water and related resources in Uganda. Stakeholders' participation in management of water and related resources at the lowest appropriate level forms one of the pillars for this approach. 22 Water and related resources stakeholders' governance structures called Catchment Management organizations (CMOs) have been formulated in various catchments and sub catchments with a total of 605 Catchment Management Committee (CMC) members. The CMO manual requires all local governments in a catchment to be represented on CMC by at least a political or administrative head and that the chairperson of the CMC shall be a political head of one of the LGs and the secretary a head of a technical department. MWE sector guidelines provide for women to take up key executive positions on the committees. There is a challenge to have representation of women on the CMCs as per the guidelines and IWRM principles. Analysis made from the four Water management zone structures has revealed that there is a less representation of women with no woman chairing any of the 22 CMC formed to date. This article will share experiences on involvement of women in key decision making for water resources management through the CMCs through highlights of the gender composition of the various committees. The article will also assess the strength and weaknesses of the various provisions of the guidelines for women involvement in Water Resources Management as well as the limiting factors to their involvement

USING GIS TO VISUALIZE THE IMPACT OF INTERMITTENT WATER SUPPLY ON METER PERFORMANCE IN A WATER UTILITY

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Water utilities install meters at customer premises in order to determine the volume of water used by each household, and therefore the amount due to the utility for the service rendered. The performance of the water meter is therefore critical to the financial viability of the utility. Intermittent water supply systems are characterized by high fluctuations in water flow and pressures over time. These fluctuations negatively impact on meter performance and lead to meter failure. This study examines the impact of intermittent water supply on meter performance based on age, size and class of the meter. The study area is Kampala, which is the largest urban area of operation of NWSC. Two areas were selected for investigation. One located in an intermittent water supply area (in the outskirts of the network supply area) and another in a non-intermittent water supply zone. Data from the utility billing system that is reported by the Marketing Assistants who read the meters and report meter anomalies on a monthly basis. GIS is used to define the two contrasting water supply zones, extraction of the meter points based on their coordinates and visualization of the findings of the study. Statistical Package for Social Scientists (SPSS) is used for statistical analysis. Meter performance is defined by the monthly observations made by the Marketing Assistants and defective meters are identified. Meters are then classified based on their age, size, and class. These parameters are subjected to regression and correlation analyses to determine their interrelationships. The resulting coefficients are compared within and across the two supply zones and geovisualised to generate spatial maps that support participatory decision-making. The results generated from the study help the utility to develop appropriate interventions aimed at effective meter management in an intermittent water supply area

ON-FARM PLANTING OF BAMBOO AS A COMMUNITY CLIMATE-SMART ENERGY LIVELIHOOD OPTION

David Kisakye

Bamboo is a multi-purpose woody grass with international interest driven by the promotion of green energy and economy (Houdanon *et al.*, 2018). Worldwide, it is recognized as a significant rural livelihood plant for its socio-cultural, economic and ecological importance. More attention is shifting to bamboo as a crop by both developed and the developing countries alike for its excellent characteristics and high level uses in value added applications. According to INBAR (2019), bamboo is attracting increasing interest as a strategic resource that can provide clean energy to millions of rural communities across Africa without necessarily amounting to deforestation. In Uganda, the bamboo biomass energy is largely untapped despite its potential to generate 30% more biomass than trees and reduce forest cover loss which stands at approximately 92612ha per annum (NFA, 2016). This is because the bamboo resource estimated to be 545 km² is limited and mainly concentrated in central forest reserves where harvesting is restricted with little on private land. This gap is made wider by the dearth of information regarding bamboo farming and integration in farming systems (FAO, 2007). Consequently, energy has been consumed at the cost of the environment leading to loss of indigenous livelihood tree species that take relatively long to mature. We are promoting bamboo planting on farm amongst small holder farmers to generate biomass to meet household's energy needs as well as other environmental services. We use the biomass to make bamboo briquettes which are more sustainable, produce no soot, burn longer and have a higher calorific than traditional fuels like firewood. Bamboo grows so fast, its tolerant to water and mineral stress and has a high productivity per unit area because it mandates annual selective harvesting. On farm planting of bamboo will substantially help communities realize their energy targets.

INNOVATIVE SANITATION DECISION SUPPORT TOOLS: PART OF THE KNOWLEDGE TO PRACTICE (K2P) AGENDA FOR SAFE SANITATION PLANNING IN UGANDA

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Water and environment are essential priorities for attainment of the sustainable development goals (SDGs). However, meeting universal access to water and sanitation necessitates improved and evidence-based WASH decision making. Unfortunately, there is still a need to improve accessibility and the translation of knowledge from scientific data for practitioners to support decision-making and advocacy efforts related to the links between pathogens, disease and health. We present two new tools that help meet this need: a sanitation system pathogen flow tool and a pathogen emissions mapping tool to guide safe sanitation planning. These tools focus on managing and reducing the release of waterborne pathogens from excreta and sewage into the environment. The development of these tools is a spin-off of the Global Water Pathogen Project (GWPP), which provides comprehensive updated reference materials on waterborne pathogens and risks from excreta and sewage. With support from IT and data-sharing expert AgroKnow, the book is now being disseminated as an open-access online resource with a collaboration network of 257 contributors from 46 different countries on six different continents (www.waterpathogens.org/network). The development of the tools is a collaborative effort under the K2P agenda that involves National Water and Sewerage Corporation) and WASH-related stakeholders in Uganda (from government and non-government agencies) and scientists and engineers from different institutions (Michigan State University, San Diego State University, Wageningen University, Agrowknow and Temple University). The overall outcome of the K2P agenda is to provide improved scientific tools and data that WASH professionals can use to make evidence-based decisions for water and sanitation safety planning. Some intermediate outcomes include: An established coalition of national and global stakeholders who are involved in the work to monitor pathogens, reduce fecal pollution and improve progress toward the water and sanitation targets for SDG 6; Improved analytical tools to access and interpret scientific data on the efficacy of sanitation services, from the GWPP and to link these data with other national databases, and derive appropriate statistics and modeling results that can be used for evidence-based water and sanitation safety planning and effort prioritization to meet sanitation goals as part of SDG6; Increased local capacity for our partners in Uganda and Africa.

MEASURING WASH INTERVENTION EFFECTS: CASE OF NO IMPACT FROM MOWE'S WASH INTERVENTIONS ON UNDER-FIVE DIARRHOEA IN WANDI SMALL TOWN, ARUA DISTRICT

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Clean water and environment are essential priorities for societies' wellbeing and for the national attainment of the sustainable development goals (SDGs). Inadequate access to these essentials has detrimental effects on vulnerable populations, such as children under five years. This presentation shares findings from a cross-sectional study on access to WASH services and prevalence of under-five diarrhoea from a study conducted in Wandu town in Northern Uganda. This followed a WASH intervention by the Ministry of Water and Environment. Out of 390 household respondents, 69% were from intervention villages and 31% from control villages. The majority of the respondents (84.4%) were mothers and their highest level of education was primary (73.3%). Only 6.4% of the respondents reported having access to piped water services. More than a third (32.1%) depended on unprotected springs. Less than 10 percent of the respondents treated their drinking water before consumption. Handwashing prioritization at critical times was low, with washing behaviours such as before breast feeding (1.8%), after cleaning a child (4.2%) and before preparing food (6.2%) being less prioritized. The prevalence of under-five diarrhoea in both the control and intervention areas was 44.6% respectively. Over half of the respondents (60%) perceived diarrhoea to be caused

by other factors (such as malaria and worms) than due to living in a dirty environment (4%), poor personal hygiene (10%), poor sanitation (12%) and poor water quality (14%). The findings from this study provide lessons to WASH practitioners on the importance of baseline assessments before any interventions are implemented to effectively target interventions, and to enable effective measuring of the changes accruing from the interventions in regard to impact. Lastly, it also points to communication messaging during sensitizations for such interventions to have meaningful impact on behaviour change.

ACCESSIBILITY AND SAFETY AUDIT FOR SCHOOL WATER, SANITATION AND HYGIENE FACILITIES IN PUBLIC SCHOOLS IN KAMPALA

Chanchal Kumar^a Ceaser Kimbugwe^b and Joseph Walugembe^c

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If the environment and design of Water, Sanitation and Hygiene (WASH) facilities in schools cannot permit independent navigation and use, these children's right to privacy (Article 22 of the UN CRPD) is compromised. The same can be said of the right to health (Article 25). Investigating the accessibility and safety of WASH facilities in schools is essential in shaping policy and strategies for improving WASH access for children with disabilities. Availability of accessible WASH facilities in schools by all standards is a precondition for the realization of these aspirations and reaching everyone, everywhere. A pilot study was conducted by WaterAid in collaboration with Kampala Capital City Authority in 12 schools guided by the "Accessibility Standards" of the Ministry of Gender, Labor and Social Development in conjunction with Uganda National Action on Physical Disability. The study was aimed at informing the design and testing of inclusive school WASH facilities in Kampala. Data was collected through observation, photography and key informant interviews. The study found out that None of the 12 schools in the pilot study offered "Total Accessibility," from the access path, main entrance to the school, corridors to classroom blocks, classroom block to toilet/latrine and within the latrine and other WASH facilities. There are variations at school level in terms of the corrective actions required to improve accessibility to WASH facilities by children with disabilities. It is imperative that WASH facilities in schools are made disability friendly and accessible to all children with disabilities to realise their right to education, water, sanitation and health. Government needs to enforce compliance to accessibility standards provided in the Building Control Act of 2013; reinforced with provisions of other laws like the Persons' with disabilities Act (2003) and conventions which Uganda has ratified.

ASSESSING THE ROLES OF THE SOCIETY TOWARDS FLOOD AND LANDSLIDE MANAGEMENT AS A WAY OF PROMOTING GROWTH AND ALLEVIATING POVERTY IN BUDUDA DISTRICT

Trust Brenda

Water has always played a central role in human societies. It is a key driver of sustainable growth and poverty alleviation as an input to almost all production, in agriculture, industry, energy, transport, by healthy people in healthy ecosystems. It can however be a force for destruction, catastrophically through drought, flood, landslides and epidemic diseases. Landslides are simply defined as the mass movement of rock, debris or earth down a slope and include a broad range of motions like falling, sliding and flowing under the influence of gravity of dislodged earth material.

Bududa District in Eastern Uganda has faced scandals of landslides many times since 1997, claiming the lives of many people and destroying property which is a hinderance to development of the area and Nation at large because, famine, resettlement, loss of manpower, reduction in agricultural practices and other economic activities lead to a downfall in the economy of the country. This paper sets out therefore to assess the roles played by the society more especially; the community, water management team under the government of Uganda towards landslide protection in BUDUDA so as to create an environment for development in the area. Research shows that the 2010 debris flow landslides in Bududa were due to continuous rains that caused several soil slips, the few vegetation around the hills; eucalyptus trees which have shallow roots couldn't help anchor the soil because the failure plane was deeper than the influence of the roots; this called for the government and the community to plant more trees like Cordia Africana, an indigenous tree in the mount Elgon area that has been singled out by communities to prevent landslides on

slopes. This was apparently not done and many other landslide measures; which led again to the landslide occurrences in 2018. So as to prevent more loss of lives and property due to landslides and floods, activities such as warning systems and forecasts for resettlement, planting deep rooted trees around the floodplains of the area as well as hills, encouraging people vacate floodplains and many others should be done with combined hands of both the community and other stakeholders as this will create grounds for development and alleviation of poverty

BLOCKAGES TO SERVICE SUSTAINABILITY OF WATER, SANITATION AND HYGIENE IN SCHOOLS. CASE STUDY OF SELECTED PUBLIC SCHOOLS IN KAMPALA UGANDA

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When Water, Sanitation and Hygiene (WASH) are not adequately available in schools, children's safety and health are compromised as their precious education time is lost collecting water and or queuing up to access the limited sanitation facilities. This has a regressive bearing on (1) privacy and dignity (2) school attendance (3) student health (4) learning outcomes (5) gender equity and (6) poverty. Every child deserves an opportunity to learn in a safe and healthy environment. Safe drinking water and a safe place to use the toilet are as important as teachers, classrooms, and books. Generating evidence on the cause of service failures and low sustainability of school Water Sanitation and Hygiene services is essential to improve the quality of education. This study assessed blockages to WASH service sustainability of Water Sanitation and Hygiene in Kampala's public primary schools to inform the development of sustainable WASH in school's service delivery and management models. Data collection methods included desk reviews, key informant interviews and focus group discussions. WASH blockages analysis was conducted to give a visual representation of the challenges and barriers prohibiting sustainable access to WASH in Schools. Key study findings highlighted three categories of blockage including; enabling environment, WASH infrastructure supply, and service sustainability.

DETERMINANTS OF USERS' WILLINGNESS TO CONTRIBUTE TO SAFE WATER PROVISION IN RURAL UGANDA

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In the context of recent devolution processes in Uganda, operation and maintenance of drinking water infrastructure still pose a major challenge. Given the importance of water user fees and local collective action for operation and maintenance, it is paramount to consider factors influencing the users' willingness to contribute. Based on 802 structured household interviews, this paper presents the link between willingness to contribute and actual contribution and also presents variables influencing users' willingness to contribute to water provision. The variables demonstrated by the logistic regression model to increase the likelihood of users' willingness to contribute are categorized as institutional, bio-physical and demographic ones.

HARNESSING INFORMATION TECHNOLOGY TO WATER RESOURCE MANAGEMENT: A CASE STUDY OF UGANDA.

Kizito Francis Xavier
Ministry of Water and Environment

The water and environment sector's capacity to meet the changing demand of water is being questioned. This has significant implications on all other sectors hindering promotion of a smart, sustainable and inclusive economic growth and employment opportunities in the country. It is therefore important to strengthen the sector's capacity in water resource management to serve a greater proportion of other sectors, most of the opportunities for which might

be facilitated by IT. Ultimate goal of identifying strategies that can strengthen the management of the water resources through deployment and innovations in Information Technology. From discussions with stakeholders across the country focusing on; planning for the water resources, development of water resources, distribution and managing the optimum use of water resources, More issues discussed included: (1) Water resource challenges that can be readily solved by IT, (2) individual experiences with IT implementation, (3) engagement with hard-to-reach groups, and (5) social media use. Although participants were aware of the issues surrounding the use of IT, including limited and unreliable internet connection, data integrity, they were equally aware of the opportunities afforded by IT. With appropriate support, they indicated that IT could help to sustainably manage Water Resources. This could be demonstrated via research, initiatives that improve governance arrangements within the sector (through Catchment Management Structures) also and beyond the water and environment sector, programmes that enhance IT solutions and innovations. IT is not taken vital in development, management and implementation of water resource systems. Technical and access issues continue to hamper dissemination of innovations. Since sharing knowledge and inspiration is equally important in our professional spheres, it can foster vision in others and strengthen professional ties. Need for leadership in developing IT water resource management solutions remains paramount, with the sector best able to negotiate with the key stakeholders at the helm.

SPATIAL DISTRIBUTION AND ACCESS TO DOMESTIC WATER IN A HUMANITARIAN SETTING, CASE OF RHINO REFUGEE CAMP IN ARUA DISTRICT, UGANDA.

Dorina Keji

The study aimed to assess the community accessibility to water sources. Garmin GPS 76 Global Position Satellite (GPS) was used to map out the water sources, secondary data was reviewed, Key informant interviews, Focus group discussions and survey with 200 refugee households). The data obtained were analyzed by contextual interpretation of the results obtained, ArcGIS 10.22 software was used to generate maps of the water source distribution and Chi square and Regressions tests were performed using R software. Water coverage was very low in the two zones studied in camp, three parameters selected for the choice of the drinking water sources showed significant interactions. Accessibility to drinking water is 10.1 liter/person/day in the households and the regression models showed high significant interactions. Conclusions, water coverage was low in the two zones of the camp studied and there is low accessibility water for domestic use by the refugee community in Rhino camp.

GRAVITY FED LARGE RURAL PIPED WATER SUPPLY SCHEMES IN UGANDA

Lessons Learnt

Eng. Chris Tumusiime, and Eng. Stanley Watenga,

Ministry of Water and Environment

Uganda's rural water supplies include groundwater through boreholes, shallow wells, springs and gravity fed piped water supplies, whose sources are mostly small rivers or streams which originate from hills or mountains. A good example of a large gravity fed piped water supply is the Nyarwodho Gravity Fed Rural Piped Water Supply Scheme, which is among the largest such schemes in Uganda, projected to serving over 120,000 people with over two thousand private connections and communal taps. Previously there have been challenges concerning management and community ownership such that the sustainability of such schemes was doubtful. Consequently, the Government, through the Ministry of Water and Environment Development (MoWE), in consultation with beneficiary district councils, established Umbrella Authorities to operate and manage the scheme, and to improve community involvement, sustainability and service delivery. There have been a number of advantages and lessons learnt through using these approaches for rural communities. However, there are several challenges relating to past history of not having to pay for water out of the tap, leading to unwillingness of some consumers to pay water tariffs and politicians giving conflicting messages concerning the piped water supply services in rural areas. The whole concept shows that the use of rural large piped water supplies taking advantage of the large rivers in mountainous areas can greatly solve the challenges in water stressed areas of the country. The paper discusses how the challenges are overcome in such situations and how this approach gives a brighter solution to addressing water supplies in rural communities as we move towards implementing the Strategic Development Goals.

IMPACT OF IMPLEMENTATION OF DEMAND SIDE MANAGEMENT OF WATER USE IN A SUGAR INDUSTRY A CASE STUDY OF SUGAR CORPORATION OF (U) LTD

Sugar Corporation of (U) Ltd (SCOUL) is a sugar processing company under the Mehta Group established in 1926 and employs about 4,500 male and 1,500 female with 2,700 being youth. SCOUL decided to implement demand side management of water use techniques and practices so as to improve on its water productivity. With technical support from Uganda Cleaner Production Centre, the company implemented a number of water saving initiatives including; development of a maintenance check list aimed at tracking all the water leakages for timely closure, recovery of water from vacuum pumps and Sulphur burner compressor which was just sent to drain, installation of water level control on the filter hot wash water tank, clear juice tanks and MCT water tank to eliminate overflows, closure of vent vessel for re-circulation line from vacuum pumps with water being now recirculated, closure of injection channel holes to keep more water in circulation, installation of steam injectors to pump molasses back to the tank instead of just washing it away and installation of 4 lines to transfer water which was overflowing from the main conservation tank i.e for storage, to injection water channel for make-up due to evaporation thus eliminated use of abstracted water, for use in chemical boiling in evaporators during cleaning and for use in chemical preparation. Implementation of such initiatives has resulted in: reduced waste water intensity from 0.036m³ of waste water/tonne of sugar processed to 0.032m³ of waste water/tonne of sugar processed, reduced volume of effluent, reduced costs from the reduced amount of water abstracted annually by 3,718m³ averagely amounting to **USD. 1,957** and improved livelihoods of downstream communities

WATER SUPPLY SERVICES TO BENEFIT LOW INCOME POPULATION IN SMALL TOWNS AND RURAL GROWTH CENTERS: EXPERIENCES FROM CENTRAL UMBRELLA OF WATER AND SANITATION.

Eng. Atwongyeire Dorcus, Kamara Julia, and Eng. Turyatunga Emmex
Ministry of Water and Environment

Access to safe water and sanitation is essential for health, security, livelihoods, and quality of life. The percentage of Uganda's rural population with access to safe water is estimated to be 70% and 71% in the urban¹. As of the year 2017, there were 11112 piped water supply systems serving small towns and rural growth centres in Uganda that were managed by various authorities. Prior to Umbrellas of water and sanitation authorities establishment in 2017, Operation and Maintenance (O&M) of piped water supply systems serving small towns and rural growth centres (RGCs) was greatly constrained by high Operational costs, low service coverage, less population served, low revenues and low infrastructure reinvestment. This prompted the Ministry of water and environment to come up with new approaches to address these constraints. Establishment of Umbrella authorities is one of the strategies to improve management of Water supply systems. This paper reviews the various water supply management approaches in Uganda's water sector and documents the umbrella model impact in Low income communities of Central Uganda. Work presented in this paper is based on a survey on livelihoods in kyamulimbwa water supply area, a review of studies conducted by various stakeholders in the water sector and data from umbrella performance reports submitted to the Ministry of Water and environment. Interventions under the umbrella model so far show a positive impact on livelihoods as perceived or measured by respondents like quality of water, amount spent on water, time spent to fetch water at public stand posts and hours of supply per day. There is also registered improved system functionality according to the scheme operators hence a conclusion that umbrella model of management is prevailing and benefits the low income population in Uganda

WIMES A SOLUTION FOR WATER AND ENVIRONMENTAL MANAGEMENT

Isabelle Hubiche
BRL Ingénierie

Throughout its 60 years of experience in Integrated Water Resources management and Water and Environment Information systems, BRL has developed several softwares to satisfy specific users' needs. The feedbacks have

made emerged the need for capitalizing tools and practices. BRLI has therefore developed “WIMES”, a collection of software components and services to build efficient, reliable and cross-cutting Water and Environment Information Ecosystems and Services. With regard to water, environment, energy, ecosystems management, there is a huge need for reliable data. From the definition of policies to their implementation and operation, it is essential to have quality data at different scales of time and space adapted to the needs of the user. To this end, we have developed a tool at the service of users, based on our experience as Designers, Operators and Hydraulic Works Managers. Wimes is an open, modular, upgradeable and scalable solution. Wimes is a customized solution: from data acquisition to strategic planning - from big data to smart decisions. Examples of uses: Information systems on water and the environment; Rationalization of measurement networks (with the Open Hardware option); Hydrological and hydraulic modelling (with the HPC option); Institutional support and governance strengthening; Capacity building, training and capacity building; Maintenance, warranty and operational assistance; Real-time and timely risk management; Innovation: integration of spatial data. Assistance to farmers for optimization of irrigation and yield. The platform integrates data from different sources: In Situ, Satellite, or forecasts. The data is then validated and made available or used in hydrological or hydraulic models for its valorization and production of services such as drought and flood forecasting or infrastructure management. It is not only a database, but it also provides of reliable, processed data and associated services.

ECOLOGICAL INNOVATIVE APPROACHES TO WATER OPTIMIZATION AND POLLUTION PREVENTION IN THE MANUFACTURING SECTOR IN UGANDA

Adongo, F.G.,

Ministry of Water and Environment,

The manufacturing sector in Uganda is the major polluter and user of water resources in Uganda. Despite issuance of permits for wastewater discharge and water abstraction, compliance to laws and regulations is minimal due to inefficiencies and inadequate capacity. Moreover, reduction quantity of renewable surface water and declining quality of water bodies continue. The introduction of cleaner production technology as a proactive innovative approach to small and medium enterprises (SMEs) to optimize water use and prevent pollution was adopted by Lakeside Dairy Limited, Rwizi catchment to reduce risks associated with water availability, prevent pollution in a three year project. The project focused to enhance capacity of the private sector to adopt best practices through eco-innovative cleaner production technology. The specific objective was to improve water efficiency and productivity so as to reduce industrial effluent pollution at source and improve compliance. Methodology involved a sequential approach to awareness raising, training and baseline data collection, water audit, scientific measurements of water consumption and wastewater effluent characteristics before and implementation of eco-innovative strategic interventions. Technical performance evaluation with Interviews and questionnaires were performed within the company employees. Statistical tools involving linear regression analysis, coefficient of determination (R^2) or correlation (R) were used to analyze data. The results of interventions in waste reduction, water efficiency and productivity translated into multiple economic, social and environmental benefits for the enterprise, environment and other stakeholders. A total of 13,500 m³/year constituting 40% of demand was saved from supply. Water productivity increased by 40% leading to a significant reduction unit cost of production, achieving a good correlation factor (R^2) = 0.94 or 94%. A reduction of 86% BOD₅ concentration pushed the enterprise to compliance with national effluent standards of 50 mg/L although COD reduction did not reach the mark required. Significant pollution load reduction at 93% BOD and 74% COD translated into 21,870 kg/year of BOD₅ and 2,651 kg/year of COD removal discharge. 3 fold (USD 13,158) private sector investment was attracted and earned a payback period of 1 -1.5 years. The study concludes that industrial pollution was caused by production inefficiencies, inadequate capacity, inadequate wastewater treatment and poor practices. Capacity enhancement and adoption of cleaner production practices did not only trigger compliance to set regulations but also generated multiple economic, social and environmental benefits as incentives. Leadership and top management ‘buy-in’ was steered the success of eco-innovation. Private sector has the potential to turn waste into opportunity and can provide alternative strategic financing mechanism to boost water security and pollution prevention. There is need for a policy shift towards integrated pollution management approach and inclusiveness for efficient water use and pollution prevention.

CHALLENGES OF OPERATION AND MAINTENANCE IN WATER SUPPLY SYSTEMS FOR HEALTH CENTRES IN KARAMOJA

Andrea Schalla and John Bosco Oryema,

GIZ – ENWASS

The inadequate water services and sanitation problems in Health Centres (HCs) in Karamoja are indications for the need for a better management strategy by the government. Operation and maintenance (O&M) of the water supply systems in the health centres is one of the key challenges of the functionality and sustainability of water supply in Uganda. While investment in new infrastructure continues, greater attention must be paid to the sustainability of those facilities. Every year, government and non-government actors invest billions of shillings in the construction of new facilities, as they strive to attain the national targets for access to safe water. Some of the key challenges in the management of the water supply systems in health centres are the weaknesses of the Water User Committees (WUC), lack of information on water supply facilities such as inventory data and water supply maps, insufficiency of practical monitoring of the facilities as well as inadequate funding allocated to the HCs and unclear structures for O & M. In view of the trends and challenges in O & M, which strategies should be adopted to ensure efficiency and sustainability of water supply systems in health centres? GIZ under its project “Strengthening Climate Resilience and Operation and Maintenance of Water Supply Systems of Selected Health Centres in Karamoja” addresses some of the challenges in an integrated approach by considering hydrological and climate patterns as well as the generally low level of functionality of the water supply systems. Thus, it links water supply, O & M and water source protection together and brings the diverse stakeholders from all levels involved in this field together to enhance their exchange and cooperation to achieve a wider impact building on each other’s contributions and interventions for the benefit of the current and future generation.

OPERATION AND MAINTENANCE OF MINI WATER SUPPLY SYSTEMS AND POINT WATER SOURCES FOR THE RURAL COMMUNITIES OF UGANDA

Eng. Ahmed Sentumbwe and Ms Edrida Musinguzi

Ministry of Water and Environment

An estimated 28.4 million (82%) of Uganda’s population lives in the rural areas. The main technologies of accessing safe water for the rural population is; 41% deep boreholes, 25% shallow wells, 23% protected springs and 11% others (piped water schemes; gravity fed; piped water schemes - Mini, Medium and large; valley tanks and rainwater harvesting tanks (RWHT)). The Ministry currently has three key operation and maintenance (O&M) models for the rural water supplies as National Water and Sewerage Cooperation (NWSC for Medium and large water supply systems; Umbrella Authorities (UA) Medium and large water supply systems and Rural Water Supply and Sanitation Department (RWSSD)/Local Governments (LG) for Mini water supply systems and point water sources. RWSSD/LG are charged with the O&M of the Mini water supply systems and point water sources that are not economically viable for both NWSC and UA direct management. The O&M of these rural water facilities is largely based on the Community Based Maintenance System (CBMS). The Concept of CBMS put the responsibility of O&M to the user community through community support structures like, sub county water supply and sanitation boards (SCWSSB), Water and Sanitation Committees (WSCs), sources caretakers, hand pump mechanics (HPMs) and plumbers, scheme attendants and private operators. CBMS structures are supported by local governments (District and Sub County), civil society organizations (CSOs) and the Ministry through the RWSSD. The whole process is guided by the O&M framework 2011. Functionality of the rural water supply facilities has been reported at 85% for the last two years. The paper looks at: the O&M implementation under RWSSD and LG support; guiding principles, the different implementation methodologies, actors and their responsibilities, successes, challenge and recommendations for improvement

URBAN GROUNDWATER AND SANITATION: PRELIMINARY FINDINGS OF STATUS OF LUKAYA TOWN COUNCIL, KALUNGU DISTRICT.

Nayebare, J.G.¹, Owor, M.M.¹, Kulabako, R.², and Taylor, R.G.³

Makerere University^{1,2} and University College London³

Shallow groundwater systems, on-site water supplies and sanitation systems are in common use in developing urban centres including Lukaya town. Such scenarios pose risk to human health resulting from nature and mismanagement of the facilities. Geophysical surveys, well logging, pumping tests, focus group discussions, water point mapping, sanitary-risk inspections, health facility visits and water quality analysis were conducted in a small, rapidly growing town in central Uganda (Lukaya), served primarily by on-site water supply and sanitation facilities. The aim was to evaluate the status of shallow groundwater systems, on-site water sources and sanitation facilities. The area is characterised by parched unconfined semi-confined variable aquifers with shallow water tables 0.4-8mbgl and variable discharges of 2-17m³/hr. Ninety-four per cent of the residents are served by hand dug shallow and 89 % of residents use traditional pit latrines with a risk score of 77. Since the water sources are vulnerable to contamination, regular monitoring and maintenance are of critical importance.

WATER SOURCE PROTECTION: CHALLENGES AND POSSIBLE SOLUTIONS OF WATER SOURCES OF HEALTH CENTRES IN KARAMOJA

Louis Muguisha¹, Andrea Schalla² and Dennis Ross Ngole²

Ministry of Water and Environment ¹; GIZ – ENWASS²

Uganda has set itself an ambitious target of attaining a middle-income status by 2020 and has also committed itself to the achievement of the sustainable development goals (SDGs) including the SDG no.6 (Clean Water and Sanitation). However, with the challenges of rapid population growth that leads to the encroachment of wetlands and river banks and massive clearance of forest for agriculture and other uses resulting into a bare landscape which is not retaining and purifying water and thus leading to rapid run off, soil erosion, siltation and water shortages causing reduced water levels and insufficient water supply for the local communities and water dependent businesses and other activities. This puts the attainment of middle-income status and the SDGs into serious jeopardy. Protection of water sources therefore becomes crucial. To protect the country's water sources, the Ministry of Water and Environment (MWE) has developed Water Source Protection Guidelines which provide their users and/or developers ways in identifying the threats and the required actions to avert the degradation of the water resources. The main objective of these guidelines is improved water quantity and quality as well as improving livelihoods for the communities. Water source protection in Karamoja is nearly non-existent. Therefore, GIZ under its project "Strengthening Climate Resilience and Operation and Maintenance of Water Supply Systems of Selected Health Centres in Karamoja" supports MWE to mitigate the insufficiency of the protection of the water sources of some health facilities by developing Water Source Protection Plans and implementing some measures at these sources. Bringing together the diverse stakeholders from all levels plays a crucial role to develop a common understanding, enhance their exchange and cooperation to secure adequate water in quantity and quality for all needs for the benefit of the current and future generation.

THE VALUE OF REMOTE SENSING DATA TO WATER POTENTIAL STUDIES IN UN-GAUGED BASINS

A case study of hydrological feasibility assessment for Ngenge Sub-County Water Supply System, Kyoga Water Management Zone

Maximo Basheija Twinomuhangi

Ministry of Water and Environment

Hydrological assessments rely on river flow data from gauging stations. However, the data exists for only major rivers, leaving smaller catchments un-gauged. This leads to reliance on hydrological models to estimate flows for

decision making regarding water engineering applications like water supply. Water and Sanitation Development Facility-East in Kyoga Water Management Zone identified Atari River as a potential source of water for Ngenge Sub-county Water Supply System. To guide feasible and sustainable design of the system, a detailed hydrological assessment was carried out to assess the long-term water potential at the proposed intake on the un-gauged Atari River. The study objectives included; assessing the long-term variability of the Atari River flows at the proposed intake, assessing the characteristics of the low flows that are most reliable for the design and operation of the scheme and guiding the choice of sustainable design flows that take into account environmental flow requirements. Since the delineated intake catchment is un-gauged and there are no ground-based rainfall and evapotranspiration observations, remote sensing (satellite) data sets were used in Quantum GIS Ensemble Framework for Flash Flood Forecasting (EF5) hydrological model to set-up, calibrate and validate a rainfall-runoff model for the nearby gauged Sipi catchment followed by transferring the model parameters to the Atari River intake catchment to simulate the long-term flows. Flow duration analysis of the simulated long-term flows for the intake catchment quantified the low flows that are critical for the design and operation of the scheme. Q_{95} flow is $0.474 \text{ m}^3/\text{s}$ ($40,932 \text{ m}^3/\text{day}$) and long-term minimum flow is $0.03 \text{ m}^3/\text{s}$ ($2,592 \text{ m}^3/\text{day}$). Water balance assessment indicates that the estimated water potential greatly exceeds the estimated water abstraction, with the ultimate year (2043) abstraction being only 3% of the Q_{95} flow. This implies that the water abstraction can be sustained while maintaining the environmental flow.

A STUDY ON THE ENVIRONMENTAL IMPACT OF SETTLING REFUGEES IN REFUGE HOSTING AREA IN UGANDA

Eileen Lara

The study set out to assess the impact of settling refugees in refugee hosting areas in Uganda with specific objectives on; 1) the impact of settling refugees and their energy use on the environment with emphasis on forests and vegetation cover in the surrounding; 2) the impact of environmental changes and their energy use on the livelihoods and well-being of refugees and host communities (men, women & children) ; and lastly 3) prospectively examine existing and potential mitigation measures against the misuses of energy conservation and the continued deforestation and vegetation loss. Following a field survey of 5392 respondents (both refugee and host community) from 13 refugee settlements in Uganda with the largest refugee respondents being South Sudanese (49%) and Congolese (41%), this study has come to the following conclusions: Generally, there were major increases in land extents since 2014. Coverage of tree plantations was on a downward trend, the wetland cover had reduced in size, and the woodlands faced enormous declines in land area. Open waters had declined in land mass and grasslands had reduced. On fuels and stove for cooking, 51% of the refugees are still using the traditional three stone fires for cooking and are facing serious shortages in fuel for cooking with 59% reporting a scarcity of fuel wood. For many, the distance walked to collect wood has significantly increased. This has forced many to find ways of coping by selling food items, animals, personal items and other key assets. The findings showed that we are already in crisis stage and sustainable interventions such as the above mentioned should be put in place and closely monitored. Therefore, right after shelter and food, sustainable energy provision with a holistic approach to energy efficiency should be at the centre of all refugee crisis interventions given that refugees stay in the settlements for a long period of time. This kind of investment should be done for both refugees and host communities while leveraging on innovative business models, private sector for sustainability and local government engagement.

REDUCTION OF IRON AND MANGANESE CONTENT IN BOREHOLE WATER USING CORNCOB

Mbabazi Richard and Nicholas Kiggundu

Makerere University

Boreholes are a major source of portable water in many rural areas of Uganda. Borehole water usage takes the highest percentage of 45.9% in rural areas. Borehole water is an example of a groundwater source and is by far the safest source of water as compared to surface water sources that are exposed to heavy contamination. However, groundwater may be exposed to heavy metal contamination. Groundwater quality problems are typically associated with high level of iron and manganese concentration in Ntungamo District, Uganda. The normal drinking water contains permissible limit of iron and manganese concentration 0.3 mg/L and 0.5 mg/L respectively (WHO, 2013) but

groundwater in Ntungamo contains 5 mg/L of iron concentration and 0.6 mg/L of manganese concentration. The affected water stains clothes with a brownish color and also has unpleasant smell. In this study corncob activated carbon was evaluated as a bio sorbent for the removal of iron (Fe) and Manganese (Mn) from selected areas of Rugarama and Nyaruntuntu in Ntungamo district. since they exhibited concentrations of 4.9233 mg/L (Fe), 0.167 mg/L (Mn) and 5.2198 mg/L (Fe), 0.643 mg/L (Mn) respectively. Corncob exhibits remarkable binding characteristics for removal of total iron and manganese, so special interest was devoted for optimizing its uptake and studying its selectivity properties. The parameters of adsorbent dosage and contact time were studied. The maximum sorption efficiency of Fe and Mn was found to be 78% and 83% respectively. Sorption was most efficient at adsorbent dose of 20 g and at contact time of 60 minutes. The adsorption of both metals increased as the quantity of adsorbent increased. From this study it is conclusive that corncob as an environmentally friendly material can be used for removal of iron and manganese from ground water

ADVANCING CIVIL SOCIETY ORGANISATIONS AND NETWORKS COORDINATION FOR CONTRIBUTION TO EFFECTIVE RENEWABLE ENERGY POLICY FORMULATION AND IMPLEMENTATION IN UGANDA.

Kamoga, A., Nalule, R. and Zake J

Environmental Alert

This paper highlights the potential of a strengthened Civil Society Organizations and Networks coordination and reporting mechanisms for structured engagements agenda with the relevant key stakeholder in Renewable energy sub sector to influence access to clean and sustainable management of renewable energy Resources. It also reflects on the value added by strengthening Civil Society Organizations & networks coordination to contribute to their mandate in respect to policy formulation and implementation in the renewable energy sub-sector in Uganda for sustainable renewable energy development. In 2018, the Civil Society Organizations & networks agreed to establish the National network for civil society engaging on renewable energy called, '*National Renewable Energy Civil Society Organizations Network*', 'as a coordination mechanism for reporting, joint & structured advocacy engagements among other interests. The approach used involved consultations with 10 selected representatives of CSOs & Networks in the renewable energy sub-sector as key informants; line Government Agencies and Development Partners. The collected views and ideas were synthesized into the different scenarios for coordination and presented during the workshop for further discussion and validation. The outcome of these engagements informed the CSOs decision and agreed to form a loose semi-formal National Network for the civil society organizations in Renewable energy currently hosted by Environmental Alert. This initiative was implemented with support through the Clean Energy Project framework, implemented by Environmental Alert in partnership with WWF-Uganda Country Office with financial support from NORAD. Some of the key achievements delivered through this process are: A Civil Society Organizations consolidated performance report FY 2017/18 based on 28 Civil Society Organizations highlighting their contribution to sector development. These invested a total amount of USD 20,725,238 in the sector. A Civil Society Organizations position paper with key emerging issues and targeted recommendations was developed and submitted to the Ministry of Energy and Mineral Development for consideration during the National Energy Policy review and development. A Civil Society Organizations & Network's advocacy strategy for advancing access to clean renewable energy was developed and is being implemented. Furthermore, as part of institutional development, a capacity assessment was conducted that informed the capacity building plan for the Network.

Moving forward, the National Renewable Energy Civil Society Organizations Network is pursuing the implementation of the capacity building plan for the Network and the following are some of the planned engagements: a) Further policy engagement for a conducive policy environment for renewable energy access and sustainable utilization; b) Ensuring that individuals, institutions, CSOs and Networks engaged in Renewable Energy progressively develop capacity in policy analysis, advocacy and independent monitoring; c) Developing the Memorandum of Principles and establishment/operationalization of the Network's governance structures which will be approved during the Network's 1st General Assembly; and d) Development of the Network's strategic plan. These engagements will be implemented by bringing on board other likeminded strategic stakeholders and partners for technical and financial support.

THE STATUS OF TIMBER TRADE IN UGANDA; KEY EMERGING POLICY AND PRACTICE ISSUES FOR REFLECTION.

Dr. Zake J.

This paper presents a reflection on the status of timber trade in Uganda highlighting the current practices and emerging issues. Based on these policy and practice recommendations are suggested for consideration and implementation at different levels by the responsible duty bearers. This is targeted at delivering of the current and future national timber demands and contribute to sustainable forest management. The methods and approaches used in the compilation of the paper is largely literature review, gap analyses and synthesis of relevant documents and publications in respect to timber production, trade and sustainable forest management in Uganda and other countries.

BUILDING RESILIENCE OF WATER SERVICES TO THE EFFECTS OF CLIMATE CHANGE IN UGANDA

Flavia Byekwaso

Climate change is one the greatest development challenges threatening human survival and existence. Both the Fifth and Sixth Assessment Reports of the Intergovernmental Panel on Climate Change indicate that the climate system has been greatly impacted by various anthropogenic activities. Global temperatures have increased by 1.3oC since 1960s. Uganda's Greenhouse House Gas (GHG) emissions grew by 50% from 1990-2012. Emissions of greenhouse gasses has been a singled out activity that has disrupted the equilibrium of the climate system. Currently, in Uganda, climate change impacts have become more severe causing irreversible effects on communities, water and environment resources. Furthermore, the reform studies done by the Directorate of Water Resources Management in 2005 revealed that Uganda will be water stressed by 2020 (1000-2000m3/ person/year) and water scarce by 2030 (1000m3/person/year). Frequent droughts and high temperatures have caused increased frequency of water insecurity and this has affected livelihoods of many vulnerable people. The impacts of climate change on the water services is also affecting Uganda's efforts to achieve the targets envisioned in the National Development Plan II, vision 2040 and the sustainable development goals. Given the current, expected and projected rise in temperature, climate change adaptation and mitigation in the water sector is inevitable. By means of a structured literature review and field visits, this paper examines the various climate change adaptation and mitigation options that can be adopted in the water service sector. The identified options will be used to influence a change of paradigm by all stakeholders to use actions which reduce emissions and improve climate change resilience with front runner soft and hard infrastructures in water services.

THE ROLE OF COMMUNITY PARTICIPATION IN WATER SOURCE PROTECTION ACTIVITIES IN PIPED WATER SUPPLY SYSTEM; A CASE STUDY OF KOBOKO DISTRICT

Christine Niwamanya,

Ministry of Water and Environment

Protecting Water Source from pollution, siltation and low water flows still possess a challenge to water quality and quantity. Using Participatory approach and stakeholder engagement this study analyses the role of community participation in water source protection in Koboko District. The results indicate that the communities were involved in identification of the encroachers, Identification of the threats affecting the river, formulation of water source protection committee, formation of the bye-laws governing the water source, demarcation of the buffer zone, selection of water friendly tree species to be planted in the buffer zone. Drawing from the results community participation is key in sustainability of piped water supply system.

THE CONTRIBUTIONS OF THE HAND PUMP MECHANICS ASSOCIATIONS IN IMPROVING FUNCTIONALITY AND WASH SERVICE DELIVERY; A CASE OF KYENJOJO AND KABAROLE DISTRICTS IN WESTERN UGANDA

Eng. Peter Opwanya

Since 2002 the Ministry of Water and Environment and development partners namely UNICEF and SNV supported the establishment of Hand Pump Mechanics in all sub-counties of the district by providing them with tool boxes and training with the objective of strengthening Community Based Maintenance System (CBMS). Until 2014, the HPMS were engaged as individuals, never before had they been engaged as service providers on the basis of their registration as an association. By March 2015, the average safe water coverage was estimated to be 77.3% and the functionality of point water facilities (boreholes, shallow wells and protected springs) was estimated at 81.2%. (SPR, 2016). However, boreholes had the lowest functionality at 71.6% with longer downtimes. It's important to note that the functionality of water sources is boosted by the established community-based maintenance structures namely; water and sanitation committees, Hand Pump Mechanics Associations and access to reliable and genuine spare parts for hand pumps, which remain a challenge. Realizing that the maintenance of point water sources was enormous challenge; owing to long downtime of water sources, failure to recognize the HPMS as community WASH resource persons, poor quality rehabilitation by unscrupulous contractors, weak sense of ownership and responsibility for operation and maintenance; the districts embraced the initiative of forming Hand Pump Mechanics Associations which gave birth to a number of HPMS in Mid-Western Uganda and further took advantage of PPDA clearance, procured under framework contracts. It's worth noting that the contribution of HPMS through district based contracts for major repairs and engagement by water and sanitation committees to carry out minor repairs has raised the functionality of point water facilities by 5% annually in some districts. This paper therefore examines the contribution made by these associations, especially in Kyenjojo and Kabarole districts in improving the functionality rates and service delivery levels.

TOWARDS COST EFFECTIVE TOTAL LANDSCAPE RESTORATION:

The Story of Kakondo Micro-Catchment.

Kizito and Joshua Zzake

Environmental Alert

Kakondo is part of Rwizi catchment that drains into Lake Victoria basin which is part of the general Nile basin. The delineated Kakondo Sub-catchment is located in Mbarara District. The sub-catchment is facing a number of challenges which include; flash floods, loss of soil fertility, as well as destruction of infrastructure, plantations, and death of animals. As a redress measure, a number of interventions in the micro-catchment. These included engaging the affected communities to jointly prescribe relevant remedies. A Catchment land scape management plan that stipulates processes, restoration activities and sustainability strategies was developed, approved, adopted and disseminated to the relevant stakeholders. The plan was jointly implemented by ACORD, the VWMZ staff, NEMA, sub-county leaders and the affected community. A number of outputs were realized as shown below; A well-defined profile of Kakondo Micro-catchment showing hotspots and planned interventions that suite the different zones of the micro-catchment (upstream, mid-stream and downstream). A number of soil and water conservation structures such as gabions, earth bunds, stone bunds, retention ditches and trenches. After 12 months' remarkable results had already been sighted; Increased soil and water retention; increased Banana production as sighted by testimonies from the beneficiaries; Regenerated wetland vegetation down stream Meaningful involvement of the community in all processes right from planning, implementation, monitoring and evaluation is important for sustainable land scape management creates buy-in cost effectiveness and success of any restoration project. Interventions that create direct benefits to the affected communities should be put at the centre stage of sub-catchment restoration.

UNDERSTANDING WATER AVAILABILITY WITHIN UGANDAN THROUGH THE DROUGHT AND FLOOD MITIGATION SERVICE

Samantha Lavender

DFMS Consortium

A consortium led by the RHEA Group, working with the Ugandan Ministry of Water and Environment and local Non-Governmental Organizations (NGOs, AgriTechTalk Uganda and Mercy Corps) has developed a Drought and Flood Mitigation Service (DFMS). It is funded as part of the UK Space Agency's International Partnership Programme, with 21 projects chosen to provide solutions to local issues in countries across Africa, Asia, Central and South America. To create the service, DFMS is using satellite Earth observation (EO) data alongside meteorological and hydrological modelling and ground-based data within an innovative cloud computing-based platform. EO products come from multiple missions (including Copernicus Sentinel -1 to -3, Landsat-8, METOP-A, SMOS, Terra and Aqua), and are the basis for the onward development of information services with the modelling activities allowing for future predictions to be made.

The project is within its third year, of a four-year programme, and is focused on the service development alongside engaging with the community in Uganda to ensure what's developed is fit for purpose. For EO, related to water availability, this includes: • 1 km spatial resolution maps of Land Surface Temperature (LST) and soil moisture; 10 m resolution vegetation indices and water extent maps; • Point based water height data. The different products are being combined to provide insights into the soil / LST / vegetation 'triangle' with evapotranspiration currently being developed as a tool to assess vegetation stress. The presentation will showcase the products and relationships between them, providing insights into Uganda's water cycles.

OPERATION, MAINTENANCE AND MANAGEMENT FRAMEWORK FOR ENSURING SUSTAINABLE WASH FACILITIES IN REFUGEE SETTLEMENTS AND HOST COMMUNITY CONTEXTS

Nabide Isah Kiti

This study explores Operational and Maintenance of emergency WASH management systems in Uganda. It documents findings to stimulate thinking on sustainability from the wider WASH sector in Uganda. Its focus is primarily on refugees and host populations in Northern Uganda. The investigation was based on a desk review, site visits to refugee camps in Arua, Yumbe, Lamwo and Isingiro, a series of semi structured interviews with key informants and focus group discussions with selected stakeholders. Initially, the majority of refugees received high quality water "free of charge" for their domestic needs through water trucking which was replaced by either Point water sources piped water sources (reticulation systems). With sanitation, there has a shift from emergency communal latrines to individual household facilities achieved through the distribution of latrine digging kits and construction materials, coupled with enhanced sanitation campaigns on safe excreta disposal. Hygiene promotion focuses on supporting refugee communities to act to prevent hygiene related diseases by a sharing knowledge and information, mobilizing refugee and host communities and providing essential hygiene materials. The role of refugees in the operation and maintenance of water supply services in most settlements is limited to ensuring orderly access at water. Refugees do not pay for water and none of the piped water supply systems are metered to measure consumption. The levels of water point functionality were high in refugee settlements due to hard work by INGOs. This change if water supply services are handed over to another entity (such as community management structures or government institutions) the same functionality levels would not be maintained due to the absence of a systems approach.

A conceptual framework for the piped water supply system that provides important factors to be considered when planning and implementing and consequently operating and maintaining emergency water supplies was developed. The prerequisite factors for the framework are enabling legal, policy and institutional framework that provides for as well as design reviews, attitude of beneficiaries, financial/ economic status of the beneficiaries, the environmental suitability, management technical capacity, technological option and governance structures/ setup. Since constructed WASH facilities will be handed over to the appropriate central or/ and local government when the humanitarian

interventions end and mainstreaming the O&M of WASH facilities into the respective national framework is at the heart of their sustainable operation and maintenance. The improved CBM is appropriate and recommended for the point water sources while Commercialized approach through water authorities is recommended for piped water supply systems whose operation and maintenance are more complex. The household latrines are managed by respective users. In that regards, the focus is in creating demand for household sanitation facilities. In pursuit of this, information packaged to change attitudes, livelihood interventions to enhance ability to pay; WASH facilities should be planned, designed and constructed according to national standards and guidelines to improve Water resources management. Concerns should be adequately considered; and interventions should include Human and Institutional Capacity building intervention

REGISTRATION OF GROUNDWATER CONSULTANTS IN UGANDA: RATIONALE AND STATUS

Anthony Kyalirizo,

Ministry of water and Environment

There is heavy reliance on groundwater in most of Uganda for rural and urban water supply due to its wide distribution and general good quality. While groundwater development is on the increase water supply coverage has not increased substantially despite increased funding. This is attributed to a number of reasons including poor performance of groundwater consultants. Groundwater consultants play a big role in the success of borehole drilling in terms of selection of drilling sites, supervision of drilling activities and general guidance of drilling operations. There is therefore need to improve the professional conduct of groundwater consultants. Starting with the Financial Year 2015/16 the Ministry of Water and Environment embarked on registration of individual groundwater professionals and groundwater consultancy firms. Evaluation of applications for registration is conducted by a seven-member committee comprised of membership from within the sector and academia. A list of registered groundwater consultants is published annually in local print media and ministry website. Regulation of the consultants will improve the drilling industry and hence ensure efficiency and effectiveness in groundwater development.

WATER SANITATION AND HYGIENE: A STRATEGY TOWARDS ENDING HEALTH CARE FACILITY ACQUIRED INFECTIONS

Grace Kanweri

Water for People

Water For People is supporting the Kamwenge District Local Government to implement the Everyone Forever model. It is aimed at demonstrating that attainment of access to universal WASH services is possible. The main focus is on ensuring every school, health care facility, and household has access to sustainable water sanitation and hygiene services. The district was supported to reach Health Care Facilities (HCFs) with interventions to address HCF-acquired infections. This was implemented in 27 Public HCFs. The interventions supported are related to controlling infections from patient-Health Care Worker interactions, drinking contaminated water at the facility, contaminated hands and poor waste management. Water For People, in partnership with the Centers for Disease Control (CDC), implemented an HCF Assessment to establish baseline information, trained HCF workers and assessed Knowledge Attitude and Practice, and assessed the patient care areas for proper placing of the handwashing with soap (HWWS), drinking water stations, and waste management bins within the facilities. The HWWS, drinking water stations, and waste management bins supplied to the 27 HCFs are a short-term intervention, and the program has plans to implement long-term actions as development of water supply and sanitation infrastructure to total WASH service delivery in the target HCFs. With CDC, Water For People conducted a baseline survey in HCFs in Kamwenge. It was aimed at establishing the status of Water, Sanitation and Hygiene (WASH) facilities and services across the district. Of the private (35) and public (27) HCFs, 43% had water and soap for handwashing. 12% had handwashing facilities without water, and 43% had water for handwashing without soap. Out of samples taken from 43 HCFs' water sources, 37% had E. coli. Of those that tested positive, 32% were improved and 67% unimproved. 33% HCFs were sorting waste into infectious, non-infectious, and sharps. Another gap was HCF staff's inadequate knowledge of appropriate hygiene, sanitation, and water management practices. It also involved enumerator training in data collection, baseline findings, dissemination and training of HCF staff in WASH including drinking water

storage, handwashing containers, water guard, soap, waste bins provision, joint support supervision with the District Health Officials, and evaluation of progress. Key achievements include client friendliness of the HCFs, patients' swallowing of first medication dosage from HCFs and WASH prioritization by HCFs.

WATER ACCESSIBILITY BY FEMALE AND MALE PASTORALISTS IN A SEMI-ARID ECOSYSTEM A CASE STUDY OF NAKASONGOLA DISTRICT, CENTRAL UGANDA

Winnie Ndagire

In a typical semi-arid pastoral ecosystem, water scarcity is one of the most challenging basic need. Access to the scarce water resources affects women and men pastoralists differently. Earlier studies on water availability in Nakasongola district have not emphasized the role of gender among the pastoralists. A study will be conducted in Nakasongola District to generally explore water accessibility among male and female pastoralists in a semi-arid ecosystem of Nakasongola District. Specifically, it intends to: determine the different sources of water for domestic and livestock use, assess the gender roles among the pastoralists for accessing water, establish challenges faced by female and male pastoralists in accessing water, and establish the coping mechanisms adopted by pastoralists in mitigating water scarcity. A comprehensive structured questionnaire will be used and administered to households within the study area targeting both male and female respondents to obtain data for the specific objectives. Further, the major permanent water sources will be identified and geo-referenced using GPS to generate a map in GIS Software indicating their spatial distribution. In addition, key informants drawn from the district and subcounty technocrats in the areas of production, natural resources, agriculturalists/veterinary services and local government leadership will be interviewed to obtain expert information that will be used to validate household information. The data will be analyzed using most recent and available Statistical Package for Social Scientists (SPSS). Interpretation of the results will be presented in form of graphs and tables. The findings of this study will inform policy makers and planners about the challenges faced by the pastoralists in accessing water for domestic and livestock use and call for sustainable interventions that will help reduce the burden.

WATER QUALITY, THE MISSING LINK IN WASH EFFORTS IN UGANDA

Idrakua Lillian,

Ministry of Water and Environment

Ministry of Water and Environment has both international and constitutional obligations to supply safe drinking water to the people of Uganda. Access to 'safe' drinking water in the urban and rural areas were 73% and 65% respectively as at 30th June 2015 (MWE Sector Performance Report, 2015). These figures however, assume all 'improved' sources supply 'safe' drinking water. However, according to the same report only 58% of the urban water supplies and 36% of the rural water supplies were safe for drinking based on microbiological quality of the water. The implication of these figures is that, in 2015, the 'Safe Rural Water Coverage' in Uganda was just about 20%. In Uganda, water-borne diseases, especially diarrhoea will pose a big challenge to attainment of both health and water related Sustainable Development Goals. There is extensive evidence to show that diarrhoea illness is more likely than not to be a result of inadequacies in water, sanitation, and hygiene (WHO 2002; Pruss-Ustunet al. 2004). These findings illustrate the interdependence of water supply, water quality, sanitation and good hygiene practices in order to ensure safe water for drinking at the point of consumption, which is the household. WHO (WHO, 2004) reported that improved water supply reduces diarrhoea morbidity by between 6% to 25%, if severe outcomes are included. Improved sanitation reduces diarrhoea morbidity by 32%. Hygiene interventions including hygiene education and promotion of hand washing can lead to a reduction of diarrhoeal cases by up to 45%. Improvements in drinking-water quality can lead to a reduction of diarrhoea episodes by between 35% and 39%.

UMBRELLAS OF WATER AND SANITATION AS WATER AUTHORITIES

The Success Story of a New Management Model Introduced Since 2017

Eng. Godfrey Hashakimana, Reinold Seidelmann, Eng. Dominic Kavutse, Eng. Herbert Nuwamanya⁴

Ministry of Water and Environment,

The Urban Water and Sewerage Department has introduced a new management model for small piped water supply systems. The six regional Umbrellas of Water and Sanitation (created between 2002 and 2014) underwent a fundamental institutional transformation. Instead of supporting the local Water Boards and operators, as before, they are now directly responsible for service delivery. The Umbrellas were formally gazetted as Water Authorities and, under this mandate, contract the scheme operators and ensure revenue collection using electronic systems. This transformation came in response to years of experience with poor service quality, low revenue collections, lack of investments and deterioration of assets. The new management model shall also help to extend piped water services to the unserved population. As part of this transformation, the Ministry has introduced a number of innovative tools, in particular electronic billing and revenue collection systems, a revolving facility to finance minor investments, and a web-based performance monitoring system (UPMIS). While utility management is professionalized, the local communities are still represented by Water and Sanitation Committees. Tariffs remain affordable, in particular for gravity flow and solar powered schemes where no pumping costs have to be paid for. To date (February 2019), the Umbrellas were gazetted as Water Authorities for 434 schemes which supply about 2.5 million people. Of these, 218 schemes were effectively taken over and are using electronic payment systems. For many others the takeover process is underway. The Umbrellas are currently serving 35,000 connections with a service reliability and water quality compliance of around 90%. The number of connections and water sales went up by more than 25% for the first 58 schemes that had been taken over.

Revenue collections have increased significantly and are now sufficient to cover not only the day-to-day operation costs, but also an increasing part of the regional overhead costs and investment costs such as major repairs and pipeline extensions. External support will still be required to finance substantial system expansions, rehabilitations and replacements; cost recovery of capital investments is not (yet) possible while keeping tariffs affordable, given the current poverty levels.

SDGS FRAMEWORKS AND FINANCING

This theme will focus on innovative funding opportunities and investment vehicles that can support national efforts to achieve the SDGs related to water and environment. It will also discuss the current and potential roles of the private sector in delivery of water and environment services.

KEY NOTE ADDRESS

FINANCING SUSTAINABLE DEVELOPMENT GOALS

Ian Palmer

Adjunct Professor, University of Cape Town

Water and environment are central to three of the SDGs (6, 13 and 14) but are strongly linked to six of the remaining fourteen goals, and associated with several others. Therefore access to sufficient finance for water and environment related activities is clearly necessary if the SDGs are to be achieved. This keynote address deals with the challenge Uganda faces in accessing finance, starting with an understanding of the sector, including urban, rural, production and natural environment contexts. It includes a high level estimate of finance needs and sets this against the current funding available. Looking to the future, the range of financing options is covered, including national and local public finance sources, international concessional finance, green finance mechanisms, the role of the private sector through debt and equity financing, and community contributions.

MEASURING AND TACKLING OBSTACLES TO SDG 6 PROGRESS: EXPERIENCES OF DESIGNING WASH PROGRAMMES THAT RESPOND TO WEAKNESSES IN THE 'SYSTEM'

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Measuring progress towards the achievement of Sustainable Development Goal (SDG) 6 requires governments to track not only service levels, but also the underlying blockages constraining progressive realization of the SDG target. Blockages include unclear institutional arrangements, ineffective coordination mechanisms, poor planning, limited monitoring, insufficient financing, fragmented service delivery, weak accountability and poor water resource management. Whereas processes to identify and address these issues often exist at the national level, mechanisms for effective review and responsive action remain weak at the sub-national level. The author presents results from practical trials of a participatory framework for measuring the strength of the city or district level system into which WASH services are introduced and, more significantly, designing and implementing district wide programmes that respond to sustainability blockages identified. Government, utilities, service users, the private sector and civil society are involved in the process. The author discusses the efficacy of the framework and some of its limitations. There is a focus on ensuring that hygiene, sanitation and water system strengthening components receive equal attention. Lessons will be shared from Kampala, Uganda.

ADOPTION OF SUSTAINABLE DEVELOPMENT GOAL 6 ON WATER AND SANITATION IN UGANDA: STATUS AND FUTURE PROSPECTS

Dr Callist Tindimugaya¹, Joseph Eritu¹, Gerald Kairu² and Solomon Kyeyune³

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The 2030 Agenda for Sustainable Development has a dedicated goal on Water and Sanitation (SDG6). Achievement of this goal requires credible data to underpin sector advocacy, stimulate political commitment, and trigger informed investments towards optimum health, environment and economic development. Uganda was one of the 6 countries in the world to pilot test methodologies for monitoring SDG6 indicators and has embarked on collecting baseline

information. The process has involved six task teams for the different targets namely; Drinking Water, Sanitation and Hygiene, Waste water and Water quality, Water Use and scarcity, Integrated Resources Management, and Water related Ecosystems. The Water and Environment Sector in Uganda has made significant progress in adoption of SDG6 indicators and recently revised the sector performance monitoring framework to integrate the relevant SDG6 indicators to allow assessment of sector performance annually in line with SDGs. The Strategic Sector Investment Plan attempted to establish a baseline for use in measuring progress of the sector in line with SDGs. Experiences during pilot testing and baseline data collection however indicate that understanding of the meaning of the various indicators and targets by various stakeholders as well as capacity for collection and interpretation of most of the data are limited. The sector therefore needs to give more priority to awareness raising as well as data collection and analysis if indeed full adoption of SDG6 indicators is to be realized. The challenges faced and lesson learnt during pilot testing of SDG6 indicators and baseline data collection will need to be fully utilized to guide the full adoption of SDG6 indicators.

LOCALIZING THE SDGS FOR RESILIENCE OF WATER TOWERS IN UGANDA

Philbert Nsengiyumva, Salome Alweny, Samuel Kanyamibwa

Mountains provide up to 80 percent of the world's freshwater for drinking, irrigation, industry, food and energy production. The 2030 agenda explicitly highlights the importance of mountains for sustainable global development. This gives the sustainable development goals (SDGs) a potential to preserving mountains and their services for future generations. But, to realize that potential, the SDGs must be translated – i.e. “localized” to mountain areas. This will enable policymakers and implementers at local and national levels to understand mountain priorities, customize actions, and measure progress towards the SDGs. To aid such localization, expert assessments on SDGs in mountains was conducted in Uganda and three other countries namely Nepal, Equador, Switzerland. The objective was to identify development issues and corresponding SDGs to ensure that mountains are considered in SDGs implementation. In Uganda, development issues in mountains included ecosystems degradation, climate change and disaster risks, land fragmentation, and lack of basic infrastructure in mountains. Specifically, sustainable use of freshwater ecosystems and their services (Target 15.1) and improving water quality by reducing pollution (Target 6.3), came among the highest priority in Mountains of Uganda. As such, considering mountains ecosystems and their services in SDGs implementation is crucial to the country's sustainable development.

FINANCING SUSTAINABLE DEVELOPMENT: ENGAGING THE PRIVATE MUSCLE IN THE PUBLIC

The Case of the WASH & Learn Programme Interventions in Uganda, Kenya and Tanzania.

Lilian Linda

One of the concerns the WASH sector continues to grapple with is how to get the Public-Private Partnership boat off the anchor and sail it to financial sustainability. The paper addresses practical initiatives that set the boat sailing during the WASH & Learn Programme operations from 2016 to 2018. The WASH & Learn Programme, a WASH in Schools programme, has been implemented by Simavi and six local partners: CABDA in Kenya, UFUNDIKO and TDFT in Tanzania and JESE, HEWASA, and EMESCO in Uganda. The key objectives of the programme included: providing access to WASH service in schools and communities; ensuring sustainability of the WASH service; and facilitate learning and innovation with the local partners. The programme was funded by Walking for Water 2016-2018, Rotary district 1570, Aqua for All and Waterloo Foundation. In this programme financial sustainability was an important ingredient that partner organisation worked on using the Private Public Partnership canvas model. It also gave Public Private-Partnership meaning as the programme beneficiaries/stakeholders were fine-tuned to try it out at project level, as well as by engaging external partnerships. In this paper, illustrations of how schools modelled themselves to use the private entities approach, to make the required capital needed for operation and maintenance expenses in the short and long run, for the WASH investment made, is discussed. As well as how they engaged private entities within their operation sphere, attracting them to contribute. The paper also shares how the interplay of FIETS (Financial, Institutional, Environmental, Technological and Social) sustainability principles was utilized

alongside sustainability tools (Risk Assessment/mitigation and cost recovery planning) to generate sustainable results during the programme implementation period.

BREAKING DOWN BARRIERS TO FINANCIAL ACCESS FOR SANITATION AND BUSINESSES

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1 Caritas Fort Portal – HEWASA, 2 WASTE Netherlands

Since 2013, HEWASA and WASTE Netherlands have been implementing the Rwenzori urban Sanitation Programme (RUSP) using a market-based approach for sanitation. The major objective for the Programme has been Universal access to safe and well managed sanitation facilities, healthier and economically empowered communities in Rwenzori region. Focus has been on building sustainable Systems that propel sanitation access while promoting and strengthening the value chain for sanitation. The Diamond approach, which is a market-based innovation that brings together Private Sector, Financing Institutions, Government, and Households was used to bring sanitation to scale. Demand was created using sanitation marketing, private sector supported to see business opportunities in sanitation, financing institutions engaged to offer credit products while Governments provided an enabling environment. Achievements included household sanitation increase from 36% to 56%, increased public latrine coverage being managed under the business approach, improvement in people's health due to reduction in sanitation related disease incidences, youth employment in sanitation service provision and promotion, and sanitation business expansion due to high demand. A self-sustaining system linking Households, Private Sector, Government and Financiers is in place and being strengthened. Post Bank, Centenary Bank and Finance Trust have developed and are marketing WASH products thus bridging the financing gap. A total of UGX560,000,000 has been disbursed as loans to households for sanitation investment and to entrepreneurs for boosting their sanitation businesses, increasing the WASH loan portfolio from zero (0) in 2012 to UGX560,000,000 to date with a 98% recovery rate. Fort Portal, Kyenjojo, Kamwenge and Kyegegwa towns have WASTE Management Master plans. The Diamond Approach has been tested and found to be effective in accelerating sanitation access. It is hereby recommended that sanitation actors adopt this approach for accelerated attainment of SDG 6.

THE STATE OF CLIMATE OF UGANDA IN 2017

Bob Ogwang

The annual state of climate of Uganda in 2017 is examined in this study. Observed and gridded temperature and rainfall datasets are used over the period from 1950 to 2017 (for temperature) and 1981-2017 (for rainfall). Both spatial and temporal anomalies and trends were analyzed to examine the state of climate of Uganda and the sub-regions of Uganda in 2017, compared to the rest of the years over the study period. Results show that year 2017 was the second warmest year on record over Uganda since 1950. It was the warmest of all La Nina years on record over Uganda. The warmest year on record over Uganda since 1950 was found to be year 2009. Further analysis revealed that the rate of increase of temperature over Uganda during the period from 1950 to 2017 was 0.23 °C/decade, and for the recent years, 1991 to 2017, it was found to be 0.25 °C/decade. Western Uganda was found to be warming faster than the rest of the regions, with a warming rates of 0.60°C/decade and 0.64 °C/decade over the periods: 1950-2017 and 1991-2017, respectively. Well above average rainfall with floods were recorded over most parts of Uganda in 2017, resulting in mudslides, displacement of people and loss of properties, among other devastating impacts. The report on the annual state of climate of Uganda provided by the Uganda National Meteorological Authority is meant to raise awareness and help in the formulation of plans and policies in the country as it reveals the extent of climate variability and change, and needs to be routinely published as an initiative to support the development of Uganda.

OPPORTUNITIES AND CHALLENGES OF HUMAN CAPACITY DEVELOPMENT IN UGANDA'S WATER AND ENVIRONMENT SECTOR

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Human Capacity Development (HCD) in Uganda's Water and Environment (W+E) sector is steadily improving mainly as evidenced by the improved service delivery and achievement of national and global development targets within the sector. The W+E sector in Uganda is coordinated by the Ministry of Water and Environment (MWE) and consists of the Water & Sanitation sub-sector and the Environment & Natural Resources sub-sector. This paper presents the opportunities and challenges for ongoing and planned HCD interventions in the water and sanitation sub sector and measures to ensure efficient and effective service delivery. This paper presents work from studies conducted with various stakeholders including UNESCO, Makerere University, GIZ among others. During the various studies, the data was collected from surveys, key informative interviews, focus group discussions, and review of existing publication from stakeholders including the MWE, the Local Government, Donors, Civil Society Organizations (CSOs) and Private Sector. HCD within the context of the water and sanitation sub sector addresses both the supply and demand side, and includes programmes for fresh University graduates with zero to about 3 years of professional work in the water sector, technical professionals who undertake certificate and diploma courses in vocational training institutions, including apprenticeship programmes. Senior professionals within the sector also undergo routine capacity development but mainly in strategic management, leadership and performance management. The priority capacity gaps and challenges within the water sector are related to technical skills, leadership management, performance management, information and knowledge management, catchment management, communication and stakeholder engagement. This paper will provide the priority capacity development opportunities and challenges for junior, technical and senior professionals in the water and sanitation sub sector in Uganda.

NATURAL CAPITAL ACCOUNTING IN UGANDA; A PRE REQUISITE FOR ATTACHING APPROPRIATE ENVIRONMENT ECONOMIC VALUE IN DECISION MAKING AND COUNTRY DEVELOPMENT AGENDA.

Dr Sam Mugume Koojo

Gross Domestic Product (GDP) is one of the major global economic parameters used to determine the economic performance. GDP is measured by summing up all the value added in a given country for a specified period usually called the output approach. In Uganda, like in many other developing and developed countries GDP just measures utilisation of natural resources without taking into account the depletion of the natural stock. Uganda's GDP growth rate was 6.1% for the previous financial year (2017/18), this year, it is expected to grow at 6%, gradually raising to 7% over the medium term, while the quantity and quality of natural capital keeps deteriorating, for example Uganda loses about 6,000 hectares of forests every 30 days. For economic growth to be sustained, natural capital and other forms of capital need to be maintained or increased over time and thus there is a need to create systems to measure the state and trends of natural capital. This can be achieved through credible Natural Capital Accounts (NCA). United Nations has a standard system for environmental-economic accounting (SEEA). Uganda being a natural resource based country and a member for the United Nations, has adopted these standards; some accounts such as the species account (first in the entire world), the water accounts, and the forest accounts have been prepared though not yet published. In October 2018, a project on NCA being supported by WAVES-World Bank and spearheaded by MoFPED, MWE, UBOS and NPA was launched with a major aim of ensuring that natural capital accounts are produced and used for decision making. This is not an easy task but it can be achieved if there is a will from both implementers and decision makers. Given the visible trends in climate change, increased awareness, the existing laws and the emphasis in environmental management within the SDGs and NDPIi, it is anticipated that the required attention will be given to the accounts. Countries such as Indonesia, Botswana, Costa Rica and Rwanda have taken this path and are already getting dividends. The project will strategically engage ministries and agencies into production and use of NCA through capacity building, advocacy and dissemination of the accounts. It is anticipated that in the near future GDP will not be looked at on its own but in relationship to the capital account balances and thereby development decisions including allocation of resources will be objectively informed. We accordingly implore

everybody to be on the lookout for these accounts and whenever UBOS is disseminating the GDP numbers NCA estimates should be highlighted.

URBAN SANITATION:

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Government with support from partners in a bid to improve urban sanitation has vested more efforts in improving the entire sanitation value chain right from containment to endues/reuse with construction of water supply and appropriate sanitation facilities in learning institutions, public places such as markets, bus parks and households. Achievements in faecal sludge management by the unit have been made. The sector has for the last two years focused on improving faecal sludge management services across the country. The sector put in place a strategy of clustering small towns into 50 clusters to guide sector investment in cost-effective shared faecal sludge treatment/disposal facilities and better engagement of the private sector and local authorities in service delivery. Out of 50 identified clusters, 13 have been existing and by the end of the year 2017/18, an additional seven faecal sludge treatment/disposal facilities have been constructed. Cross cutting activities in the day to day implementation of urban sanitation include; hygiene and sanitation education and promotion, sanitation marketing, Town sanitation planning, giving back up support on operation and maintenance of constructed facilities, water source protection, Environment and social safeguards, Gender and HIV/AIDs mainstreaming, considerations for PWDs, Environment and Social Impact assessment and Resettlement Action Planning among others. Urban sanitation is being implemented under central managed projects and in the regions by the Water and Sanitation Development Facilities (WSDFs) and the Umbrella Water and Sanitation Authorities of the Ministry with support from Development Partners.

CONTRIBUTION OF UNIVERSITY ACADEMIC OUTREACH IN UNDERSTANDING THE LANDSCAPE ENVIRONMENT IN UGANDA

Patrick Musinguzi, Twaha Ali Basamba, Giregon Olupot, Emmanuel Opolot, Lukman Mulumba

Makerere University.

Universities are often mandated to conduct teaching, research and outreach services to the community. Some of the outreach services include students interfacing with communities through academic trips and internship, which are characteristic of collective hands-on-learning, practical engagements and reporting, with the support of academic staff. However, important observations in most of these outreach activities are not well documented. In this work, findings were documented by students and lecturers of Makerere University for a period of 5 years of academic trips for students of Bachelor of Science in Agricultural Land Use and Management (2014-2018). Different regions of Uganda were visited and observations taken on state of landscape environment in Uganda. Academic trips covered Bunyoro Region (BR) in the Hoima oil belt in 2014; Rwenzori Region (RR) in Kabarole, Kasese, Bundibugyo and Ntoroko in 2015; Elgon Region (ER) in Tororo-Butaleja-Mbale-Bududa-Kapchorwa (2016), Ankole Region (AR) in Mbarara-Bushenyi-Rukungiri and Kanungu (2017); and Cattle Corridor-West Nile Region (WNR) in Nakaseke, Kiryandongo, and Arua (2018). The trips comprised of site visitations, focus group discussion and technical studies about selected land uses, waste management centres, fragile ecosystems, agro processing facilities and developmental but environmentally sensitive projects. Generally, findings suggest that the state of soil/land quality varies among districts and regions. Rampant exposure of land to soil loss and environmental degradation was more evident in highland areas of Kanungu, Mbale and Kasese with massive soil loss from farmlands. Rampant deforestation was notable across all districts with severe cases evident in Hoima, Arua, Kasese, and Bundibugyo. Some districts such as Bushenyi, Rukungiri, and Ntoroko were least affected in terms of land degradation. Land management skills were evidently limited across all regions. Strategic interventions with appropriate environmental conservation measures in severely degraded regions such as highlands are recommended. University outreach activities proved to be a good measure for identifying environmentally threatened ecosystems.

FINANCING RURAL WATER POINT MAINTENANCE THROUGH COMMUNITY SAVINGS GROUPS

Chris Prottas

In rural Uganda, an estimated 45% of rural water points are broken. The financing of operations and maintenance for rural water points remains a significant obstacle to sustainable access to clean water. In 2016, The Water Trust adapted the village savings and loan association methodology to create a community-based savings vehicle for maintenance and repairs. The groups are referred to as “self-help groups” to reflect the groups’ purpose and agency. Community members that share the same water point are invited to save and take out personal loans, while agreeing to maintain a reserve fund for water point maintenance and repairs. The weekly group meetings are also then leveraged for hygiene and sanitation promotion by The Water Trust staff. To date The Water Trust has trained more than 120 active self-help groups in the districts of Kiryandongo and Masindi. This scale-up followed an initial pilot in 18 communities that saw annual water point contributions increase from an average of \$2 to \$164. Results suggest that self-help groups can play a critical role in mobilizing community funds for critical maintenance and repairs. The Kiryandongo district government has asked that The Water Trust help them implement this approach across the district, and is seeking funds to do so. In addition to the impact on water point sustainability and sanitation promotion, the groups advance the Ugandan government’s goals related to rural economic development. Prior to the groups’ formation, household surveys found that just one-third of households had cash savings in any form (including local banks, savings groups, or at home.) The average group of 33 members loaned out \$75 per member each year, and sharing out \$46 in savings and interest on an annual basis. Group members report using 62% of both their loans and share-out for income-generating activities, with the remainder spent on home improvements and other immediate needs. In conclusion, the self-help group approach represents a successful, scalable solution to the challenge of financing rural water point maintenance and a catalyst for rural investment and growth.

EXPLORING SUSTAINABLE FINANCING MECHANISMS FOR INTEGRATED WATER RESOURCES MANAGEMENT IN UGANDA:

A Case Study of the Rwenzori Mountain Ecosystem

Simon Peter Weredwong

Rwenzori Mountain Ecosystem, located in Western Uganda, is among key water towers in the country. The ecosystem supports downstream economies; hydro power generation, mining industries, irrigation, agriculture, fisheries, domestic and industrial water supply. It supports millions of people who derive their livelihoods in ecosystem services and goods. However, human population is exerting pressure on the ecosystem. Coupled with the increasing effects of climate change, the potential of the mountain ecosystem to support downstream communities and local economics may be impaired. Furthermore, recent flooding and erosion on steep slopes are causing siltation and sedimentation of rivers, subsequently compromising water quality and quantity in the region. Through Public Private Partnership, WWF Uganda Country Office is working to develop a sustainable financing mechanism, Payment for Ecosystem Services (PES) and tourism. Strengthening Corporate Social Responsibility and water stewardship has been integrated as mechanisms for improving the quality of watersheds and its benefits to communities. Through a combination of baseline hydrological, social economic and agronomic studies, WWF has supported Government of Uganda to develop policy framework and manual for PES and also demonstrated that the quality and quantity of water in the Rwenzori river systems could improve through adoption of sustainable land management practices by upstream communities. This is critical for supporting irrigation, hydropower, domestic and industrial water supply among downstream communities. WWF UCO and its global network will continue to engage with other partners including the Private Sector to consolidate achievements from; private sector involvement, establishment of community catchment management fund, Payment for Environmental Services schemes, effective tourism development, productive water use technologies, and design of a compelling PES policy. Conserving the Rwenzori ecosystem is vital for improving quality and quantity of water flows hence leveraging the Government of Uganda’s contribution to SDGs number 1, 2, 6, 7, 13 and 17.

EFFECTIVENESS OF COMMUNITY FINANCIAL MANAGEMENT SYSTEMS AND THE ECONOMIC VALUE OF COMMUNITY CONTRIBUTION TOWARDS OPERATION AND MAINTENANCE OF RURAL WATER FACILITIES.

The Community Based Maintenance System (CBMS) was introduced in Uganda in 1986 to address challenges of functionality of rural water facilities. Despite the good performance of CBMS, the functionality rate of rural water facilities has stagnated at 85% for the last 5 years with only 50% of the districts meeting the national average of 85%. One of the key challenges affecting functionality is the capacity of community to raise and manage funds for Operation and Maintenance (O&M) of water facilities. This abstract is on a study undertaken in 17 districts, to assess the effectiveness of the CBMS and the Community Financial Management Systems (CMFS) in particular. The study examined a number of issues including, the Sources of O&M funds, tariff setting, forms of community contribution, storage of funds, transparency and accountability, monitoring and auditing of funds, the role of women in financial management among others. The economic value of community contribution to operation and maintenance of rural water facilities was also established. A number of challenges affecting the community financial management system were identified by the study, including the embezzlement of funds, poor custody of funds, lack of financial records, negative attitude towards community contribution, illiteracy, high cost of spare parts, lack of guidelines, seasonal incomes, absence of financial institutions and the lack of systems for follow up among others. Conclusions and recommendations to address the above challenges were identified for inclusion in the Operation and Maintenance Frameworks to be revised in FY 2018/19

THE ECOLOGICAL AND SOCIOECONOMIC BENEFITS OF COMMUNITY ENVIRONMENTAL CONSERVATION FUND AND RESTORATION

Mujurizi peter

The Directorate of Water Resources Management is operationalising Catchment Based Water Resources Management (CbWRM) through four delineated water management Zones these Recognize water and environmental conservation as a key factor in poverty reduction and sustainable development also drives national planning in that regard This abstract intends to determine the economic value of the community environment conservation fund (CECF) in wetland restoration and also communal conservation of endangered tree species for example shea trees which are currently under threat due to charcoal burning in the region. The ecological and socioeconomic benefits of environmental conservation and restoration of agro ecological zones of Uganda where approximately 12 wetland systems totaling to over 400 acres so far have been restored, such ecological and socioeconomic benefits like added incomes, food and medicine are embedded in the theme of water week 2019 which is Water and Environment a Strategic Driver in Attainment of Sustainable Development Goal 2030. Community environmental conservation fund provide to communities with funds (revolving funds) as an incentive to draw away local communities from cultivating in identified hotspots like wetlands and along river banks, and also develop village-based Credit Co-operative to manage revolving funds as an alternative source of income where by communities use borrowed funds to venture into other income generating actives and social welfare. Shea butter activities have proved to be vital source of income to women in northern Uganda particularly in Otuke district where supported women groups are involved in additional value chain to shea butter to make soap and soft skin care products in addition shea oil is also food thus improving their livelihoods.as stated in the theme, proper management of water and associated resources will lead Uganda to attainment of sustainable development goal 2030

OPTIMISING INVESTMENTS TO ACHIEVE ACCESS TO SAFE WATER AND SANITATION FOR ALL

Case of National Water and Sewerage Corporation

Johnson Amayo and Mahmood Lutaaya
National Water and Sewerage Corporation.

A substantial increase in sector financing will be necessary to achieve Sustainable Development Goal 6 calling for universal access to safe water and sanitation while addressing issues of climate change, water quality and scarcity. Recent estimates by the World Bank's Water and Sanitation Program indicate that the present value of the additional investment in water supply and sanitation alone needed through 2030 will exceed US\$1.7 trillion (Hutton & Varughese 2016). Existing funding falls far short of this amount; countries may have to increase their investment in the water and sanitation sectors by up to four times in order to meet the SDGs. In this paper, we present the innovative financing options that have been adopted by NWSC to invest in the much-needed infrastructure. This was after the Corporation securing the highest ever credit rating for a water utility in Sub-Saharan Africa. The paper also presents approaches the Corporation has adopted in optimizing investment- achieving more with less - which has been a vital strategy in implementation of the 100% Service Coverage Acceleration Project (SCAP 100%); a project that is aimed at achieving 100% safe water coverage in all NWSC towns. The paper demonstrates the importance of better reflecting the value of water as a driver for improved water management and stimulation of further investment and converting the benefits of investments into revenue streams to increase the risk-return profile of investments to attract financiers. Understanding the financial and economic implications of implementing Forest Landscape Restoration in Uganda: A case of Karamoja and Northern Uganda. Sub theme 5: Financing the Sustainable development Goals The financial and economic assessment of Forest Landscape Restoration options is one of the upfront readiness activities by Government of Uganda and partners to lay ground for restoration of degraded and deforested land in the country. It builds on a comprehensive Forest Landscape Restoration (FLR) Opportunities Assessment (FLR-OA, 2016), which identified the available land for restoration, and proposed the most appropriate restoration options per landscape. All this is in response to the Government of Uganda's pledge towards the Bonn Challenge, to restore 2.5 million hectares of degraded and deforested landscapes by 2020, as well as the NDP II target to restore forest cover to 24% of the total land area by 2040.

The financial and economic assessment focused on Karamoja and Northern Moist FLR zones, and achieved the following: (i) established costs and benefits of investments in forest landscape restoration options; (ii) identified and analyzed the types of finance and resourcing options available to support the restoration opportunities; and (iii) recommended the most suitable and feasible funding options. The financial analysis determined the commercial profitability and viability of implementing FLR interventions, while the Economic analysis established the viability of all benefits including the multiple ecosystem services. In terms of methodology, the analysis comprised of discounted cash flow and economic cost benefit analyses, considerable expert judgment as well as input from the stakeholders' validation workshop. Results of the assessment show that; Implementation of FLR in the Northern Moist zone would require UGX 55.8 million per district per year in variable costs and UGX 1.4 billion/district in fixed costs. Karamoja on the other hand would require UGX 36.1 million per district per year in variable costs and UGX 470.7 million per district in fixed costs.

The funding options available include; Private sector finance for the financially viable FLR options, as well as public, civil society, and development partners funding for the economically viable FLR options. Financing through existing funds such as the Environment and Tree fund is limited by the restrictive provisions of the Public Finance Management Act (2015), but this could be unlocked through lobbying. The use of Capital market instruments could also be explored, as well as investing in development of forest value chains.

FINANCING SUSTAINABLE DEVELOPMENT: GOALS (SDGS)-

Rupert Allan

Between 25th November 2017 and 21st February 2018, HOT completed mapping all of the refugee hosting sub-counties of Arua district, identifying over 8300 geo-points, representing communities, their services, and even their roads. 3,500 water points, formal and informal, constituted a demonstrative majority of the data, proving the centrality of water access for livelihoods and resilience. Open Street Map is a global creative collaboration platform, which is owned by its participants as a 'wiki-map'. OSM users around the world map their local parks, tourist companies map 'cycle maps', hotels, and other businesses. Apple Maps and Facebook too, base business applications like Apple Maps on Open Street Map. Open Street Map can be seen as both a resource, a methodology, and a philosophy. For years, it has been harnessed by the global humanitarian community to assist in connecting community needs with resources in both response and development settings around the world. This community is globally incorporated as 'Humanitarian Open Street Map Team' (HOT). Contributors receive globally-supported vocational training in the latest (free) GIS tools, then use those skills to map their environmental conditions. It is cash-neutral, and leverages the surprising fact that smartphones are present in almost every sub-Saharan African Community. In Uganda, HOT's objective is split between data collection (map creation) and community capacity-building. It engages community to collect data and produce maps such as this, and this. It identifies all informal features too, informing more effective intervention, inside and outside refugee settlements. This presentation will discuss ways in which officials and communities can continue to use this free tooling system nationally of their own volition, monitoring and reporting on water supply, deploying for flood risk mapping, showing the advantages of participatory community water monitoring, and the socio-economic advantages of such engagement.

GREEN GROWTH:

The theme will aim at exploring opportunities for achieving green growth through sustainable development and management of water and environment resources. It will focus on the key principles of a green economy such as equity, environment sustainability, resource efficiency, pollution prevention technologies and best practices, climate change adaptation and mitigation and inclusiveness. Special focus will be given to Green cities, Sustainable energy, Green jobs and employment as well as sustainable production.

KEY NOTE ADDRESS

Green Growth

Stuart Worsley

Green Economy Coalition (GEC)

Countries Programme Director.

Our economic systems are failing us. We are reaching environmental limits, poverty abounds, and inequality is getting worse. Our planet is in crisis. The Green Economy frames a way for sustainable prosperity, and many nations are investing in this. Since the late 1700's, the global economy has expanded with unrestricted access to resources and un-costed use of the environment. At the start of the 21 st century, we have come to understand that there are limits to growth within a finite system and increasingly serious risks have been created by the current macro industrial model. Green Economy has been championed as part of the mitigating models to sustainable prosperity, and it is gaining traction.

There is a growing demand for economic change, with campaigns for finance reform, well-being and social innovation. Global Policy has defined 17 SDGs and has achieved a climate deal. 60 countries now have green economy/growth national plans, and international organisations and the EU have adopted green economy investment practices. If we are to transition to a green economy, it is critical that societal demand and public policy come together in every country. On the one side, there needs to be a critical mass of people to effectively demand and support transition. On the other, public policy must enable people to sustainably prosper. The presentation on green economy will therefore provide lessons and experiences that can inform countries strategies to transition to Green Economy.

GREEN INFRASTRUCTURE FOR WATER SECURITY -PRELIMINARY FINDINGS FROM THE ACHOLI IWRM PILOT PROJECT

James W. Kisekka¹, Isa Sematimba²

¹RAIN/Aidenvironment, ²Amref Health Africa,

Northern Uganda has many areas where groundwater is deep and difficult to reach. At many places the terrain is unsuitable for earth dams or valley dams due to the undulating landscape. In some places people and animals scramble for the same boreholes and problems with building new water points occur at places where the groundwater potential is low. As a step towards finding solutions, RAIN and Amref Health Africa implemented a pilot project (action research), under the WASH SDG Programme, testing the viability of small-scale green infrastructure to improve water security. The project involves the use of elevated roads (crossing seasonal streams) to retain water and create shallow wetlands. The main questions to be answered through the project are the feasibility and impacts of wetland creation on shallow groundwater, ecosystems and livelihoods. In April/May 2018, one pilot site was implemented along the Lokwangole - Olyelo-wi-dyel road in Kotomor Subcounty, Agago district. It has been observed that the elevated road retains water upstream of it, thereby creating a shallow wetland where neighboring community graze and drench their cattle during the past dry season for more days into the dry season compared to before. Further, through very basic measurements (done in November/December 2018), it was found that baseflow has increased during the dryer months at the pilot site. Monitoring of the changes in (shallow) ground water, abundance of wetland plants, and the use by the community of the newly-created wetland is proving the test of this pilot. Some neighboring communities were able to water their plants during the past dry spell, boosting their food access and

income. This now permanent wetland provides full time water access for other domestic uses such as washing and bathing. Lessons from engaging Uganda's Indigenous Forest Dependent People in REDD+

As Uganda continues to grapple with the increasing loss of forest cover, it is evident that all the relevant stakeholders and actors across the country need to swing into action, to tackle the multi-sectoral nature of the drivers of deforestation and forest degradation. Among such relevant stakeholder categories, are the indigenous forest dependent people, who despite their recognition as key players in the management of the forest resources, have not had a clearly defined platform to ensure their effective contribution to the process. Engagement of this stakeholder category is in line with Sustainable Development Goals 13 (13.B) which emphasizes specific focus on marginalized communities and ethnic groups, as well as 10 (10.2) which emphasizes inclusion of all irrespective of race, ethnicity or origin. Through the national REDD+ programme, tailor-made tools and platforms were used to effectively engage the Ika and Tepeth of Karamoja, the Batwa of Western Uganda and the Ndorobo of Mt. Elgon in the preparation of the National REDD+ strategy. The engagements revealed that effective engagement of forest dependent people means involving them through their own structures, and their own selected representatives. In addition, assurance of land tenure is critical for the forest dependent people to fully participate in REDD+ and related conservation initiatives. Important to note is also the fact that benefits from collaborative management of protected forests go beyond access to forest resources, and includes access to cultural heritage sites as and when needed. Therefore, protection and enrichment of the cultural heritage of indigenous forest dependent people would ensure preservation of the practices attached to management and use of forests, their products and services.

LIMITATIONS TO SOLAR TECHNOLOGY UPTAKE IN UGANDA

Isaiah Eitu

The solar PV technology grew from 10 Gigawatts in 2007 to 402 Gigawatts in 2017, with China, Japan, US, India and Turkey accounting for close to 84% of these new installations. These 5 solar PV giant countries do not only produce solar PV technologies for their domestic consumption but have earned their place in the world market for solar technologies export. They have apprehended their solar PV uptake barriers categorized under; technical, business management, policy and economic related. They have learnt to work around these limitations and continued to improve their innovations to meet the international standards. Developing countries on the other hand continue to lag behind despite having the most suitable climate for solar technologies. Uganda for example is endowed with sunshine that is well distributed and high throughout the year. The country experiences 5-6 kWh M-2 radiation⁷ per day on flat surfaces yet the uptake of solar technology remains very low. From the finding of this study, 80% of the respondents pointed out high solar costs as the major limitation while (70%) sighted inadequate knowledge of the potential and reliability of solar systems as a principle limitation to solar technology adoption. On a positive note, all the bottlenecks identified by the study can be effectively addressed through; review of government policies (tax exemption, tax holiday, subsidize), advocacy and standard control mechanism that play a pertinent role in enhancement of solar technology uptake

ADOPTION OF GREEN PRODUCTION AMONG SMALL AND MEDIUM ENTERPRISES IN UGANDA

The Role of Institutional and Organizational Factors

Solomon Kyeyune

Uganda's economic development and socioeconomic transformation is premised on green economy principles. of: equity; environment sustainability; resource efficiency; inclusiveness; climate change adaptation; and mitigation. Consequently, it is increasingly important that businesses including Small and Medium Enterprises (SMEs) adopt green production in order to give Uganda a sustainable advantage over other countries. This study looked at the adoption of green production among SMEs in Uganda and focused on the role of both institutional and organizational factors of interest. Institutional factors studied included customer pressure, regulatory pressure, government support and environment uncertainty while Organizational factors addressed were; organizational support, quality of human resources and company size. A cross-sectional research design with a sample of 384 SMEs was used to assess the influence of institutional and organizational factors of interest on adoption of green production among SMEs in

Uganda. To test this influence, regression analysis was utilized based on Ordinary Least Square (OLS) method of estimation. Based on the regression analysis the study findings indicate that that government support and organizational size, were significant in the adoption of green production. Based on these findings it is recommended that to improve adoption of green production among SMEs, government should put in place a policy to effectively regulate SMEs. This shall strengthen the role of regulatory and compliance bodies such as National Environment Management Authority (NEMA). The policy should focus on increasing public awareness through mobilization and sensitization about the green production

CONTRIBUTION TO A LOW CARBON AND CLIMATE RESILIENT DEVELOPMENT IN LANDSCAPES

Margaret A. Mwebesa

Ministry of Water and Environment, Uganda

The forest sector is one of the national development priorities as reflected in Uganda's Vision 2040, NDP II, National Forest Plan. Uganda's forest cover has declined from 24% (1990) to 12% in 2015 (NFA 2017) and majorly because of deforestation and forest degradation and currently Forest Emissions Level – is 8,254,691 MtCO₂e (2017) and also submitted to UNFCCC. According to Uganda's NDC (October 2015), Land Use Land Use Change and Forests contribute over 60% of GHG emissions. Uganda's Forest Investment Plan (FIP), developed with financial and technical support from the Climate Investment Programme; and World Bank and African Development Bank and FAO-Forest Landscape Restoration respectively will contribute towards the country's aspirations and development priorities as stated in NDP II and Vision 2040, and Uganda's NDC and Sustainable Development Goals 2030. Uganda's FIP a government led process was informed by the national REDD+ process and the National REDD+ Strategy. Its Goal: "A Low Carbon and Climate Resilient Development in land-use" and the Expected Transformational Impact is "Reduced Deforestation and Forest Degradation, well-coordinated and governed forestry resources contributing to improving resilience of rural livelihoods to climate change in the targeted landscape." Overall the FIP will promote integrated landscape management, livelihoods improvement, provide enabling environment for investment in conservation including high-end tourism in Uganda, e.g "Space for Giants" Initiative" that connects tourism, conservation and communities and also can promote the country's image.

INNOVATIONS IN WETLANDS MANAGEMENT.

Ssebyoto Asadhu

Wetlands Management Department under the Ministry of Water and Environment exercises stewardship over the wetlands in Uganda. One of its key obligations is to survey, quantify and map all wetlands in Uganda in order to provide a knowledge base for wetlands management and decision making. In order to attain the sustainable development goals by 2030 especially goals that are directly related to the department i.e. Goal 6 of clean water and sanitation that focuses on water production, water treatment, water distribution and use and goal 13 of climate action, the department has focused on use of earth observation innovations and technology to help achieve these goals. Earth Observation technology is an important tool for the Multilateral Environment Agreements (MAE) to support the Contracting Parties, and local, national and international bodies involved in the implementation of the Conventions. Some of these technologies have enhanced the capacity of the department to develop national wetland observatories and fulfil our Ramsar commitments. Among these we have developed a National Wetlands Information System (NWIS) which uses Geographical Information Systems technology to capture, store and analyse wetlands data. This system has been very helpful in storing inventory data which is a key component in determining wetlands extents and locations. The department also recently developed an earth observation system with support from other international partners called the GlobWetland Africa toolbox. This is a "free of charge" and "open source" software toolbox that better assess the state and change in wetlands it also accesses "freely and openly available" satellite observations from the most recent and innovative EO assets (mainly Sentinels of the European Copernicus Program and NASA/USGS Landsat 8). Therefore with all these innovations, wetlands management is made easy thus enabling

wetlands perform their natural functions of water treatment, production, storage and climate moderation which are key in achieving SDGs 6 and 13.

RENEWABLE ENERGY FOR SUSTAINABLE AGRICULTURE IN UGANDA

Noble Banadda,

Makerere University,

Agriculture is the sole provider of human food. Most farm machines are driven by fossil fuels, which contribute to greenhouse gas emissions and, in turn, accelerate climate change. Such environmental damage can be mitigated by the promotion of renewable resources such as solar, wind, biomass, tidal, geo-thermal, small-scale hydro, biofuels and wave-generated power. These renewable resources have a huge potential for the agriculture industry. By 2050, global demand for energy will nearly double, while water and food demand is set to increase by over 50%. Meeting this surge of demand presents a tremendous challenge, given competing needs for limited resources amid heightened climate change effects. To overcome the increasing constraints the world faces, we need to fundamentally rethink how we produce and consume energy in relation to the water and food sectors. Renewable energy technologies provide access to a cost-effective, secure and environmentally sustainable supply of energy. Their rapid growth can have substantial spill-over effects in the water and food sectors. Yet detailed knowledge on the role renewables can play in the nexus remains limited and widely dispersed. Renewable Energy in the Water, Energy and Food Nexus aims to bridge this gap, providing the broad analysis that has been lacking on the interactions of renewables within those key sectors. This study examines both global and Uganda-specific cases to highlight how renewable energy can address the trade-offs, helping to address the pressing water, energy and food challenges.

GREENHOUSE GAS EMISSIONS FROM UGANDA'S CATTLE CORRIDOR FARMING SYSTEMS

Nicholas Kiggundu^{a*}, Stanley Peter Ddungu^b, Joshua Wanyama^a, Denis Mpairwe^c, Sam Cheroticha, Emmanuel Zziwa^c, Faizal Mutebia, Alessandra Falcuccid

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The Uganda's cattle corridor is increasingly experiencing climate change induced droughts and as a consequence sustaining cattle production is uncertain. The objective of this study was to estimate the greenhouse gas (GHG) emissions from practised cattle farming systems (Stall, Semi-Intensive, Grazing, Tethering and Scavenging) and identify potential areas for GHG mitigation. Using the Global Livestock Environmental Assessment Model (GLEAM-i), GHG emissions in 2016 were 2,009 Gg CO₂-eq/yr of which the Grazing system contributed 88.5%. Enteric fermentation produced about 75.8% of the total GHG emissions. At an annual growth rate of 3%, the projected GHG for 2020 and 2025 would increase by 12.6% and 30.7% respectively. The milk and meat emission intensities (74.8 and 639 kg CO₂-eq/kg protein respectively) were far higher than the global averages. A reduction in grazing by 10% and a 10% increase in use of anaerobic digesters to handle manure resulted in a 4.4% reduction in annual GHG emission.

RESIN TAPPING FROM MATURE PINE TREES

Margaret A.Mwebesa

Ministry of Water and Environment

Forestry is a science and therefore dynamic. Over the years, changes in technology and the evolving nature of forestry have meant that there are new practices that are being realized for which Uganda should be ready to experience. Growth and development in the commercial forestry sector is mainly being engineered by the private sector. Plantation forestry is a long term investment. Pine trees take about 16 years while eucalyptus will mature at 12-15 for timber respectively, depending on quality of site. This calls for immense patience during which time, the tree farmers need to get an interim source of funds for weeding, fire protection, pruning and thinning. Whereas

thinning is a silvicultural activity, the markets for immature wood are small and the receipts only to meet the cost of that operation. Uganda's growing population is increasingly yearning for more environmental, social and economic products from the forests. These include wood and non-wood products and there is need for all stakeholders to adjust in order to accommodate this. Resin is one of such products and is being driven by Uganda Timber Growers Association (UTGA) to help tree farmers realize some intermediate capital to maintain their plantations and/or expand acreage under forestry which is good for Uganda. The pine trees, preferably *Pinus caribaea* from which resin is tapped must be 10 years and/or more, with 18cm or more diameter at breast height. The forest plantation must be thinned to at least 500 stems per hectare and UTGA advises that the trees should not be on extremely marginal sites e.g. very poor soils. Plantations that are in proximity with others enjoy group/shared benefits and UTGA provides oversight, monitoring and inspection services and maintains regular contact with resin contractor to ensure compliance. There are multiple benefits of resin tapping and these include increased profitability of forest plantations with 76% increase in Internal Rate of Return (IRR) and 10-30% increase in Net Present Value (NPV) over a management strategy of timber alone. Resin tapping offers a partial solution to current timber trade challenges in an informal sector and is an incentive to maintaining high quality pine plantations. It ensures a reduced payback period for an investment in commercial forestry and ensures the upholding of Forest Stewardship Council (FSC) standards and provides opportunities of increased value of products from Ugandan forests through strengthening links with international & global players. Present and guaranteed markets for resin ensures interim revenue and therefore recovery of establishment costs, improves cash flow and is responsible for the change in mindset - a solution to growers previously frustrated by the long term period of growing pine. There are more forestry jobs created, more funds coming into the industry and improved livelihoods for those in the resin value chain.

WETLAND CODING AND NAMING IN PREPARATION FOR WETLAND GAZZETTMENT.

Takuwa Nuubu

Wetlands Management Department (WMD) under Ministry of Water and Environment is the lead agency for wetlands management in Uganda. Wetland degradation is on the rise, thus the need to gazette all wetlands in order to enhance effective management. WMD therefore, initiated the process of gazetting wetlands in Uganda, a process that requires comprehensive information on all wetlands such as names of wetlands, codes, location and coverage. The National Wetland Project in collaboration with National Biomass Study Project carried out the classification, mapping, coding and naming of wetlands in 1994. In the financial year 2014/2015, WMD started the process of reviewing the wetland database and filling data gaps in all the eight drainage basins in Uganda i.e. L. Kyoga, L. Victoria, L. Albert, L. Edward, Victoria Nile, Albert Nile, Aswa and Kidepo. Each wetland required a unique identifier/code and name for easy identification. The aim of this exercise was to name and code all wetlands in the National Wetlands Information System (NWIS) in order to provide sufficient information for wetland gazettelement in Uganda. The approach involved deskwork and field work to locate wetlands without names. The Wetlands were coded following the wetland complexities (Primary, Secondary, Tertiary and Quaternary wetlands). A wetland code consists of thirteen digits e.g. 01001001001001. Wetlands were named using the wetland names in the District Wetland Inventory Reports (DWIRs), River names, with the assistance of local people and some Village names were also used to name wetlands. The results obtained from the wetland naming and coding exercise were summarised in tables and wetland maps of each district produced. With all the wetland information gaps filled, the wetlands gazettelement process can effectively be carried out.

COLLABORATIVE WATER RESOURCE PLANNING AND MANAGEMENT IN MPOLOGOMA CATCHMENT

Waiswa Nelson

Lack of collaborative planning and management of water resources has been identified as a key hinderance to effective resource planning and management. The major objective of this paper is to analyse the effectiveness of collaboration by the diverse stakeholders in water resources planning and management in Mpologoma Catchment. Information and data was obtained through consultative meetings and stakeholder engagement in Mpologoma. The results indicate that the collaborative structures in Mpologoma catchment have enhanced information sharing. The

results further show that collaboration among diverse stakeholders leads to sustainable planning and management of water and related resources. Collaborative water resources planning and management is still a relatively new concept and therefore it's important to pay particular, attention to the ways in which stakeholders involved in this catchment management initiative understand and execute collaboration when they on the other hand have extensive leeway, discretion and autonomy as District Local Governments and private sector.

GREEN GROWTH OPPORTUNITIES FOR GREEN CITIES

Irene Chekwot

The global recession and continued concern over climate change calls into question the ability of current models for economic growth to foster long-term prosperity. Faced with economic hardship and pressing social problems, countries around the globe have pursued a wide range of policy and investment strategies to jumpstart economic recovery. "Green growth", is generally defined as a means to create jobs and economic growth while reducing costs and environmental impacts over the long run. More than half of the global population (3.49 billion) now lives in urban areas which is expected to reach nearly 70% by 2050. As key engines of economic growth, job creation and innovation, but also as major contributors to global warming and environmental problems, cities are at the heart of the transition to a green global economy. The current growth rate in urban population is 5.6 percent per year, with around 14-16 percent of the population in Uganda live in urban areas. There are around 289 urban centers⁴ in Uganda, the urban population has been increasing over time from about 1.7 million in 1991 to nearly 7.4 million in 2014. The Uganda Green Growth Development Strategy focuses on supporting comprehensive economic physical planning and efficient waste management for at least five cities and 15 municipalities, promoting sustainable procurement and interlinkage between the rural raw material production base and industrial production in cities. The implementation of Uganda's green growth development model for green cities with focus on areas with the highest potential in terms of investments and contribution to the national development goals, will lead to realization of income and livelihoods enhancement, decent green jobs, climate change mitigation and adaptation, environment and natural resources management, food and nutrition security, resource use efficiency, social inclusiveness, and economic transformation at city level.

THE ROLE OF BIOCHAR AND ECTOMYCORRHIZA IN MITIGATING CLIMATE CHANGE.

Opiro Lakuma Kenneth

Atmospheric carbon dioxide concentrations have significant effects on climate change. Biochar is a stable, recalcitrant organic carbon compound created when plant biomass is heated at very high temperatures, under very low oxygen concentration. The roots of some trees form symbiotic association with some fungi called ectomycorrhiza. Biochar added to soil is very efficient in fixing atmospheric carbon dioxide. Moreover, the carbon fixed can stay in the soil for hundreds of years. While trees absorb carbon dioxide, they do not do this alone. It has been found out that particular root fungi called ectomycorrhiza do help trees absorb carbon dioxide even faster. Trees which form association with ectomycorrhizal fungi are better in mitigating climate change than those without the partnership. Furthermore, ectomycorrhizal fungi can slow down decomposition, a natural process that returns carbon from soils back to the atmosphere. In these ways ectomycorrhizal fungi enhance the ability of forests to keep carbon locked up in trees and soil and out of the atmosphere. Therefore, both biochar and ectomycorrhiza play significant role in mitigating climate change.

THE KAMPALA GREEN INDUSTRY CAMPAIGN

Vanessa Tyaba

Kampala city majorly relies on the Inner Murchison Bay of Lake Victoria for fresh water supply however, this source is highly polluted as households and industries dispose of their waste and untreated wastewater into drainage systems that lead directly to the lake. This has affected the ecological functions of wetland ecosystems and the quality of water in Lake Victoria. The non-compliance by the industrial sector to wastewater discharge and waste management regulations is also a contributing factor to the pollution. Technical and financial support for investment in green

manufacturing is essential towards achieving sustainable development and management of natural resources. The GIC inspires change in the water sector by promoting a shift from business as usual in industries within Kampala. The Kampala Pollution Control Taskforce (PTF) is a multi-stakeholder partnership that aims to strengthen collective action for a pollution-free Greater Kampala that safeguards water and environmental resources while fostering inclusive growth. The PTF spearheaded the GIC to enhance compliance to environmental regulations through an innovative incentive-based approach. The campaign was in the form of a competition where the best performing industries were awarded according to the laid commitment in implementing cleaner production solutions. Through providing fully funded on-site technical assessments and trainings on Resource Efficiency and Cleaner Production (RECP) to the 20 participating industries, main challenges in implementing cleaner production practices were identified and easy low-cost solutions were proposed. The GIC is a first of its kind in Kampala and resulted in dialogue with the industrial sector to understand their challenges in green manufacturing, increase awareness on environmental compliance and how both the private and the public sector can amicably work together to reduce pollution going into the environment.

THE UGANDA REDD+ NATIONAL STRATEGY WAS LAUNCHED IN NOVEMBER 2017! SO WHAT NEXT MOVING FORWARD?

By: Zake J*

This paper reflects on the Uganda REDD+ National Strategy with a focus on the process of formulation, the underlying identified key drivers of deforestation and forest degradation, the associated strategic options for addressing them. It also underpins the key early actions which should advance to set the ground for full implementation of the strategy at the national and sub-national levels. The methods and approaches used in the compilation of the paper is largely literature review and synthesis of relevant documents and publications in relation to REDD+ process in Uganda. The results clearly indicate that Uganda is in the advanced stage of its REDD readiness phase and thus, timely to transit into the REDD implementation phase. In the latter phase, the REDD+ National strategy and other REDD+ framework documents should be implemented and operationalized. Besides, a robust institutional framework should be established building on the existing institutional arrangements to support effective implementation, reporting and verification of REDD+ activities in Uganda at national and local levels.

CIVIL SOCIETY ORGANISATION'S CONTRIBUTION IN ADVANCING UGANDA'S GREEN GROWTH PATH;

A case of the Environment and Natural Resources Civil Society Organisations Network.

Nakiyingi, E., Kayiita, J. and Zake.J.

Environmental Alert

This paper highlights how the Environment and Natural Resources Civil Society Organisations Network has positioned herself to deliver on its role in greening Uganda's economy. Whereas government recognises the role civil society organisations they play in supporting her efforts, Civil Society Organisations have inadequate knowledge and institutional capacity to effectively complement Government's work as well as delivering on their mandate as stipulated in several National Policies and Legislations. For this reason, the Government entered into structured partnerships for joint program implementation with Environment and Natural resources Civil Society Organisations Network to bridge the existing gaps and provide an enabling ground for green growth policy advocacy. Inclusive Green Growth for Poverty Reduction is one of the joint partnership projects between Government and Environment and Natural Resources Civil Society Organisation Network whose overall objective is to accelerate and sustain progress towards poverty and inequality reduction. Under this joint partnership, the Environment and Natural Resources Civil Society Organisations networks' contribution is to ensure that by the end of 2019, relevant Civil Society Organisations have adequate technical, technological, operational and financial capacity to raise awareness and engage the public in Natural Resource Management, promote and document good community practices that link Natural resources management to improved livelihood and job creation.

In order to attain the above, a capacity needs assessment in the context of green growth for 101 Environment and Natural Resources Civil Society Organisations across the country and Strategic engagements on the draft urban waste management policy were conducted. The methodology for the assessment included: Key informant interviews and Focused group discussions administered with selected members of the network. An assessment report and a capacity building plan were developed and validated by the relevant stakeholders at both local and national levels. Apparently there is an elementary degree of awareness about green growth amongst the targeted Environment and Natural Resources Civil Society Organisations, youth, women and Indigenous People's Organizations. Furthermore, key policy issues and related recommendations in respect to green growth were presented and discussed during a national multi-stakeholder platform, which involved 40 (23 male and 17 female) participants comprising of representatives from relevant line ministries, departments & authorities and Environment and Natural Resources Civil Society Organisations, youth, women and Indigenous People's Organizations. In conclusion, Civil Society Organisations can effectively deliver on their roles in respect to delivering Uganda's economy through a green growth path when they have adequate knowledge and institutional capacity. This will be achieved through implementation of the institutional capacity building plan and related issue based structured policy engagement at national and local levels. Strategic partners should be engaged to support implementation of this capacity building plan.

BAMBOO GROWING AND VALUE ADDITION FOR ECOSYSTEM HEALTH AND WEALTH CREATION

Munaaba Flavia Nabugere

Uganda Bamboo Association

Climate Change impacts and rampant land degradation of water catchment areas, particularly river banks, lake shores, wetlands and fragile mountain slopes threaten the capacity of the Water and Environment Ministry in fulfilling its mandate of ensuring availability of quality water supply. During the Uganda World Water week in March 2019, the Ministry together with stakeholders will demonstrate initiatives in water resource management that address Global sustainable development goals. Uganda Bamboo Association is one of these stakeholders. This paper highlights opportunities for achieving green growth in the sustainable development and management of water and environment resource using bamboo. In that regard, it demonstrates how bamboo growing will give a quick fix to environment degradation, improve people's livelihoods and create decent work. It also raises awareness of the versatile nature of bamboo, a crop that grows very fast in all climatic conditions across the world and on maturity is self-regenerating. The paper further highlights UBA demonstrable capacity to offer knowledge and skills in bamboo propagation, multiplication, nursery and plantation establishment and management. In addition, this paper shows how Bamboo vegetation cover can improve soil stability, reduce soil erosion and siltation of water resources, slow down soil moisture loss, improve water retention, improve air and water purity. The resulting bamboo will create a critical mass of bamboo raw material to support industrialization and establishment of large scale factories for energy production, timber, cloth, and higher value products for export market. In an exhibition at the sidelines of the UWEWK UBA will showcase bamboo products and skills in making bamboo furniture, crafts, jewelry, salads, cosmetics, bicycles, water pipes energy products, fertilizers, construction materials and others household/domestic appliances. This paper will enhance the visibility of bamboo for environmental conservation, demonstrate skills in working with bamboo and availability of a market for bamboo products.

PURSUING A GREEN GROWTH APPROACH FOR SUSTAINABLE DEVELOPMENT

Nathan Mununuzi

Uganda is heavily dependent on natural resources for economic growth and the livelihoods of its people. The natural resource-based sectors of agriculture, tourism, minerals and forests, among other resources, are the engines of economic growth. Agriculture for instance, contributes approximately 23 percent of the country's GDP, 48 percent of the total exports and 68 percent of the total employment. Despite their importance, Uganda's natural resources are under threat from natural and man-made causes. The country is experiencing a declining natural capital base, resource productivity and diversity. Recent studies indicate that over a period of 25 years from 1990 to 2015, Uganda lost about 63 percent of its forests and wetlands declined from 18 percent to 8 percent during the same period. The

declining natural resource base and productivity, coupled with the high population growth rate of 3.2 percent, a very high vulnerability to external shocks and the adverse impacts of climate change, are imposing high social, environmental, economic and political costs to the country. The degradation of natural resources is contributing to declining levels of economic growth stagnating at a low average of 3.9 percent per annum for the last 2 years against the NDP 11 target of 6.5 percent per annum. Implementing a green growth model is an exciting approach that can significantly boost Uganda's effort towards achieving sustainable development. Green growth is one that aims at achieving sustainable development without degrading the environment. Key attributes of green growth include- low greenhouse emissions, sustainable use of natural resources; and social inclusiveness and equity. The green growth model if effectively implemented has the potential to contribute to addressing some of the sustainable development challenges facing the country such as high levels of unemployment especially for the youths, natural resources degradation, inequitable growth and poverty.

IMPORTANCE OF BAMBOO TOWARDS GREENING THE ENVIRONMENT AND ECONOMIC DEVELOPMENT IN UGANDA.

Tom Obong Okello

National Forestry Authority

Uganda has an estimated bamboo growing area of about 18, 000 hectares (World bamboo resources, 2005). Based on the recent GIS based study conducted by Zhao et al (2017), Uganda has a total bamboo growing area of about 545.87 km² – this includes pure bamboo stands, mosaic of bamboo and trees. Bamboos in Uganda are mainly found in protected areas and national parks (under government control) such as Mt. Elgon, Rwenzori, Mgahinga, Bwindi Impenetrable National Park, Otzi West and East, Ayipe, Atiya, Agoro-Agu and Echuya forests (Zhoa et al, 2017). Bamboo is the most important non-timber forest product locally to supplement timber in making handicrafts and furniture, construction, food (bamboo shoots), energy (firewood and charcoal). Bamboo furniture and crafts training in Mgahinga and Moyo respectively. Bamboo products are key value-chains generating income and employment for local communities in Uganda. However, bamboo faces biggest challenges including lack of awareness and finances to innovate and use bamboo resources, limiting sustainable management and development of the resource. Lack of a reliable database on bamboo resources, future use and market trends, and suitable tree planting materials.

PROFILING URBAN WATER AND CLIMATE CHANGE: PROPELLING CITIES TOWARDS GREEN GROWTH AND SUSTAINABLE DEVELOPMENT

Martin Owor

Office of the prime Minister

Although Uganda is well endowed with fresh water resources; water availability is closely tied to the prevailing climate. The degradation of water resources has reached critical levels and is heightening climate risks. The impacts of a changing climate (droughts, storm water, and floods) are already causing stress on water resources, and the projected future climate will amplify stress on water availability and water quality which will significantly affect the urban population, economy and environment. Kampala and Jinja are highly affected because their fresh water supply is drawn directly from Lake Victoria. With the predicted climate (increased intensity of rainfall), the impacts of flooding on water in the future will be severe but more importantly they are likely to be more indirect, through increased cost of water treatment, than through direct damage of the infrastructure. Moreover, urban water supply is managed at national level, by the National Water and Sewerage Corporation (NWSC), and not by the urban authorities which presents vulnerability as NWSC is not able to cover all towns in their entirety with piped water. Furthermore, the water connection costs and tariffs are prohibitive for the poor communities. Yet alternative sources like boreholes, protected and unprotected springs, streams, rivers, swamps and wetlands are highly dependent on climate vagaries.

Basing on the National Urban Climate Change Profile (2018), this paper seeks to highlight the criticality of the water-climate change nexus, in achieving green growth in cities and sustainable development. It identifies concrete current

challenges in aspects of water availability, quality, security and supply and their possible solutions. The paper concludes with recommendations categorized into: information (early warning, improve weather fore casting), institutional (enhance capacity of technical staff, develop catchment plans) and infrastructural (critical investments in water infrastructure and flood control) among others to address some of the observed challenges

BLUE ECONOMY AND SDGS

The theme will introduce the Blue Economy concept, which is the economic benefit, and value we realize from the Earth's freshwater environment. Sustainable Blue Economy provides social and economic benefits for current and future generations, restores, protects and maintains the diversity, productivity and resilience of aquatic ecosystems, and is based on clean technologies, renewable energy, and circular material flows. The theme will also discover how sustainable development furthers social progress growth and challenges faced as we move towards a sustainable economy, and how to work together to overcome them. The theme will also address issue of transboundary water cooperation and its role in achieving a blue economy and SDGs.

TURNING FAECAL SLUDGE INTO FUEL BRIQUETTES: EXPERIENCES FROM A PARTNERSHIP BETWEEN WATER FOR PEOPLE AND NATIONAL WATER AND SEWERAGE CORPORATION IN KAMPALA, UGANDA

Y, Lugali, J. M., Maiteki , C.Z., Nimanyac

Water for People Uganda

For many years in Africa, faecal sludge has been regarded as a hazardous material, given little attention about energy recovery from the bio solids with its most common reuse option as a soil conditioner. Water for People in its mandate to develop appropriate and sustainable sanitation technologies partnered with National Water and Sewerage Corporation (NWSC) to set-up a faecal sludge briquette production plant in Kampala. In this partnership, NWSC agreed to provide sludge for the briquette production as well as land for set-up of a carbonizer facility at the treatment plant in Lubigi. Water For People was responsible for the set-up of the briquette facility. Research was undertaken to understand the physical and fuel properties of two types of sludge; Top Scum collected scooped from the top of the sedimentation tank and Bottom sludge collected from the bottom of the tank at the treatment plant. The parameters tested for included; calorific value, ash content, moisture content, volatile matter, fixed carbon, water boiling tests and emission tests. Results indicated that briquettes with a composition of 40% FS and other materials were comparatively competitive with charcoal having a calorific value is approximately 24MJ and ash content of 18%. To date, more than 1000kg of FS briquettes-both stick and honeycombs have been produced with focus on increasing the production of the facilities in Nyanama and Lubigi to meet a target of 5000kg/week. An understanding of the market segment for FS briquettes as an alternative fuel source shows a potential demand in chicken farmers (market size of 2000-4000) and supermarkets (market size of 18-25).

THE ROLE OF PRIVATE SECTOR IN ENTREPRENEURING SANITATION SERVICE CHAIN TO IMPROVE FECAL SLUDGE MANAGEMENT

- Lydia Biira

IRC

International Water and Sanitation Centre (IRC) in 2017, carried out a Sanitation Market Based Assessment in Kabarole District to determine the overall size of rural sanitation market and the demand for different services across the sanitation value chain; fecal containment, emptying, transportation, disposal and treatment. As well as assess the capacities of sanitation service providers to deliver sustainable services and develop the proposal of enabling environment required for the sanitation market to thrive. An analysis of the findings showed that 2% of the population is connected to the sewer, leaving 98% using on-site sanitation facilities. One percent (1%) of the Onsite sanitation facilities are septic tanks and 4% are lined pits implying that the other 93% are unlined. 80% of the unlined facilities are abandon when full and the other 20% use some form of (manual) emptying. The availability of only one cess pool emptier truck in the district is also major hindrance to emptying services. The study indicates that that there is a huge potential demand for Fecal Sludge emptying services from Kabarole and surrounding districts subject to upgrading and lining of traditional unlined pit latrines. The actual quantity of FS currently collected and discharge at the existing wastewater (FS) treatment plant is 280m³/day at low fees. The majority of faecal sludge remains uncollected and reflects the existing gap in FS emptying services due to non-emptiable sanitation facilities and the limited capacity of

the existing private operators involved in this business. IRC has developed the capacity of private sector [KAHASA] in sanitation as a business model to diversify their services and improve sanitation. KAHASA was supported by IRC with a pit emptying kit for safer disposal of fecal sludge.

THE UGANDA NATIONAL FOREST STEWARDSHIP STANDARD APPROVED AND LAUNCHED; WHAT ARE THE OPPORTUNITIES FOR ADVANCING RESPONSIBLE FOREST MANAGEMENT IN UGANDA.

Dr. Zake J.

Recently, Uganda concluded the process for development of the National Forest Stewardship Standard. It was a very successful process because the standard was approved by the Forest Stewardship Council and launched by the Ministry of Water and Environment. Thus, Uganda is the 1st country in Africa and the 8th in world to have such a standard. In this paper the process for development of the Uganda National Forest Stewardship Standard is described, highlighting the key lessons learnt. Furthermore, it provides a reflection on the key opportunities along this process, which could be tapped into to advance full implementation of the standard to contribute to responsible forest management through forest certification. The methods and approaches used in the compilation of the paper is largely literature review and synthesis of relevant documents and publications in respect to forest certification and standards development. The standard provides a national framework for promotion of responsible forest management through certification. However, there are several opportunities that must be harnessed for the intended aspirations and outcomes of the standard to be achieved. It requires development and implementation of a structured and institutionalized roadmap for operationalization of the standard. The stakeholders involved in the development of the standard should equally and effectively be involved in the development and implementation of this road map. The Ministry of Water and Environment through the Forest Sector Support Department should effectively coordinate this process.

PRODUCTION OF ACTIVATED CARBON FROM COFFEE HUSKS FOR WASTEWATER TREATMENT

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The demand for activated carbon is increasing due to the increased effectiveness of the carbon materials in wastewater treatment. The goal of this research was to assess the performance of coffee husk activated carbon in treatment of dye wastewater. Coffee husks were selected because of their high carbon content and abundance in the country. Dried coffee husks were crushed to particle size of 750 μm sieve size to reduce the consumption of activating agent and were then subjected to different preparation variables such as impregnation ratio, carbonizing temperature and carbonizing time. The Response Surface Methodology (RSM) based on Central Composite Design (CCD) was used to optimize the preparation variables with percentage yields of activated carbon and dye removal as the targeted responses. The optimal conditions for the preparation of activated carbon using design expert software were 453oC, 61 minutes and 1.8 impregnation ratio. These set of conditions gave activated carbon yield of 43.3% and methylene blue removal of 85.8%. Analysis of Variance (ANOVA) for activated carbon yield and methylene blue dye removal showed the developed model equations were significant ($p \leq 0.05$). The experimental and predicted values of activated carbon yield and methylene blue dye removal were in close agreement with correlation coefficients (R^2 -values) of 0.9703 and 0.9767 respectively. Characterization results showed low: moisture content (6.05%), ash content (2.48%) and volatile matter (28.46%) which indicated that produced coffee husk activated carbons were excellent adsorbent material to be used in bed reactors. Generally the results show that coffee husk activated carbon is a good adsorbent material in dye wastewater treatment.

THE FAECAL SLUDGE FIELD LAB

Magdalena Baeuerl

Providing adequate sanitation is a top priority in emergencies. With more and more emergencies occurring in urban contexts or becoming of more long-term nature, there is an increased need for faecal sludge (FS) treatment, but standard laboratories to monitor the treatment process are often far away and expensive. The FS field lab, developed by the Austrian Red Cross and its partners, is the first to answer to this need, allowing on-site monitoring of the process and its end-products in order to ensure public health. The readily available FS field lab fulfils following design criteria: Appropriateness → delivers comparable results with a standard lab; Applicability → works in the field; Affordability → is cheaper than a standard lab; Mobility → fits in a Toyota Land cruiser. The field lab is assembled in several modules, including equipment for sets of parameters to ensure public health (Microbiology and Helminths), for different treatment processes as well as for various end-use intentions. Support kits would include basic lab support, personal protective equipment as well as power supply. Analytics from the FS field lab are expected to provide an objective basis for informed decision-making and contribute to overall awareness raising for the importance of safe FS management to ensure public health, especially in emergencies. In 2018, about 20 lab technicians were trained at Lubigi FS Treatment Plant. A Ugandan training participant is currently co-leading the FS field lab that was deployed to Cox's Bazar in due course of the Bangladesh Population Movement Operation. The FS field lab that remained in Uganda will be used for further training activities and to analyse the effectiveness of FS treatment plants installed in West Nile. Besides continuous refinement of the FS field lab, follow-up activities will include the development of a web-based lab management software.

BALANCING DEVELOPMENT AND CONSERVATION IN UGANDA THROUGH THE APPLICATION OF THE MITIGATION HIERARCHY

Beatrice Kyasiimire, Grace Nangendo, Sam Ayebare and Simon Nampindo

Governments and the private sector are seeking better ways to address biodiversity loss that occurs through development projects. Biodiversity offsets are one important tool for mitigating biodiversity loss in situations where development is sought despite detrimental environmental impacts. Worldwide, countries are progressively reviewing their legislative frameworks to provide for more effective protection of biodiversity and sustain ecosystem services that support economic development. The mitigation hierarchy, if well designed and implemented can ensure the conservation of biodiversity and ecosystem services and achieve Not Net Loss (NNL). Uganda is undergoing rapid development across all sectors. The National Development Plan II (NDPII) proposes that by 2020, Uganda will be a middle income country and the development interventions envisaged by the Vision 2040 would invariably result in residual impacts on biodiversity and ecosystems. This implies that the government will have to implement a number of institutional, legal and policy reforms in order to achieve the No Net Loss principle for all economic developments across sectors. It is clear that most of the major infrastructure projects such as roads, industrial parks and bridges, and energy-related projects e.g. oil and gas exploration and production and hydropower dams being developed heavily impact Key Biodiversity areas (KBAs) and the abatement cost is quite enormous for a poor country like Uganda to afford. The country has not yet legally institutionalized the application of the mitigation hierarchy for achieving NNL. This paper discusses some of the benefits of applying the mitigation hierarchy and also proposes some policy, legal, institutional and financing mechanisms that Uganda needs to undertake in order to sustain the stocks and flow of ecosystems services and achieve its international targets and commitments to protect and conserve biodiversity

BIG SIZE-STONE MASONRY RAINWATER HARVESTING TANK TECHNOLOGY FOR INCREASED SAFE WATER, FOOD SECURITY AND FOR RESILIENT TO CLIMATE CHANGE IN MPIGI DISTRICT

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Uganda Muslim Rural Development Association (UMURDA)

UMURDA's experience in Rainwater harvesting in Uganda has been growing since 2007 and an assessment of its impact shows a level of government and community embrace and indications of social, environmental and economic impacts far beyond expectations. UMURDA has improved the technology it originally had and now constructs higher capacity systems (500,000 litres) that have a major place in the future of water provision in water stressed areas and have applications in institutions and semi-urban situations. By harvesting and storing the rain that falls during the wet seasons it is possible for Uganda to meet its water needs during the dry seasons. If water is harvested efficiently it would be possible to support the 30% of the population that do not have access to clean water. These tanks act as stores of water and can help the communities to become resilient with the impacts of climate change. The water can be used as for enterprises such as bee keeping, fish farming poultry and solar powered irrigation for kitchen gardens

BOUNDARY TREE PLANTING FOR WATER AND SOIL CONSERVATION ALONG ADMINISTRATIVE BOUNDARIES IN UGANDA

Eng. Biyomotho Jimmy,

This paper addresses the need for Government to take action on demarcation of all international, district, sub-county, parish, and village boundaries with trees. Currently, the border disputes leads to long time of claiming for the administrative jurisdictions that were in most cases carried out by the colonial Governments. There are various tree species that should be planted that includes fruit trees, commercial trees of pines, eucalyptus, teak, benny, mahogany, medicinal trees that can clearly define the administrative boundaries. Experience shows that hills, valleys, rivers among other physical features were used by the colonial Governments to demarcate the administrative boundaries some of those features are not clearly visualized practically. It is difficult to know the administrative boundaries in Uganda, unless somebody shows you the physical features of hills, rivers, swamps. The methodology of planting the trees shall be through the engagement of the owner of the land adjacent to the border. The trees shall belong to government who shall provide the seedlings ready for planting. The land owners adjacent to the boundary shall plant and care for the trees. A spacing of 50m interval is proposed for the trees of various species based on the ecology. The high internal rate of return on this project, the environmental benefits to soil and water conservation is self-explanatory. Such trees were planted by Semei Kakungulu during the colonial administration and currently provides good identification footmarks of sub-county and district headquarters that are visible to date especially in Eastern Uganda. The fruit trees shall range from avocado, mangoes, jack fruit, oranges, among others based on the local climatic conditions in the region. The boundary tree planting programme and marking should be extended to demarcation of wetlands by Ministry of water and environment instead of relying only on the concrete pillars only that are expensive. This will provide food security and nutrition to the community members. Uganda National Roads Authority (UNRA) and Local Governments should embrace tree planting in all the road reserves for trunk, district and community access roads. These trees planted shall remain the property of the respective administrative units that can also provide income and environmental sustainability to the local Governments. The concrete pillars by UNRA should include writing kilometer and reflector as value addition to the existing pillars having a tree planted next to it. National Forestry Authority (NFA) and UNRA should have a memorandum of understanding for undertaking the project for sustainability. High population growth and limited space for tree planting poses a great threat on the environment and yet our boundaries, if well utilized can provide very high density of trees that can conserve the environment and improve the nutritional level in the communities.

APPLYING CIRCULAR ECONOMY PRINCIPLES TO GREENING AGRICULTURE IN THE FACE OF CLIMATE CHANGE

The Ugandan Perspective of Organic Farming

Flavia Byekwaso

A global development challenge that still awaits effective redress is the fact that while world food production has increased substantially over the years, most developing countries, especially in Africa, are still food insecure. Food insecurity in many of these countries has been exacerbated by climate change, rapid population growth, environmental degradation, extreme weather conditions, conversion of agricultural lands for cultivating bio-fuel crops and an increased use of cereals to feed animals, poverty and escalating food prices. Today, about 923 million people are suffering from chronic food insecurity, hunger and malnutrition worldwide. The highest incidence of undernourishment is in Sub-Saharan Africa, where one in every three persons suffers from chronic hunger. Improving food security in Uganda requires application of circular strategies to economically, environmentally, and socially appropriate agricultural system based on local people's needs. This paper argues that greening agriculture, especially organic agriculture, is one of the most feasible sustainable production agricultural systems in Uganda through the viewpoint of its links to implementation of circular economy concept and its potential to contribute to sustainable rural development. On the basis of a comprehensive bibliographical search, the potential of using an organic agriculture model to promote food security, climate change adaptation and environmental management in Uganda is analyzed. The paper aims to contribute to the creation of adequate awareness among policy-makers, government bureaucrats, development stakeholders and farmers on the challenges hindering the greening of agriculture using sustainable farming systems in Uganda, especially the promotion of organic agriculture. A number of recommendations are provided for popularizing organic agriculture in Uganda to achieve a circular flow of materials and energy.

WOMEN PARTICIPATION AGROFORESTRY AND SUSTAINABLE LAND MANAGEMENT IN MOUNTAIN ECOSYSTEMS

Peter Fuuna

Gender equality continues to be increasingly recognized as a critical crosscutting issue in major multilateral environmental agreements. Land Degradation is a global concern for sustainable development, conservation of biodiversity and mitigating and adapting to climate change. It refers to reduction or loss of the biological or economic productivity and complexity of land, reducing carbon storage in soil and vegetation, driving the loss of biodiversity and accelerating climate change. It is vital that land degradation receives adequate attention from the nature conservation community and is addressed pro-actively in the implementation of the Convention on Biological Diversity (CBD) and the United Nations Framework Convention on Climate Change (UNFCCC). The three Conventions have incorporated gender equality at different paces and in different manners. Over the past several years, there has been an exceptional increase in gender-sensitive decisions. The integration of women's rights and gender equality issues into the mitigation of biodiversity loss, desertification, and climate change is not only essential, but maximizes the efficacy of interventions, programs and resources. Women have considerable knowledge and experience in managing and conserving natural resources. Reversing land degradation is essential if we are to achieve the goals of the UNCCD, CBD or the UNFCCC as well as to continue meeting related sustainable development targets. This paper examines the role of women in Agroforestry and sustainable land management, given its close links with other environmental and sustainable development challenges, including poverty, climate change and biodiversity loss.

