

**2<sup>nd</sup> International Maji Scientific Conference**  
**(IMSC 2023)**

**The Programme**

**Convened by: Water Institute,  
Ministry of Water, Tanzania**

**Dates: 8<sup>th</sup> to 10<sup>th</sup> March, 2023**

**Ubungo Plaza Conference Centre,  
Dar es Salaam, Tanzania**

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## **1. Introduction**

The *Maji* Scientific conference serves as a platform to bring together scientists and researchers to address water sector challenges. In responding to challenges and technological advancement on water sector, the Water Institute in collaboration with Ministry of Water organizes water scientific conferences. The first conference took place from 4<sup>th</sup> - 5<sup>th</sup> April, 2022 at Julius Nyerere International Convention Centre (JNICC) in Dar es Salaam. The conference was attended by more than 400 multidisciplinary delegates from different countries where by 65 papers were presented through oral, posters and virtual sessions. The conference brought together the ideas of water resources and management, water supply and sanitation services and water management technologies and techniques. Henceforth, the conference audience gained new insights to pursuing water resources management for sustainable water supply and sanitation services.

Considering the success of that the Institute in collaboration with Ministry of Water has yet again organized the second annual International Maji Scientific Conference to be held from **8<sup>th</sup> -10<sup>th</sup> March, 2023**. The conference aims to bring together more than 500 multidisciplinary researchers and practitioners from different countries in the world, and to propagate further discussions and demonstration of experiences gained and knowledge developed through tackling water related challenges and through exploiting opportunities within the sector, to speed up change towards sector empowerment. This is inline with global focus for 2023 “Accelerating change”.

It is expected that more than 60 papers of 20 minutes each will be presented through oral, poster and virtual sessions. Also, the conference has been designed to accommodate a plenary session and workshops of maximum two (2) hours each as further elaborated in the timetable in the following sections. The plenary session will comprise of opening ceremony, key note speech and panel discussion. This will be followed up with workshops, which will give a platform for interested water sector stakeholders to elaborate and demonstrate in details their role in contributing to sector empowerment. Then presentations will be extended from selected abstracts subject to approval through peer review. Simultaneously, we will have exhibitions of products and services offered by various stakeholders.

## 2. Tentative Programme

**2<sup>nd</sup> International Maji Scientific Conference 8<sup>th</sup>, 9<sup>th</sup>, 10<sup>th</sup> March, 2023**

**Event Managers: Eng. N. Mpembe, Mr. I. Wikedzi, Ms. G. Chanzi**

<b>Day 1: Wednesday 8<sup>th</sup> March, 2023</b>
<b>08:00 – 09:00</b> <b>Registration of Participants &amp; Welcoming Tea</b> <b>Venue: Ubungo Plaza Conference Centre</b>
<b>09:00 – 09:20</b> <b>Arrival of Guest of honor and Tour of Exhibition booths</b>
<b>09:20 – 10:45</b> <b>Official Opening</b> <b>Venue : Kilimanjaro Hall</b>
Singing of the Tanzanian National Anthem (5 min)
Singing of the East African Anthem (5 min)
Overview of International Maji Scientific Conference: <b>Dr. Tulinave Mwamila – DR-ARC, WI</b> (10 min)
Short Presentation from Sponsors (20 min)
Welcoming Speech & WI Documentary: <b>Dr. Adam Karia – Rector WI</b> (20 min)
Official Opening of the Maji Scientific Conference: <b>Hon. Jumaa Aweso (MP)-Minister for Water (Guest of Honor)</b> (20 min)
Vote of thanks/ Rewards to Guest of Honor: WI Alumni (5 min)
<b>10:45 – 11:00</b> <b>Group photo</b>
<b>11:00 – 12:30</b> <b>PLENARY SESSION</b> Moderator: <b>Ms. Rehema Tukai</b> (Water For People)
Key Note Address: <b>Eng. Mbogo Futakamba-</b> Chairperson National Water Board
Theme: <b>Water Above, On, and Below the Ground: The concerns of it All</b>
<b>Panel Session</b> Moderator: <b>Ms. Rehema Tukai</b> (Water for People) Panelist 1: <b>Prof. Nancy Marobhe (ARU)</b>

Panelist 2: <b>Dr. Victor Kongo (GWP-TZ)</b> Panelist 3: <b>Mr Lukas Kwezi (Tetrattech TZ)</b> Panelist 4: <b>Eng. Herbert Kashililah (Shahidi wa Maji)</b>		
12:30– 13:30 Lunch break		
13:30– 16:30 Side Events		
Venue: Kilimanjaro Hall		Venue: Tanzanite
<b>Workshop 1:</b> Rainwater harvesting management and technology for sustainable development <i>Organized by: IWA RWHM specialist group</i>		<b>Workshop 2:</b> Experiences in management of fluoride challenges in African context <i>Organized by: WI Research campus (Ngurdoto) and OIKOS TZ</i>
<b>Workshop 3:</b> Accelerating change in services delivery through learning hubs <i>Organized by: Eco valley, WI and NM-AIST</i>		<b>Workshop 4:</b> Integrated leakage management system empowering WSSAs in NRW control <i>Organized by: WI R&amp;D team</i>
16:30 – 17:00 Tour of Exhibition booths & Posters, & Evening Tea		
17:00 End		
Day 2: Thursday 9 <sup>th</sup> March, 2023		
08:00 – 09:00 Registration of Participants & Welcoming Tea Venue: Ubungo Plaza Conference Centre		
09:00– 12:40 SUB-THEME PAPER PRESENTATIONS AND DISCUSSIONS Sessions Chair: Dr. Nyangi M.		
<b>Theme:</b> Water Resources Management and Governance for Sustainable and Equitable Development (WRMG) <b>Venue:</b> Kilimanjaro <b>Moderators:</b> Dr. Munishi S. & Dr. Dickson G. <b>Rapporteurs :</b> Sanka P./Rogath S.	<b>Theme:</b> Unleashing Concerns Around Harnessed Groundwater Quality and Quantity (GWQQ) <b>Venue:</b> Tanzanite <b>Moderators:</b> Dr. Kimwaga R. & Dr. Lusajo M. <b>Rapporteurs :</b> Eliamringi L./Gobry, J.	<b>Theme:</b> Emerging Solutions to Groundwater Exploration and Protection (GWEP) <b>Venue:</b> Classic A <b>Moderators:</b> Dr. Mwakalesi A. & Dr. Mutayoba E. <b>Rapporteurs :</b> Marwa L./Mwakasangula T.

Authors	Title	Authors	Title	Authors	Title
Godwin L et al.	Integration of Remote Sensing and Isotope Approaches in Water Balance Estimation of Ungauged Lakes	Doglas B. & Tulinave M	Suitability of treated FS using <i>Jatropha curcas</i> on unplanted sand drying beds for agricultural use in Dar es Salaam, Tanzania	Mary K. et al	Assessment of Vegetables Performance and Nutritive Values Through Application of Treated Domestic Wastewater by High Rate Algal Pond
Margaret K et al.	Integration of gender considerations into Tanzania's climate and water policies	Magdaline B. & Makarius L.	The influence of anthropogenic activities on wetland integrity Along Mara River Wetlands, Tanzania	Chang Ki Lee,	Critical public health problems because of fluoride in water and propose the solution by CDI technology through maintenance concep
Alinanuswe M & Ian D.P	Removal of Picloram and Related Herbicides from an Aqueous Environment using Polymer Inclusion Membranes	Saul M.	Use of ICT tools for improved enforcement and monitoring on fecal sludge management in Shinyanga municipality	Benson L. et al.	Determination of Green and Blue Water Foot Print of Major Crops for Efficient Use of Water and Environmental Conservation: A Case of Wami/Ruvu Basin - Tanzania
Baraka M et al.	Analysis of silting trends of Lwanyo Dam	Doglas B & Richard K.	Model for prediction of the optimal dose of <i>Jatropha Curcas</i> in FS dewatering	Godfrey M et al.	Tanzania's Experience in the Nalgonda Water Defluoridation Technology
Christossy L et al.	Investigating the Effect of Climate Change and Human Activities on Water Availability in Wami River Sub-basin, Tanzania	Matungwa W. & Zacharia K.	Temporal Variation in Water Quality of Shallow Wells in Half-London Ward-Tunduma Town	Jonas B et al.	Non-Competitive and Competitive Detoxification of As(III) Ions from Single and Binary Biosorption Systems and Biosorbent Regeneration
Kaitaba R. et al.	Analyzing Options for Improving Non-Revenue Water Management System to Enhance Water Supply Services in Dodoma City, Tanzania	Mesia L.	Status to centralized disinfection of piped groundwater public supplies	Magige J.	Prioritization of iringa district rural water supply project preparations, application of micro integration decision model (mid)- innovation
Christossy L et al.	Long-term changes in climatic, and hydrological variables and their impacts on future river discharge in Wami river sub-basin, Tanzania.	Stuart S & Naftal M.	Methods in Well Rehabilitation and Maintenance for Groundwater Well Fields: A Review of the State of the Art	Dorothea D. et al	Piloting the Remote Sensing-based Water Accounting Plus Framework in Tanzania: A case study of Wami-Ruvu Basin, Tanzania

Opportuna K. & Jesper K.	Which way to best studying accountability in water sector in Tanzania?	Saul M & Herieth M	Integration of safe sanitation behaviors along the sanitation service chain for safely managed sanitation	Morris H.	A Column Design with Low-Cost Adsorbent for Hard Water Treatment: A Case Study of Dodoma City
Frank J .W	Implications of temporal hybridization of rainfall data on streamflow in the African Great Lakes region	Josephine G et al.	Occurrence of Harmful Algal Blooms in Freshwater Bodies and their Molecular Identification: A Case of Mindu and Nyumba ya Mungu Dams in Tanzania.	Parestico P.	Decentralization and accountability in community water governance in Tanzania
Kaitaba R Makarius L Stelyus Mkoma	Analyzing Options for Improving Non-Revenue Water Management System to Enhance Water Supply Services in Dodoma City, Tanzania	Riccardo Z & Avantika Singh	COVID-19 and the Water Sector	Benjamin D et al.	Removal Kinetics of Escherichia Coli from Faecal Sludge Treated with Moringa Oleifera on Unplanted Sand Drying Beds.
Miraji H. & Ripanda A	Smart Data Management of Non-Revenue Water: A Black Side for Sustainable Development Goals 3 & 6	Renatus J et al.	Tracing the dominant sources of sediment flowing toward Lake Victoria using geochemical tracers and a Bayesian Mixing Model	Magori N et al.	Banana Peel a Natural Biosorbent for the Reduction of Turbidity and Chemical Oxygen Demand from Municipal Wastewater
<b>12:40 – 13:00</b> <b>Tour of Exhibition booths &amp; Posters</b>					
<b>13:00 – 14:00</b> <b>Lunch break</b>					
<b>14:00– 15:40</b> <b>SUB-THEME PAPER PRESENTATIONS AND DISCUSSIONS</b>					
<b>Theme:</b> Water Resources Management and Governance for Sustainable and Equitable Development (WRMG) <b>Venue:</b> Kilimanjaro <b>Moderators:</b> Dr. Munishi S. & Dr. Dickson G. <b>Rapporteurs :</b> Sanka P./Rogath S.		<b>Theme:</b> Unleashing Concerns Around Harnessed Groundwater Quality and Quantity (GWQQ) <b>Venue:</b> Tanzanite <b>Moderators:</b> Dr. Kimwaga R. & Dr Makungu E. <b>Rapporteurs :</b> Eliamringi L./Gobry, J.		<b>Theme:</b> Emerging Solutions to Groundwater Exploration and Protection (GWEP) <b>Venue:</b> Classic A <b>Moderators:</b> Dr. Mwakalesi A. & Dr. Mmassy D. <b>Rapporteurs :</b> Marwa L./Mwakasangula T.	
Opportuna K. & Neil M.	Towards Urban water community-based organization:	Method G.	Topo-Bathymetric Study for Storage Capacity Estimation of Mindu Dam Reservoir in	Leyla K.	Being smart about sanitation: the case of ibinzamata public

	experiences from reporting of water problems in Dar es Salaam		Morogoro Municipality, Tanzania		toilet biogas system in Shinyanga, Tanzania
Preksedis N et al.	Climate change vulnerability mapping in the Wami/Ruvu basin: A review	Pendo H.	Challenges of water allocation and secure water tenure among pastoralist and smallholder farmers in Kilombero and Kilosa	Pitio N.	Gender Power Inequality and Community-Based Water Supply Management: Causes, consequences, Challenges and Remedy
Raphael L, et al.	Intra—annual hydrological calculation and water management for River Ruvu, monthly production capacity, monthly deficit and monthly excess for redistribution	Omary R. et al.	Use of Macroinvertebrates to assess the impacts of Anthropogenic activities on the Pinyinyi River, Arusha, Tanzania	Pilly K. & Lymond T	Socio-economic Factors Affecting Management of Catchment Forest Areas in Tanzania
Salma I. et al.	Linking Freshwater Reduction Along Rufiji River and Mangrove Dynamics in Rufiji Delta, Tanzania	Ghanima C.	Current status and future prediction of land use land cover changes, and it is the magnitude at kilombero river basin	Godfrey M. et al.	Bonechar Water Defluoridation Technology, Achievements, Challenges, and Experience in Tanzania
Aaron S	Partly Financed Water Projects: Addressing Sustainability Problems for Majority of the Rural Water Projects in Tanzania – The Case of Korogwe	Leah M et al.	Addressing Pumps Functionality as a Limitation to Performance of Rural Water Supply Schemes in Tanzania”	Mihayo N. et al.	Application of octacalcium Phosphate with an Innovative Household-scale Defluoridator Prototype and Adoption in Rural Communities of the East Africa Rift Valley
15:40– 16:00					
Tour of Exhibition booths & Posters and Tea break					
16:00					
End of day 2					



Day 3: Friday 10 <sup>th</sup> March, 2023					
08:00 – 09:00 Registration of Participants & Welcoming Tea Venue: Ubungu Plaza Conference Centre					
09:00– 12:20 SUB-THEME PAPER PRESENTATIONS AND DISCUSSIONS					
<b>Theme:</b> Water Resources Management and Governance for Sustainable and Equitable Development (WRMG) <b>Venue:</b> Kilimanjaro <b>Moderators:</b> Dr. Massawe F. & Dr. Senkondo W. <b>Rapporteurs :</b> Paul Sanka/Sophia Rogath		<b>Theme:</b> Unleashing Concerns Around Harnessed Groundwater Quality and Quantity (GWQQ) <b>Venue:</b> Tanzanite <b>Moderators:</b> Dr. Kimwaga R. & Dr. Makungu E <b>Rapporteurs :</b> Eliamringi L./Gobry, J.		<b>Theme:</b> Emerging Solutions to Groundwater Exploration and Protection (GWEP) <b>Venue:</b> Classic A <b>Moderators:</b> Munishi S. & <b>Rapporteurs :</b> Marwa L./Mwakasangula T.	
Alinanuswe M & Ian P	Exploiting ion-dipole and ion-exchange interactions for the decontamination of aqueous solutions from aminopyridines				
Aaron S.	Developing Matrix Model (MM) as a Tool for Deciding Procurement Method(s) for Acquisition of Service Providers in the Water Sector				
Theophile R.	The impact of prepaid water meters on clients and utility's outcomes: the case of iringa municipality				
Alinanuswe M & Ian P.	Removal of Picloram and Related Herbicides from an Aqueous Environment using Polymer Inclusion Membranes				
Mutazamba, J.	Water resource management through infrastructure scoping for water supply projects in Rukwa and Njombe regions in Tanzania				

Leopard G.	Contribution of private boreholes in minimizing domestic water shortage in Dodoma district, Tanzania				
Alinanuswe M & Ian D. Potter	Targeting of Cationic Organic Pesticide Residues using Polymer Inclusion Membranes containing Anacardic Acid from Cashew Nut Shell Liquid as a Green Carrier				
Sanga K.	Analysis of land use/land cover changes in surface water dynamics, a case study of Singida urban a part of Tanzania				
12:20– 13:20 Lunch break					
13:20– 15:40 Virtual Presentations Venue: Kilimanjaro Moderators: Massawe F. & Makungu E.					
1.	Karlye W et al.	Investigating field effectiveness and feasibility of carbon neutral water treatment through the solar-powered ultraviolet light-emitting diode (UV-LED) disinfection			
2.	Paul C.	Estimation of Groundwater Recharge in Makutupora basin Located in a Semi-Arid Regio in Central Tanzania using Soil Moisture Balance (SMB) and Chloride Mass Balance (CMB) Techniques			
3.	Tim F. et al.	Climate Sensitive and Resource Efficient Wastewater Treatment: Small-Scale Decentralized in Dar es Salaam, Tanzania and Large-Scale Centralized in Hamburg, Germany			
4.	Fanuel L. et al.	Groundwater chemistry in the gold mining areas of the Lake Victoria basin, northwest Tanzania: In-situ, ex-situ assessment, and geochemical modeling.			
5	Maureen M.	Assessment of the impact of land use on river water quality in selected rivers in Mzimba District Malawi			
6	Michael C.	Co-creating a sustainable water technology platform to tackle urban water issues in Dar es salaam			

POSTERS		
Sahani N.	Occurrence of fluoride to six most fluorotic regions in Tanzania	
Leyla K.	Being smart about sanitation: the case of ibinzFamata public toilet biogas system in Shinyanga, Tanzania	
Magori N.	Groundwater Physicochemical Properties of Ubungo, Dar es Salaam and the Potential of Cassava Peel Biosorbent for Reducing Chloride and Total Hardness from Groundwater	
August F.	Innovative filtration galleries for draining groundwater from hills	
Lusajo M.	The impact of land use/cover change on surface runoff at the Kibungo sub-catchment of Upper Ruvu catchment in Tanzania	
Ally M.	Geotechnical investigation consultancy services offered by Water Institute	
Godfrey M	Effects of fluoride to human health and potential water Defluoridation technologies	
15:40– 16:00		
Arrival of Guest of Honor and Tour in Exhibition booths		
16:00– 17:00		
Closing Session		
Young Researchers Awarding Ceremony (15 min)		
Evaluation/Feedback from participants (15 min)		
Vote of Thanks: Water Institute Alumni (15 min)		
Closing Remarks: MoW Management (15 min)		
17:00 – 18:00		
Evening Tea		
18:00 – 22:00		
Cocktail/Live band		

### **3. Conference Themes**

**The main theme for this 2023 scientific conference is** *Water Above, On, and Below the Ground: The Concerns of it All.*

Water is an important element of human life, and vital for the healthy functioning of socio-ecological systems. Environmental and ecological change has created a large demand of water hence necessitating further exploration and protection of safe water sources. A decline in clean and safe surface water has increased pressure on human dependency on groundwater. The groundwater provides about 50% of all drinking water and 40% of irrigation and industrial activities. Therefore, proper management of all sources of water is of vital importance to reduce scarcity of water and maintain ecological systems.

**Sub-themes extended from the main theme:**

- i. *Water Resources Management and Governance for Sustainable and Equitable Development.* Under this sub theme the following subjects will be discussed:
  - a) Water resources exploration, conservation, protection, exploitation, and sustainability (groundwater, surface water, rainwater, seawater).
  - b) Water resources and Climate Change/variability.
  - c) Water resources governance (incl. transboundary and confined water resources).
  - d) Economics and investments for water resources management.
  - e) Groundwater resources mapping and potential.
  - f) Policy and Legal issues in water management.
  - g) Conflicts control and resolutions of water-related issues.
  - h) Water quality management and governance (e.g., studies addressing the increased water/groundwater contamination from emerging pollutants).
- ii. *Unleashing Concerns Around Harnessed Groundwater Quality and Quantity.* Under this sub theme the following subjects will be discussed:
  - a) Security measures for water supply and sanitation (including self-water supply initiatives, urban water management models, and community management models).
  - b) Water, energy, and food nexus.
  - c) Initiatives for achieving safely managed water supply and sanitation services.
  - d) Eco-sanitation and Low impact designs for quantity and/or quality control.

- e) Non-Revenue water management (exploring pathways, frameworks, systems, norms, and traditions).
  - f) Interlinkage between rainwater, surface, and groundwater on their quality and supply quantity.
  - g) Water quality monitoring, forecasts, quality indexes.
  - h) Modified Methods/ new approaches to sample analysis/preparation etc.
- iii. *Emerging Solutions to Groundwater Exploration and Protection.* Under this sub theme the following subjects will be discussed:
- a) Innovative technologies and techniques for groundwater security empowerment.
  - b) Artificial intelligence and other digital technologies in groundwater resources identification, pollution control, and mitigation.
  - c) Leakage and apparent losses assessment, reduction, and control techniques.
  - d) Nature-based solutions and indigenous techniques for groundwater management.
  - e) GIS and Remote Sensing in resource identification and management.
  - f) Resource planning and modeling (such as hydraulic/hydrological modeling).
  - g) Intellectual properties, patents, and right to innovations in the water sector.
  - h) Development of parametric and non-parametric utility regulation tools in the groundwater sector.
  - i) Efficiency- and management-specific features assessment in the groundwater industry.
  - j) Financial management innovations for effective groundwater exploitation.
  - k) Data envelopment analysis and stochastic frontiers analysis in groundwater.
  - l) Groundwater exploration and protection techniques, the modern ways.

#### **4. Plenary Session**

Plenary session will comprise of opening ceremony officiated by the Guest of Honor, Minister for Water, Honorable Mr. Jumaa Aweso (MP). The opening ceremony will be followed by a keynote speech and panel discussion. The key note speech and panel discussion aims at extensively discussing the message brought forth through the conference main theme. Hence paving way for each participant to identify their take home message at the end of the conference.

**A. Key note speaker:** Eng. Mbogo Futakamba (*National Chair – National Water Board*)

**Eng. Mbogo Futakamba** is a retired Permanent Secretary who served in the Ministry of Water



and also worked as the Deputy Permanent Secretary in the Ministry of Agriculture. He has a well loaded experience in Water Resources Management both in development and management coupled with the planning of this Integrated Water Resources. He has served the Government and the private sector for over 30 years.

Currently, he is chairing both the national Multi-Sectoral Forum on Integrated Water Resources Management and the recent appointment as the Chair of the National Water Board.

On the issues pertaining to Water Energy and Food nexus, he is well versed on those securities bearing in mind that during his chairmanship of Permanent Secretaries in charge of water in the Lake Victoria Basin Commission and also in the Nile Basin Initiative he devoted much of his time on dealing holistically with water resources and related ecosystems in a balanced manner.

Being a retired civil irrigation engineer he has been involved in mult-sectoral issues on infrastructure development addressing much of the adversity of the climate change which is showing both positive and negative impacts. With regard to nexus issues, he is active in various institutions both local and international as most of the developmental concerns has water as a common denominator, hence needing integrated planning approach, strong technical capacity and vibrant stakeholders' participation.

In the mean time he is fully available with Tanzania Office Global Water Partnership as an expert and a voluntary ambassador.

**B. Moderator:** Ms. Rehema Tukai (*Water for People*)

**Ms. Rehema Tukai** joined Water For People in Tanzania as its first Country Director in



November 2022. Rehema has in-depth national and regional development experience promoting interactions between civil society, government, and other stakeholders and has invested over 15 years in senior management and governance roles of donor-funded development programs. She is particularly interested in leading processes of designing and deciding on

implementation approaches for integrated development funding programs that prioritize investing in the development of organizational capacity, optimizing partnerships with key stakeholders for impact, and managing-associated partnership risks. Before joining Water for People, Rehema was a consultant with KPMG International Development Advisory Services in Tanzania, serving as

Deputy Director of the accountability in-Tanzania Program, a UKaid funded program managed by KPMG. She also worked at REPOA, a National policy research Think Tank, and WaterAid in Tanzania. She holds a Research Honors degree in Natural Resources Science and Management from University of Canberra, Australia and a Postgraduate Diploma in Poverty Analysis for Socioeconomic Security and Development from International Institute of Social Studies (ISS)– Erasmus University in the Netherlands.

### C. Panel discussion members

- 1. Prof. Nancy Jotham Marobhe** is an Associate Professor in the School of Engineering and Environmental Studies at Ardhi University - Dar es Salaam. She is a holder of PhD in Land and Water Resources Engineering from KTH-Sweden; MSc. Gen. Microbiology from Helsinki University, Finland; MSc. Human Ecology from VUB-Belgium, and BSc (Ed) from UDSM-Tanzania. She has strong academic background and professional experience in Environmental Microbiology and Water Treatment. She is also specialised in Environmental Ecology, Environmental Health and Epidemiology and Water Pollution Management. Her main research areas are human ecological (holistic) approaches in solving environmental problems, natural and emerging water treatment technologies. She offers consultancy services in EIA, evaluation of water and sanitation projects and industrial hygiene and microbial contaminants. She has published a number of journal papers and has engaged into mentorship of academic staff.



- 2. Eng. Herbert Kasililah** is a founder of Shahidi wa Maji, a not-for-profit organisation dedicated to support a fair water future for every Tanzanian. He has over 30 years supporting development of water and Sanitation sector in Tanzania and East Africa. Formerly a deputy chair With National Water board, he currently chairs for Water and Environmental boards, including a chair of WASH network (TAWASANET) and Water Resources Catchment Authority (Lake Rukwa Basin Water Board) in Tanzania, he is an advisor to (ANEW) African Network on Water and Sanitation. His broad experience and skills working with government, CSO and private sector brings vast knowledge in policy and practice in the sector that include contribution to the National Water policy of 2002, and the development of water sector development programme (WSDP). He has been a mentor to a number of graduate engineers, he



is currently an associate editor with the Journal of Water Resources, Engineering, Management and Policy (JWEMPO). He holds a degree in Engineering and Water Resources.

**3. Dr. Victor Kongo** is a Water Resources Engineer and a vetted international consultant



for UNDP under the Experts Roster on Climate Change and Resilience. He is the Executive Director for Global Water Partnership Tanzania – the national arm of Global Water Partnership Organization (GWPO) in Tanzania. He is the immediate Country Coordinator for the World Bank 2030 Water Resources Group (WRG) in Tanzania. He has served as an Advisor to the Bill and Melinda Gates Foundation (BMGF) for the Eastern Africa Region. He is the regional advisor for the SADC Water-Energy-Food Security Nexus Youth Innovation Network; a regional programme targeting to address job creation and employment for the youth by championing leadership and entrepreneurship through a Nexus approach. He is a Technical Advisor to the Ministry of Water, Energy and Minerals in Zanzibar and also a part of a high-level eight-member global Advisory Team for the Global Water Partnership Organization on strategic operationalization of its knowledge management portfolio. Victor has more than 20 years of professional experience in research and development in various fronts including water resources management & development, climate change, food security and sustainable development in the Southern and Eastern Africa region. Mostly as a technical lead, Dr. Kongo has successfully implemented over 45 projects for international organizations, governments and research institutions including the United Nations, World Bank, GIZ, GWP, Bill & Melinda Gates, International Water Management Institute (WMI), Stockholm Environment Institute and others. Dr. Kongo is a great team player, motivator and leader with a desire for continued excellence to exceed the established goals.

**4. Mr. Lukas Kwezi** is water and sanitation specialist with more than 10 years of experience



in leading, designing, delivering, and evaluating a range of water sector development programs in Tanzania and sub-Saharan Africa, for which he incorporates inter-sectoral approaches (environment, sanitation and hygiene, health and nutrition, behaviour change communications [BCC], agriculture, climate change) to program design and delivery. Currently, Mr. Kwezi is a Chief of Party (COP) for a US\$25million USAID funded Maji na Usafi wa Mazingira (MUM) Activity in Tanzania implemented by Tetrattech. At MUM Mr. Kwezi provides technical and management leadership to a team of 40 staff in the implementation of the MUM Activity. Mr.



Kwezi is a well-respected leader in Tanzania's water, sanitation, and hygiene (WASH) sector, and prior to joining MUM/Tetrtech he facilitated high-level coordination between the Government of Tanzania (GoT) and 20 development partners to secure \$3.3B in financing to support improved WASH in Tanzania. Between 2012-2021, he was a Water and Sanitation Advisor for the UK Department for International Development (DFID), where he led a team of 5 staff and managed 7 contractors in a DFID's water sector investments in Tanzania, including the \$208.3M Rural Water Supply and Sanitation in Tanzania Program. He has advised a range of public, private, donor, and local stakeholders on WASH strategy, policy, governance, and finance activities, and additionally provided technical advisory support on several consulting and business development assignments to a number of youths led enterprises and organizations. During his time at DFID Mr. Kwezi worked closely with RUWASA to design and mainstream a capacity building program (RUWASA Learning Hub Program) which includes apprenticeship scheme for young graduates in the water sector. Mr. Kwezi maintains excellent relationships with GoT, including the Ministry of Water (MoW), TAWASANET, EWURA, the National Water Fund (NWF), Ministry of Health (MoH) and the Rural Water Supply and Sanitation Agency (RUWASA), and effectively communicates with and builds the capacity of project staff, donor representatives, private sector, service providers, and beneficiaries.

## ***5. Technical Workshops***

Workshops are meant to provide extended platform in terms of time and audience so as to further address and learn of the businesses of a workshop host in relation to sector empowerment. The host gains publicity for his shared works hence an effective way of disseminating information to public.

*Workshop 1:* Rainwater harvesting management and technology for sustainable development.

*Organized by:* International Water Association Rainwater Harvesting Management specialist group ([www.iwa-network.org](http://www.iwa-network.org))

This brings together professionals and experts with vast experience in the subject of water harvesting for addressing water security challenges. Through presentations and discussions of related field work in different parts of the world, it is expected that it will provide answers to underlying questions which have contributed to hesitation and poor performance in adoption of rainwater harvesting techniques.

### *Workshop 2: Accelerating Change in Services Delivery through Learning hubs*

*Organized by:* Eco valley Advisers, Water Institute and Nelson Mandela African Institution of Science and Technology ([www.ecovalleyadvisers.co.tz](http://www.ecovalleyadvisers.co.tz), [www.waterinstitute.ac.tz](http://www.waterinstitute.ac.tz), [www.nm-aist.ac.tz](http://www.nm-aist.ac.tz))

Contrary to the perception that learning, research and development are for academic institutions, which has affected organizations' efforts to implement capacity building programs; as part of innovation this workshop aims to display alternative practical ways of ensuring non academic organization embrace learning culture to enhance performance at different levels of their operations. The pilot project at RUWASA will be used as a case study.

### *Workshop 3: Experiences in management of fluoride challenges, the African context.*

*Organized by:* Water Institute Research Campus Arusha (Ngurdoto) and OIKOS East Africa ([www.waterinstitute.ac.tz](http://www.waterinstitute.ac.tz), [www.oikosea.co.tz](http://www.oikosea.co.tz))

Known for its reputable innovation "Bone char" in treatment of fluoride contaminated water, commonly found in areas located within the long stretching rift valley crossing borders to other East African countries; an innovation which has lasted over 30 years, and still relied on solely and in hybrid treatment systems. Nowadays even incorporated with nano technology. Through this workshop, the experts will share the journey in fluoride related research and development for community empowerment and security.

### *Workshop 4: Integrated leakage management system empowering WSSAs in NRW control*

*Organized by:* WI R&D team ([www.waterinstitute.ac.tz](http://www.waterinstitute.ac.tz))

This is a system designed for the purpose of reducing water losses (real and physical) by using low-cost techniques in comparison to currently relied technologies and approaches. In ensuring leakage is reported immediately the system operates both manually and automatically. Through this workshop the experts will among other things demonstrate how the system works, and share success stories from utilities where it has been installed which includes ZAWA, MBEYA UWSSA, TANGA UWSSA and DUWASA.

## **6. Conference Abstracts**

All abstracts are directly link to one of the conference sub-themes. The submitted abstracts were systematically reviewed by experts whereby the following selection criteria were considered: clarity, originality, supporting evidence, scientific rigor, relevance, potential significance, innovation, or usefulness in the water sector and allied fields. The accepted abstracts are published

herewith for reference. The author also has an option to publish his/her manuscript in the special issue of the Journal of Water Resources, Engineering, Management and Policy (JWEMPO), [www.jwemppo.ac.tz](http://www.jwemppo.ac.tz). The abstracts for the conference under each theme is as attached in Appendix A. Bibliography of the authors is also available in the appendix.

## Conference Deliverables

The organizing committee will ensure that conference content is well captured and later on compiled so as to allow retrieval by participants post conference, but also consumption by the general public beyond borders and in future. Hence rapporteurs are fully engaged and well equipped, and the following are expected deliverables:

- i. Conference proceedings
- ii. Conference report which will include all key issues gathered from the presentations, and evaluation of the conference.
- iii. Publication in special issue of scientific conference of JWEMPO journal ([www.jwemppo.ac.tz](http://www.jwemppo.ac.tz))

## 7. Accommodation information

We understand the importance of a secured accommodation for our guests, hence we have compiled a list of reliable spots as displayed in the following map (Figure 1). You may search them through google search engine for more specific information and bookings.

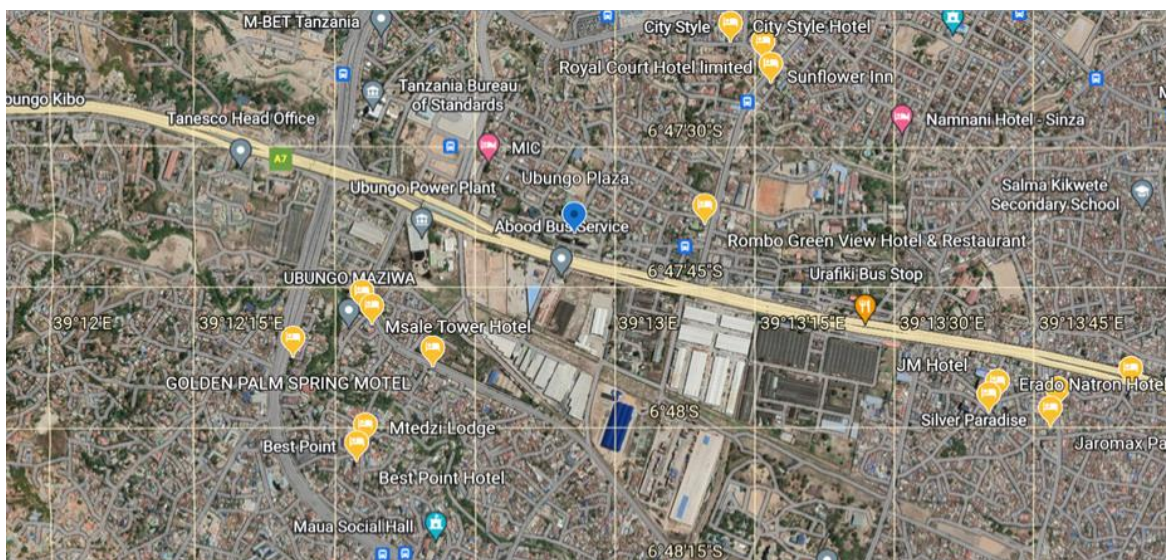


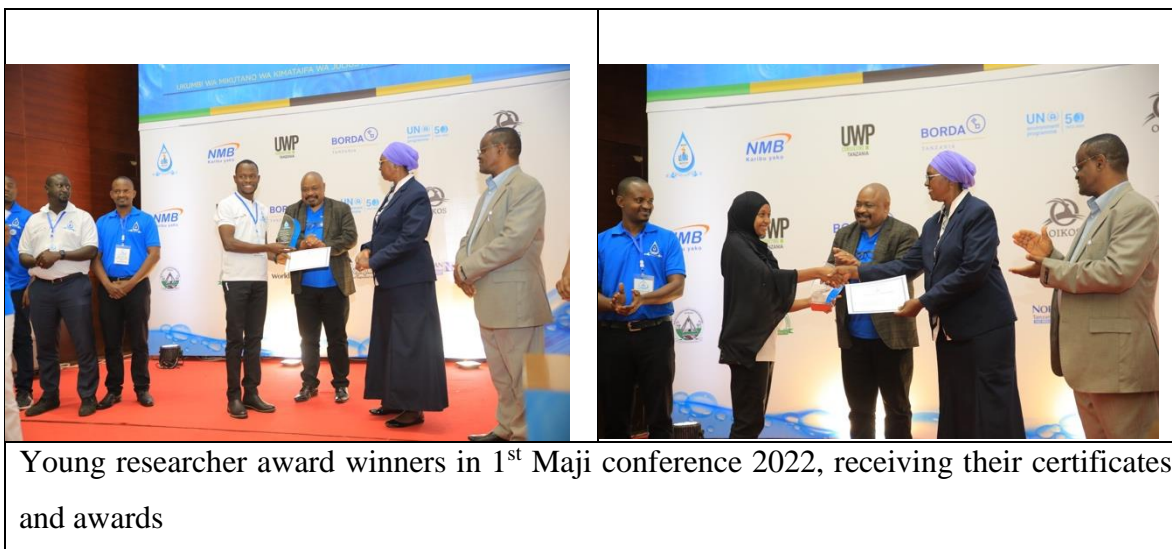
Figure 1: Nearby recommended hotels for accommodation (Source: *Google Earth map*)

## **8. Transportation and Mobility within the city**

Dar es salaam being the fastest growing city in the country, transport services are plenty, ranging from internet based like Uber, Indrive and Taxify (App installation is essential), to normal taxi available at taxi stands at any time of the day and night in any street of the city. As well there are public transportation systems, like rapid transit buses (UDART) and non rapid transit buses. Additionally, upon guests' request hotels can organise transport for its guests to shuttle around the city, and to and from the airport.

## **9. Young Researcher awards**

The conference will acknowledge some of participants that have remarkably added value to the scientific community by awarding Young Scientist/Researchers (under 35) with Best Presenter' Awards under each sub-theme and Poster. The Awards aim at motivating innovative research and recognizing their significant contributions to the scientific community in relation to the conference themes. This provides an opportunity to the young participants like outstanding researchers, exceptional graduates or early career academicians and/or researchers to showcase their best research and projects to the world. Proper adjudication procedures will be followed to identify outstanding young individuals.



## **10. Post conference (Cocktail party, Recreation/Tourism)**

The conference organizing committee understands that there is always a healthy way of ending an enriching and empowering experience like that brought forth by a scientific conference. Henceforth, cocktail party, field and recreational tours have been organised for all interested conference participants.

In the evening of the 10<sup>th</sup> March, after the conference closing ceremony, a cocktail party filled with soothing refreshments and mouth-watering snacks, will be open to all participants of the conference. Feel free to dress up in an evening attire, and dance yourself through the night, while continuing to network.

As it is well known Tanzania is blessed with varieties of tourism spots, ranging from historical sites to national parks and game reserves. To mention few of them includes National parks like Serengeti, Ngorongoro, Manyara, Mikumi, where you are sure of sighting either or all of the big five animals (elephant, lion, leopard, buffalo, rhino) among others, the highest in Africa and second world highest mountain “Kilimanjaro”, historical sites like Bagamoyo, the homes of whale sharks and coral reefs in the Islands of Zanzibar and Mafia. For more information on where, when and what to see in various sites please visit <https://www.tanzaniaparks.go.tz>. On 11<sup>th</sup> March, interested participants will have opportunities to visit either of the following touristic spots booked for us: Bagamoyo Historical Sites or Saadani National Park in Pwani Region, Or go for an industrial tour at either of the following industries: PLASCO Ltd., Lodhia Plastics Industries Ltd., Simba Pipe Industries Ltd., however there are limited spaces, thus you must register to secure a spot.

#### **A. Bagamoyo Historical sites**

In Bagamoyo it is expected to visit the following areas:

*i. Caravan Serai (Slaves Museum)*

This was used as a stopping station for slaves when they were being transported to Zanzibar to be sold.

*ii. Roman Catholic Museum*

This place has a lot of historical things to explore and learn.

- a) This touring site has the first Cross built on the ground in 1868 as a symbol of the beginning of Roman Catholic church,
- b) It was where Dr. Livingstone body spent the night in 1974 before transported to his country
- c) There is a first church in East Africa built in 1872
- d) The site also shows different history on Germany Rule, slave trade, traditional beliefs, different culture and instruments from four different tribes that was found in Bagamoyo

*iii. Kaole Ruins*

The site has historical attractions such as



- a) The remains of the mosques that was built in 13<sup>th</sup> century,
  - b) Graves of the two lovers who were buried together,
  - c) A well of holy water that its water neither reduced or increase during the rains or dry period,
  - d) Building from 800 years ago
  - e) Ritual sites
  - f) Baobab tree of more than 500 years which is used for rituals
- iv. *Kaole Snake Park*
- This site has beautiful animals and birds to see such as Crocodiles, snakes, Concubines, Eagles, Camel etc. There is also Camel riding.
- Note:** Entrance fees for each site ranges from TZS 3000/= to TZS 25,000/=

## **B. Saadani National Park**

Saadani national park offers different exploration as follows:

- a) Animal viewing
- b) Salt ponds, where salt is harvested
- c) Boating around to see where the lake meets the ocean
- d) Crocodiles and Rhinoceros
- e) And many more exciting views

Entrance and other fees ranges from TZS 5000/= to TZS 70,000/=

**Note:** There is no food on site and animal seeing is better if starts around 3:00 pm because that's when the animals return from wondering for food.

**C: Industial Tours:** Industries with vast experience in the business of manufacturing and supplying of water related fixtures, fittings, machines, etc in Tanzania have offered space for conference participants to visit their factories and learn more of their business from the technical point of view. We highly appreciate their support. There is no entry fee. Industries included are PLASCO, Simba Pipes Industry, Lodhia Plastics Industries Ltd.

## **11. Conference abstract reviewers**

The conference organizing committee highly appreciates the role played by reviewers (listed in

	<b>Reviewer's name</b>	<b>Organization</b>
<b>1</b>	Dr. Magori J. Nyangi	Water Institute
<b>2</b>	Dr. William Senkondo	Water Institute
<b>3</b>	Dr. Madirisha Makungu	University of Dar es Salaam
<b>4</b>	Dr. Dickson K. Dickson	Water Institute
<b>5</b>	Dr. Lusajo Mfwango	Water Institute
<b>6</b>	Dr. Eunice Makungu	Water Institute
<b>7</b>	Dr. Kessy Kilulya	University of Dar es Salaam
<b>8</b>	Dr. Edmund Mutayoba	Water Institute
<b>9</b>	Dr. Mwemezi Rwiza	Nelson Mandela African Institution of Science and Technology
<b>10</b>	Prof. Zacharia Katambara	Mbeya University of Science and Technology
<b>11</b>	Dr. Yona Kimori	Freelance consultant
<b>12</b>	Dr. Gislay Kifanyi	Mbeya University of Science and Technology
<b>13</b>	Dr. Mwakalesi Alinanuswe	Sokoine University of Agriculture
<b>14</b>	Dr. Getachew Dagnew	Addis Ababa University

table below), from whose commitment and devotion we have a compilation of great presentations, empowering, challenging the norms, eye opening and guiding.

## 12. Conference Exhibitors

The conference organizing committee appreciates various professionals and practitioners who through their participation as exhibitors they play a significant role in contributing to the liveliness of the conference. Your most welcome to visit the exhibitors in their booths and have a ground breaking and eye opening experience.

## 13. Conference Sponsors

The conference organizing committee recognizes and highly appreciates the support in cash and in kind extended by our various sponsors, who even at short notice were available to support the good cause of this conference. We wish them success and blessings. Please meet our sponsors.





## **Appendix A:**

### **Abstracts of all presentations in 2<sup>nd</sup> International Maji Scientific Conference**

#### **Theme1: WATER RESOURCES MANAGEMENT AND GOVERNANCE FOR SUSTAINABLE AND EQUITABLE DEVELOPMENT (WRMG)**

##### **1. Current Status and Future Prediction of Land use Land Cover Changes, and it's Magnitude at Kilombero River Basin**

Ghanima Chanzi

*Department of Water Resources, Water Institute, P.O Box 35059, Dar es Salaam, Tanzania*

##### **Abstract**

Worldwide, land use and land cover change are associated with increased built-up and the stock of facilities areas at the cost of natural vegetation which affects billions of people with much impact on the least developed people. The changes result into loss of economic, life and living things productivity, shortage of safe and clean water, drought hence drying flows of water bodies, food insecurity and loss of biodiversity. This study investigates current status and future prediction of land use land cover changes and its magnitude at Kilombero river basin by using GIS and remote sensing. Data used were Digital Elevation Model and Landsat Images. The Digital Elevation Model was obtained from the SRTM Digital Elevation Model (DEM) at a 90-meter resolution. Landsat images obtained from ALOS World 3D and USGS for the years 1990, 2000, 2010 and 2020. The method used were ArcGIS 10.5 (Support Vector Machine -SVM) classifier specifically for images classification. The Land Change Modeler (LCM) in the TerrSet2020 Geospatial Monitoring and Modelling System (TGMMS) were used to assess land use land cover change and to predict future changes. The kappa coefficient/score was used for model validation to compare the predicted and actual 2020 land use maps. Results from the Kappa score exceeds 75%, meaning the model is substantial and can be used for further analysis and prediction. The 40-year analysis in Land Use Land Cover from 1990 to 2020 showed that the forest area has a more significant proportion of the land use class, has decreased significantly, followed by grassland. Similarly, the least prevalent land use types, wetland and water, have dropped forest distribution in the study area. Current status, significant transformations observed were the sharp decline of forests and the sharp gain of agricultural land in the basin by 25%. Most forest, wetland, and grass land areas are lost to agriculture. Future status, the wetland is predicted to decline further in 2070 where by agricultural land is predicted to gain more land in 2070 if the drivers of the past are not changed. Finally, Integrated water resource management plan should be fully implemented in the area.

**Key words:** Current Status, Future Prediction, Kilombero Basin, Land Cover and Land Use.

## 2. Integration of Remote Sensing and Isotope Approaches in Water Balance Estimation of Ungauged Lakes

Godwin Lucas<sup>1 2 4\*</sup>, Hans Komakech<sup>1 2</sup> Ceven Shemsanga<sup>3</sup>,

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<sup>2</sup>*Water Infrastructure and Sustainable Energy Futures, Nelson Mandela African Institution of Science and Technology, P.O. Box 447 Arusha, Tanzania.*

<sup>3</sup>*Department of Environmental Engineering and Management, University of Dodoma, P.O. Box 259, Dodoma, Tanzania.*

<sup>4</sup>*Pangani Basin Water Board, Ministry of Water, P.O. Box 7617, Moshi, Tanzania.*

### Abstract

The hydrological water balance is a widely used technique in the world to understand the interaction of components of the hydrological cycle. Limited ground collected data lead to most of inland lakes hydrology to be not well understood. The current study focuses on the closed ungauged Emakati Crater Lake associated to the East African Rift Valley of the Northern Crater Highlands. Water samples for analysis of  $\text{NO}_3^-$ ,  $\text{Cl}^-$  and stable isotopes ( $^2\text{H}$  and  $^{18}\text{O}$ ) were collected from the Emakat lake, springs of the inner, outer and the foot of the Empakaai Crater rims. A combination of satellite data and the stable isotope data obtained from ground collected water samples from the lake enabled the computation of lake water balance. Results show that, evaporation (1694.57 mm) surpasses rainfall (878.68 mm) hence higher enrichments of  $\delta^{18}\text{O}$  and  $\delta^2\text{H}$  in the lake ranging between 3.28‰ to 3.96‰ and 31.99 to 33.93‰. The water balance in the area shows that, groundwater flow plays a major role on the lakes hydrological system as it contributes about 22,004,361.12 m<sup>3</sup>/year as groundwater inflow to Emakat Lake which is about 56% of the lake's total inflow and about 22,734,274.00 m<sup>3</sup>/year as groundwater outflow which is about 63% of total lake outflow.

**Keywords:** Emakat Crater lake, lake water balance, stable isotopes of water, ungauged lakes

## 3. Smart Data Management of Non-Revenue Water: A Black Side for Sustainable Development Goals 3 & 6

Miraji Hossein\* & Ripanda Asha

*Department of Chemistry, College of Natural and Mathematical Sciences, The University of Dodoma, P. O. Box 338, Dodoma, Tanzania.*

### Abstract

The current global provision of improved water sources is trailing 94%, nonetheless, climatic changes, urbanization and population growth continuously hinder access to sufficient clean water in order to attain SDG3. Poor and old water distribution infrastructures result in leakage, while backflows of contaminated water is suspected to have significant health risk and therefore difficulties to attain SDG6. Over 780 million global populations, which is 1.04 times the European

population lack access to basic drinking water. Despite the scarcity, again the global volume of non-revenue water is  $126 \times 10^9 \text{ m}^3$  per year, which is 1.8 times the amount of water used in China per year. The annual non-revenue water causes approximately loss of USD 39 billion per year, which is nearly 2.41 times the Tanzania 2022 annual budget. Henceforth, the current study focuses on addressing the value of adopting smart data and energy utility managements in management of non-revenue water. The obtained data are essential in addressing the extent of non-renewable water crisis and proposing managerial approaches in alignment to SDGs.

**Keywords:** Non-Revenue Water; Water Leakage; Backflow; Bibliometric data; Smart Data; Energy Utility.

#### **4. Analyzing Options for Improving Non-Revenue Water Management System to Enhance Water Supply Services in Dodoma City, Tanzania**

Kaitaba Rugakingira<sup>1</sup>, Makarius C.S. Lalika<sup>1,2</sup> and Stelyus Mkoma<sup>3</sup>

<sup>1</sup>*Department of Geography and Environmental Studies, College of Natural and Applied Sciences, Sokoine University of Agriculture, P.O.BOX 3038 Morogoro*

<sup>2</sup>*UNESCO Chair on Ecohydrology and Transboundary Water Management, Sokoine University of Agriculture, P.O. Box 3038 Morogoro, Tanzania*

<sup>3</sup>*Department of Chemistry and Physics, College of Natural and Applied Sciences, Sokoine University of Agriculture, P.O.BOX 3038 Morogoro*

##### **Abstract**

The rapid human population increase in cities including Dodoma City, has accelerated high demand of water for domestic and industries. The increased water demand poses some challenges on water supply and sanitation services and therefore calling for alternative options for more water sources. Amongst the key challenges in water supply services is the issue of non-revenue water (NRW). Non-Revenue Water is the amount of water produced and not counted for by a water utility less the amount that is sold to customers and is presented as a percentage of water produced and/or purchased. The recommended value of NRW should be less than 20%. NRW has become a pressing issue not only for Dodoma City but also in Tanzania at large. Considering its strategic potential Dodoma City through Dodoma Water Supply and Sanitation Authority has experienced significant increase in the percentage of NRW over the past three years mainly due to water leakages. Other challenges about water supply includes unmeters customers, illegal connection, substandard pipes, trench pipes depth not reached 1m depth hence easily to be damaged by human activities. Ultimately, this situation has resulted into insufficient water supply coverage In Dodoma City. This paper is tracing the nature of these underlying challenges of NRW, indicating technical and long-term solutions that have been formulated to address these problems of NRW. Considering the current fluctuations on environmental flows attributed by issues on climate changes, and degradation of water resources by human activities, to ensure that water supply agencies have developed a plan to rectify the challenges of NRW. This will ensure that quantity versus water demanding estimates is balanced.

**Keywords:** Non-revenue water; water demand; unmeters

## **5. Investigating the Effect of Climate Change and Human Activities on Water Availability in Wami River Sub-basin, Tanzania**

Christossy B. C. Lalika<sup>1, 2\*</sup>, Peter Molnar<sup>1</sup>, Darcy Molnar<sup>1</sup> Makarius C.S. Lalika<sup>2,3</sup> and Malemi Sendama<sup>4</sup>

<sup>1</sup>*Department of Civil, Environmental and Geomatic Engineering, Institute of Environmental Engineering, Chair of Hydrology and Water Resources Management, ETH Zürich, Rämistrasse 101, 8092 Zürich*

<sup>2</sup>*UNESCO Chair on Ecohydrology and Transboundary Water Management, Sokoine University of Agriculture, P.O. Box 3038 Morogoro, Tanzania*

<sup>3</sup>*Department of Geography and Environmental Studies, College of Natural and Applied Sciences, Sokoine University of Agriculture, P.O. Box 3038 Morogoro, Tanzania*

<sup>4</sup>*Wami/Ruvu Basin Water Board, P.O. Box 826, Morogoro, Tanzania*

### **Abstract**

Understanding the trend, extent, and effect of climate change and human activities are globally important for monitoring river basin water resources. Due to majority of river basins from developing countries like Tanzania to experience lack of long-term time series data, we used long-term remote sensing data from ERA5-Land (1960-2021) reanalysis data as a basis to examine the effect of climate change and human activities on water availability along Wami river-sub basin. The Mann-Kendal Sneyer test was used and revealed an abrupt change that reflecting the effect of human activities on runoff in 1992, hence resulting in two periods: a pre-change period (1960-1992) and post-change period (1993-2021); mean annual runoff, precipitation and actual evapotranspiration decreased by 19%, 9.7% and 8.9%, respectively, in the post-change period, while potential evapotranspiration increased by 5%. Hydrological sensitivity analysis revealed that climate variability was the main factor that reduced runoff with contribution to 69%, while human activities accounted 31%, this implying that runoff is more sensitive to climate variability than human activities as the largest parts of the basin are arid, and semi-arid regions while only 2.3% regions are dry sub-humid zone. Our study suggest that is substantial important adoption of Nature-basin Solutions (NbS) for sustainable development and social economic in the Wami river sub-basin.

**Keywords:** Climate change, human activities, runoff, Wami river sub-basin. water availability,

## **6. Long-term changes in climatic, and hydrological variables and their impacts on future river discharge in Wami river sub-basin, Tanzania.**

Christossy B. C. Lalika<sup>1, 2\*</sup>, Peter Molnar<sup>1</sup>, Darcy Molnar<sup>1</sup> Makarius C.S. Lalika<sup>2,3</sup> and Malemi Sendama<sup>4</sup>

<sup>1</sup>*Department of Civil, Environmental and Geomatic Engineering, Institute of Environmental Engineering, Chair of Hydrology and Water Resources Management, ETH Zürich, Rämistrasse 101, 8092 Zürich.*

<sup>2</sup>*UNESCO Chair on Ecohydrology and Transboundary Water Management, Sokoine University of Agriculture, P.O. Box 3038 Morogoro, Tanzania*

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<sup>4</sup>*Wami/Ruvu Basin Water Board, P.O. Box 826, Morogoro, Tanzania*

### **Abstract**

Despite its ecological and economic importance, the Wami River Sub-basin is under stress, with serious consequences for aquatic biodiversity loss and a shift in water resource management. The study was carried out to assess the climate trend and hydrological prediction along the sub-basin for better water resources management and planning. In this study, a longterm (1960-2021) remote sensing ERA5-Land reanalysis data at ten meteorological and one hydrological station were used, and a non-parametric Mann Kendall trend test and Sen's slope was applied to identify annual climate variability and trends along the sub-basin. The findings indicated decrease trends in annual precipitation, and runoff, whereby annual temperature indicated extremely significantly increase trend ( $\alpha=0.001$ ) along the sub-basin. Findings from ABCD water balance conceptual model under the CMIP6 model under three scenarios indicated that by 2035 the Wami river discharge under SSP2-4.5 will increase by 1.3% (flooding), while for SSP3-7.0, and under the worst-case scenario SSP5-8.5 the discharge will decrease by 13% and 30%, respectively. Based on the above findings, the climate change will continue to have significant impact, hence we recommend affective implementation of management framework that encompass participatory and integrated planning (PIP) approach for better water resources management and policies enforcements.

**Key words:** ABCD model, Climate change, discharge, variability, and Wami river subbasin.

## **7. Addressing Pumps Functionality as a Limitation to Performance of Rural Water Supply Schemes in Tanzania”**

Leah I. Marwa<sup>1\*</sup>, Subira Munishi<sup>1</sup>, Tulinave B. Mwamila<sup>2</sup>

<sup>1</sup> *Department of Water Resources Engineering, University of Dar es Salaam, Tanzania.*

<sup>2</sup> *Water Supply and Irrigation Engineering, Water Institute, Tanzania.*

### **Abstract**

Pumps are the most vulnerable components of any Water Supply Network and are frequently found to be at fault. While significant initial capital is needed to install these pumps, a sustained long-term effort and investment is also required to maintain these pumps. The study highlights opportunities and challenges in the operation of pumped water supply schemes as it investigates the most applicable and locally suitable approach(es) to designing, installation, operation and maintenance of water pumps in the rural settings of Tanzania. Qualitative research approach was used to carry out the study and data collection tools included online questionnaires and interviews from key informants such as the District, Regional Managers and water pump professionals available in water sector. Field visit to pump supplier's offices were also carried out to get familiar with water pumps. The study identified a number of issues of concern common to most respondents. It was discovered that a lot more attention is paid to designing and installation of pumps that mostly takes into account discharge/yield, pumping head, characteristics of the fluid to be pumped and water demand factors. While less attention is paid to issues of pump efficiency, pump capacity and power consumptions during the design stage. Findings show that these are the major issues contributing to operational failures of these pumps and therefore the entire water supply system. Also it was discovered that little knowledge on commissioning process has resulted into lack of baseline information about water pumps which could act as a starting point during routine checkups and maintenance. This study has made significant contribution in identifying appropriate factors and procedures to be considered in design, installation, operation and maintenance of the water pumps to ensure proper functioning of the water pump units.

**Key Words:** Commissioning of water pump; Designing and installation of pumps; Pump functionality; Routine checkups and maintenance; Water supply projects

## **8. Topo-Bathymetric Study for Storage Capacity Estimation of Mindu Dam Reservoir in Morogoro Municipality, Tanzania**

Method J. Gwaleba

*LandTek Limited*

### **Abstract**

From a global perspective, dams are built to store water flowing from upstream to downstream for several purposes such as to aid community livelihoods. However, the storage capacity of water can be considerably reduced by sediment accumulation. Mindu dam is a used for irrigation and domestic activities. Nonetheless, it has been observed that there is a shortage of water in its storage capacity and supplies due to sediment accumulation in the reservoir, coupled with the fact there was a challenge of water within the Municipality and including nearest neighborhoods. For a contemporary storage capacity estimation towards effective management, topographic and bathymetric data were used to assess the aforementioned challenge. The assessment involved subtracting two-period capacities (the designated and estimated storage capacities). The topo-bathymetric survey was conducted using single beam echo sounder (HD 370) by means of transducer to collect water depths and a dual-frequency Real-Time Kinematic Global

Positioning Systems (RTK GPS) receiver mounted above the echo sounder to collect horizontal positions. The water depth and coordinate data were pre-processed at every end of the survey mission and post-processed and imported into processing software with information from field notes. A topo-bathymetric surface model (triangular irregular network (TIN) was created using the combined data sets from reservoir-bed dataset as well as water-level dataset by using ArcGIS 10.2 software as well as AutoCAD Civil 3D 18 software. The model was used estimate the Surface area and storage capacity of the dam reservoir. The results indicate that the current storage capacity of the reservoir at its normal water-surface elevation (i.e. 507.0m) is about 11,291,556.78m<sup>3</sup> with an area of 3,491,645.53m<sup>2</sup>. The bathymetric survey showed that 1,331,443.22m<sup>3</sup> of sediment had accumulated in the reservoir over 37 years of operation. The result makes the decrease of about 10.5% of its estimated original storage capacity. This decrease were caused by sediments and other deposits loaded into the dam reservoir through the feeding rivers due to human activities and soil erosion from upstream areas of the dam reservoir. The study suggests that dredging should be carried out to boost the reservoir capacity. Besides, an embankment can be constructed to improve the dam reservoir storage capacity.

**Key words:** Mindu dam, topo-bathymetric survey, reservoir, storage capacity

## **9. Assessment of the Impacts of Land Use On River Water Quality In Selected Rivers In Mzimba District, Malawi**

Maureen Kapute Mzuza<sup>1\*</sup> and Chikondi Kapute<sup>2</sup>

*1 The Catholic University of Malawi, Department of Geography and Environmental Studies, Malawi*

*2 Mzuzu University, Department of Water and Sanitation, P/Bag 201, Luwingu 2, Mzuzu*

### **Abstract**

Land use has transformed a large proportion of the planet's land surface. Hitherto, there is a paucity of empirical information on how land use affects the river water quality worldwide. Therefore, this study assessed the impacts of land use on river water quality in selected rivers of Mzimba District, Malawi. Structured and semi-structured questionnaires were administered to assess the level of knowledge and perception of people on land use. The Land Use or Land Cover classified series of satellite images of the years 2000, 2010 and 2020 of the selected four river buffer zones were produced to show the trend of degradation. Water quality characteristics of selected four rivers were measured with selected Physico-chemical and microbiological parameters. Results revealed that the majority of respondents (80%,  $n = 80$ ) do not have enough knowledge of the management of the river environment. On average, vegetation area coverage was 23.73% while the land-use area coverage was 71.27%. This showed that the buffer zones in each river were massively degraded. The NO<sub>3</sub><sup>-</sup> (0.80–1.80 mg/L), K (3.0–5.8 mg/L), PO<sub>4</sub><sup>3-</sup> (0.060–0.899 mg/L), TDS (56–189 mg/L), EC (94–314 µS/cm) and pH (6.67–7.45) were all within the standards of Malawi Bureau of Standards (MBS) and World Health Organisation (WHO). Turbidity (15.6–145 NTU), water temperature (21.4°C–28.47°C) and faecal coliform

values (80–808 C/100 mL) were not within the standards of MBS and WHO. In conclusion, the study indicated that water in the study area is unsafe for consumption without treatment. There is a need for an awareness campaign to the general public and a revision of the policies and laws that govern water and land use.

**Keywords:** Land use; Land cover; Buffer zones; Satellite classified images; Water quality.

## **10. Towards Urban water community-based organization: Experiences from reporting of water problems in Dar es Salaam**

Opportuna Kweka<sup>1</sup> and Neil Munro<sup>2</sup>

*1 University of Dar es Salaam*

*2 University of Glasgow*

### **Abstract**

This paper present results of a qualitative study on citizens' use of existing water reporting systems. The study was done in Dar es Salaam in 2021. Through a review of literature on water governance which called for adaptive and integrative approach in water governance in urban areas, the paper introduced the concept of urban water communities as small areas sharing one water source in urban as areas for governance of water. Increasing commodification of water has led to injustice in water provision where urban water governance has concentrated on ensuring payment of bills than access and quality of water provided to the community. The paper presents accountability failures in dealing with urban water problems by the duty bearers and argue for restoration of urban water communities which will follow up on reported problems and hold accountable the duty bearers. This structure as we argue will integrate the urban dwellers back into the decision making and activate their citizenship role despite the partial commodification of water sector in urban areas.

**Keywords:** Effective governance, urban water communities, social accountability, water reporting systems.

## **11. Water Resource Management Through Infrastructure Scoping For Water Supply Projects in Rukwa And Njombe Regions in Tanzania - Maji Na Usafi Wa Mazingira (MUM) Experience**

Mutazamba Jackson

*Maji na Usafi wa Mazingira*

### **Abstract**

MUM project has conducted a water infrastructure scoping assessment in 5 Districts of Kalambo, Nkasi, Sumbawanga, Makete and Ludewa in Rukwa and Njombe regions. The assessment exercise has established evidence-based challenges on technical as well as management practices



in the ten catchments located in the three basin water boards of Lake Rukwa, Lake Nyasa and Lake Tanganyika. This was followed by water quality and quantity assessment of water sources for the proposed 61 water supply projects which revealed that there are challenge of availability of adequate and clean surface water to support the develop of water supply projects in some of the villages in Nkasi, Kalambo and Sumbawanga Districts. Contributing factors include anthropogenic and climatic factors, lack of strong governing bodies to create community awareness and enforcement measures to protect water resource that hinder sustainability of water supply projects within the. The proposed intervention measures include promotion of coordination among major stakeholders especially WUAs, CBWSOs, LGAs and WSSAs to influence behavioral change towards protection and conservation of water sources.

**Keywords:** Water quality; climatic factors; anthropogenic

## **12. Socio-economic Factors Affecting Management of Catchment Forest Areas in Tanzania**

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### **Abstract**

Forest resources have been under pressure worldwide due to the important roles play in socio-economic development. Catchment forests are potential for safe and quality water in supporting communities' livelihood and biodiversity conservation. However, these benefits are jeopardized by socio-economic activities as most of the catchment areas that could be important for water filters and discharge have been systematically disturbed. This paper provides synthesis of the socio-economic factors affecting catchment forests and pays particular attention to stakeholders on the solution to catchments forests for discharge quality water. The literature review was used to capture information for this paper. Community adjacent catchment forest use water resources for their livelihood, but human activities have great contribution on degradation of forest catchments which disturb water discharge. Both direct and indirect socio-economic factors affect forest catchments. Direct factors include cultivation near water sources, grazing, use of fire as tools for agriculture, hunting and mining while indirect factors include conflicting policy among sectors, less involvement of community in management of catchment forests. Management of catchments forest for sustainable water supply needs collaborations among sectors. The study recommends the serious campaigns to create awareness on importance of management of forest catchments for biodiversity conservation and communities' livelihoods.

**Keywords:** Catchment; management; forest

### **13. Intra—annual hydrological calculation and water management for River Ruvu, monthly production capacity, monthly deficit and monthly excess for redistribution**

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#### **Abstract**

The Intra—Annual hydrological calculation helps in bringing climatological concept and hydrological concept in predicting and managing hydrological phenomena in difference months in the year. Sur as water deficit or flooding. In this study focus was to River Ruvu due to its important to more than 5 million people and industries that depends to the production of water by this river, either interest was bolded by the fact that there have been situation of scarcity of water in the city of Dar-Es Salaam in deferent months, so the study was to identify exactly which month are they and the amount of water that required to reach the suppling capacity (amount of deficit). Two methods were applied which are calculation by Average distribution of flow over the years of characteristic gradation of water content and calculation by Real minimum year. Calculation by Average distribution of Flow is the method more statistical and can be recommended for long time planning while Real minimum year is recommended for application. The findings were different in both methods where by in Calculation by Average distribution of flow only one month (October) were obtained to be months with scarcity with the total of  $3.05 \times 10^6 \text{ m}^3$  while in Calculation by Real minimum year the total of five (5) months from September to January were found to have deficit of water with the total of  $33.61 \times 10^6 \text{ m}^3$  and the total Annual excess of  $1026.09 \times 10^6 \text{ m}^3$

Keywords: Water management; hydrology; flow distribution

### **14. Analysis of land use / land cover changes in surface water dynamics, a case study of Singida urban a part of Tanzania.**

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#### **Abstract**

This study cantered on the flow work on investigating the changes in surface water bodies in Singida Urban locale. Within the locale the issue was voiced in year 2020 by local government authority as two portions of Lake Kindai happened to merge and cover a part of road network of almost 1.1km out of 4.4km which was the section along from Singida Urban to South-West outskirt districts wards including Nyranga. Huge precipitation changeability was noted from year 2018, 2019 and year 2020. The locale continuously observes total average yearly precipitation of

approximately 66.67mm, within the year 2018, 2019 and in 2020 the locale experienced average yearly precipitation of almost 138.82mm, 118.93 and 141.46 individually. This precipitation profoundly affected the changes in surface water bodies in Singida Urban in year 2020. Surface water bodies particularly the Lakes were exceedingly affected of which the Lakes in 2020 expanded in their coverage by around three quarter of their original coverage from year 2000. From year 2000 to year 2010 an increment of Lakes by 6.19% of the first zone scope was noted whereas the Swamps decreased by 30.84%. From the year 2000 to 2020 an increase in Lakes was noted to be by 76.05% of the initial coverage whereas the Swamps were noted to decrease by 25.18% from the initial coverage. The grave increment in Lake's scope coverage of around three quarter of the initial coverage from year 2000 was noted within the locale. The locale was found to be having two Lakes specifically Lake Kindai and Lake Singidani, both Lakes were subjected to changes and an increment in their area cover was noted. As for the directions of change Lake Kindai, it was inspected to have an expansion in NorthWest ward expansion, South ward expansion and South-East ward expansion. As for Lake Singidani a noteworthy expansion in North-East ward direction was noted. This study accurately measures the amount of changes in area cover, the spatial direction of expansions of the Lakes and afterward suggest solutions to the reported problem. NASA global precipitation data were employed to draw connection on the conceivable source of changes in surface water bodies in Singida Urban from year 2000 to 2010 to finally 2020.

**Keywords:** Surface water dynamics; Land cover change; Landsat; Land use monitoring; Geometric network analysis

## **15. Partly Financed Water Projects: Addressing Sustainability Problems for Majority of the Rural Water Projects in Tanzania – The Case of Korogwe**

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### **Abstract (Field experience)**

The Tanzanian's water supply and sanitation services in the 1990's were still inadequate despite major investments in the sector in the 1970s and 1980s, among others, due to inadequate community and private sector participation in implementation and management of water facilities. The Government prepared the first National Water Policy (NAWAPO) in 1991, to address the sector challenges; however, emphasis was put on the central Government as the sole implementer and provider leading to un sustainable management and development of water resources. The policy was then revised into the National Water Policy (NAWAPO 2002) which introduces elements of devolution and public and civil service reforms. It is strongly influenced by national policy instruments that address issues of poverty and economic development, and incorporate water sector reforms as one of several related components which, when combined, offer a multi-sector approach to poverty reduction and economic growth (*Programme Operational Manual (PoM), Water Sector Development Programme (WSDP), 2006*).

Following a sectoral reform, for over the past fifteen (15) years now, the sector has been encouraging Private Sector participation as highlighted by the NAWAPO 2002 and thus several Development Partners (DP's) have been plugging financial supports to the Rural Water Supply portfolio and thence the National Rural Water Supply and Sanitation Programme (NRWSSP); a multimillion dollars World Bank (WB) Programme came into being. The NRWSSP is being implemented according to the principles and strategies set out in the NAWAPO 2002. The Programme is designed to assist institutions and communities to adapt to the new policy that includes an emphasis on community ownership and management, and *“shifting service delivery to the private sector whenever possible, thus leaving government departments free to focus on programme facilitation, coordination, monitoring and evaluation and overall policy formulation”* (PoM, WSDP 2006).

As a results of that, Korogwe District was one of the beneficiaries and Implementing Agency of the said programme; then adequate funding, amounting to more than USD 4.3m was plugged in by the year 2015 (*DWE's Office, 2015*) from vast numbers of the DP's including the WB & AfDB, World Vision Tanzania (WVT), Poland Embassy (PE), Tanzania Social Action Funds (TASAF), Tanzania Forest Conservation Group (TFCG) and Devon Aid Korogwe (DAK), a UK based Charity Organization. Furthermore, in the period of almost 10 years (2006-2015) of the implementation of the NRWSSP more than 77 water supply projects were either newly constructed or rehabilitated (*of either Shallow Wells, Improved Spring Sources, Rehabilitated Shallow Wells and Piped Gravity Water Supply Schemes*) with an additional access to water coverage of more than 48,349 rural inhabitants (*which equates to more than 20.01% additional coverage*); which counted a coverage of more than 46.14%.

According to the reforms, preferably the NAWAPO 2002; and the other Sectoral Guidelines such as Programme Implementation Manual (PIM) and the District Operational Manual (DoM), and as afore explained above, before following all procedures for implementing a rural water supply project, Community participation for the aim of getting them to the sense of ownership was very crucial for the enhancement of the projects' sustainability. This was done first by establishing the Community Owned Water Supply Organizations (COWSO's); now referred to as Community Based Water Supply Organizations (CBWSO's)) with an account opened for funds maintenance (*as instructed by NAWAPO 2002*). This was done by *“either cash or in kind”* (*and by percentage of the Project cost as stipulated by the PIM*).

Irrespective of the aforementioned set down sectoral guidelines, yet due to political interferences, some of the DP's projects were not following the guidelines and hence led to implementation of the non-sustainable water supply projects. For instance, according to the primary data collected from the DWE's Office, it was revealed that, those projects under WB & AfDB had on average more than 75% of its projects non – sustainable. However, on the other hand, the strictly and stringent DP's (*such as DAK*) who stucked on the guidelines, their projects have been sustainable to date (*more than 90%*).

The objective of this study is to empirically show how sustainable rural water projects can become if there are set down best community participation and ownership strategies, strong institutional

and legal framework(s), strong political will and guidelines (*as the DAK case is evidenced*). It is therefore pioneered that; this study will specifically focus on:

*i. How many projects which had partly DPs funding support were sustainable? ii. How many projects which had full DP's funding support were sustainable? and iii. How does political will has an effect on the sustainability of the water projects?*

By conclusion, it is therefore envisaged to carry out this study for not only knowledge gain to the Researchers, Policy Makers and Practitioners but also to the Water Sector, preferably the Ministry of Water and its Organizations such as the Rural Water Supply and Sanitation Agency (RUWASA) who are the major beneficiaries of the study.

Furthermore, the study will create an awareness and/or raise an alarming note to the Decision Makers on the importance of the study to the Public at large and sees how crucial it's for the mindset changes as far as water projects sustainability is concerned.

## **16. The Impact of Prepaid Water Meters on Clients and Utility's Outcomes: The Case of Iringa Municipality**

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### **Abstract**

Water is the essence to life, economy and environment as all human activities depend on it. Among 17 Sustainable Development Goals (SDGs), SDG 6 aims to “ensure availability and sustainable management of water and sanitation for all”. As African cities’ population grow at 5 percent annually, water utilities are facing economic water scarcity brought about financial, technology and human capacities for managing water. The prevailing revenue flows of most urban utilities fall beyond the requirements to fund investments and efficient services to meet rapidly growing demand. While considering postpaid meters as remedy, the technology mostly subjected to billing inaccuracy, payment delays, higher operational cost among others. This calls for prepaid water meters (PPWMs) technology on most of sub-Saharan African utilities. Therefore, this study employed fixed-effects panel data analysis technique through staggered adoption difference-indifference design to explore causal-effects of PPWMs on water utility’s revenue collections, efficiency and client’s consumption in Iringa urban. The finding shows PPWMs significantly increases revenue collections and efficiency beyond postpaid meters. However, no consistent improvements on client’s consumption till after long exposure to PPWMs. Although PPWMs can potentially improve the quality of water service provision, much can be realized if financial options are supporting such technological interventions.

*Keywords:* postpaid; prepaid; water meters, revenue collections, efficiency, water consumption

## **17. Climate Sensitive and Resource Efficient Wastewater Treatment: Small-Scale Decentralized in Dar es Salaam, Tanzania and Large-Scale Centralized in Hamburg, Germany**

Tim Fettback<sup>1</sup>, Charles Muhamba<sup>2</sup>, Hendrik Schurig<sup>3</sup>, Riccardo Zennaro<sup>4</sup> and Avantika Singh<sup>4</sup>

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### **Abstract**

Sanitation and wastewater management significantly contribute to Green House Gas [GHG] Emissions and are affected by the effects of climate change [1,2,3,4]. Climate sensitive and resource efficient wastewater treatment is a key component for cities globally to mitigate and adapt to climate change. For this, we evaluated, compared and presented two wastewater treatment approaches (small-scale decentralized [DEWATS] and large-scale centralized) in two regions (Dar es Salaam, Tanzania and Hamburg, Germany). The research presents the performance of the different approaches and discusses their strengths, weaknesses, opportunities and threats, based on experiences from two treatment plants. The findings show, that both approaches are appropriate for their respective context and show the importance of context specific citywide inclusive sanitation planning [CWIS]. Both approaches enable an energy self-sufficient operation of the wastewater treatment processes. While the large-scale system can generate significantly more energy and can also function as a renewable power plant, it also requires more energy than the DEWATS. Furthermore, it was observed that DEWATS in Tanzania face challenges in using the generated biogas, but enable extended resource efficiency by also reusing treated wastewater and the nutrients in it.

**Keywords:** Wastewater Management, Resource Efficiency, Environmental Sustainability Development, Water resources and Climate Change/variability

## **18. Implications of temporal hybridization of rainfall data on streamflow in the African Great Lakes region**

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### **Abstract**

Managing transboundary water resources requires a hydrological understanding of the transboundary catchments. However, that understanding is usually hindered by a lack of readily

available observed data necessary for the hydrological modelling of catchments across borders. This study investigates the implications of the degree of hybridization of observed rainfall data using ERA5 reanalysis precipitation data on simulating stream flows in the Ruvuvu River catchment across the Tanzania-Burundi border. Firstly, the observed rainfall data and estimated evapotranspiration data for the catchment were used to set up an HBV model. Then, the model was calibrated using parameter combinations sampled using the Monte Carlo technique. During the calibration, simulated flows were evaluated using observed streamflow data at the catchment outlet, and the best parameter combination was eventually fitted in the model. Thirdly, the calibrated model was run using different proportions of hybrid rainfall data, and corresponding simulated flows were also evaluated using observed streamflow data at the outlet. Finally, another six HBV models with different proportions of hybrid rainfall data for the catchment were set up and calibrated using the same parameter combinations. Simulated flows from these models were also evaluated using observed streamflow data at the catchment outlet. The findings show that the performance of the hydrological model in the Ruvuvu catchment decreases as the proportion of hybridization increases. Moreover, it was also found that model parameter calibration cannot compensate for input uncertainty caused by more than 15% hybridization of rainfall data in the catchment model. This implies that a hydrological model set up using rainfall data with more than 15% inaccurate records in the Ruvuvu River catchment might not be satisfactorily calibrated. Therefore, these findings show the need for the development of thresholds of rainfall data hybridization for different global precipitation datasets in data-scarce river catchments.

**Keywords:** ERA5 reanalysis; Hybridization; Input uncertainty; Model parameter; Parameter combinations; Ruvuvu catchment

## 19. Climate change vulnerability mapping in the Wami/Ruvu basin: A review

Preksedis Marco Ndomba<sup>1</sup>, Frank Joseph Wambura<sup>2\*</sup>, Chrisogonus Kibugu<sup>3</sup>, Victor Kongo<sup>3</sup>

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<sup>3</sup>*Global Water Partnership Tanzania, Dar es Salaam, Tanzania*

### Abstract

Despite the potential of the Integrated Water Resources Management (IWRM) framework to promote the development and sustainable management of water and land resources, it does not explicitly provide for climate resilience and hence the latter does not feature as a major component of IWRM. This is more evident in most of the Integrated Water Resources and Development Plans (IWRM+D) for river basins in Tanzania, including the Wami-Ruvu Basin. To provide a climate resilience perspective of the existing IWRM framework in the Wami-Ruvu basin, a study was undertaken that applied a tailor-made approach coupled with standard frameworks before engaging a stakeholders' validation process. The study critically and systematically reviewed all available literature on water resources management for Wami-Ruvu Basin and identified climate resilience hot spots as well as possible interventions. Although the study proposed both basin-wide and local-level climate change adaptations options, stakeholders had an opinion that, in the

context of the Wami-Ruvu Basin, interventions at a local level were more appropriate in managing the two-pronged manifestations of climate change i.e., droughts and floods. Further, the study mapped the most vulnerable communities in the basin which were found to be located in Kiteto and Kilosa districts. These localities were established to have been severely exposed to droughts and floods, respectively, and have relatively low adaptive capacity to the impacts of climate change. The two key interventions that were recommended by stakeholders are the construction of small detention dams locally known as "*Mabirika*" and the restoration of landscapes through afforestation. However, the stakeholders further recommended a follow-up field-based ground-truthing mission for the proposed interventions before their implementations.

**Keywords:** Climate change, Exposure, Sensitivity, Adaptation capacity, Stakeholders, Vulnerability.

## **20. Which way to best studying accountability in water sector in Tanzania?**

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<sup>1</sup>*Senior lecturer, Geography, University of Dar es Salaam*

<sup>2</sup>*Lecturer, Political Science, University of Dodoma*

### **Abstract**

This paper provides a review of literature on governance and political economy of water sector in Tanzania in order to measure accountability factors. The paper findings shows that accountability in water sector is best studied by dividing the sector into three levels, the macro, meso and micro level and analysis of actors and processes. The paper concludes by arguing that while a scalar analysis is important, in the end, a centralized accountability mechanism is needed in order to get to an aggregated national level picture of water sector performance in both rural and urban areas for prioritization.

**Keywords:** Governance; accountability; scalar analysis

## **21. Hydropower Production, Agriculture, and Biodiversity Conservation in Kihansi Catchment, Tanzania: What is the Balance?**

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<sup>4</sup>*Department of Forest and environmental Economics, Box 3011 Chuo Kikuu Morogoro*

### **Abstract**



Hydropower is considered to be cheap, cleaner and reliable source of electricity production. Kihansi catchment has become important towards economic contribution for hydropower production, agriculture and biodiversity values. Besides this importance, there are number of cross-sectoral challenges associated with rational allocation to ensure a balance, and sustained power production, agriculture gains and ecological requirements. While the integration and sustainable management of water sources in catchments is insisted in the policy, there seems a gap of what the balance should be when more activities are placed on the same catchment. This article highlights the importance of hydropower production and their challenges using a case of the Kihansi Catchment. The catchment is used to provide water for power generation, meanwhile, agriculture and international importance biodiversity. This paper analyses the economic compliment of these activities to provide direction as to how conservation of catchment environment can be sustained. Results show that, allocation for the compensation value of social efforts from farming activities will assure conservation of ecological environment at highest economic value for the biodiversity. The value of biodiversity determines resilience in the ecosystem for serving the hydrology of the catchment for hydropower production. Therefore, to ensure stable ecosystem of catchment environment and effective hydropower production, the opportunity costs of farming should importantly be internalized in the hydropower production activities in Kihansi catchment. There should be a monitoring plan for inputs that may lead to attain biodiversity conservation at maximum economic value; this may help to reach a level by which ecosystem processes of the catchment can deliver a win-win that support hydrology for power production, agriculture in upstream and biodiversity in the catchment.

**Key words:** Hydropower production, Agriculture, Bio-diversity, resource balance

## **Theme 2: EMERGING SOLUTIONS TO GROUNDWATER EXPLORATION AND PROTECTION (GWEP)**

### **1. Exploiting ion-dipole and ion-exchange interactions for the decontamination of aqueous solutions from aminopyridines**

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#### **Abstract**

The decontamination of process water and remediation of natural waters are significant environmental challenges. Aminopyridines, such as 4-amino-2-chloropyridine (ACP), are not only starting materials for many useful chemicals but also decomposition products that are stable in the environment. Our preliminary work on remediation of environmental waters using PIMs containing Aliquat 336 as carrier indicated some transport of ACP. This was unexpected and more investigations on whether a carrier widely used to extract anions could be involved in facilitated transport of a chemical that exists as a neutral or cationic species in natural waters were carried out. Molecular dynamics simulations indicated that the presence of orthophosphate in the feed solution promoted ion-exchange with the original chloride counterion of Aliquat and ion-dipole interactions with ACP to form Aliquat:orthophosphate-ACP aggregates. An average activation energy of 32 kJ mol<sup>-1</sup> indicated the transport of ACP through the PIM involved both passive and facilitated diffusion in the rate-determining steps. Facilitated transport became significant with PIMs containing 10 wt% or more Aliquat. Transport of ACP was fundamentally driven by pH but also benefited from a chloride gradient that also transported orthophosphate across the PIM. An optimal membrane composition delivered a reasonable flux of  $413 (\pm 9) \times 10^{-8}$  mol m<sup>-2</sup> s<sup>-1</sup> and good transport efficiency of 98% for ACP. Our findings provide more incentive for the continued development of PIM chemistry to target troublesome pollutants and recover useful chemicals from water sources.

**Keywords:** Environmental remediation; membrane technology; polymer inclusion membrane; aminopyridines; molecular dynamics simulation; Aliquat 336

### **2. Removal of Picloram and Related Herbicides from an Aqueous Environment using Polymer Inclusion Membranes**

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## Abstract

The beneficial use of herbicides on pastures to increase crop yields is offset by associated risks from chemical runoff contaminating environmental waters. Simple remediation methods that do not use or produce toxic chemicals during treatment of contaminated waters are needed. To promote this outcome the development of a cellulose triacetate (CTA)-based polymer inclusion membrane (PIM) containing Aliquat 336 (extractant) and 2-nitrophenyl octyl ether (NPOE) (plasticiser) for the extraction of picloram herbicide is reported. The optimised membrane composition of 25 wt% CTA, 30 wt% Aliquat 336 and 45 wt% NPOE produced an initial flux of  $(294 \pm 14) \times 10^{-8} \text{ mol.m}^{-2}.\text{s}^{-1}$  and a transport efficiency of  $95 \pm 1\%$ . The polymer membranes was reusable for five consecutive transport cycles with a negligible change in flux during later cycles. The findings also demonstrated that the membrane was suitable for the effective removal of a mixture of picloram, clopyralid, 2,4-D and triclopyr herbicides with efficiencies of  $97 \pm 5\%$ ,  $98 \pm 3\%$ ,  $84 \pm 6\%$  and  $89 \pm 5\%$ , respectively. The practical application of the membrane for the real environmental water samples produced promising outcome. The results from this study demonstrated that the polymer membranes can serve as a potential green method to target the removal of picloram and related problematic herbicides from natural waters.

**Keywords:** facilitated transport; polymer inclusion membrane; picloram; herbicide.

## 3. Determination of Green and Blue Water Foot Print of Major Crops for Efficient Use of Water and Environmental Conservation: A Case of Wami/Ruvu Basin – Tanzania

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<sup>2</sup>*School of Environmental Science and Technology, Department of Environmental Engineering Ardhi University, Dar es salaam, Tanzania*

## Abstract

It is vital to have an understanding of crop water requirements (CWR) of various crops grown in a Water Basin for designing of optimizing efficient use of available Blue and Green water for sustainable environmental conservation. The crop water needs of the major crops grown in Wami/Ruvu Basin were calculated using the FAO-CROPWAT model basing on meteorological parameters. This study estimated the crop reference evapotranspiration ( $ET_0$ ), actual evapotranspiration ( $ET_c$ ) taken as Green water and the irrigation requirements taken as Blue water for the major crops grown in the study area, which are Rice, Maize, Bean, Tomatoes and Sugarcane. The climatic data utilized in this study were from weather stations in proximity of the study area which are Ubungo, Dar es Salaam-Airport, Dar es salaam, Morogoro, Ilonga, Kongwa and Doma stations as are imbedded in FAO software CLIMWAT database. The Penman-Monteith method was utilized in the estimation of the  $ET_0$ . The crop coefficients ( $K_c$ ) of various growth stages of the crops were used in the adjustment and estimation of actual evapotranspiration ( $ET_c$ ). The results indicate that the mean annual reference evapotranspiration ( $ET_0$ ) is estimated

to be 1604 mm. The average ( $ET_0$ ) per month was 134mm, whereby in most of the months except October, November and December have relatively high values greater than average  $ET_0$  per month, while the lowest monthly value of  $ET_0$  were observed in the month of April, May, June and July. The highest total irrigation water requirement is recorded in sugarcane followed by rice, while the lowest is recorded in beans and Tomato. The highest cumulative crop evapotranspiration ( $\Sigma ET_c$ ) was found in Sugarcane and rice while bean and maize had the lowest cumulative crop evapotranspiration. The results showed that crop evapotranspiration ( $\Sigma ET_c$ ) was significantly higher in crops that had prolonged growing seasons as compared to those having short growing seasons. The findings leads to proper planning for irrigation scheduling that enables efficiency use of water to meet the respective crop water requirements at the same time avoid wastage of water.

**Keywords:** Water footprint, Crop coefficient, Crop evapotranspiration, Reference evapotranspiration, CROPWAT model

#### **4. Removal Kinetics of *Escherichia Coli* from Faecal Sludge Treated with *Moringa Oleifera* on Unplanted Sand Drying Beds.**

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##### **Abstract**

The removal kinetics of *Escherichia coli* (E. Coli) from Faecal Sludge (FS) on an unplanted sand drying bed was studied. The unplanted sand drying beds consist of a six-bed unit with an effective surface area of 1.5mx1.5m (2.25m<sup>2</sup>) and three depth layers of coarse gravel. Fine gravel and sand each of 0.1m were used. A total of 100 samples from influent and effluent of the sad bed unit were collected for mathematical model calibration. The bacterial removal mechanisms which were studied included the effects of environmental temperature, solar radiation, conditioner, adoption, diffusion and filtration. The model results show that the *Escherichia Coli* removal kinetics was largely contributed by the combined mechanisms of adsorption, diffusion and filtration accounting for 64.3% of total removal. The die-off mechanism enhanced *Moringa Oleifera* conditioner accounted for 34.7%. The influence of other parameters such as temperature and solar intensity was insignificant ( $p=0.72$  at  $\alpha=0.05$ ) contributing to about 0.7% and 0.3% respectively. Construction of FS dewatering facility need to consider the temperature, viscosity of FS and particle size of filter media and, also the contact time, concentration of *Moringa oleifera* stock solution and its dilution factors for improving the efficiency of FS treatment plants

**Keywords:** Moringa oleifera; kinetics; escchericha coli

## **5. Investigating field effectiveness and feasibility of carbon neutral water treatment through solar-powered ultraviolet light-emitting diode (UV-LED) disinfection**

Karlye Wong<sup>1</sup> \*, Ron Hofmann<sup>1</sup>, and Mistelle Haughton<sup>1</sup>

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### **Abstract**

Low-to-middle income countries are experiencing significant population growth, altering the landscape of human settlement and living conditions. Rapid urbanization and unplanned settlements have led to a deficiency of centralized services, like water supply and treatment, leading to increased risk of waterborne pathogens and illness. As such, rainwater harvesting (RWH) is an affordable and practical source of water where centralized infrastructure is unavailable, but can be subject to faecal contamination from collection surfaces. This research investigates a novel treatment technology, UV-LED disinfection, which includes promising characteristics suitable for low-resource environments. These differ from traditional UV lamps in that they have instantaneous start-up times, less energy requirements, a lower cost trajectory, and a longer lifespan, up to 10 years – characteristics suited for off-grid contexts. This research builds upon findings and observations from traditional UV RWH systems at health care facilities in Geita, where devices have been deployed and observed for 24 months. Second-generation prototype systems have coupled UV-LED with solar-power and RWH and show that UV-LED could be a carbon-neutral, decentralized, and economical treatment option to address microbial contamination and enhance water autonomy and resilience, where centralized water services are unavailable.

**Keywords:** UV disinfection, rainwater, Ultraviolet light-emitting diode (UV-LED), water treatment

## **6. Contribution of private boreholes in minimizing domestic water shortage in Dodoma district, Tanzania**

Leopord Gayo

*Dodoma district*

### **Abstract**

Provisioning of alternative water sources in urban areas apart from formal urban water supply is essential because of increasing human population. The study assessed the role of private boreholes in resolving increased water shortage for domestic uses in Dodoma district between June and October 2022. It investigated spatial distribution of private boreholes within the district to determine uncovered areas for potential future water supply investment, and level of community reliance on private water supply for domestic uses. Data were collected through household questionnaire survey, key informants' interview, focused group discussion and documentary review. About 384 households in Nzuguni, Ipagala, Mnadani and Nkuhungu wards were surveyed. Qualitative data were analyzed using content analysis while SPSS version 20 was applied for

quantitative data analysis. Twenty-three private boreholes were identified and 69.6% concentrated on the same locality leaving large part of district experiencing high water shortage uncovered. About 81.8% of the respondents relied on private water sources for domestic uses. Despite financial limitation, 74.3% of the respondents acknowledged the private water provisioning to increase water access. Innovative and affordable technologies for groundwater exploration to enhance effective private water supply among urban and peri-urban inhabitants are paramount for sustainable and equitable development.

**Keywords:** Informal water supply, Semi-arid areas, Urban water scarcity, and Groundwater exploration

## **7. Prioritization of Iringa district rural water supply project preparations, application of micro integration decision model (mid)- innovation**

Magige Joseph<sup>1</sup>

<sup>1</sup>*Rural Water Supply and Sanitation Agency Iringa*

### **Abstract**

Though water is covering 71 percent of earth's surface, less than 1 percent is available for human consumption. Inadequate and unsafe water to community causes waterborne and wash diseases; and estimated 502,000 diarrheal deaths per year caused by unsafe water access in low and middle-income countries<sup>11</sup>. The global community declared, water and sanitation for all by 2030. The Micro Integration Decision (MID) model is designed to address, obviously and worldwide decision markers' allocation challenge facing public resources, budget constraint, the overlooked inter-sectoral requirements and unexplored micro social beneficial, a non-monetary values<sup>1</sup>. Each subsector, such as health and education, all has equal weight, as expressed in project planning and developments. Twenty-seven ward-datasets of Iringa rural community have been analyzed by MID model. Among many possible descriptive models; population not access water and none functioning community water points, opted to address community water priorities. These two main models have internal associative correlation ( $R^2$ ) of project preparation priorities, range from 61.7 to 69.1% and, 84.0 to 90.5%, respectively, as one outlier (<5%) eliminated. The MID has proposed three main clusters; cluster-A, a high attention to cluster-C, a less attention cluster. Either, MID model was validated through Infrastructure Priority Framework, financial and economic index, IPF-FEI (Sri-Lanka, 27 water projects), Innovative Network - Data Envelopment Analysis, DEA (27 Brazilian Provinces, WASH investments) and Filipino Provinces poverty rank (Top 20 Provinces Poverty Incidents); and had attended correlation of determinant of: 30.8 to 37.2%, 58.3 to 68.6%, and 84.1 to 87.6%, respectively, as one outlier eliminated. Noted, uncertainty might be arise in some models due to stakeholders' weight factors-assumptions etc.

**Keyword:** water supply prioritization, planning and developments, micro integration decision, MID model, regression, classification

## **8. Banana Peel a Natural Biosorbent for the Reduction of Turbidity and Chemical Oxygen Demand from Municipal Wastewater**

Magori J. Nyangi<sup>1\*</sup>, Alinanuswe Mwakalesi Joel<sup>2</sup>, Dickson K. Gidion<sup>1</sup>,

<sup>1</sup>*Department of Water Resources, Water Institute, P.O Box 35059, Dar es Salaam, Tanzania.*

<sup>2</sup>*Department of Chemistry and Physics, College of Natural and Applied Sciences, Sokoine University of Agriculture, P.O Box 3038, Morogoro, Tanzania.*

### **Abstract**

This study investigated the reduction of turbidity (TB) and chemical oxygen demand (COD) from municipal wastewater effluent by using unmodified banana peels (BP) biosorbent in a batch reactor. A Box-Behnken Design (BBD) was applied to optimize the independent variables at mixing time (10 – 60 min), pH (4 – 9), and BP dose (50 - 200 mg/L). The correlation coefficients ( $R^2$ ) of 0.99 and 0.98 were obtained for the reduction of TB and COD, respectively. The agreement between experimental results and the developed models confirmed the validity of the data. Meanwhile at the optimized operation conditions of mixing time of 55 min, 4.8 pH and 181 mg/L BP dosage produced reduction percentages of 93 and 79 % for TB (341 NTU) and COD (84 mg/L), respectively. The reduction of both TB and COD followed pseudo second order (PSO) and Freundlich adsorption model. The performance of BP exhibited the adsorption capacities of 7.812 and 1.736 mg/g for TB and COD, respectively. The findings from this study suggest that the unmodified BP could serve as the effective potential natural biosorbent for municipal wastewater treatment.

**Keywords.** Stabilization pond, green method, response surface methodology, wastewater

## **9. Application of Octacalcium Phosphate with an Innovative Household-scale Defluoridator Prototype and Adoption in Rural Communities of the East Africa Rift Valley**

Mihayo Nkinda<sup>1</sup>, Alfredo Idini, Franco Frau, Luciano Gutierrez, Elisabetta Dore, Giuseppe Nocella, Giorgio Ghiglieri, Giorgio Colombo, Revocatus Machunda, Willison Mahene, Godfrey Mkongo, Simon Kajala

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### **Abstract**

Natural fluoride contamination of drinking water is a serious issue that affect several countries of the world. Water consumption with fluoride ( $F^-$ ) concentration greater than 1.5 mg/L can cause fluorosis to people. Within the frame work of the European Union (EU) Horizon 2020 FLOWERED project, we first designed an effective defluoridation device based on innovative application of octacalcium phosphate (OCP) and then explored its acceptance within rural communities. The prototype (Flowered Defluoridation Device (FDD)) essentially is composed of

a 20-L tank and a recirculating pump that guarantees the interaction between water and OCP. The device is powered by a car battery for a fixed pumping working time using a fixed amount of OCP for every defluoridation cycle. Using similar method, a jar test experiment was conducted at the Water Institute Research Campus (Ngurdoto) in Tanzania. Promising results indicated that water samples with concentration of 23 mgF/L, 12 mgF/L and 4 mgF/L treated with 12 g/L, 4 g/L, 3 g/L of OCP and stirred for 2 hours reduces  $F^-$  concentration to 0.92 mgF/L, 0.52 mgF/L and 0.13 mgF/L respectively. Furthermore, water quality test results indicated that only total phosphate concentration was above WHO and TBS guideline. Hence, further investigation to reduce the level of phosphates concentration is in progress.

**Keyword:** Octacalcium Phosphate, Fluoride contamination, Defluoridation method.

## **10. Bonechar Water Defluoridation Technology, Achievements, Challenges and Experience in Tanzania.**

Godfrey B. Mkongo\*, Mihayo S. Nkinda, Francis J. Gumbo, Hassani J. Mjengera

### **Abstract:**

About one third of the country of Tanzania is fluorotic. Most water sources in these areas contain fluoride concentrations exceeding WHO guideline of 1.5 mgF/L. In these areas people suffer from severe dental to skeletal fluorosis. In efforts to alleviate the situation, the government of Tanzania established a Defluoridation Research Station at Ngurdoto – Arusha. The station aims at developing the least cost water defluoridation technologies that can be used in the country. At the research station different materials and methods have been tested on capabilities to defluoridate drinking water. Materials tested include cow bone char, aluminum sulfate and lime, magnesite, activated aluminum and zirconium oxide to mention a few. The present paper discusses the application, experience, challenges and design of defluoridation systems for household and community uses in Tanzania. The experimental results indicated that optimum bone charring temperature is between 500 to 600 °C. The bonechar particle sizes should be 0.5 to 3.0 mm for effective defluoridation and economical reasons. Moreover, the household unit of capacity of 5 kg bonechair can defluoridate 2 m<sup>3</sup> of water with initial fluoride concentration of 8 mg/L.

**Keywords:** bonechar defluoridation, particle sizes, dental and skeletal fluorosis, charring temperature.

## **11. A Column Design with Low-Cost Adsorbent for Hard Water Treatment: A Case Study of Dodoma City.**

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## **Abstract**

Dodoma city is located in central Tanzania in a semi - arid position. The major source of tape water is ground water from Nzakwe. Many city residences complain about high concentration of salt present in a tape water which affect the potability and the use of water. Cheap adsorbent, cactus material has been proved to remove 80% of hardness of water. In this work a column design with low-cost adsorbent for hard water treatment was designed. The column reduces hardness of water supplied by DUWASA pipe line system. The total hardness, calcium hardness and magnesium hardness were reduced by 32.81%, 22.44% and 89.85% respectively. The recommended column design parameters were as follows: area (A) of 19.6 cm<sup>2</sup>; diameter (d) of 5 cm and height of column of one meter with flow rate of 20 l/h. The research is still in progress to meet TBS - standards and improving the operation of the column for effective and efficient process.

**Keywords:** Column design, Low-cost Adsorbent, Cactus Material, Water Treatment, Dodoma City.

## **12. Decentralization and accountability in community water governance in Tanzania**

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*Department of Political Science and Public Administration The University of Dodoma P.O Box Tanzania.*

## **Abstract**

Tanzania is experiencing challenges in delivering water security. The water equity report reveals that 40% of citizens lack access to improved water, 40% of water points are not functional and 50% of the rural population lack basic sanitation. Management of water resources is also at stake. Water resources are facing severe depletion and degradation due to climate change and unregulated socio-economic activities up and downstream. The institutional framework for both water provision and water resources management decentralizes water governance to grassroots institutions in the hope that community institutions would play a role in mitigating water challenges. Yet, the challenges continue to persist and even increasing. This paper contributes to water governance literature by examining factors that constrain effective accountability of water institutions at the grassroots level.

**Keywords:** Water equity; sanitation; management; governance

## **13. Gender Power Inequality and Community-Based Water Supply Management: Causes, consequences, Challenges and Remedy**

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*Institute of Lands Dar es Salaam*

## **Abstract**

Gender is a critical issue in water resources management globally, and particularly in the global south. Its criticality is reflected in its inclusion in the WRM criteria monitored through SDG indicator 6.5.1. for various reasons. First, water scarcity disproportionately affects poor communities and the most marginalized individuals in society (UN, 2018). Second, access to water is relevant for women's empowerment because it further affects women's access to education and health, as well as their income and safety. This paper presents the objective of the study which was to assess gender power relations in Community Based Water Supply Organizations (CBWSOs) in three Tanzania water basins: Pangani, Wami-Ruvu and Lake Victoria. The study adopted qualitative and ethnographic study method. The findings show that social economic, political and cultural barriers limit the full participation of women in decision making and weaken accountability in the CBWSOs. To ensure inclusivity and accountability in CBWSOs, women should be empowered through policies and laws, including dismantling cultural practices that limit their participation.

**Key words:** Accountability, Community based, gender, participation, water

#### **14. Co-creating a sustainable water technology platform to tackle urban water issues in Dar es Salaam**

Michael Coto<sup>1</sup>

*Majicom, Cambridge, United Kingdom*

##### **Abstract**

Through research collaborations and a community-centric approach Majicom has created a solar kiosk platform that is capable of providing clean, affordable, and sustainable drinking water to communities. This talk will cover Majicom's 4 year journey, with an initial focus on the background scientific research and collaborative work carried out with institutions and NGO's in both Tanzania and the UK. This importance of this first phase of work in demonstrating the effectiveness of new technologies in solving modern water challenges will be discussed. The talk will then highlight the role that community engagement and co- creation has played in defining Majicom's solution, and how the constant stakeholder input has been the keystone to developing sustainable water solutions. Finally, the presentation will conclude by outlining the future work planned, including ongoing collaborations with Ardhi University and new initiatives with The Water Institute, designed to accelerate the impact of new water solutions and to foster international collaborations.

**Keywords:** Sustainability, solar, kiosk, co-creation, community

#### **15. Analysis of silting trends of Iwanyo dam**

Baraka M. Moshi\*, Zacharia Katambara<sup>1</sup>, Mwajuma Lingwanda<sup>2</sup>, and Hieronimi Mboya<sup>3</sup>.

*Department of Civil Engineering, College of Engineering and Technology, Mbeya University of Science and Technology, P.O. Box 131, Mbeya, Tanzania*

## **Abstract**

The long-life span depends on how well the design, construction, maintenance and monitoring of the embankment of the reservoir systems. Siltation is among the process that lessens the live storage capacity of the reservoir and the induced seismic load effect towards the dam structure. Anthropogenic activities including crop cultivation and upstream animal keeping are the source of silt formation that flows and accumulate downstream of the catchment. Among the system that had suffered from silting is the Lwanyo dam with an upstream catchment area of approximate 11.7km<sup>2</sup> originating from Poroto Mountain. Approximately areas 128,991m<sup>2</sup> and 5.89km<sup>2</sup> are under cultivation and pastoralism activities respectively. These activities are the major source of the continued supply of silt that flows to reservoir. The open pit approach was used to determine the amount of silt based on observed layers. The average silt layer thickness ranged from 542mm to 987mm per rain season. Top surface layer of 0.00mm – 540mm Silt material (SM) is found followed by an intermediate clay (CI) material at 540mm to 3100mm. The current average silt depth is 1,270mm with approximate siltation volume of 58,349.4644m<sup>3</sup>. The dam has a storage capacity of 210,153m<sup>3</sup> which its storage has already reduced by 27.765%. Furthermore, the analysis it indicates that 3.085% storage in being reduced each year and after 24years the dam will be having zero storage. The study recommends on incorporation of silt flushing tunnels or inflow catchment channel silt check dam.

**Keywords:** Siltation, Silt, Catchment, Lwanyo dam, Dam failure

## **16. Tanzania's Experience in the Nalgonda Water Defluoridation Technology.**

Godfrey B. Mkongo\*, Fransis J. Gumbo, Hassan J. Mjengera

\* Author, Email: godfrey.mkongo@yahoo.com

### **Abstract:**

In efforts to alleviate high fluoride consequences in fluorotic areas of Tanzania, the government had to embark on research to develop the least-cost water defluoridation technologies. Several methods have been tested and one of them is the use of aluminium sulphate (The Nalgonda Technic). The optimum pH for maximum fluoride removal and minimum residual aluminum in treated water is adjusted by the addition of a correct amount of lime. In this paper performance of the method on different initial fluoride was tested. The results show that the performance of the method is optimal at pH around 6.5 and is economical at intial fluoride concentrations below 10 mg/L. It was also observed that the coagulant dose increased with initial fluoride which lead to an increase of residual sulphate.

**Keywords:** Aluminum sulfate, optimum pH, coagulant aid

## 17. Assessment of Vegetables Performance and Nutritive Values Through Application of Treated Domestic Wastewater by High Rate Algal Pond

Mary Kayombo<sup>1\*</sup>, Richard Kimwaga<sup>1</sup>, Augustina Alexander,<sup>1</sup> Joseph Mtamba<sup>1</sup>, Donatha Tibuhwa,<sup>2</sup>

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<sup>2</sup>Department of Molecular biology and biotechnology, University of Dar es Salaam, P.O. Box 35179, Dar es Salaam Tanzania.

### Abstract

Worldwide, wastewater is currently an alternative source of water for urban farming through gardening and horticultures. Wastewater from waste stabilization pond has been used for irrigation mostly by small scale farmers and to some of the communities is even used to grow food product like maize, beans, banana etc. This article assesses the plant performance and green vegetables (*Amaranthus hybrida*, *Brassica chinensis* and *Solanum nigrum*) nutritive value supplied with effluent from High Rate Algal Pond (HRAP) in comparison with commercial inorganic fertilizer through assessing the vegetable quality, mineral nutrients and secondary metabolites. The study further determined both quantitative and qualitatively their free radical scavenger ability, antioxidant (phenolic and flavonoid contents) antiradical activity, vitamins and proteins using methanolic extracts. Results reveal that vegetables treated with bio- fertilizer (effluent from HRAP), performed better than inorganic fertilizer-NPK and control. Vegetable quality indicated differences in growth parameters amongst treatments whereby vegetables treated with effluent depicted good performance  $p < 0.005$ . Significant difference was depicted in quality measures of height between treatments on each specie *A. hybrida* ( $F = 953.39$ ,  $df = 2$ ,  $p = 0.0000$ ) *B. chinensis* ( $F = 2619.49$ ,  $df = 2$ ,  $p = 0.0000$ ) and *S. nigrum* ( $F = 1756$ ,  $df = 2$ ,  $p = 0.0000$ ) whereas, the highest number for plant height, leaf area, leaf number, branch number as well as biomass were recorded on vegetables irrigated with effluent. Similarly, vegetables treated with reclaimed wastewater, were well enriched with nutrients with the highest quantities in *A. hybrida* compared to other vegetable species  $p < 0.000$ . Vegetable treated with effluent had significantly higher antiradical activity than other treatments except for *A. hybrida* ( $\chi^2 = 4.588$ ,  $df = 2$ ,  $p = 0.1009$ ) *B. chinensis* ( $\chi^2 = 7.450$ ,  $df = 2$ ,  $p = 0.0241$ ) and *S. nigrum* ( $\chi^2 = 11.942$ ,  $df = 2$ ,  $p = 0.0026$ ) while higher antiradical activity were recorded in *S. nigrum*  $35.23 \pm 2.7$  EAU (515) and the low value in *A. hybrida*  $(14.53 \pm 4.0)$  EAU (515). It was noted that vegetables that exhibited high antiradical activity also portrayed higher values of phenolic and flavonoid content. The study concludes that, wastewater effluent from HRAP can potentially be used for urban farming for production of food with rich nutrients and antioxidants compared to commercial inorganic fertilizer.

**Keywords:** High Rate Algal Pond; Treatments; Vegetables species, Antioxidants, Mineral Nutrients.

## 18. Targeting of Cationic Organic Pesticide Residues using Polymer Inclusion Membranes containing Anacardic Acid from Cashew Nut Shell Liquid as a Green Carrier

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<sup>2</sup> *Department of Chemistry and Physics, Sokoine University of Agriculture, P.O. Box 3038, Tanzania.*

### Abstract

Many emerging organic pollutants exist as cationic residues at environmentally relevant pH. This indicates a need to develop economically viable and robust methods to remove such residues from environmental waters. In this paper, we report using polymer inclusion membranes (PIMs) containing anacardic acid (AA), sourced from cashew nut shells, as an acidic carrier for the extraction and transport of 4-amino-2-chloropyridine (ACP), paraquat and diquat as representative target solutes of organic pesticide residues in aqueous solutions. Amounts of cellulose triacetate (CTA) as polymer, 2-nitrophenyl octyl ether (NPOE) as plasticizer, AA as carrier, and 1-dodecanol as modifier were used to prepare membranes. An optimal composition of 30 wt% CTA, 40 wt% NPOE, 10 wt% AA and 20 wt% dodecanol produced an initial flux of  $364 (\pm 16) \times 10^{-8} \text{ mol m}^{-2} \text{ s}^{-1}$  for transport of ACP. The extraction performance of AA was comparable to bis-(2-ethylhexyl) phosphoric acid, a widely used acidic carrier, in PIMs of similar composition. PIMs utilizing AA were also successfully applied to a sample of environmental water for the competitive recovery of ACP, paraquat and diquat, each at 500 g/L. Using chemicals from plants was shown to be an effective strategy to enhance the green chemistry credentials associated with methods for water remediation.

**Keywords:** Anacardic acid, cashew nut shell liquid, organic pesticides, facilitated transport, polymer inclusion membrane, green chemistry.

## 19. Integration of gender considerations into Tanzania's climate and water policies

Margaret Sima Kironde<sup>1, 2,\*</sup>, Oludare Sunday Durodola<sup>2</sup> and Claydon Mumba Kanyunge<sup>2</sup>

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<sup>2</sup> *Pan African University Institute of Water and Energy Sciences,*

<sup>2</sup> *Abou Bekr Belkaid University of Tlemcen, Tlemcen, Algeria*

### Abstract

Integrating gender considerations into national policies is a critical step towards achieving gender equality, resilient systems, sustainable water access and management of climate change. In Tanzania, women play a vital role in water management and could be more vulnerable to climate change impacts than their male counterparts. While there are few attempts in existing literature

to examine the integration of gender considerations into water and climate policies, analyzing policies' formulation process has not been given attention.

Thus, this study analyzed the extent and effectiveness of gender integration in climate change and water policies and explored the climate change and water policy formulation process in Tanzania. The assessment was conducted based on Tanzania (NSGD) for integrating gender in national policies and strategies in Tanzania and the Guidelines for Gender Integration in Agricultural and Climate Change Policies in Latin America'. The content analysis school of thought was adopted to assess the content of policies with respect to the degree to which women's concerns are addressed. The study shows that there is a substantial acknowledgment of gender issues in the reviewed policy documents but there exist considerable gaps in terms of integrating gender issues in the documents and during formulation processes.

**Key words:** Climate change, Nexus, Policy, Water, Women

## **20. Groundwater Physicochemical Properties of Ubungo, Dar es Salaam and the Potential of Cassava Peel Biosorbent for Removal of Chloride and Total Hardness from Groundwater**

Magori Jackson Nyangi\*

<sup>1</sup> *Department of Water Resources, Water Institute, P.O Box 35059, Dar es Salaam, Tanzania*

### **Abstract**

The physicochemical characteristics of groundwater of Ubungo, Dar es salaam and the potential of Cassava peel biosorbent for the removal of Chloride (Cl) and Total hardness (TH) from groundwater in a batch reactor was investigated. The analysis of groundwater revealed the dominance of the ions in the order:  $\text{Na}^+ > \text{Ca}^{2+} > \text{Mg}^{2+} > \text{K}^+ > \text{Fe}^{3+}$  and  $\text{Cl}^- > \text{HCO}_3^{2-} > \text{CO}_3^{2-} > \text{SO}_4^{2-}$ . The factors, initial pH, time, CP dose, and stirring rate of the adsorption process were optimized using response surface methodology RSM. The CP removes 50 mg/L (Cl) and 120 mg/L (TH) by 92 and 95 %, respectively at the optimum conditions of CP dose 3.4 g, treatment time 30 min, initial pH 5.8, and stirring rate 240 rpm. The adsorption capacity ( $q_m$ ) of 12.7 and 7.5 mg/g towards Cl and TH respectively were observed. CP can be potential adsorbent for remediating Cl and TH from groundwater.

**Key terms;** Groundwater; surface response methodology; desalination; hardness

## **21. Innovative filtration galleries for drain groundwater from hills**

August Mboya and Wilhelmina Malima

*Sanitation and Water Action-SAWA*

Mpapa village is one of the villages in Mbinga DC which did not have access to clean water since 2009. The village has more than 2150 people including children and elders. Through WASH improvement in Mpapa Health Care Center project funded by WEFTA and Implemented by

SAWA, Mpapa community and now have a sustainable access to clean water. Improved is reaching the Health care where delivering mothers can now access water supply service without problem also parish, primary school and community use this water. Project was involving drain of water from hill by innovative solution and construction sedimentation chamber. After excavating more than 6 meter along, we found water are penetrating from every point within 6 meter, then we employ the technique of filtration galleries after conducting different onsite hydraulic test which final result to of innovation filtration galleries which provide the best in this kind of intake.

### **Theme 3: UNLEASHING CONCERNS AROUND HARNESSED GROUNDWATER QUALITY AND QUANTITY (GWQQ)**

#### **1. Critical public health problems because of fluoride in water and propose the solution by CDI technology through maintenance concept**

Chang Ki Lee, Derick Erastus Majatta.

##### **Abstract**

Tanzania and other African countries have been struggling for a long time to solve the high concentrations of fluoride in surface and borehole water. It gives critical and serious public health problems and millions of Tanzanians are suffering because of this issue. To solve this issue, there are several technologies have been developed and representative examples include RO by using reverse osmosis principle and CDI technology to deionize. CDI concept has been originated 1962 and increased with the treatment efficiency and currently, it is commercialized by companies. CDI technology can remove fluoride in water by using state of the art electrodes running with very low amount of electricity with just DC 1.5 volts and its operational costs are cheaper than any other Defluoridation technologies. Based on TDS 250, 0.3 kw/h of electricity is consumed to process for 1m<sup>3</sup>, which is about 4 ~5 times energy-saving compared to RO technology on the same basis. However, no matter how well the machines are installed with excellent technology & equipment, if continuous maintenance is not performed, it starts to fail after years and eventually stop working. Therefore, combining the two factors is required for efficient fluoride removal and continuous maintenance for sustainable management.

**Keywords:** Fluoride; RO-Reverse Osmosis; CDI-Capacitive deionization; treatment efficiency energy saving.

#### **2. Model for prediction of the optimal dose of *Jatropha Curcas* in FS dewatering**

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<sup>2</sup> *Department of Water Resources Engineering, College of Engineering and Technology, University of Dar es Salaam, P. O. Box 35131, Dar es Salaam, Tanzania*

##### **Abstract**

*Jatropha Curcas* (JC) is a highly effective conditioner in dewatering fecal sludge (FS); however, there are limited studies on the model predicting its optimal dose. This study presents the results of the developed model for predicting JC optimal doses. The developed model assessed the FS parameters and JC stock solution. We analyzed the FS samples from a mixture of a pit latrine and



septic tank at the water quality laboratory of the University of Dar es Salaam. The multiple linear regression model was used to establish a relationship between JC optimal dose as a function of FS characteristics (pH, electrical conductivity, total solids, total suspended solids and concentration of the JC stock solution). The results indicated that 90.4% of the JC optimum dosage was determined and contributed by FS characteristics and JC stock solution concentrations. Also, the main explanatory factors determining the JC optimal dose were the JC stock solution concentration, followed by the pH of FS. The model results showed a good agreement between the predicted and observed JC optimal dose with a coefficient of determination of  $R^2 = 0.904$  and  $0.7879$  for calibration and validation, respectively. Therefore, the model can be adapted to determine the JC optimal dose without running the jar test experiment.

**Keywords:** Fecal sludge, optimization; *Jatropha Curcas*

### **3. Suitability of treated FS using *Jatropha curcas* on unplanted sand drying beds for agricultural use in Dar es Salaam, Tanzania**

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#### **Abstract**

The huge amount of water in Faecal Sludge (FS) has been presented as one of the major Faecal Sludge Managements (FSM) challenges and concerns. *Jatropha Curcas* (JC) has been adopted as a dewatering and disinfection solution for FS treatment. However, very little is known about the agricultural suitability of their physical–chemical characteristics, nutrient and pathogen levels. The agricultural suitability of by-products from the unplanted sand drying beds was investigated by assessing the physical–chemical parametric indices, Wilcox diagram and pathogen removal rate. The qualitative method was adopted for both untreated and treated FS samples. A total of 60 samples for dry sludge and 70 samples for both leachates from control and JC chambers were analyzed for three months. Its agricultural suitability was judged by the level of salinity and sodium hazard in leachate and pathogen levels. The results showed that the salinity level of leachate from the JC chamber falls under medium- and low-risk levels. The removal efficiency of *Escherichia coli* by JC in leachate was from  $7 \pm 2 \times 10^9$  CFU/g to  $6 \pm 1 \times 10^2$  CFU/100 mL.

#### **4. Occurrence of Harmful Algal Blooms in Freshwater Bodies and their Molecular Identification: A Case of Mindu and Nyumba ya Mungu Dams in Tanzania.**

Josephine J. Gobry<sup>1,2</sup>, Hilda S. Bachwenkizi<sup>3</sup>, Offoro N. Kimambo<sup>4</sup>, Faustin Ngassapa<sup>1</sup>, Kessy F. Kiluliya<sup>1</sup>

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<sup>4</sup>Department of Geography & Environmental Studies, Sokoine University of Agriculture, Morogoro, Tanzania

#### **Abstract**

Harmful algal blooms (HAB) are known to produce toxins (cynotoxins) that are risky to aquatic organisms, animals and humans. The current study identified the occurrence of toxin-producing genes using PCR technique in freshwater bodies of Mindu and Nyumba ya Mungu dams in Tanzania. The water samples were cultured, and followed by DNA extraction from cultured and uncultured samples using cetyl trimethyl ammonium bromide (CTAB) method. Using Sanger sequencing technique different HAB were detected from both dams. Blast in NCBI revealed highest hits which were close related to uncultured *antarctic cyanobacterium*, *Leptolyngbya* species, *Anabaena* species and *microcystis aeruginosa* for uncultured blooms. The cultured water blooms sequences were close related to *Nodularia spumigena*, *Amazoninema brasiliense*, *Anabaena* species and *microcystis aeruginosa*. Percentage nucleotide sequence similarity of uncultured cyanobacteria among Tanzanian isolates ranged from 85 to 96% and those from Tanzania to other species from the database ranged from 85 to 100%. For cultured cyanobacteria among Tanzanian species and other species from the database nucleotide identity ranged from 81 to 97% and 81 to 100% respectively. Molecular identification of *microcystis aeruginosa* supports the occurrence of HABs at Mindu and Nyumba ya Mungu Dams in Tanzania. Therefore, this study will help on improving monitoring, for the detection of HABs contamination for ensuring water safety for aquatic organisms, animals and humans.

**Key words:** 16S rRNA, Cultured, Harmful algal blooms, Molecular identification, Uncultured

#### **5. Groundwater chemistry in the gold mining areas of the Lake Victoria basin, northwest Tanzania: In-situ, ex-situ assessment, and geochemical modeling.**

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## **Abstract**

Geogenic contamination of drinking water sources in the gold mining areas of the Lake Victoria basin (LVB) in northwest Tanzania is an emerging health risk of concern. The present study aimed to evaluate the drinking water quality with a focus on physicochemical parameters, major ions, and trace elements of health concern based on 54 water samples collected from the drinking water sources within the LVB. Statistical and geochemical modeling software such as R studio, and visual MINTEQ, were used to understand the geochemical characteristics of the water samples based on physicochemical water quality parameters, the concentration of major elements, and trace elements. The hydrochemical character of water in the LVB was dominated by Ca-HCO<sub>3</sub> and Na-HCO<sub>3</sub> water types. The concentration of the major ions was mostly within the World Health Organization (WHO) drinking water guidelines in the following order of abundance; for cations: Ca<sup>2+</sup>~Na<sup>+</sup>>Mg<sup>2+</sup>>K<sup>+</sup>, and for anions: HCO<sub>3</sub><sup>-</sup>>SO<sub>4</sub><sup>2-</sup>>NO<sub>3</sub><sup>-</sup>Cl<sup>-</sup>>PO<sub>4</sub><sup>3-</sup>. The results show that the availability of major ions in drinking water depends upon geogenic sources typically through weathering of parent rocks under favorable geochemical conditions. The concentration of toxic element arsenic (As) varied between 1 and 300 µg/L with higher levels in streams followed by shallow wells and boreholes in that order. About 53% of the studied areas exhibited a higher concentration of As exceeding the WHO limit of 10 µg/L for drinking water. The variation of pH ranging from 5.7 to 7.21 is one of the important factors that influence the mobilization of As through both reductive and oxidative dissolution of As-bearing minerals such as pyrites, arsenopyrites, and chalcopyrite. The mining activities trigger the weathering of the exposed parent rock minerals in an oxidized environment. Visual MINTEQ modeling results revealed that factors such as temperature, ionic strength, complexation, ion exchange, and the formation of Na-HCO<sub>3</sub> water type were responsible for the control of mobilization of trace elements in groundwater. Based on this study, we suggest further geochemical exploration and periodic risk assessment of drinking water from groundwater sources in areas associated with the mining activities to avoid health risks to the community.

**Keywords:** Arsenic, geogenic contamination, geochemical modeling, drinking water quality, Lake Victoria Basin

## **6. The influence of anthropogenic activities on wetland integrity Along Mara River Wetlands, Tanzania.**

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### **Abstract**

The Mara Wetlands are mainly is an integral part of the Mara River, which originates in the Mau Forest in Kenya and drains into Lake Victoria. The Mara wetlands encompasses a broad selection of landscapes which supports a wide array of ecosystem and human needs. Despite their ecological, biological, and socioeconomic importance in supporting the livelihood of communities living around the Mara Wetlands, have come under increasing pressure and the wetland has been altered through agriculture, rapid growing of human population, mining and water abstraction. As land pressure intensifies, wetland habitats are also undergoing progressive modification, conversion, and degradation. The study aims at informing anthropogenic activities and their effects on health of Mara wetlands. The methodology applied was detailed case studies, life histories, participant observation, interviews, water quality analysis and grey-literature review. Socio-economic data were analyzed by using Statistical Package for Social Science. Results revealed a change of Mara wetland (expanding) due to climate change, as the results of agriculture (40%), mining (36%), livestock keeping (15%) and deforestation (9%). For sustainability of Mara wetland we need to rehabilitate and protect the integrity of the wetland, public awareness on function and benefit of the wetland resources.

**Keywords:** Anthropogenic activities, Ecohydrology, Mara River Wetland, Management, Water.

## **7. Temporal Variation in Water Quality of Shallow Wells in Half-London Ward-Tunduma Town**

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### **Abstract**

The demands for water include the use for domestic, agriculture, industry and the maintenance of the ecology. In places where there is inadequate water supply system to meet domestic water demand, the communities opt for shallow wells as the main source of water. Communities in the Half-London Ward in Tunduma Town use shallow wells as the source for water for domestic

purposes. This current ongoing study investigated the temporal and spatial variation of the water quality in five shallow wells (WW1, WW2, WW3, WW4 and WW5). The depth of the wells ranged from 5 m to 9 m and the elevation ranged from 1549 m to 1585 m above mean sea level. The sampling was done for twelve months. Each sample was analyzed in MUST laboratory for twenty-one parameters that fall under the physical, chemical and biological parameters. Temporarily the quality characteristics were clustered into four seasons, summer, autumn, winter and spring. For all five wells, the total coliform ranged from 0.0 to 16.67 with high values being observed in summer for WW3. Turbidity ranged from 6.09 to 12.94 with WW2 having the maximum value in autumn. Using the water quality index, in winter and autumn, with the exception of WW3 which scored GOOD the rest of the well had an excellent index value. In spring and summer WW3 scored a medium rank, WW1 scored a GOOD rank and WW2, WW4 and WW5 scored an Excellent rank. The influence of rainwater considered to impact the water quality in summer and autumn since there is subsurface flow from river into wells. The further study will analyze the spatial water quality in relation to the stream flow.

**Keywords:** shallow wells, total coliform, water quality, water quality index

## **8. Status to centralized disinfection of piped groundwater public supplies**

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### **Abstract**

Water as an essential to human life component receives preferential priority for domestic use allocation through small and large water supply projects in rural and urban communities respectively. Most deep groundwater sources are free from microbial contamination, but disinfection is employed to satisfy regulatory requirements and, more importantly, remediate any potential recontamination in the supply networks. In this study, Residual Chlorine was assessed at water points leaving the treatment plant, direct domestic points from treatment supplies, as well as indirect domestic points i.e., after residential reservoirs. DPD Free Chlorine method was employed using DR 1900. Residual chlorine findings showed 73% of non-conformity against WHO drinking water standards in the treated potable water supply at all tested domestic points. Treatment practice issues, the proximity of Domestic Points to the Treatment plants, supply network re-contamination, and household user practices were major reasons for these findings. Results show that disinfection of groundwater becomes a less effective and needy practice, especially when realized at the centralized level in a public supply network. Sustainable Development Goal 6.1 is therefore not effectively addressed to assure safe water for all. Therefore,

current observations call for a need to assess the feasibility of decentralizing disinfection practices at or near the point of use.

**Keywords:** Chlorination; Disinfection; Domestic; Groundwater; Microbiology; Water Supply

## **9. Use of Macroinvertebrates to assess the impacts of Anthropogenic activities on Pinyinyi river, Arusha, Tanzania**

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### **Abstract**

Water resources are important for aquatic biodiversity, especially fish and birds. The increasing impact of human activities degrades rivers and decreases their capacity to offer ecosystem services. In the current study, benthic macro-invertebrates were used to assess the impact of anthropogenic activities on the Pinyinyi River. A macro-invertebrate's hand net with 250µm mesh size was used to collect the macro invertebrates per sampling point. During dry season, aquatic caterpillar, pouch snail, dragon flies and mosquito's larva were collected. During wet season, creeping water bugs, predacious dividing beetles, pigmy back swimmer, water mites, back flies, mosquitos' larva, midges, aquatic earth worm, snail and moth flies were collected. Identification was done using the Aquatic invertebrates of South African Rivers field guidebook. Average score per taxon (ASPT) were calculated and the results indicated that, the Pinyinyi River was moderately polluted (ASPT = 5.25) during the dry season and seriously polluted during the wet season (ASPT = 3.6). The study revealed that, human activities such as agricultural activities and livestock keeping affect the water quality of the river. The study recommends riparian buffer creation, strictly laws, best management of agriculture practices, education provision and livestock exclusion to be the best ways of Pinyinyi River restoration.

**Keywords:** Anthropogenic activities; bioassessment; bioindicator; biotopes; Lake Natron; restoration.

## **10. Challenges of water allocation and secure water tenure among pastoralist and smallholder famers in Kilombero and Kilosa**

Pendo Hyera

*Shahidi wa Maji*

### **Abstract**

Equitable water allocation is necessary in achieving water security for all. The Ministry of Water established procedures to guide proper water allocation however, vulnerable communities in

Tanzania still face water security issues because of weak water resource governance. The study used a mixed methods to assess water governance issues affecting secure water tenure and equitable water allocation among pastoralists and smallholder farmers in Kilosa and Kilombero districts. Water-shortage and lack of water infrastructure were the most water security problem revealed by 72% pastoralist and 74% farmers. Water conflicts were highly reported in Kilosa. Most pastoralists (85%) and smallholder farmers (80%) were unaware of the policies, laws, and regulations on water resources management and procedure in obtaining water use permits. Majority (72% pastoralists) and (56% farmers) never reported problems to responsible authority. Inadequate sector coordination, budget deficit, and low community participation constrain equitable water resources management. The study recommends critical Government actions to strengthen sector coordination and increase funding to ensure water security for all.

**Key words:** Water allocation, water resources governance, water security

## **11. Tracing the dominant sources of sediment flowing towards Lake Victoria using geochemical tracers and a Bayesian Mixing Model**

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### **Abstract**

Lake Victoria has been increasingly silting over the past decades, impacting water quality and loss of biodiversity. Sediment control strategies require information on the relative and absolute contributions of sediment from different sources, however, to date, there is no continuous monitoring of sediment flux or water quality in any of the tributaries, prohibiting an assessment of the scale of the problem. The aim of this study was to trace the dominant sources of riverine sediment using geochemical fingerprinting, thereby generating a knowledge base for improving land management and reducing sediment yields in Simiyu River catchment, one of the main contributing rivers to Lake Victoria. Geochemical tracer concentrations were analyzed in transported sediment from the main river and two tributaries (riverbed sediments), and from soils in five dominant land use types (agricultural land, bush land, forest land, channel banks and main river banks). Dominant sources to the Simiyu main river sediment were attributed using the Bayesian MixSIAR model. The mixing model outputs showed that the Simiyu tributary was the dominant source of sediment to the Simiyu main river with 63.2 %, while the Duma tributary accounted for 36.8%. Cultivated land was shown to be the main land use source of riverine sediment, accounting for 80 % and 86.4 % in Simiyu and Duma sub-tributaries respectively, followed by channel banks with 9 % in both sub-tributaries. Direct unmixing of the Simiyu main

river sediment to the land use sources yielded 64.7% contribution of cultivated land and 26.5 % of channel banks. The demonstrated application of sediment source tracing provides an important pathway for quantifying the dominant sources of sediment in the rivers flowing towards Lake Victoria. Eroded soil from agricultural areas is the biggest contributor to transported sediment in the Simiyu river. This information is vital for the design of catchment wide management plans that should focus on reducing soil erosion and sediment delivery from farming areas to the river networks, ultimately supporting both food security and water quality in the Lake Victoria Basin.

**Keywords:** Soil erosion; Water Quality; Lake Victoria Basin; Sediment fingerprinting; MixSIAR; Simiyu Catchment

## **12. COVID-19 and the Water Sector**

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<sup>1</sup> *United Nations Environment Programme, Nairobi, Kenya*

### **Abstract:**

The COVID-19 pandemic has been responsible for the loss of millions of human lives. In addition, the public health and economic burdens of COVID-19 have been particularly heavy in low and middle-income countries. Virtually every economic sector has been affected by the pandemic, which has acted as a stress test for the entire water sector with implications for water infrastructure and the health and safety of the water and wastewater utility workforce. The possibility that SARS-CoV-2 might be present in drinking water or transported in the terrestrial and water environments through wastewater, has affected wastewater monitoring, treatment, water and sludge recycling and reuse schemes. Conventional wastewater treatment systems have thus far played an important role in pandemic control, as they have been effective in removing the virus. Continuing to monitor for SARS-CoV-2 in water will be essential. Monitoring provides information on the prevalence and distribution of the virus in different communities and possible infection dynamics to help prevent future outbreaks.

**Keywords:** Wastewater Management, COVID-19, Monitoring and Surveillance.

## **13. Methods in Well Rehabilitation and Maintenance for Groundwater Well Fields: A Review of the State of the Art**

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<sup>1</sup>*Ground Water Science LLC, Youngstown, Ohio USA*

<sup>2</sup>*N&S Ground Water Tanzania, Ltd., Dodoma, Tanzania*

### **Abstracts**

Groundwater wells (boreholes) and arrays of boreholes (well fields) are subject to performance degradation due to geochemical, biological, and hydrologic processes, often working interactively, and sometimes enhanced by borehole design and operation choices. Such performance decline



may be expressed as lowered pumping water levels, reduced pump flow rate and short service life for components, and higher energy costs. Both the mechanisms of decline and their symptoms are experienced globally, across climatic and hydrogeologic situations. The effects of these performance-degrading processes can be minimized or reversed through various well rehabilitation methods, and especially when combined with systematic planning, design, and management. Having observed and performed borehole inspection and cleaning in Tanzania, as well as in other countries, the purpose of this talk is to introduce a wider range of well rehabilitation methods and the principles of asset management in strategic operation of well fields to make best use of the resources available. Not all of the enhanced well rehabilitation methods are exotic or “high tech” and can be implemented with the groundwater sector state of the art. Wellfield asset management is a systems approach to using existing expertise, systems, and information to optimize performance and to reduce decline.

**Keywords:** asset management, borehole maintenance, borehole rehabilitation, sustainability, water-energy nexus

#### **14. Use of ICT tools for improved enforcement and monitoring on Faecal sludge management in Shinyanga municipality**

Saul Cornel Mwandosya,

*SNV Tanzania in collaboration with Shinyanga Municipal Council and SHUWASA.*

##### **Abstract**

The SNV-led WASH-SDG programme aims to improve health and quality of life in Arusha and Shinyanga through access to sustainable and environmentally safe sanitation and improved hygiene practices, in collaboration with Local Government Authorities (LGAs) and Water Utilities. A core part of this programme aims to have affordable and safe faecal sludge emptying services with improved Occupational Health and Safety (OHS). Smart enforcement of sanitation legislations on emptying, transportation and treatment of faecal sludge have been used to support and improve compliance, monitoring and decision-making. To understand the motives and barriers behind poor OHS compliance of emptying services and limited enforcement, formative research was conducted in Arusha and Shinyanga. The research included policy desk reviews, field surveys, focus group discussions and stakeholders’ validation meetings. To strengthen enforcement of regulations and monitoring of OHS, a CCTV camera system was installed at Kizumbi Faecal Sludge Treatment Plant (FSTP), and GPS trackers fixed on all sludge emptying trucks in Shinyanga Municipality. The installation of ICT tools was complemented with theoretical and practical training sessions with local government and private sector sanitation providers, aimed at ensuring increased use of PPEs and compliance with OHS protocols, while embedding the sustainability of these tools within emptying licensing agreements. The interventions and introduction of ICT tools significantly boosted the enforcement capacity of the municipal council and water utility in ensuring legal and safe sludge disposal, increased sanctioning of non-compliance on PPE use, and real-time data use for planning and decisionmaking. Subscriptions and O&M requirements are captured in licensing agreements and

facility checklists, ensuring the approaches' sustainability. Personnel capacity to ensure the enforcement of rules is limited, and ICT is a strategic investment to support local government authorities to boost their ability to verify, reward and sanction issues linked to compliance. Essential is to introduce technology that is not only effective, but also accessible and sustainable in terms of running costs, understanding of the technology and use of the generated data.

**Keywords:** Information and Communication Technology (ICT), Occupation Health and Safety (OHS), Personal Protective Equipment (PPE), GPS (Global Positioning System).

## **15. Integration of safe sanitation behaviours along the Sanitation service chain for safely managed sanitation**

Saul Cornel Mwandosya, Herieth Manyika

*SNV Tanzania, in collaboration with Shinyanga Municipal Council, SHUWASA, Arusha City Council and AUWSA.*

### **Abstracts**

The SNV-led WASH-SDG programme aims to improve health and quality of life in Arusha and Shinyanga through access to sustainable and environmentally safe sanitation and improved hygiene practices, in collaboration with LGAs and Utilities. A core part of this programme aims to contribute to safely managed sanitation services through fostering improved sanitation behaviours relating to safe emptying practices and hygienic solid waste storage at premise level, together with the provision of safe and professional sanitation services. To understand the motives and barriers behind poor sanitation behaviours, a baseline study and formative research were conducted in Arusha and Shinyanga. The studies included field surveys, focus group discussions and stakeholders' validation meetings. Strategies on attaining safe sanitation behaviours along with upgrading onsite sanitation and emptying services were developed. The strategies considered households, schools, sanitation service providers, and health care facilities. This resulted in the design of the Mazingira Safi Maisha Bora Campaign (community meetings, SWASH 8 weeks programme, radio discussion programme, website, social media and sanitation events) and strengthening service delivery of faecal sludge emptying by service providers and toilets masons through tailored training and behaviour change approaches (linked to FSTPs, PPE uptake, storage bins, and semi-mechanised tools for manual emptiers). To achieve safely managed sanitation for all, it is critical to address safe sanitation behaviours throughout all the sanitation service chain changes. Typically, countries have focused on eradicating open defecation through promoting improved toilets, but in fast expanding urban and peri-urban areas it is crucial that behaviours linked to emptying, storage and sanitation services are addressed to lift people beyond basic sanitation. In addition, behaviour change success is linked to ongoing monitoring to learn and adjust, and digitalising this process improves the ability for tracking progress and decision-making. Lastly, it is important to recognise the complementary role of regulations and enforcement to build and support behaviour change efforts.

**Key words:** Personal Protective Equipment (PPE), SHUWASA (Shinyanga Urban Water

## **16. Developing Matrix Model (MM) as a Tool for Deciding Procurement Method(s) for Acquisition of Service Providers in the Water Sector ”**

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### **Abstract (Field experience)**

The Public Procurement Act of Tanzania (*PPA 2011*) defines Procurement as “*means buying, purchasing, renting, leasing or otherwise acquiring any goods, works or services by a procuring entity and includes all functions that pertain to the obtaining of any goods, works or services, including description of requirements, selection and invitation of tenderers, preparation and award of contracts*”; whilst AfDB defines Procurement as “*Procurement refers to the process of acquiring goods, works and services resulting in the award of contracts under which payments are made in the implementation of projects, in accordance with the governing Rules and Procedures and Guidelines of the financing agency or agencies*” and finally, the European Institute of Public Administration (*EIPA*) defines Public Procurement as “*Public Procurement refers to the process by which public money is awarded to companies by the public sector, to buy works, goods or services*”.

As a rule of thumb, for every government yearly budget it is expected that between 75% to 85% of the allocated budgetary funds is spent in Public Procurement. For that matter, it is a disastrous if it happens that public funds are misused through mis-procurement.

The water sector being one of the government sectors which is benefiting from the yearly allocated budget it is not in isolation that it can fall under this risk of mis-procurement. Nevertheless, according to the World Bank report on the implementation of Water Sector Development Programme I (*WSDP I/2006-2015*) reported more than 19% of the constructed water infrastructures did not even work after their completion and thus ended up being white elephants’ projects. This is one of the scenarios where we ended up with mis-procurement of the Service Providers (*i.e., be it Contractors or Consultants*).

For over the past five (5) years, the water sector (*preferably the Rural Water Supply and Sanitation Agency (RUWASA)*) has been struggling out on which better procurement method they should use. Initially, it was reported that the WSDP I was mishandled due to a lot of mis-procurement of the Service Providers (*SPs*); and for that matter, during the WSDP II it was agreed to change from procuring the *SPs* (*by either National Competiting Bidding (NCB) or International Competiting*

*Bidding (ICB))* and instead the Force Account (*FA*) method should be used aiming at acquiring the 3E's of Procurement (*i.e., Efficiency, Effectiveness and Economy*) without forgetting the Value for Money (*VFM*) of the method.

Though, it is now reported that RUWASA has gone back to the older method of using NCB or ICB to acquire the SPs. The FA is now used very occasionally. This has often resulted into mis-procurement; and thus, ending up with bad quality workmanship. The objective of this study is to develop a simple “*Matrix Model*” (*MM*) which will be used by Decision Makers of RUWASA (*e.g., District and Regional Managers (DMs & RMs)*) to make decision as to which preferably procurement method they should use, NCB, ICB or FA?

On the MM Tool, one has to insert some important parameters for it to decide. To mention a few, includes (a) *Source of funds* (b) *Registration Class of the SPs* (c) *Number of years of experience on works of similar nature*; (d) *Liquidity of the SPs over the past 5 years* (e) *SPs' Personnel qualifications, et cetera (for making decision)*.

By the way of conclusion, this study not only will avail a quicker knowledge to the Practitioners and Decision Makers but also to the Water Sector, preferably the Ministry of Water and its Organizations especially RUWASA who are the one of the beneficiaries.

## **17. Non-Competitive and Competitive Detoxification of As(III) Ions from Single and Binary Biosorption Systems and Biosorbent Regeneration**

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### **Abstract**

The quantity of studies reporting on single-metal sorption systems is increasing every day whilst the elimination of heavy metals in binary and multi-solute systems is seldom reported. Therefore, the biosorption and desorption of arsenic from single and binary systems on granular activated carbon have been investigated using batch technique. The hybrid granular activated carbon was characterized using Fourier Transform Infrared Spectrometer and Brunauer-Emmett-Teller and the results showed that the biosorbent surface characteristics could facilitate arsenic removal from the non- and competitive biosorption media. The main biosorption mechanisms of arsenic on the biosorbent involved surface complexation, electrostatic attraction, and replacement of hydroxyl groups. Besides, the effective elimination of arsenic was discovered to be reliant on the sorbent's

physicochemical properties as well as all the studied independent biosorption factors. The equilibrium sorption data of both the single and binary systems were best explained by the Langmuir and pseudo-second-order models indicating the mechanism of arsenic biosorption was mainly chemisorption. The Langmuir maximum monolayer sorption capacities of the biosorbent were 205.76 and 153.09 mg/g for the single and binary systems, respectively. While the evaluated thermodynamic parameters suggest that the adsorptive removal of arsenic from both sorption systems was spontaneous and endothermic with increasing randomness on the liquid-solid interface. The successive biosorption-desorption studies indicated that the exhausted biosorbent can be renewed without a substantial deterioration in its uptake capacity even after the seventh regeneration cycle. This indicates that the biosorbent has the economic potential to be used repeatedly in arsenic species sequestration from wastewater.

**Keywords:** Binary System, Biosorption, Desorption, Regeneration, Single System

### **18. Assessment of Vegetables Performance and Nutritive Values Through Application of Treated Domestic Wastewater by High Rate Algal Pond**

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#### **Abstract**

Worldwide, wastewater is currently an alternative source of water for urban farming through gardening and horticultures. Wastewater from waste stabilization pond has been used for irrigation mostly by small scale farmers and to some of the communities is even used to grow food product like maize, beans, banana etc. This article assesses the plant performance and green vegetables (*Amaranthus hybrida*, *Brassica chinensis* and *Solanum nigrum*) nutritive value supplied with effluent from High Rate Algal Pond (HRAP) in comparison with commercial inorganic fertilizer through assessing the vegetable quality, mineral nutrients and secondary metabolites. The study further determined both quantitative and qualitatively their free radical scavenger ability, antioxidant (phenolic and flavonoid contents) antiradical activity, vitamins and proteins using methanolic extracts. Results reveal that vegetables treated with bio- fertilizer (effluent from HRAP), performed better than inorganic fertilizer-NPK and control. Vegetable quality indicated differences in growth parameters amongst treatments whereby vegetables treated with effluent depicted good performance  $p < 0.005$ . Significant difference was depicted in quality measures of height between treatments on each specie *A. hybrida* ( $F = 953.39$ ,  $df = 2$ ,  $p = 0.0000$ ) *B. chinensis* ( $F = 2619.49$ ,  $df = 2$ ,  $p = 0.0000$ ) and *S. nigrum* ( $F = 1756$ ,  $df = 2$ ,  $p = 0.0000$ ) whereas, the highest number for plant height, leaf area, leaf number, branch number as well as biomass were recorded on vegetables irrigated with effluent. Similarly, vegetables treated with reclaimed wastewater, were well enriched with nutrients with the highest quantities in *A. hybrida*

compared to other vegetable species  $p < 0.000$ . Vegetable treated with effluent had significantly higher antiradical activity than other treatments except for *A. hybrida* ( $\chi^2 = 4.588$ ,  $df = 2$ ,  $p = 0.1009$ ) *B. chinensis* ( $\chi^2 = 7.450$ ,  $df = 2$ ,  $p = 0.0241$ ) and *S. nigrum* ( $\chi^2 = 11.942$ ,  $df = 2$ ,  $p = 0.0026$ ) while higher antiradical activity were recorded in *S. nigrum*  $35.23 \pm 2.7$  EAU (515) and the low value in *A. hybrida*  $14.53 \pm 4.0$  EAU (515). It was noted that vegetables that exhibited high antiradical activity also portrayed higher values of phenolic and flavonoid content. The study concludes that, wastewater effluent from HRAP can potentially be used for urban farming for production of food with rich nutrients and antioxidants compared to commercial inorganic fertilizer.

**Keywords:** High Rate Algal Pond; Treatments; Vegetables species, Antioxidants, Mineral Nutrients.

### **19. Being smart about sanitation: the case of ibinzamata public Toilet biogas system in Shinyanga, Tanzania**

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#### **Abstract**

Public toilets in Tanzania are among the main sanitation services provided for the community. In areas like the Ibinzamata regional stand in Shinyanga, visited by more than 1000 people in one day, sanitation services are crucial to ensure public health and safely managed sanitation. The WASH SDG programme together with partners (City/municipal councils and water authorities), aims to improve health and quality of life in Arusha and Shinyanga through access to sustainable and environmentally safe sanitation and improved hygiene practices. A public spaces research was conducted in Shinyanga Municipality and Arusha city (as are the areas of implementation of the WASH SDG programme) through survey method and collection of information such as number of visitors, workers at the station and currently available sanitation facilities. In Shinyanga Municipality, it was determined that the previous public toilet had insufficient capacity to cater for the population of workers and visitors at the regional bus stand. Therefore, there was a clear need to build a new public toilet to accommodate the growing population at the stand. A new toilet (Ibinzamata public toilet) was built and opened early 2022 with a biogas digester. The biogas option is the result of the programme efforts to improve the full cycle of the sanitation service chain, from capture all the way to re-use. Not only does it provide extra revenue for the system, it provides eco-friendly treatment and re-use of faecal sludge. The restaurant uses the biogas generated to cook food for customers. The way forward is popularization of the toilet and its biogas features, alongside other re-use options and products in Shinyanga such as the Kizumbi faecal sludge treatment plant where SHUWASA produces co-compost made of faecal sludge and organic waste. The programme is ensuring that this knowledge, these ideas and eco-friendly sanitation solutions are promoted and shared by transforming the public toilet and treatment plant as learning centres for other municipalities and cities in Tanzania.

**Key words:** Eco friendly sanitation, biogas, public toilet, business, and faecal sludge