Panel 5: Securing futures through sustainable water management

ABSTRACTS

Surfacing Water Management Opportunities between The Port and Its City in Tema, Ghana

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Applying theories of middleground and socio-technical imaginaries, this paper focuses on the role of port infrastructures in negotiating social, economic, and environmental sustainable practices in the relationship between port and city in Tema , Ghana. We have collected the empirical material for our exploration during the past 6 years. A mixed method guided our data collection through joint fieldwork, participatory observations, stakeholder interviews, archival research, and a survey. We argue that the gap between port and city infrastructures have challenged sustainable water practices, however, the awareness of the challenges has increased dramatically over the past three years. We conclude that due to incremental changes in the socio technical imaginary of the middle ground of the port and city of Tema, new opportunities for sustainable water management are surfacing.

Securing futures through sustainable water management

Apiwe Mdunyelwa – University of the Western Cape

Sustainable water management is one of the most important things that can be done to protect the health and well-being of future generations as world problems get worse. This theme talks about the many ways to make sure everyone has access to enough water, with a focus on how natural sustainability, social justice, and economic resilience all affect each other. Cutting-edge technologies, community-led projects, and policy changes can all be put together to make strong water governance systems that meet both present needs and the unknowns of the future. Key tactics include setting up decentralised water systems to make access and fairness better, encouraging people to use less water through education and policy incentives, and using flexible management systems that can adapt to changing climates. In addition, this method shows how important it is to have collaborative governance models that bring together different parties to deal with the tricky problems of water management. To make sure that futures are safe through sustainable water management, we need a big picture view that connects what we do locally with big goals like the Sustainable Development Goals. Creating a culture of water care and innovation can help communities become more resistant to water-related risks and secure a bright future for everyone. This vision shows how water management could help bring about bigger changes in society and the world.

Seasonal Energy Balance and Its Influence on Evapotranspiration in Tomato Field: Sensible and Latent Heat Dynamics

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Efficient water management is important in tomato crop production, particularlyin semi-arid regions. Evapotranspiration (ET), influenced by surface energy fluxes such as sensible heat (H) and latent heat (LE), is a critical factor in determining water use efficiency. While, there is existing research information on evapotranspiration in crop production, limited studies have explored the interaction between sensible and latent heat fluxes across different seasons in tomato fields. This study, therefore, investigated seasonal energy fluxes and their relationship with evapotranspiration. Data on sensible heat, latent heat and evapotranspiration were collected using an open path Eddy Covariance (EC) technique over an irrigated tomato field from February to September 2023. Results showed a stronger correlation between evapotranspiration and latent heat (R2=0.849) during the summer months, and less correlation between sensible heat and evapotranspiration (R2=0.044) suggesting that LE significantly drives ET under high solar radiation and increased air temperature. In contrast, both sensible and latent heat had a weak correlation with evapotranspiration (R2=0.002 and R2=0.190) during winter months. According to literature, decreased solar radiation during winter months limits the energy available for both sensible and latent heat fluxes, also leading to lower ET rates. ET rates ranged from 38 to 430 mm and 68 to 525 mm, in winter and summer respectively. These findings highlight the importance of understanding seasonal dynamics of energy fluxes in influencing evapotranspiration and optimizing irrigation scheduling for tomato crop production. Keywords: Eddy Covariance, Evapotranspiration, latent heat flux, sensible heat flux, and tomato crop production.

Water Use Efficiency (WUE) and Nutrient Concentration of Selected Fodder Radish (Raphanus sativus L.) Genotypes for Sustainable Diets

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Changing climates challenges and threaten crop growth, fand fodder yields in dryland farming. The study aimed to assess two radish genotypes' (LINE 2, ENDURANCE) response to water use over two consecutive seasons (2021/22 and 2022/23) using a factorial design with three water regimes (W1 = well-watered; W2 = moderate water stress; W3 = severe water stress) two genotypes, and two leaf harvesting options (H1 and H2). Key findings revealed that water

regime significantly ($P < 0.05$) affected WUE, with W2 yielding (4.71 kg ha-1mm-1) higher values. The combination of W3 and LINE 2 biomass were reduced by ≈ 60.09% in 2021/22 and ≈ 71.06% in 2022/23, whereas ENDURANCE declined by ≈ 63.9% and ≈ 53.33%. Furthermore, tuber yield was highest under W1 and W2, with ENDURANCE yielding 59 t ha-1 (W1) and 48 t ha-1 (W2). Water stress decreased micronutrient concentration (iron, zinc, β-carotene and vitamin C). For example, W2 improved vitamin E and key findings showed that human dietary for women and children can be met. Interestingly, extreme water stress (W3) nutrient concentration exceeded vitamin E, iron, and zinc recommendations for all ages. Genotypes exhibited similar biomass under W2 and W1; this suggest that moderate water stress can be applied and similar yields can be attained. The highest WUE and CP yield were attained at the moderate water stress for both genotypes. The findings emphasise the importance of strategic water management in increasing food and fodder security while meeting nutritional needs for humans and grazing livestock in water-scarce regions.

Hydrochemical and environmental isotope investigation of groundwater and surface water quality in the Upper Olifants River Catchment, Mpumalanga Province, South Africa

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This study used hydrochemical and environmental isotope data to investigate the vulnerability of water resources in the Upper Olifants River Catchment, situated in the Mpumalanga Province in South Africa. The study aimed to assess the impacts of various land use activities on water resources. Factor analysis was conducted on the hydrochemical data to identify the primary factors influencing the area's variations in groundwater and surface water chemistry. Three factors with eigenvalues >1 explained 76% of the hydrochemical variation in the area. Component 1 contains most of the explained variance (28.4%), with positive loading for EC, Ca, Mg, K, and SO4 concentrations. The mineralogy of aquifer material may have influenced these chemical properties due to the area's location within coalfields. Component 2 explains 15% of the hydrochemical data variance and shows elevated Na and Cl levels. Ion exchange and high evaporation likely contributed to these concentrations. Five hydrochemical facies were identified: CaSO4Cl (43%), CaMgHCO3 (33%), Ca-Mg-Cl mixed (11%), CaNaHCO3 mixed (8%), and NaCl (5%). Water composition mainly depends on interactions with surrounding geology. Oxygen and hydrogen isotopes range from -5.08 to 0.81 and -22.75 to 7.51 (‰), and tritium concentrations in groundwater and surface water range from 0.20 to 2.50 (‰). The isotopes show five distinct groups, indicating extreme evaporation, kinetic and equilibrium fractionation, local rainfall, preferential rainfall, and palaeowater. Most samples, aged 8 to 40 years, reflect recently recharged water, with a few between 40 and 54 years old. Keywords: hydrochemistry, Isotope, water, age.

Groundwater Governance Challenges and Sustainable Water Resource Management in South Africa's Peri-Urban and Rural Regions

Mwamusa Maripa (Stellenbosch University), Annah Chuene (University of the Western Cape)

The rapid expansion of urban and peri-urban settlements in South Africa, coupled with economic growth, has intensified water demand and resource management challenges, particularly in rural and peri-urban areas. Increasingly, rural populations returning to ancestral lands are constructing modern homes beyond the jurisdiction of formal municipal water services, leading to reliance on privately drilled boreholes (Mukheibir, 2008). The proliferation of unregulated groundwater abstraction raises concerns regarding the long-term sustainability of aquifer systems, as competition for groundwater between households and agricultural users escalates (Knüppe, 2011). Weak regulatory oversight and the absence of coordinated groundwater governance frameworks further exacerbate risks to water security, public health, and ecological integrity (Tshibalo & Olivier, 2020). Inadequate water quality monitoring in rural areas increases the likelihood of contamination, posing significant health risks to communities dependent on groundwater for domestic and agricultural use (Adelana & Xu, 2006). Moreover, the governance gaps surrounding groundwater abstraction contradict the principles outlined in the Southern African Development Community (SADC) Protocol on Shared Watercourses, which emphasizes equitable access and cooperative management of transboundary water resources (SADC, 2000). To address these challenges, an integrated approach that includes investment in rural water infrastructure, implementation of robust groundwater monitoring mechanisms, and community-based governance structures is required. Strengthening policy frameworks that promote shared infrastructure, water quality surveillance, and sustainable borehole management is crucial for ensuring long-term water security and resilience in South Africa's rural and peri-urban regions. Keywords: Groundwater governance, water security, peri-urban development, rural water infrastructure, South Africa, SADC, borehole management.

Advanced Photocatalytic Remediation of Methyl Orange: Sustainable Water Purification for Climate Resilience and Economic Growth

Natascha Ross – University of the Western Cape

The organic water contaminant, methyl orange (M.O), has increasingly polluted water systems due to its widespread industrial use, posing environmental and public health risks. Addressing this challenge requires sustainable remediation strategies that enhance water quality while supporting climate adaptation and economic growth. This study investigates the photocatalytic degradation of M.O using modified TiO2 composite catalysts under artificial irradiation. Photocatalytic activity is influenced by functional groups in organic pollutants, and

our research evaluates the efficiency of silver-iron and silver-iron-reduced graphene oxide-modified titanium dioxide as cost-effective photocatalysts. Results confirm that the novel AgFe-functionalized TiO2 catalyst (AgFe-TiO2) exhibits superior remediation performance compared to reduced graphene oxide (rGO)-modified TiO2, attributed to a reduced band gap from 3.02 eV to 2.5 eV, enhancing photocatalytic efficiency. Spectroscopic and microscopic analyses show that improved M.O degradation is due to increased surface area, enhanced electron diffusion, and reduced recombination of photo-generated electron-hole pairs. This research presents an economically viable and scalable solution for wastewater treatment, mitigating industrial pollution while promoting cleaner water management. By integrating advanced photocatalysis with sustainable practices, this work supports climate resilience and economic sustainability, addressing the global demand for efficient and cost-effective water purification technologies.

Plastic and waste water threats to aquatic ecosystems: lessons from case studies

Niels Ekelund (Malmö University), Sadhana Manik (University of KwaZulu-Natal)

This presentation targets SDG 14 (Life Below Water), where there is a dearth of research on collaborative efforts for coastal areas under threat. Decades of degradation of aquatic ecosystems have resulted in challenges for restoration and management. This will leave a legacy of ecological and economic costs for future generations. Presently, there is a need for urgent action to address the major environmental and human health consequences of high microplastic accumulation in regions and inadequate waste water management. The aim of this paper is to outline critical events and challenges of managing plastic pollution and wastewater in coastal areas. We do this through a case study of two coastal cities, one in the Global North and one in Global South which were part of a SASUF project. We utilize secondary data highlighting recent studies in aquatic science that have demonstrated disturbing evidence of plastic pollution in coastal cities, extrapolating from this data. We also draw from evidence linked to the floods in Durban, KwaZulu-Natal, South Africa and we draw selected lessons from innovative flood responses in Malmo, Sweden. The study identified a range of actors at the local, regional, national, and international levels as responsible for plastics in water. We suggest an enhancement of regulations to strengthen waste water management policies and the implementation of stringent regulations on plastic use. As researchers and educators, we advocate for grassroots collaborations through NGOs and educational campaigns to raise awareness about the sources and impacts of plastics for life under the water.

‘DID YOU EVER STOP TO NOTICE THIS CRYING EARTH’*? LOCALISING THE SDGs THROUGH STUDENT ACTIVISM IN WATER PROJECTS * the excerpt is from Michael Jackson's Earth song on the state of the environment

Sadhana Manik (University of KwaZulu-Natal), Vibeke Vagenes (Western Norway University of Applied Sciences)

The SDGs are 17 immense goals to achieve. The first Global Wetland Outlook (Ramsar Convention, 2018) found that wetlands are disappearing three times faster than forests. As university lecturers in teacher education committed to sustainable living practices, we feel inherently propelled to resolving and reversing 'wicked' Climate problems such wetland degradation but in our our micro contexts. Our aim is to localize Climate Action through our curriculum offerings. We draw on SDG 6 (water) and seek to inspire student activism through a Participatory Action Research assessment at undergraduate level. This presentation focuses on our mulit pronged efforts in 2024 as we refine our module offerings in three countries (Norway, Tanzania and South Africa) to better manage water resources. We focused on Climate Change, the destruction of wetlands and evidence of plastic pollution as key caveats. Our student teachers are the participants and our data gathering tools were multiple: class discussions, focus group discussions, documentary videos and written narrative evidence. The theoretical framing comprised: theories of change (Reinholz and Andrews, 2020) and transformation O'Brian & Sygna (2013) with an emphasis on graduate attributes for civic environmentalism. We present students prioritisation of 'wicked problems' and their efforts at rehabilitation of wetlands. Our findings reveal students' values and priorities and noticing 'this crying earth' as a step towards civic environmentalism. The study also established that practical solutions to wetland rehabilitation require commitment to collective cross disciplinary intervention. We conclude that rehabilitation and of wetlands must be main streamed to reverse the current situation.

Socio-economic Evaluation of Wastewater Recycling Technology into a WEF Nexus Approach: The Case of the Philippi Horticultural Area in relation to the Lynedoch Eco Village in the Western Cape Province, South Africa

Shadeon Hansen – University of the Western Cape

The researcher aims to implement a pilot wastewater recycling system that consists of a biolytix worm filter; a biogas digester; and a vertically constructed wetland in the PHA. The biolytix system captures the nutrients from the sewerage water in a bid to safeguard food security (SDG 2). The biogas digester captures the biogas from the sewerage to safeguard energy security (SDG 7). The vertically constructed wetland aims to remove the nutrient load from the sewerage water so that it can be reused to flush the toilets as well as to recharge the aquifer (SDG 6). The researcher will evaluate the cost-benefit and cost-effectiveness of this technology into a WEF Nexus approach incorporating the concepts of sustainable livelihoods and poverty reduction. The study will introduce the WEF Nexus notion as well as looking at policies and plans that addresses water, energy, and food security in the City of Cape Town, the Western Cape, and South Africa. In addition, it will uncover how the WEF nexus is configured

in the PHA and Lynedoch Eco Village, i.e., how the water, energy, and food systems are organised in these areas. This study will also examine the current challenges, barriers, enablers, WEF nexus synergies, and trade-offs of improving the current wastewater recycling system at the Lynedoch Eco Village and implementing the wastewater recycling system on one small farm in the PHA.

Climate changes and water harvesting in northern Tanzania

Staffan Rossel (Linnaeus University), Yusuph J. Kulindwa (Moshi Co-operative University)

Northern Tanzanian rural livelihoods, which mainly depend on subsistence farming, face water shortages, particularly in light of the rising temperatures and increased rainfall variability caused by climate change. Although there are two rainy seasons in the area, which account for 90% of the yearly rainfall, the prolonged dry seasons necessitate the need for dependable water sources outside of rainfall seasons. Aim is to analyse climate data such as daily rainfall data and monthly minimum and maximum temperature, water harvesting practices, economic input related to water harvesting and possibilities for water harvesting in the future in Moshi and Same region in northern Tanzania. This study will employ a mixed-methodology approach that combines quantitative and qualitative data collection to assess water harvesting practices and their economic implications. Analysis of climate data will be done and survey farmers and other stakeholders. To supplement the quantitative data, field observations and evaluations of land use practices, water harvesting infrastructure, and water use will be conducted in the areas of study. A sustainable rural livelihoods framework will be used as a tool to analyse the challenges farmers are facing with water related issues for farming and for household water Preliminary findings so far are increased average temperature during past 30 years and increased rainfall March to May. Expected results will include decisions and costs of water harvesting. A look into the future and suggestions of sustainable water use and due to climate changes will be performed.

Impact of Water Subsidies on Water Conservation: Balancing Affordability and Sustainability

Sylvia Banda – University of Limpopo

Globally, water security challenges persist due to anthropogenic activity including climate change, population growth, and inefficient water usage. Meanwhile, water demand continues to rise and is projected to surpass supply by 40% by 2030. To ensure affordability and access, governments worldwide allocate substantial subsidies to water and sanitation, accounting for 1.5% to 2% of global gross domestic product. These subsidies aim to fulfil the human right to water by bridging the gap between the cost of providing services and affordability for the users. However, while subsidies improve affordability and accessibility, they may lead to

unintended consequences such as overuse, environmental degradation, and fiscal strain. This aligns with the Tragedy of Commons theory, which presumes that when resources are freely available or significantly subsidised, this may lead to overconsumption and long-term resource depletion. As water security threats intensify, reassessing the design and role of subsidies has become a necessity. This study seeks to investigate the nexus between water subsidies and water conservation. A mixed approach will be adopted with data collected through a semi-structured questionnaire that will be administered to various stakeholders. Quantitative data collected will be analysed using SPSS, applying descriptive statistics while qualitative data will be processed in NVIVO to identify key themes. Findings from both methods will be triangulated to provide a comprehensive understanding of the impact of subsidies on water conservation. Findings will provide insights into how water subsidies impact while balancing affordability, equity and sustainability, contributing to informed policy reform.

Plastic Particles in Pristine Waters? Investigating Microplastic Contamination in Natural Springs of Southern Africa

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Microplastic (MP) pollution has emerged as a significant environmental concern, impacting even the most remote freshwater ecosystems. While extensive research has focused on rivers and reservoirs, natural springs remain largely unstudied. Given their importance as sources of clean water, the presence of MPs in these springs presents serious ecological and human health risks. This study aimed to assess the abundance and characteristics of MPs in 43 natural springs across South Africa, with the hypothesis that peri-urban springs would have higher MP densities due to human settlement proximity. This is the first study to report on MP contamination in South African natural springs. Water samples were collected from 12 peri-urban and 31 rural springs, filtered using sieves (100, 250, 500, and 1000 µm). MPs were detected in 40 out of 43 springs (93%), with densities ranging from 0 to 38 particles/L. Contrary to expectations, the highest density (38 particles/L) was found in a rural spring. Fibers (67.5%) and blue-colored particles (28.8%) were most prevalent, with the 100 µm sieve retaining the largest proportion of MPs (48.3%). The presence of MPs in South African natural springs highlights significant water quality concerns, particularly for communities relying on these sources for drinking water. Additionally, the potential ingestion of MPs by aquatic organisms poses further ecological risks. These findings highlight the need for sustainable water management practices that incorporate effective monitoring and mitigation strategies to safeguard the health of both human populations and freshwater ecosystems.