



PROGRAMME: Book of Abstracts

6th SADC
GROUNDWATER
CONFERENCE

13th - 15th NOVEMBER 2024
AVANI MASERU



Promoting Peace Across Borders through Conjunctive Water Management





Welcome to another exciting instalment of the SADC Groundwater Conference. What began as an idea a few years ago has blossomed into one of the significant events in the water calendar in the SADC region. First and foremost, I would like to extend my sincere gratitude to the Government of Lesotho and the Ministry of Natural Resources for their support in hosting this conference through the Department of Water Affairs. We truly appreciate all the support we have received since we started preparations for the conference.

The 6th SADC Groundwater Conference is not just another event but a significant milestone in our journey. It provides an extraordinary platform for sharing knowledge and exchanging experiences among participants, which aligns with our mandate of promoting sustainable groundwater Management and providing solutions to groundwater challenges across the SADC region for improved livelihoods.

This year, the conference focuses on an essential theme: Promoting Peace Across Borders through Conjunctive Water Management. This theme is inspired by World Water Week's initiative, "Bridging Borders: Water for a Peaceful and Sustainable Future," and seeks to foster collaboration in water management to enhance peace and security. We hope this theme inspires you to shape our discussions throughout the conference.

In accordance with our established conference tradition, we are pleased to present an exceptional lineup of experienced presenters and keynote speakers. These carefully selected individuals share their expertise, insights, and personal experiences related to sustainable water management and the overall development of our region.

This year, the conference theme is structured around three distinct sub-themes: (i) Using advanced technologies, (ii) Harnessing Data, and (iii) Establishing Innovative Governance Structures - allowing for a focused exploration of key issues that impact water sustainability across the SADC region and beyond. Our seasoned speakers intend to deliver presentations tailored to one of these themes, offering a comprehensive understanding of our challenges and opportunities.

By tradition, our conference features an exhibition space where partner organisations can display their products and services to our broad audience from the region and beyond.

We recognise that your engagement is crucial to the conference's success. An open dialogue fosters collaboration and innovation, and we greatly value your input. Therefore, we invite you to actively participate in the discussions and contribute your perspectives to enrich the overall experience. We eagerly anticipate your involvement as we work together towards practical solutions for sustainable water management and regional development.

On a lighter note, we are excited to invite you to our social events—a cocktail party and a gala dinner. These events aim to foster connections and provide networking opportunities for our participants. So, slip on your dancing shoes and prepare to blast on the fantastic night we've lined up for you.

Last but certainly not least, let me take this opportunity to thank our sponsors for financially supporting our vision, our technical Committee for their technical support and contribution, and the Local Organising Committee for hitting the ground running as we put together the conference. The success we see today is the result of unwavering dedication. This achievement would not have been possible without all your contributions.

Welcome to the 6th SADC Groundwater Conference, and I wish you successful deliberations.

MESSAGE DE BIENVENUE DU DIRECTEUR EXÉCUTIF DU SADC-GMI, IR. JAMES SAURAMBA

Bienvenue à cette nouvelle édition de la Conférence sur les eaux souterraines de la SADC, qui, née d'une simple idée il y a quelques années, est devenue un événement désormais incontournable du calendrier de l'eau dans notre région. Permettez-moi tout d'abord d'exprimer ma sincère gratitude au gouvernement du Lesotho et au ministère des Ressources naturelles, notamment par l'intermédiaire du département des Affaires de l'Eau, pour leur soutien indispensable dans l'organisation de cette conférence. Nous sommes profondément reconnaissants pour tout le soutien que nous avons reçu depuis le début de la préparation de cet événement.

La 6^e édition de notre conférence sur les eaux souterraines marque une étape significative. Elle se présente comme une plateforme exceptionnelle pour le partage de connaissances et l'échange d'expériences, parfaitement alignée sur notre mandat de promouvoir une gestion durable des eaux souterraines et de trouver des solutions aux défis hydriques dans la région de la SADC pour améliorer les conditions de vie.

Cette année, la conférence aborde un thème crucial : « Promouvoir la paix à travers les frontières grâce à la gestion conjointe de l'eau », inspiré par l'initiative de la Semaine mondiale de l'eau : « Franchir les frontières : l'eau pour un avenir pacifique et durable ». Ce thème vise à encourager la collaboration dans la gestion de l'eau comme levier pour renforcer la paix et la sécurité. Nous espérons qu'il stimulera des discussions enrichissantes tout au long de la conférence.

Conformément à la tradition de notre conférence, nous avons l'honneur de réunir une liste prestigieuse de présentateurs et d'orateurs principaux, tous experts reconnus dans leurs domaines respectifs. Ces spécialistes partageront leur savoir, leur vision et leur expérience en matière de gestion durable de l'eau et du développement de notre région.

Le thème de cette année s'articule autour de trois sous-thèmes distincts : l'utilisation des technologies avancées, l'exploitation des données, et la mise en place de structures de gouvernance innovantes. Ces sous-thèmes permettent une exploration ciblée des enjeux clés affectant la durabilité de l'eau dans la région de la SADC et au-delà. Nos orateurs chevronnés présenteront des exposés spécifiques à chaque thème, offrant ainsi une vue d'ensemble complète de nos défis et opportunités.

Traditionnellement, la conférence comprend un espace d'exposition où les organisations partenaires peuvent présenter leurs produits et services à un public large et varié, tant régional qu'international.

Nous sommes convaincus que votre participation active est cruciale au succès de cette conférence. Un dialogue ouvert encourage la collaboration et l'innovation, et c'est la raison pour laquelle votre contribution est si précieuse. Nous vous invitons, par conséquent, à participer activement aux discussions et à partager vos perspectives pour enrichir l'expérience collective. Nous nous réjouissons de votre participation, alors que nous collaborons ensemble à l'élaboration de solutions concrètes pour une gestion durable de l'eau et le développement régional.

Sur une note plus légère, nous sommes ravis de vous convier à nos événements sociaux, notamment un cocktail et un dîner de gala, conçus pour favoriser les échanges et établir des contacts. Alors, n'oubliez pas vos chaussures de danse et préparez-vous à vivre une soirée mémorable que nous avons spécialement préparée pour vous.

Enfin et surtout, je tiens à exprimer ma profonde gratitude envers nos sponsors pour leur soutien financier, notre comité technique pour son expertise et sa contribution, ainsi que le comité local d'organisation pour son engagement et ses efforts inlassables dans l'organisation de cet événement. Le succès que nous célébrons aujourd'hui est le fruit d'un dévouement collectif. Cette réussite n'aurait pas été possible sans vos contributions.

Je vous souhaite la bienvenue à cette 6^e conférence de la SADC sur les eaux souterraines et je vous souhaite des délibérations fructueuses.

MENSAGEM DE BOAS-VINDAS DO DIRECTOR EXECUTIVO DA SADC-GMU, ENG. JAMES SAURAMBA

Bem-vindo a mais uma emocionante edição da Conferência da SADC sobre Águas Subterrâneas. O que começou como uma ideia há alguns anos transformou-se num dos eventos mais importantes do calendário hídrico da região da SADC. Antes de mais, gostaria de estender a minha sincera gratidão ao Governo do Lesoto e ao Ministério dos Recursos Naturais pelo seu apoio na organização desta conferência através do Departamento de Assuntos Hídricos. Agradecemos sinceramente todo o apoio que recebemos desde que começámos a preparar a conferência.

A 6^a Conferência da SADC sobre Águas Subterrâneas não é apenas mais um evento, mas um marco significativo na nossa jornada. Ela fornece uma plataforma extraordinária para a partilha de conhecimentos e troca de experiências entre os participantes, que se alinha com o nosso mandato de promover a gestão sustentável das águas subterrâneas e fornecer soluções para os desafios das águas subterrâneas em toda a região da SADC para melhorar os meios de subsistência.

Este ano, a conferência foca um tema essencial: Promoção da Paz Transfronteiriça através da Gestão Hídrica Conjunta. Este tema é inspirado na iniciativa da Semana Mundial da Água, "Unir fronteiras: Água para um Futuro Pacífico e Sustentável", e procura promover a colaboração na gestão hídrica como forma de reforçar a paz e a segurança. Esperamos que este tema o inspire a moldar os nossos debates ao longo da conferência.

De acordo com a tradição da nossa conferência, temos o prazer de apresentar um alinhamento excepcional de apresentadores experientes e oradores principais. Estas pessoas, cuidadosamente seleccionadas, partilharão os seus conhecimentos, perspectivas e experiências pessoais relacionadas com a gestão sustentável da água e o desenvolvimento global da nossa região.

Este ano, o tema da conferência está estruturado em torno de três sub-temas distintos (i) Utilização de tecnologias avançadas, (ii) Aproveitamento de Dados, e (iii) Estabelecimento

de Estruturas de Governação Inovadoras - permitindo uma exploração focada de questões-chave que têm impacto na sustentabilidade da água em toda a região da SADC e para além dela. Os nossos oradores experientes farão apresentações adaptadas a um destes temas, oferecendo uma compreensão abrangente dos nossos desafios e oportunidades.

Tradicionalmente, a nossa conferência contará com um espaço de exposição onde as organizações parceiras poderão apresentar os seus produtos e serviços ao nosso vasto público da região e para além dela.

Reconhecemos que a sua participação é crucial para o sucesso da conferência. Um diálogo aberto promove a colaboração e a inovação, pelo que valorizamos muito o seu contributo. Por conseguinte, convidamo-lo a participar activamente nos debates e a contribuir com as suas perspectivas para enriquecer a experiência global. Aguardamos ansiosamente a sua participação enquanto trabalhamos em conjunto para encontrar soluções práticas para a gestão sustentável da água e o desenvolvimento regional.

Numa nota mais leve, temos o prazer de o convidar para os nossos eventos sociais - um cocktail e um jantar de gala. Estes eventos têm como objectivo promover contactos e proporcionar oportunidades de trabalho em rede aos nossos participantes. Por isso, calce os seus sapatos de dança e prepare-se para a noite fantástica que preparámos para si.

Por último, mas certamente não menos importante, permitam-me que aproveite esta oportunidade para agradecer aos nossos patrocinadores por apoiarem financeiramente a nossa visão, ao nosso Comité Técnico pelo seu apoio e contribuição técnica e ao Comité Organizador Local por ter dado o seu melhor na organização da conferência. O sucesso que vemos hoje é o resultado de uma dedicação inabalável. Esta conquista não teria sido possível sem todos os vossos contributos.

Bem-vindos à 6^a Conferência da SADC sobre Águas Subterrâneas e desejo-vos deliberações bem sucedidas.

BACKGROUND

Surface- and groundwater are two components of a single water system connected in most landscapes, with few examples of managing them conjunctively across borders (Ibrahim and Lautze, 2023). The challenges include complicated cross-sectoral coordination, inadequate technical and institutional capacity, inadequate scientific data on transboundary water resources and limited financial resources. Nevertheless, the conjunctive management of surface water, groundwater, and other water cycle components represents an effective means of increasing water security as it reveals a set of water supply options different from traditional approaches to water supply management. Thus, the SADC-GMI's core mission is to **promote the conjunctive management of the SADC surface and groundwater resources at community, national, transboundary and global levels through:**

- Advocacy and providing technical support
- Creating an enabling policy, legal and regulatory environment
- The provision of evidence-based and actionable information
- Promoting impact-oriented solutions for capacity-building training
- Leading and promoting multi-sectorial coordination
- Supporting infrastructure development for sustainable groundwater management

The theme of World Water Day 2024 is 'Water for Peace'- When we cooperate on water, we create a positive ripple effect – fostering harmony, generating prosperity and building resilience to shared challenges. The Stockholm World Water Week's 2024 theme, 'Bridging Borders: Water for a Peaceful and Sustainable Future,' focuses on water cooperation for peace and security. It requires recognising communities' and nations' regional and global interconnectivity and how water-related solutions are crucial to delivering the Sustainable Development Goals. In line with SADC-GMI's core mission, the SADC-GMI hosts the SADC Groundwater Conference under the theme "**Promoting Peace Across Borders through Conjunctive Water Management**" from November 13-15, 2024, in Maseru, Lesotho. The conference modalities included high-level plenary sessions focusing on the theme and sub-themes, technical presentations, and panel discussions led by the partners of the SADC-GMI.

CONFERENCE THEME

Promoting Peace Across Borders through Conjunctive Water Management

SUBTHEMES

The following subthemes support the overall theme:

USING ADVANCED TECHNOLOGIES

This subtheme focuses on advanced technologies and systems to promote peace across borders through conjunctive water management in SADC countries. Emerging contaminants, microplastics, excess nutrients, and limited water supply are all pressing challenges requiring innovations in water treatment, reuse, and environmental biotechnologies. The numerous ways water moves through and interacts with the Earth's surface can lead to data analysis and modelling challenges. For instance, determining groundwater and surface water interactions on river courses requires complex modelling across space and time with data sets that are often sparse or highly uncertain. The sub-theme intends to discuss the extent and nature of groundwater and surface-water interactions, the geochemical effects of mixing water from different sources with aquifer water, the production and degradation of by-products from injection of treated water, and other issues.

HARNESSING DATA

Water scarcity, water disasters, extreme weather events, failures of climate change mitigation and adaptation and governance shortcomings continue to rank among SADC's leading risks. Data is fundamental to understanding areas of highest risk and contributing factors. Harnessing data can indicate probable solutions to mitigate these risks. The systematic harnessing of data uses innovative remote sensing and automatic monitoring techniques. Geographical Information Systems (GIS) and other modern ICT tools help process the collected information efficiently and convert it into information. New technological solutions, such as GIS-integrated simulation models and machine analytics, may provide reliable tools to assess space and time impacts and manage conjunctive surface water and groundwater utilisation.

ESTABLISHING INNOVATIVE GOVERNANCE STRUCTURES

Effective conjunctive water management involves many actors (politicians, government agencies, water professionals and local stakeholders). The subtheme considers institutional arrangements to advance water for peace as resolving water issues is becoming increasingly urgent and complex. This subtheme intends to discuss modalities for working together on water across borders and sectors to build resilience to climate change, contribute to disaster risk reduction, provide renewable energy, support cities and industry, and foster regional integration and peace.

KEYNOTE AND INVITED SPEAKERS

	Names: Honourable Mohlomi Moleko Position: (MP) Ministry of Natural Resource; Kingdom of Lesotho
---	--

Hon. Mohlomi Moleko is the Minister of Natural Resources in Lesotho, overseeing the mining and water sectors. With nearly two decades of experience as a Chartered Accountant, he has served as Managing Partner at Moleko & Associates and Senior Partner at Moores Rowland (Lesotho), a leading audit firm. He provides auditing, finance, and accounting support services to companies and NGOs in Lesotho and South Africa, working with clients ranging from small enterprises to large corporations. His finance and operational management expertise enabled organisations to achieve efficiency and meet growth objectives. He has extensive expertise in financial analysis, forecasting, pricing strategies, and market opportunity identification. His experience includes implementing internal controls for corporate compliance and risk minimization.

He has served as President of the Rotary Club of Maseru, President of the Lesotho Institute of Accountants, and as a board member of First National Bank Lesotho, where he chaired the Audit Committee and the Risk, Capital, and Compliance Committee. He retired from auditing and consultancy in 2018 to focus on his business ventures in mining, medicinal cannabis, cement, and real estate. Passionate about construction and mining, he founded Global Thrust (Pty) Ltd., which operates primarily in construction, cement aggregation, and mining.

His political career commenced in April 2022 and culminated in his appointment as a Cabinet Minister in October 2022, where he assumed the Minister of Natural Resources role.



Names:
Dr Alice Aureli

Position:
Senior Special Advisor

Dr Alice Aureli has been honoured to serve as the Head of the UNESCO IHP Groundwater Resources and Water Cooperation Department. She is recognized as a Senior Special Advisor at the SADC Groundwater Management Institute, where her expertise continues to contribute significantly to the water sector.

Dr Aureli has experience in the management and governance of groundwater resources. Since 2002, she has been the coordinator of UNESCO's International Shared Aquifers Resources Management (ISARM) initiative and responsible for the first inventory of the world's transboundary aquifers. She headed the UNESCO team that assisted the United Nations International Law Commission in preparing the draft articles of the "Law of Transboundary Aquifers". She has been responsible for an extensive portfolio of capacity development projects. She continues to teach in master's programs and supervise research activities and PhD students. She was recently appointed Vice President of the International Water Resources Association (IWRA).

Laureate of several international awards, including the International Association of Hydrologists (IAH) Presidents' Prize in 2015 for her work on transboundary aquifer governance and the Gilbert Castany Hydrogeology Prize in 2022. Dr Aureli is an honorary member of the International Water Resources Association (IWRA), a member of the French Partnership for Water, a Coordinator of the Liaison with the UN team of the International Association of Hydrogeologists (IAH LUNA), and a member of the IAH Commission on Transboundary Aquifers, as others think, tank to water resources management. She is a member of the Board of Directors of the UNESCO Chair on Sustainability, University of Barcelona, Spain. She is the author of numerous scientific papers on water diplomacy and the editor of international journals.



Names:

Mr James Sauramba

Position:

SADC-GMI Executive Director

James is a highly regarded Civil Engineer with an MBA from the University of the Free State. His expertise lies in infrastructure planning, development, and policy guidance throughout Southern Africa. With extensive experience in various SADC and European countries, James has committed his career to improving water and sanitation systems, urban development, solid waste management, transportation, and climate change initiatives.

One of his most significant achievements is serving as the inaugural Executive Director of the Southern African Development Community Groundwater Management Institute (SADC-GMI) since 2016. In this role, he successfully developed and implemented a five-year strategic and financial sustainability plan to secure the organisation's long-term viability and effectiveness.

His extensive experience in multiple SADC countries—including Malawi, Mozambique, Namibia, South Africa, Tanzania, and Zimbabwe—has given him valuable insights into each nation's unique challenges and opportunities. This regional expertise has not only deepened his understanding of the complex issues surrounding water management and infrastructure but has also reinforced his unwavering commitment to advancing sustainable development initiatives throughout Southern Africa. His work aims to promote resilient infrastructure, equitable resource distribution, and sustainable practices that benefit communities across the region.



Names:

Erik Aarnos

Position:

Associate Environmental Affairs Officer

United Nations Economic Commission for Europe(UNECE)

Erik Aarnos works at the Secretariat of the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention), which the United Nations Economic Commission services for Europe (UNECE). He coordinates Convention activities on monitoring, assessment and data-sharing in transboundary basins (Programme area 2.1), conjunctive water management (Programme area 3.4), and supporting accession to the Convention in Asia, Latin America, and the Caribbean.

Before joining the Secretariat, Erik spent two years as a field specialist in a water and sanitation development cooperation project in Far-Western Nepal. He has experience developing a Massive Open Online Course on Transboundary Freshwater Governance at the Global Water Partnership and co-authoring several reports on water diplomacy for the Ministry of Foreign Affairs of Finland. Erik has a Master's in Water and Environmental

Engineering from Aalto University, focusing on water diplomacy, governance, and sustainable development.



Names:
Palesa Mkorosi

Position:
**Senior Water Resources Management Specialist
Water Global Practice, World Bank**

Palesa Mkorosi is a Senior Water Resources Management Specialist in the World Bank's Water Global Practice, where she works on a successful SADC-wide groundwater management program and water infrastructure projects in Lesotho and Eswatini. Palesa has worked at the World Bank for over six years preparing and implementing projects aimed to improve water supply and sanitation, increase impact of water sector on economic, social and environmental development. Her areas of specialization are groundwater management, water resources management, and nature-based solutions. Before joining the World Bank, Palesa held roles, as a Hydrogeologist in the Ministry of Natural Resources in Lesotho, as a researcher at the African Centre for Water Research, and a Senior Water Programme Officer at the International Union for Conservation of Nature (IUCN). Palesa holds a postgraduate degree in geohydrology and a Master of Science degree in water resources management



Names:
Dr Alexandros Makarigakis

Position:
UNESCO Regional Hydrologist for Africa

Alexandros Makarigakis has over 30 years of experience in environmental sciences, with a significant focus on natural resources management and climate resilience. His career spans 23 years internationally, addressing development issues in developing and developed countries. For 21 years, he has been affiliated with UNESCO, where he has held various prominent roles, including Chief of the Disaster Risk Reduction (DRR) Unit, Global Coordinator of UNESCO's Water for Human Settlements Programme and Regional Hydrologist for Africa. His international experience includes representing UNESCO in Kenya, Uzbekistan, and Ethiopia and engaging with the African Union. In addition to his work at UNESCO, he has eight years of expertise in bioremediation of hazardous chemicals and ten years in municipal water and wastewater purification. His academic contributions include university lecturing, designing innovative treatment systems, developing mathematical models, and conducting in-situ testing and verification for groundwater remediation and waste management. He has also authored and co-authored several scientific papers and book chapters, contributing to the body of knowledge in his field.



Names:
Adv. Bokang Makututsa

Position:
Lawyer in Water Affairs

Adv. Bokang Makututsa is a water lawyer interested in water resources management, transboundary water cooperation, water services and governance. His earlier career focussed more on litigation in the Courts of Lesotho, followed by legal services in the Government of Lesotho. He currently serves the Government of Lesotho under Phase II of the Lesotho Lowlands Water Development Project, financed by the World Bank, the European Investment Bank and the European Union, providing legal services. He is continuously involved in policy, institutional, and legal frameworks for water resource management, water services, and transboundary cooperation. He contributed to the discussion on the role of water cooperation in resolving regional conflicts in arid areas and shared insights on water management at various platforms.



Names:
Gettie Shiinda

Position:
Young Professional Programme Coordinator

Gettie Shiinda is a qualified geologist with expertise in water resources management and environmental sustainability of water treatment systems. Gettie has 12 years of experience in groundwater & surface water investigation and monitoring. She is knowledgeable in quantifying groundwater abstraction volumes for domestic and irrigation purposes, determining groundwater recharge amounts and assessing the groundwater balance. She actively participates in various water-related organizations at the regional, national, and transboundary levels. Gettie is dedicated to advancing initiatives that empower young professionals and promote knowledge exchange within the field. She is a PhD candidate at the University of Leeds, UK. Her areas of expertise include groundwater management, transboundary water resources management, environmental sustainability, Integrated Water Resources Management, Business Management, Research and Innovation—her notable achievements: SADC-GMI Brand Ambassador., Coordinating the SADC-GMI Young Professionals Programme, Mandela Washington Fellowship for Young African Leaders: 2023, Mandela Washington Fellow, Business Track, University of Nevada, Reno, Conception X Cohort 7: UK's leading PhD Deeptech Venture Programme, and Namibia Hydrogeological Association: Council Member.



Names:

Mmasechaba Lebogang Moropane

Position:

Young Professional

Mmasechaba Lebogang Moropane is a Master's candidate in Environmental and Water Science at the University of the Western Cape. She specializes in geospatial and groundwater exploration applications. Her research, supported by a SADC-GMI bursary, focuses on delineating groundwater-dependent ecosystems and distinguishing invasive plants and native plants within these ecosystems, using remote sensing and machine learning techniques. Through her work in Heuningnes Catchment, she seeks to address the impacts of invasive species on groundwater resources and ecosystems, advancing sustainable water management solutions. Passionate about water and ecosystem protection, Mmasechaba's work exemplifies the potential of young leaders to contribute to environmental resilience and cross-border cooperation across the SADC region.

PROGRAMME

The conference theme and subthemes were developed in consultation with:

- Dr Alice Aureli, Senior Special Advisor
- Prof Kawawa Banda: University of Zambia
- Professor. Modreck Gomo: Institute for Groundwater Studies, University of the Free State
- Professor. Piet Kenabatho: University of Botswana
- Dr Karen G. Villholth: Director, Water Cycle Innovation (Pty) Ltd, South Africa

WEDNESDAY	13 November 2024
Opening session	M Motoho, Director, Department of Water Affairs, Programme Director G Shiinda, Chief Rapporteur
9:00-9:15	J Sauramba, Executive Director, SADC-GMI , Welcome to the SADC Groundwater Conference and conference objectives
9:15-9:30	Southern African Development Community (SADC) Secretariat , Opening remarks
9:30-10:00	Honourable M Moleko (MP), Minister of Natural Resources; Kingdom of Lesotho , <i>Official Opening of the SADC Groundwater Conference, 2024</i>
10:00-10:30	D Rodriguez, Keynote speaker, World Bank : <i>Promoting peace across borders through conjunctive management</i>
10:30-10:45	E Aarnos, Keynote speaker: UN Water Convention and Conjunctive Water Management focusing on the related work and future plans of the Convention
10:45-11:00	A Aureli, Keynote speaker: Surface water and Groundwater Conjunctive Management - Promoting Cooperation for Water Security K Pietersen , Conference modalities and programme
11:00-11:30	COMFORT BREAK
Subtheme	Using advanced technologies B Gwangwawa, Session Chair M Moropane, Rapporteur
11:30-11:45	Gomo, M. , Ngobe, T. <i>On the Telluric Electric Frequency Selection Method for geophysical groundwater exploration</i>
11:45-12:00	Johannes, M. , Muchingami, I., Hamutoko, J. <i>Application of hydrogeophysical methods in characterising Lake Oponona wetland system, Cuvelai-Etosa Basin, Namibia</i>
12:00-12:15	Angula, T. , Muchingami, I., Hamutoko, J. <i>A Hydrogeophysical Characterization of Typical Karoo and Nama Sedimentary Aquifers with Cases from the IlKharas Region, Namibia</i>
12:15-12:30	Mokhethi, M. , Chow, R., Roychoudhury, A., Towers, T. <i>Assessing the risk of using treated effluent in managed aquifer recharge schemes – a case study in the Atlantis Aquifer.</i>
12:30-12:45	Mulokoshi, G. , Asachi, M. <i>Urban Stormwater Treatment with Biofiltration Systems</i>
12:45-13:00	Wanailonga, L. , Hamutoko, J., Stuurmann, H., Muchingami, I. <i>Hydrochemical characterisation of groundwater in IlKharas Region, Namibia</i>
13:00-14:00	LUNCH
Special session	UNESCO M Munamati, Session Chair B Kitambo, Rapporteur
14:00-15:30	Sustainable groundwater utilisation under changing climatic conditions: Be Resilient Zimbabwe Project • J Sauramba, SADC-GMI. Introduction and session objectives

	• A Makarigakis, UNESCO Regional Hydrologist for Africa, keynote speaker. <i>UNESCO's Global Initiatives and Regional Strategies in Ground (Water) Management: A look at the future</i> • M Munamati, UNESCO. <i>Sustainable groundwater utilization under changing climatic conditions: Be Resilient Zimbabwe Project</i> • K Pietersen, SADC-GMI. <i>The critical role of transboundary groundwater institutions in adaptation to climate change</i> • I Muchingami, University of Namibia, Namibia. <i>Groundwater exploration approaches for enhancing technical groundwater management under a changing climate in vulnerable aquifer systems with cases from arid regions of Namibia</i> • B Kitambo, University of Lubumbashi, DRC. <i>Towards the use of satellite-based remote sensing products for sustainable groundwater management in the Congo Basin</i> • T Kanyerere, UNESCO Chair in Hydrogeology, University of Western Cape. • Questions & Answers
15:30-16:00	COMFORT BREAK
Subtheme	Using advanced technologies B Gwangwawa, Session Chair M Moropane, Rapporteur
16:00-16:15	Ligavha-Mbelengwa, L., Gomo, M., Madzivire, G. <i>Occurrence and spatial distribution of emerging organic contaminants in surface water, groundwater, and mine shafts in Gauteng, South Africa.</i>
16:15-16:30	Nhandam, I. <i>Avaliação da vulnerabilidade e contaminação das águas subterrâneas no município de Catandica -Moçambique/ Assessment of vulnerability and contamination of groundwater in the municipality of Catandica – Mozambique.</i>
16:30-16:45	David, A. <i>Estimation of groundwater recharge in the Kalahari aquifers of Kavango West and East Regions using the chloride mass balance method and environmental isotopes, Namibia.</i>
16:45-17:00	Ashili, S., Hamutoko, J., Kambatuku, J. <i>Review on the application of environmental isotopes and hydrochemistry techniques in hydrogeological studies in Namibia</i>
THURSDAY	14 November 2024
Subtheme	Using advanced technologies J Manda, Session Chair A, Kadhila, Rapporteur
8:30-8:45	Salom, N., Hamutoko, J., Muchingami, I. <i>Application of passive geophysical methods and hydrochemistry analysis in characterising the groundwater occurrence in the sedimentary and crystalline basement aquifers in the lower Orange-Fish basin, Namibia</i>
8:45-9:00	Eino, M., Uugulu, S., Uahengo, C., Nangula, O., Shuukwanyama, A. <i>A review on groundwater contamination around the Rosh Pinah Zinc mine area, Namibia.</i>
9:00-9:15	Pule, M. <i>The monitoring and analysis of groundwater quality concerning acid mine drainage in Northern KwaZulu Natal.</i>
9:15-9:30	Mofokeng, S., Gomo, M. <i>The impact of artefacts on the estimation of Darcy Velocity</i>
9:30-9:45	Leketa, K., Abiye, T. <i>Characterising the isotopic composition of rainfall to construct a local meteoric water line for Maseru Lesotho.</i>
9:45-10:00	Phori, T., Kebede, S., Leketa, K. <i>Characterisation and assessment of precipitation in Lesotho using oxygen and hydrogen isotopes.</i>
10:00-10:15	Hamutoko, J., Uugulu, S., Wanke, H., David, A., Muchingami, I. <i>The use of isotope hydrology in understanding hydrogeological processes in Namibia; a plea for environmental tracers</i>
10:15-10:30	Mohale, G., Tessema, A., Ayisi, K. <i>Hydrogeological characterization of the impact of climate change and anthropogenic factors on groundwater resource in the Klein Letaba River catchment, Mopani District of Limpopo Province.</i>

10:30-10:45	Rammutla, M., Modreck, G. <i>Investigating the influence of stratification on groundwater chemistry, faecal coliforms and stable isotopes in a typical Karoo Fractured Sandstone Aquifer</i>
10:45-11:00	Poster video presentations • de Bruyn, C., Dennis, R. <i>Exploring the unexplored: Data mining and machine learning of geohydrological datasets</i> • Mwateuvi, R., Muchingami, I., Hamutoko, J. <i>Hydrogeological characterisation of typical Nama and Karoo sedimentary aquifers in the IlKharas Region, Namibia</i> • Kakoro, S., Muchingami, I., Hamutoko, J. <i>An investigation on groundwater occurrence in the Kalahari sand aquifer with case studies from Kavango West region, Namibia</i> • Nehale, D. <i>Groundwater quality assessment and monitoring in a karst region affected by mining Operations: A case study of the Tschudi groundwater table in Namibia</i>
11:00-11:30	COMFORT BREAK
Subtheme	Harnessing data J Manda, Session Chair A, Kadhila, Rapporteur
11:30-11:45	Sonnekus, N., Du Toit, W., Lalumbe, L., Ramusiya, F. <i>Review and update of hydrogeological map series of Polokwane and information brochure</i>
11:45-12:00	Moropane, M., Dube, T. <i>Mapping Groundwater-Dependent Invasive Species with Remote Sensing and Machine Learning in Heuningnes Catchment, Western Cape, South Africa</i>
12:00-12:15	Seotla, T., Mahatane, M., Makoe, C., Pule, S. <i>The importance of data, tools, and models in delivering sustainable water resources management, protection, development, and utilisation in Lesotho</i>
12:15-12:30	Nthokwa, K., Tafesse, N., Alemaw, B., Ranganai, R. <i>Water balance model of the Motloutse sub-basin, Limpopo Basin, Botswana.</i>
12:30-12:45	Kitambo, B., Papa, F., Wongchuig, S., Tourian, M., Tshimanga, R., Paris, A., Blazquez, A., Frappart, F., Moreira, D., Fleischmann, A., Kileshye, J. <i>The spatiotemporal variability of groundwater storage variation in the Congo Basin from space</i>
12:45-13:00	Thum, T., De Vriendt, K., Bäuml, R., Houben, G. <i>New insights into the hydrogeology of Northern Namibia (to be introduced by Falco Kiowa)</i>
13:00-14:00	LUNCH
Special Session	SADC-GMI Young professionals G Shiinda, Session chair T Ngobe, Rapporteur
14:00-15:30	Leveraging the Potential of Young Professionals: Developing Water Solutions for Regional Peace and Sustainability • G Shiinda. <i>Setting the scene and overview of Young Professional Strategy</i> • B Gwangwa. <i>Building Collaborative Leadership Driven Skills for Sustainable Transboundary Water Governance and Regional Impact.</i> • Panel discussion: Championing collaborative governance (Ngobe, T – Eswatini., Kitambo, B – DRC., Kadhila, A – Namibia) • M Moropane. <i>Young Professional, Keynote speaker:</i> • Panel discussion: Drive data-driven insights (Thebeetsile, A – Botswana., Nhandamo, I – Mozambique., Rammutla, M- South Africa) • Questions & Answers
15:30-16:00	COMFORT BREAK
Subtheme	Harnessing data J Manda, Session Chair A, Kadhila, Rapporteur
16:00-16:15	Shipanga, M., Uugulu, S., Hamutoko, J. <i>Geochemical characterisation of water and sediments in Lake Oponona, Northern Namibia</i>
16:15-16:30	Mogatle, K. <i>Harnessing Data to Promote Peace Across Borders Through</i>

	<i>Conjunctive Water Management</i>
16:30-16:45	Olebetse, T. , Tafesse, N., Bagai, Z and Kenabatho, P. <i>General overview of the hydrogeology of the Khakhea-Bray transboundary aquifer</i>
16:45-17:00	Mmese, M. , Ranganai, R., Tafesse, N., Gomo, M. <i>Hydrogeological conceptual model of the dolomitic portion of the Khakhea-Bray transboundary aquifer in Botswana.</i>
FRIDAY	15 November 2024
Subtheme	Establishing Innovative governance structures A David, Session Chair K Mogatle, Rapporteur
8:30-8:45	Kadhila, A. <i>The evolution of Namibia's water sector's governance and management frameworks</i>
8:45-9:00	Museteka, L. , Rau, S. <i>Groundwater protection in Zambia - a Guideline</i>
9:00-9:15	Lukas, A. <i>The threat of mining to transboundary water resources.</i>
9:15-9:30	Ngobe, T. , Gomo, M. <i>Transboundary issues on groundwater management in rural areas: A case study of Eswatini</i>
9:30-9:45	Stuurmann, H. , Muchingami, I., Hamutoko, J. <i>Citizen science as a tool for enhancing sustainable groundwater use in the arid !Kharas Region of Namibia</i>
9:45-10:00	Mlonzi, V. , Odume, N., Murata, C. <i>Analysing the distributive, procedural, and contextual equity dimensions of water security challenges in the Nelson Mandela Bay Metropolitan Municipality</i>
10:00-10:15	Tshingana, R. <i>Adopting innovative governance structures in the Democratic Republic of Congo (DRC).</i>
10:15-10:30	Pietersen, K. , Sauramba, J. <i>Catalysing sub-national institutions in transboundary governance and management</i>
10:30-11:00	COMFORT BREAK
Special session	MK Squared L Lekhooana, Session Chair K Mogatle, Rapporteur
11:00-12:30	• Water knows no border: Fostering a multilevel, inclusive approach to water cooperation amongst Member States. • L Lekhooana, MK Squared, Session introduction and objectives • E Aarnos, Convention on the Protection and Use of Transboundary Watercourses and International Lakes • B Makututsa, A land-locked state perspective of water cooperation • Panel discussion on fostering a multilevel, inclusive approach to water cooperation amongst Member States(K Leketa, M Motoho, B Makututsa and Member State representatives) • Questions and answers
Closing session	M Motoho, Director, Department of Water Affairs, Programme Director
12:30-12:45	G Shiinda, Chief rapporteur, Key messages from the conference
12:45-13:00	J Sauramba, Conference prizes, Vote of thanks and closure of the conference
13:00-14:00	LUNCH

ORGANISING PARTNERS AND SPONSORS

SADC GROUNDWATER MANAGEMENT INSTITUTE (SADC-GMI)

The Southern African Development Community Groundwater Management Institute (SADC-GMI) serves as a Centre of Excellence for groundwater management in the SADC region. Its primary aim is to promote sustainable groundwater management and address groundwater challenges to enhance livelihoods and foster socio-economic development.

SADC-GMI is hosted by the Council for Scientific and Industrial Research (CSIR) in Pretoria, South Africa, under the strategic guidance of the SADC Secretariat, specifically the Directorate of Infrastructure and Services – Water Division, located in Gaborone, Botswana. In its Strategic Business Plan (2023 - 2028), SADC-GMI articulates its vision: "To be a Centre of Excellence in promoting equitable and sustainable groundwater management in the SADC region." SADC-GMI promotes sustainable groundwater management to achieve this vision by creating an enabling policy and legal and regulatory environment. Additionally, it focuses on capacity building, advancing research, supporting infrastructure development, and facilitating dialogue and accessibility of groundwater information. www.sadc-gmi.org

BUZI, PUNGWE, AND SAVE WATERCOURSE COMMISSION (BUPUSACOM)

The Buzi, Pungwe, and Save Watercourse Commission (BUPUSACOM) was established on 17 May 2023 in Harare, Zimbabwe, to promote sustainable shared river basins for all stakeholders. This tri-basin institution oversees the planning, development, and management of water resources within the Buzi, Pungwe, and Save (BUPUSA) River Basins, which Mozambique and Zimbabwe jointly share. The BUPUSA Commission is dedicated to fostering equitable and sustainable development of these vital water resources. Additionally, it provides a platform for consultation and coordination among the riparian states, thereby promoting integrated water resource management and development within the river basins. <https://bupusa.org/>

CUVELAI WATERCOURSE COMMISSION (CUVECOM)

The Cuvelai Watercourse Commission (CUVECOM) was established on 16 September 2014 to manage the transboundary waters of the Cuvelai Watercourse. The Commission's secretariat is currently situated in Oshakati, Namibia. CUVECOM is mandated to provide advisory support to riparian countries concerning the sustainable utilisation and management of groundwater resources, addressing both technical and political aspects. Additionally, the Commission aims to develop sustainable management strategies informed by comprehensive data and scientific research findings.

INCOMATI AND MAPUTO WATERCOURSE COMMISSION (INMACOM)

The Incomati and Maputo Watercourse Commission (INMACOM) is a transboundary river basin organisation dedicated to managing and safeguarding the water resources in the Incomati and Maputo River basins, which span tripartite states (Eswatini, Mozambique, and South Africa). Established to address the complex challenges associated with shared water resources, INMACOM aims to foster cooperation among member states.

Its vision is to be a premier institution in transboundary water management, focusing on the sustainable and equitable use of water resources. This includes promoting conservation efforts, enhancing water quality, and supporting the livelihoods of communities that depend on these vital water systems. INMACOM was officially established on 18 November 2021. Before this, it functioned as the Tripartite Permanent Technical Committee (TPTC), created in 1983. The establishment of INMACOM as a river basin organisation aligns with the Southern African Development Community (SADC) principles for managing shared transboundary water resources.

INTERNATIONAL UNION FOR CONSERVATION OF NATURE (IUCN)

IUCN is a membership Union uniquely composed of government and civil society organisations. It provides public, private, and non-governmental organisations with the knowledge and tools to enable human progress, economic development, and nature conservation to occur together. Created in 1948, IUCN is now the world's largest and most diverse environmental network, harnessing the knowledge, resources, and reach of more than 1,400 Member organisations and around 15,000 experts. It is a leading provider of conservation data, assessments, and analysis. Its broad membership enables IUCN to fill the role of incubator and trusted repository of best practices, tools, and international standards.

IUCN offers a neutral platform for stakeholders—governments, NGOs, scientists, businesses, local communities, and Indigenous organisations—to collaborate on solutions for environmental challenges and sustainable development. IUCN works with various partners to implement conservation projects worldwide. These initiatives aim to reverse habitat loss, restore ecosystems, and improve community well-being by combining modern science with local knowledge. www.iucn.org

LIMPOPO WATERCOURSE COMMISSION (LIMCOM)

The Limpopo Watercourse Commission (LIMCOM) is a River Basin Organization that was established through the Limpopo Agreement signed in November 2003 by the four Riparian States, namely Botswana, Mozambique, South Africa, and Zimbabwe, that share the Limpopo River Basin. The main objective of LIMCOM is "to advise the Contracting Parties and provide recommendations on the uses of the Limpopo, its tributaries and its waters for purpose and measures of protection, preservation, and management of the Limpopo."

The Commission fosters collaboration among the member states on issues related to managing water resources of the Limpopo River basin and its tributaries for the sustainable regional socio-economic development of the basin. The Commission also seeks to, among other aspects, promote equitable and reasonable utilisation of the Limpopo basin water resources; Encourage stakeholders to participate in the planning, utilisation, protection, and conservation of the Limpopo River; as well as collect, process, and disseminate data and information to inform policy-making. <https://limpopocommission.org/>

MK-SQUARED COMMUNICATIONS

Mk-Squared Communications is a leading Information Communication Technology (ICT) company founded by seasoned professionals with over 20 years of extensive experience in the industry. Our core principle is to cultivate meaningful relationships with clients and partners, as we firmly believe that strong connections among stakeholders are vital for the success of any business endeavour.

At Mk-Squared Communications, we deliver reliable results that enhance our clients' businesses. Our commitment to quality strengthens our integrity and fosters long-term partnerships, which are essential for achieving shared goals and providing innovative, measurable service. At Mk-Squared Communications, we are dedicated to delivering excellent service.

Our extensive knowledge in telecommunications and ICT allows us to meet clients' diverse needs. By staying ahead of industry trends, we provide relevant services that consistently exceed expectations, making us a trusted partner in their success.

ORANGE-SENQU RIVER COMMISSION (ORASECOM)

The Orange-Senqu River Commission (ORASECOM) is an intergovernmental organisation dedicated to the cooperative management of the Orange-Senqu River Basin, shared by Botswana, Namibia, Lesotho, and South Africa. ORASECOM plays a vital role in promoting equitable and sustainable water resource management, ensuring that the basin's water resources are effectively used to meet the needs of all riparian states. As a key platform for consultation and coordination, ORASECOM facilitates integrated water resource management (IWRM) through collaborative planning and decision-making. The Commission addresses pressing water use, conservation, and climate resilience challenges. It also enables data sharing, joint research, and capacity-building initiatives, fostering a deeper understanding of the basin's water resources.

ORASECOM promotes regional cooperation among member countries to achieve sustainable development goals, enhance water security, and improve the livelihoods of communities dependent on the river's resources. This collaboration contributes to regional stability and socio-economic development. www.orasecom.org

THE UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION (UNESCO)

UNESCO, the United Nations Educational, Scientific and Cultural Organization, plays a vital role in promoting peace and security through international cooperation in various fields, including education, science, culture, communication, and information. Its mission is to foster mutual understanding and respect among nations, contributing to achieving the Sustainable Development Goals outlined in the 2030 Agenda, which was adopted by the UN General Assembly in 2015. One of UNESCO's key initiatives is the Intergovernmental Hydrological Programme (IHP), the only intergovernmental cooperation program within the UN system dedicated to water research and management. IHP addresses national, regional, and global water challenges by supporting the development of sustainable and resilient societies. Under its Natural Science Sector, UNESCO implements various water-related projects on behalf of member states. For example, the Be-Resilient Zimbabwe Plus project, supported by the Adaptation Fund, aims to increase local communities' adaptive capacity and resilience to climate change. <https://www.unesco.org/en>

GROUNDWATER & MINERAL SERVICES (GMS)

Groundwater & Mineral Services (GMS) is a Botswana-based Geoscience Consulting and Contracting firm with 15 years of experience in geosciences and a staff complement of 15 employees.

GMS offers geophysical services in mineral exploration, groundwater exploration, and project management for airborne geophysical surveys. Hydrogeological services include groundwater resource quantification and development, groundwater monitoring, mine dewatering, geotechnical, civil engineering, ESIA, and EMP projects. GMS has experience developing TDA and SAP for transboundary aquifer management & managed aquifer recharge studies. A GIS and Database Division responsible for spatial data analysis, map production, and project database development complements the above.

GMS has a footprint on the entire African continent and manages airborne geophysical survey projects in Australia, Europe, and Canada. Its subsidiary, GMS Groundwater Contractors, offers test pumping, well injection tests, borehole camera surveys, and equipping services.

Web: www.gmsgeoscience.com

Email: admin@gmsgeoscience.com

MINISTRY OF NATURAL RESOURCES

The Ministry of Natural Resources came into being in 2022 through the current government by merging two former ministries, Water and Mining. It is, therefore, comprised of various departments: Administration, Rural Water Supply, Water Affairs, Water Commission, Mines, and Geology. **Vision:** To build a nation with good health from reliable, clean water supply and proper sanitation, socio-economic prosperity from responsible exploration, and competitive exploitation of water and mineral resources. **Mission:** The Ministry of Natural Resources is committed to attaining socio-economic prosperity by developing a sustainable and viable mining industry, adequate water supply, and effective management of water resources. **Objectives:** To increase access to water supply and sanitation services, to promote investment in the mining sector, to increase discovery of minerals and promote research for sustainable development of natural resources, to strengthen the development and management of water and mineral resources, and to improve service delivery. <https://www.gov.ls/ministry-of-natural-resources/>

THE AFRICAN MINISTERS' COUNCIL ON WATER (AMCOW)

In 2002, African ministers responsible for water adopted the "Abuja Ministerial Declaration on Water," establishing the African Ministers' Council on Water (AMCOW) to address the continent's water challenges. In February 2004, the AU Assembly in Libya adopted the Sirte Declaration, reinforcing support for AMCOW's role in improving water policy in Africa.

In June 2008, the African Union Assembly in Sharm el-Sheikh, Egypt, assigned the African Ministers' Council on Water (AMCOW) to develop a strategy for water and sanitation commitments. AMCOW also serves as the Working Group on Water and Sanitation for the African Union's Specialized Technical Committee on Agriculture, Rural Development, Blue Economy, Water, and Environment.

AMCOW leads in political advocacy and policy direction for the sustainable management of water resources in Africa, essential for social and economic development and ecosystem preservation. Its initiatives aim to fulfill the Africa Water Vision 2025 for equitable and sustainable water management

SPECIAL SESSIONS

UNESCO SPECIAL SESSION: SUSTAINABLE GROUNDWATER UTILISATION UNDER CHANGING CLIMATIC CONDITIONS: "BE RESILIENT ZIMBABWE PROJECT"

The session brings together hydrogeologists and development specialists from across Africa to discuss the multifaceted challenges that arise because of climate change and explore innovative solutions that empower communities to manage their groundwater resources sustainably. The session is anchored on the BE RESILIENT Zimbabwe Plus project, a collaborative initiative between UNESCO and the Ministry of Lands, Agriculture, Fisheries, Water and Rural Development with support from the Adaptation Fund. The project aims to enhance local communities' adaptive capacity and resilience through sustainable groundwater utilisation, specifically targeting the vulnerable populations in Binga and Buhera, where climate change significantly jeopardises food security and livelihoods. Participants will gain insights into the project's comprehensive approach, which comprises five key components dedicated to sustainable groundwater management as a strategy for climate change adaptation. Emphasising the importance of knowledge and capacity building in groundwater science, policy, and participatory management, this session highlights innovative solutions that empower communities to manage their groundwater resources sustainably.

SADC-GMI SPECIAL SESSION: LEVERAGING THE POTENTIAL OF YOUNG PROFESSIONALS: DEVELOPING WATER SOLUTIONS FOR REGIONAL PEACE AND SUSTAINABILITY

The special question was vested from the question, "What role do Young Professionals play in promoting peace across borders through conjunctive water management?". This session aims to provide insight into the role Young Professionals want to play and the solutions they believe will promote regional peace and sustainability. This can include the role of Young Professionals in leveraging advanced technologies, data harnessing, and innovative governance structures to tackle water challenges across the SADC region. The session will have four Young Professionals from three different sectors to explore how emerging young leaders can:

- **Champion Collaborative Governance:** Engaging Young Professionals in Policy and Decision-Making; Practical pathways for Young Professionals to engage with policymakers to contribute novel governance models integrating water management with peacebuilding across borders, especially in politically sensitive regions.
- **Drive Data-Driven Insights:** Educational pathways and career development; training, research opportunities, and skills needed in groundwater management. Showcasing how Young Professionals are

leading in adopting GIS, remote sensing, and data-driven tools for water management and mitigating risks tied to water scarcity and disasters.

MK SQUARED MEMBER STATES SPECIAL SESSION: WATER KNOWS NO BORDER: FOSTERING A MULTILEVEL, INCLUSIVE APPROACH TO WATER COOPERATION AMONGST MEMBER STATES

Water is a growing concern in many parts of the world. Climate change makes rainfall more unpredictable and is likely to trigger more and more disasters, such as droughts, floods, and water pollution. Countries can improve their resilience through water cooperation over shared waters and shared lessons. More regions need agreements where countries jointly manage rivers, lakes, and groundwater aquifers. Water security is casting a shadow over island states, ignored in water cooperation interventions. Island states' geography, unique scale, and limited resources mean that mainland solutions do not always apply. The special session will explore the Convention on the Protection and Use of Transboundary Watercourses and International Lakes as a legal instrument fostering a multilevel, inclusive approach to water cooperation amongst Member States.

Additionally, there will be reports on updating the SADC water policy and the implications of revising the SADC Revised Protocol on Shared Watercourses. Landlocked state perspective on water cooperation will be given. Member States will share progress towards implementing their policy, legal and institutional roadmaps.

CONFERENCE ABSTRACTS

USING ADVANCED TECHNOLOGIES

Angula, T., Muchingami, I., Hamutoko, J. A hydrogeophysical characterization of typical Karoo and Nama sedimentary aquifers with cases from the IlKharas Region, Namibia

Hydrogeophysical methods in groundwater exploration have continued to enhance the assessment of the subsurface structures likely to control groundwater occurrence in various aquifer systems and choose drilling locations effectively. This study applies integrated hydrogeophysical characterisation in groundwater resource potential assessment for typical Karoo and Nama sedimentary aquifers with case studies within the IlKharas Region, Namibia. The hydrogeophysical methods used included ground telluric surveys and analysis of Aeromagnetic data sets. Eight (8) traverses of varying lengths for ground telluric were conducted at a total of 6 locations. The electric potential difference was measured at depths of up to 150 m with an electrode spacing of 10 m. Preliminary results suggest a complex and heterogeneous hydrogeological system and groundwater occurrence is associated with various features, including faults, folds, and fractures. The study demonstrated the importance of integrating several geophysical methods for groundwater potential occurrence in the Karoo and Nama sedimentary aquifers. This contributes to understanding groundwater dynamics in typical sedimentary aquifers, thereby addressing the communities' water challenges in the IlKharas Region, ensuring adequate water supply and sustainable resource management.

Keywords: sedimentary aquifer, Karoo, Nama, ground telluric, magnetics

Ashili, S., Hamutoko, J., Kambatuku, J. Review on the application of environmental isotopes and hydrochemistry techniques in hydrogeological studies in Namibia

Environmental isotopes and hydrochemical techniques have been increasing globally to identify groundwater origins, quantify the spatial and temporal variations in groundwater processes, and understand aquifer interactions. These techniques reveal the first insights into groundwater processes crucial for sustainable groundwater management in semi-arid countries like Namibia and areas with scarce hydrogeological data. Therefore, this review synthesises existing research on the application of these methods in Namibian aquifers. The literature search focused on Google Scholar, ScienceDirect and Springer databases. Keywords such as "environmental isotopes", "hydrochemistry," and "Namibia Aquifer" guided the search process from 2010 onwards. Filters were applied to prioritise peer-reviewed journal articles in English of studies done in Namibia to ensure comprehensibility and relevance to the scientific community. The results show that these techniques have been used significantly since Namibia's first spectrometer (LOS GATOS DLT-100) was acquired.

Additionally, this review highlights the advancements in isotope and hydrochemical techniques, identifying the challenges and limitations. Disparities in methodological approaches and data interpretation are discussed, emphasising the need for standardised protocols. Ultimately, this review bridges research gaps and offers recommendations for future studies to enhance understanding of groundwater systems and support sustainable water management practices in Namibia's arid environment.

Keywords: environmental Isotopes, hydrochemistry, hydrogeology, Namibia

David, A. Estimation of groundwater recharge in the Kalahari aquifers of Kavango West and East Regions using the chloride mass balance method and environmental isotopes, Namibia.

This study focuses on groundwater recharge in the middle and lower Kalahari aquifers in Namibia's Kavango West and East region. The chloride mass balance method and environmental isotopes were applied to determine the groundwater recharge of the Kalahari aquifers in the Kavango West and East regions. The annual average precipitation in the study area is 570 mm/a. Episodic recharge is observed from $\delta^{18}\text{O}$ and tritium, where groundwater from similar sources is recharged over different years at certain areas in the two regions. Modern recharge is observed within the study area, mainly in the Omuramba Omatako ephemeral river. The spatial distribution of chloride in the Kalahari aquifers indicates that recharge is occurring in both the middle and lower Kalahari aquifers at varying rates. An average of 6.03 mm/a (1 % of the annual precipitation) of recharge was determined using the chloride mass balance method for the entire study area. The recharge rates estimated for the Kalahari aquifers can be used to manage these aquifers.

Keywords: recharge, environmental Isotopes, chloride mass balance

Eino, M., Uugulu, S., Uahengo, C., Nangula, O., Shuukwanyama, A. A review on groundwater contamination around the Rosh Pinah Zinc mine area, Namibia.

The mining industry, pivotal for Namibia's economic growth, raises significant environmental concerns, particularly regarding heavy metal contamination in shared ecosystems. A review of groundwater contamination by heavy metals potentially caused by mining activities at the Rosh Pinah Zinc Mine in southern Namibia was conducted. Groundwater analyses from the monitoring wells showed limited contamination, with most trace element concentrations below detection limits. However, historical data indicated high levels of total suspended particles from the uncovered tailings dam, which could potentially contribute to groundwater contamination. Recent efforts to cover two-thirds of the tailings dam's surface with water have successfully linked the tailings dam to groundwater contamination.

Nevertheless, lead and zinc levels in groundwater remain a concern, with bio-accessible lead surpassing safe daily intake limits. This underscores the urgent need for robust measures to mitigate heavy metal contamination and protect the environment. The study highlights the importance of your regional cooperation and integrated water management strategies to address these challenges and support sustainable development in mining-affected areas.

Keywords: groundwater contamination, lead, zinc, Rosh Pinah

Gomo, M., Ngobe, T. On the Telluric Electric Frequency Selection Method for geophysical groundwater exploration

The success of groundwater supply projects largely depends on the ability to locate feasible groundwater sources. Many approaches exist for prospecting groundwater, but the geophysical approach remains conventional. However, the high cost of traditional geophysical approaches remains a hindrance, particularly in low-income regions such as Africa. The 20th century has witnessed the emergence of new geophysical approaches to groundwater exploration. The Telluric Electric Frequency Selection Method (TEFSM) is one of the recent approaches. The TEFSM uses natural electromagnetic (EM) waves to evaluate the groundwater potential of the subsurface rocks. Few studies have reported on TEFSM groundwater prospecting, and the early impression is that the approach has some notable capabilities. However, several emerging issues warrant a discussion to improve the practical application knowledge of the approach. The presentation provides an overview of the principles of the TEFSM according to the available literature. Field experiences showing the strengths and limitations of the approach are discussed, while present knowledge gaps are highlighted. Recommendations for future studies are made to improve the knowledge of the TEFSM approach in hydrogeology investigations.

Keywords: aquifers, borehole siting, groundwater resources development, groundwater detector; telluric electric frequency selection method (TEFSM)

Hamutoko, J., Uugulu, S., Wanke, H., David, A., Muchingami, I.. The use of isotope hydrology in understanding hydrogeological processes in Namibia; a plea for environmental tracers

Over 60% of Namibia's population relies on groundwater; thus, understanding the processes and flow dynamics that can be controlled by groundwater is essential for sustainable groundwater management. Isotopes have been successfully used around the world to understand various hydrogeological processes. Namibia has seen an increase in the use of different isotopes, especially stable isotopes of hydrogen and oxygen, since the early 2000s when it acquired the Off-Axis Integrated Output Cavity Spectrometer (OA-ICOS, Los Gatos DLT-100) with support from the International Atomic Energy Agency. A Picarro was also acquired in 2023 through the same support. This study provides an overview of the applications of isotopes to solve hydrogeological problems in Namibia, as well as the success stories and shortcomings. The results show that most studies have focused on stable isotope analysis of groundwater from different projects in different regions of the country, with limited analysis of rainwater and surface water. Additionally, only a few studies apply other isotopic techniques, such as radioactive and noble gases, thus limiting the

knowledge of residence times for most groundwater bodies. Therefore, there is a need to date groundwater in most parts of the country and develop a strategy to include isotope studies in groundwater management plans.

Keywords: isotope hydrology, hydrogeological processes, environmental tracers, Namibia

Johannes, M., Muchingami, I., Hamutoko, J. Application of hydrogeophysical methods in characterising Lake Oponona wetland system, Cuvelai-Etosha Basin, Namibia.

Lake Oponona is a natural lake about seventy kilometres north of Etosha Pan and is an essential geological feature within the Cuvelai-Etosha Basin in northern Namibia. The study seeks to apply hydrogeophysical methods in characterising the subsurface properties of the Lake Oponona wetland system in northern Namibia. The study employs passive geophysical methods, specifically ground telluric (GT), magnetic, and vertical electrical sounding (VES) surveys, to map and analyse subsurface hydrogeological structures and groundwater movement. The VES method involved using a resistivity meter with copper wire cables, current electrodes, and potential electrodes to measure the electrical resistivity of subsurface materials at different depths. Magnetic surveys assessed changes in the Earth's magnetic field to infer the presence of geological structures and variations in subsurface conditions. The ground telluric method was used to identify and map underground water sources around the lake area. Preliminary results indicated the presence of multiple layers, including sand, silty clay, and clay overlying a sand soil layer. Significant geological structures that influence the hydrogeological dynamics of Lake Oponona could also be inferred. Understanding surface water interactions in semi-arid environments such as Lake Oponona contributes to improving sustainable water resource management and environmental conservation.

Keywords: magnetic, geophysical characterisation, Lake Oponona, wetland system, ground telluric, vertical electrical sounding (VES).

Leketa, K., Abiye, T. Characterising the isotopic composition of rainfall to construct a local meteoric water line for Maseru Lesotho.

This study presents the isotopic signature ($\delta^{18}\text{O}$ and $\delta^2\text{H}$) of rainfall in Maseru Lesotho and constructs a Maseru Local Meteoric Water Line using rainfall data from November 2017 to December 2020. It is important for researchers interested in using isotopes to study groundwater and its interaction with surface water in the area and the entire transboundary Senqu-Orange River Basin, whose main source is in Lesotho. Because of its geographical setting, Lesotho is expected to have a unique rainfall isotopic signature in the region. Daily rainfall samples were collected using a conventional rain gauge from Thuathe on the Berea Plateau (1,777 masl) and Ha Thetsane (1,502 masl). Daily temperature data for the nearest weather station, Moshoeshe I International Airport (1,637 masl), was obtained from the Lesotho Meteorological Services, while rainfall amount was recorded from the rain gauge. The R^2 values for the amount effect are 0.395 ($\delta^2\text{H}$) and 0.545 ($\delta^{18}\text{O}$), while for the temperature effect are 0.061 ($\delta^2\text{H}$) and 0.055 ($\delta^{18}\text{O}$). $\delta^2\text{H}=6.32\delta^{18}\text{O}+12.4\text{‰}$ ($n=184$, $R^2 = 0.90$) was constructed as the Maseru Local Meteoric Water Line inclusive of data from both points while $\delta^2\text{H}=6.17\delta^{18}\text{O}+12.1\text{‰}$ ($n=152$, $R^2 = 0.88$) for Ha Thetsane and $\delta^2\text{H}=6.69\delta^{18}\text{O}+13.3\text{‰}$ ($n=30$, $R^2 = 0.95$) for Thuathe.

Ligavha-Mbelengwa, L., Gomo, M., Madzivire, G. Occurrence and spatial distribution of emerging organic contaminants in surface water, groundwater, and mine shafts in Gauteng, South Africa.

Studies on the occurrence and distribution of emerging organic contaminants (EOCs) in aquatic systems are important since they provide an understanding of these compounds' behaviour. The current study investigated the occurrence of EOCs in the surface and subsurface, including groundwater and mine shafts, and their spatial distribution concerning land use. Water samples were collected from boreholes, surface water points and mine shafts. The study area is represented by multiple anthropogenic activities that potentially contaminate water systems, including residential and industrial wastewater treatment plants, uncontrolled sewage discharges, and landfills. The EOC data was used to evaluate the detection frequencies and compound concentrations in the water using Microsoft Excel to plot graphs and ArcGIS Pro to develop the spatial distribution maps. Compounds nonylphenol, methylparaben, caffeine, and carbamazepine registered a 100% detection frequency in the surface water, while caffeine, metolachlor and bisphenol A were detected in all the mine shafts. Bisphenol A, methylparaben and nonylphenol were further detected in all groundwater samples. The high detection frequency of these in groundwater correlated to their ubiquitous and persistent behaviour and, to a certain extent, the karst system. The antiretrovirals showed the highest concentrations in surface water, with concentrations of 8.48 µg/L, 7.78 µg/L, and 2.02 µg/L reported for emtricitabine, efavirenz and lopinavir, respectively. These concentrations were measured from the same point sampled <2 km downstream of the wastewater treatment plant.

The spatial distribution maps indicated that groundwater around Alexander Dam and Blesbokspruit was affected by localised anthropogenic activities, as displayed by similarities in compounds detected from surface water and those in groundwater. This is like what was seen in the mine shafts, which were influenced by human activities. The Cowles Dam groundwater consequently displayed the possible influence of the percolation of industrial waste. This study identified the importance of conducting more groundwater-based EOC research in South Africa. Likewise, it pointed out the importance of spatial distribution studies in displaying the links between sites.

Keywords: emerging organic contaminants, mine shafts, groundwater spatial distribution, detection frequency

Mofokeng, S., Gomo, M. The impact of artefacts on the estimation of Darcy Velocity

Point Dilution Tests (PDT) are used to estimate Darcy velocity (vd), a volume of water that flows through a unit cross-sectional area of a porous media per unit of time. Darcy velocity is important because it assists with investigating and understanding contaminants' transport and distribution around the aquifer. The dilution rate is believed to be controlled by horizontal groundwater flow; however, other factors, such as density and diffusion, are known as artefacts that impact the tracer dilution. The impacts of these artefacts have yet to be investigated, even though there is ample research on point dilution tests. The tracer dilution

tests using NaCl were performed for this study to investigate and provide a better understanding of the influence of these artefacts on PDT. The results obtained from using the different analytical methods indicate that the influence of artefacts impacts the early-time tracer dilution rates, leading to a wrong v_d estimation. At the same time, late-time data provides more accurate v_d estimations. Early-time data should, therefore, not be used for Darcy velocity estimations.

Keywords: aquifer, Darcy Velocity, horizontal groundwater flow, Point Dilution Tracer Test

Mohale, G., Tessema, A., Ayisi, K. Hydrogeological characterization of the impact of climate change and anthropogenic factors on groundwater resource in the Klein Letaba River catchment, Mopani District of Limpopo Province.

Groundwater is the primary source of water supply for domestic use, agricultural, and mining sectors in the Klein Letaba River Catchment, located in the central-eastern part of the Limpopo Province. As a result of the arid-to-semi-arid nature of the climate, there is limited surface water, which partly contributed to groundwater being the only dependable source of water supply for various uses. Periodic water level measurements in several boreholes indicated a continuous drop in the piezometric surface occasionally. The present study's main aim was to assess groundwater resources' vulnerability due to climate change and anthropogenic factors. To achieve the aim, multidisciplinary datasets were compiled to determine aquifer parameters MODFLOW layer groups and develop boundary conditions required for steady-state numerical simulation of groundwater.

In addition, hydrochemical and environmental isotope data were used to trace the groundwater flow path and ascertain the inflows and outflow boundaries of the conceptual groundwater flow model. The results of the steady-state model of groundwater flow indicated that recharge from the rainfall and river leakages are the most important components of the inflows that control the availability of groundwater, accounting for 44% and 40%, respectively. The major outflow components include river leakage and evapotranspiration, which contribute to 62% and 25% of the total discharge from the aquifer. The results suggest that groundwater resources are highly vulnerable to the impacts of climate change, such as declining rainfall and increased evapotranspiration. These changes reduce recharge into the aquifer, resulting in a dwindling groundwater level, subsequently changing the groundwater and surface water interactions. The climate change conditions exacerbate the problems of water and food security in the study area.

Keywords: Klein Letaba, climate change, modelling, MODFLOW, hydrochemistry, environmental isotopes

Mokhethi, M., Chow, R., Roychoudhury, A., Towers, T. Assessing the risk of using treated effluent in managed aquifer recharge schemes – a case study in the Atlantis Aquifer.

Managed aquifer recharge (MAR) using treated effluent and stormwater (TES) can help ensure the sustainability of urban aquifers used for potable water supply in water-scarce regions. However, using TES in MAR has associated safety concerns due to the potential risk of exposure to emerging contaminants (ECs). We aim to assess the impact of using TES in MAR systems on groundwater quality by quantifying the presence and spatial distribution of various ECs in the Atlantis Aquifer. A total of nineteen samples of MAR source water, groundwater and stream water were collected. Preliminary findings include detecting 120 compounds, including pharmaceuticals, pesticides, disinfection by-products (DBPs) and industrial chemicals. Groundwater receiving natural recharge had the lowest number of detections. MAR source water sites had the highest number of detections, followed by groundwater impacted by MAR, indicating that ECs are added to groundwater via MAR. However, the spatial distribution of detections suggests that some ECs, including DBPs and select pharmaceuticals and pesticides, may be attenuated in the aquifer. Our findings inform the sound water quality management in urban aquifers, promoting water resilience in light of increasing demand and environmental change.

Mulokoshi, G., Asachi, M. Urban stormwater treatment with biofiltration systems

Extremes brought about by climate change include intense and frequent rainfall in some regions and prolonged drought in others. Many countries face severe water security challenges in terms of both quality and quantity. Biofiltration systems are designed to manage stormwater runoff by improving the runoff quality and controlling the runoff quantity. Biofiltration systems consist of vegetation, engineered media, a drainage layer, and an underdrain layer to collect the treated water. This paper assesses the application of biofiltration systems to enhance the surface runoff water quality and aquifer recharge through managed aquifer recharge to increase storage and groundwater availability, which could be implemented in climate change-stricken countries experiencing frequent flooding events. The findings will provide recommendations on applying biofiltration systems to enhance water quality, facilitate groundwater infiltration, and propose ways to optimise these systems to mitigate stormwater pollutants for secure managed aquifer recharge.

Keywords: biofiltration, managed aquifer recharge, water quality, stormwater treatment, sustainable water management

Muchingami, I., Hamutoko, J., Stuurmann, H., Baloyi, L. Successes of hydrogeophysics in groundwater potential assessment in unconsolidated Kalahari sand and sedimentary aquifer systems within Namibia

The arid climatic conditions in Namibia account for over 80% of the dependence on groundwater for drinking water in vulnerable rural communities. Therefore, appropriate groundwater exploration techniques are critically important in ensuring sustainable groundwater availability. The study correlated with groundwater resource exploration, drilling log cross-sections and yield estimation. A case study from the southern ǀKharas Region, eastern Omaheke region, Northern Ohangwena and Kavango West region, Namibia. The protocol comprised integrated hydrogeophysical methods, mapping site-specific subsurface characteristics attributed to groundwater within the study areas. The results suggest hydrogeophysical and drill log cross-sections of well-defined layered aquifer formations. However, crystalline basement formations could be combined with geological observations to identify groundwater controls like lineaments and depths to fractured zones. Finally, the study advocates for technical groundwater management and promoting the utilisation of groundwater in Namibia.

Keywords: Hydrogeophysics, groundwater controls, ǀKharas Region, Namibia

Ndakola, H., Okedi, J. Groundwater quantity and quality assessment for Aquifer Recharge in Ohangwena region, Namibia

This study assessed the suitability of using surface runoff for Aquifer Recharge (AR) to supplement groundwater in the Ohangwena region in Namibia. The assessment involved using a Geographical Information System (GIS) to identify potential groundwater recharge zones, analysing the impact of AR on groundwater levels using MODFLOW, and evaluating the dispersion of contaminants associated with runoff within the aquifer using MT3DMS. The GIS analysis indicated that most of the region has high to very high groundwater recharge potential. The steady-state model showed a slight change in groundwater levels, while the transient-state model showed a gradual increase due to recharge. The MT3DMS results revealed that Chloride, Electrical Conductivity, Total Dissolved Solids (TDS), and E-coli concentrations decreased as timesteps increased. Using surface runoff for AR is appropriate for the region, and it is vital to manage groundwater resources effectively in the long run to enhance groundwater levels.

Keywords: aquifer recharge, Geographical Information System, MODFLOW, MT3DMS, Groundwater Recharge

Nehale, D. Groundwater quality assessment and monitoring in a karst region affected by mining Operations: A case study of the Tschudi groundwater table in Namibia

This study aims to assess and monitor groundwater quality in a karst region with mining operations, specifically the Tschudi Compartment near Tsumeb in Namibia. The key objectives will be to assess and characterize the water quality status following the NAMWATER and WHO regulatory compliance, establish whether the recharge volumes are significant or not, conduct an analysis of historical data and produce a trend analysis of the compartment, including the identification of any contaminant sources that could pose any potential risks. The following methods will be employed: sampling for the water quality assessment and monitoring the water for chemical, biological and physical parameters. A chloride mass balance method will be used to model whether the recharge is sufficient and identify pollutant pathways.

Laboratory analysis will use standard methods such as ICP-OES and ion chromatography to separate and find the anionic and cationic properties in the sample's matrices. Information obtained from the results will assist in the integration of geological and hydrological data to delineate the groundwater flow channels and probable pollutant transmission routes, besides the major objective of determining the effect of the mining activities on the karst in terms of the quality of the water and the recharge rates of the aquifer. Spatial maps of water quality metrics and probable pollution sources of the karst will be generated using geographic information system (GIS) software.

Nhandam, I. Avaliação da vulnerabilidade e contaminação das águas subterrâneas no Município de Catandica -Moçambique/ Assessment of vulnerability and contamination of groundwater in the municipality of Catandica - Mozambique

Vários pesquisadores em todo mundo têm debatido problemas relacionados à contaminação de águas subterrâneas e superficiais. No entanto, a falta de pesquisas prévias sobre a contaminação da água subterrânea em Moçambique trás várias implicações negativas, tendo em vista que várias infraestruturas são construídas em locais com potencial de recursos hídrico, podendo assim contaminar as águas presente no subsolo. Estudos podem ser conduzidos para avaliar a vulnerabilidade à contaminação de águas subterrâneas usando os métodos, GOD, SINTACS, Ekv e DRASTIC. Cada método avalia diferentes parâmetros geológicos. Para esta pesquisa foi utilizado o método DRASTIC, com base na análise de (7) parâmetros a profundidade da água subterrânea (D), recarga da água subterrânea (R), material do Aquífero (A), Tipo de solo (S), Topografia (T), Impacto da zona Vadosa (I) e condutividade hidráulica (C). os dados foram coletados em campo e no site da ADE (Agência Nacional de Desenvolvimento Geo-Espacial), plotados, digitalizados e espacializados em ambiente SIG, usando o software ArcGiS 10.8. Os resultados dos índices DRASTIC, variaram de 70 a 150, são divididos em 3 classes de vulnerabilidade de contaminação, muito baixa, baixa e Alta.

Palavra chave: Método DRASTIC, Risco de poluição, Vulnerabilidade, Água subterrânea.

Several researchers around the world have discussed problems related to groundwater and surface water contamination. However, the lack of previous research on groundwater contamination in Mozambique has several adverse implications, considering that several infrastructures are built in places with potential water resources, which can thus contaminate the water present in the subsoil. Studies can be conducted to assess the vulnerability to groundwater contamination using the GOD, SINTACS, Ekv and DRASTIC methods. Each method evaluates different geological parameters. For this research, the DRASTIC method was used, based on the analysis of (7) parameters: groundwater depth (D), groundwater recharge (R), aquifer material (A), soil type (S), topography (T), impact of the vadose zone (I) and hydraulic conductivity (C). The data were collected in the field and on the ADE (National Agency for Geospatial Development) website, plotted, digitized and spatialized in a GIS environment using ArcGIS 10.8 software. The results of the DRASTIC indexes, ranging from 70 to 150, are divided into 3 classes of contamination vulnerability: very low, low and high.

Keywords: DRASTIC method, pollution risk, vulnerability, groundwater.

Phori, T., Kebede, S., Leketa, K. Characterisation and assessment of precipitation in Lesotho using oxygen and hydrogen isotopes.

Lesotho is the Southern African Water Tower and has abundant water resources. However, there is limited knowledge of catchment hydrology in the country. Isotopic techniques can be used to evaluate catchment hydrology. Identifying potential recharge sources and studying the interactions between surface and groundwater is essential to protect this critical resource for current and future generations. Data has been collected from several projects across Lesotho, including the International Atomic Energy Agency's Global Network of Isotopes in Precipitation/Rivers (GNIP/R). The data utilised ranges from 2018 to 2022. The precipitation data reveals that local precipitation is enriched in heavier isotopes than the GMWL and that all of Lesotho's Local Meteoric Water Lines (Oxbow, Maseru and Abia) are enriched. This phenomenon is consistent with Southern Africa's arid to semi-arid areas. Altitude and amount effects play a pivotal role in isotope studies, and the data shows a strong correlation between heavy rainfall and high altitudes with highly depleted ^{18}O for monthly data.

The altitude and amount effects are critical on isotope hydrology studies in arid areas, and data showed a good correlation between heavy (high amount) rainfall and high altitudes having a highly depleted $\delta^{18}\text{O}$ for monthly data. The review of precipitation data for Lesotho indicates the need to collect more samples to better understand the national precipitation properties and moisture sources, especially in the highlands where snow recurs annually. The stable isotopes have been used to develop Lesotho's (Ox-LMWL, Ms-LMWL and Abia-LMWL) Local Meteoric Water Lines. The data that developed these Lesotho-LMWLs was used to establish Lesotho's precipitation isotopic effects. The study addressed gaps in

previous isotope hydrology studies by developing Lesotho's Local Meteoric Water Lines and improving the altitude effect.

Keywords:

Pule, M. The monitoring and analysis of groundwater quality concerning acid mine drainage in Northern KwaZulu Natal.

Groundwater quality is important as this resource is a go-to area during intense drought and is mostly used in rural areas for several functions, such as domestic usage and irrigation. Groundwater also has the potential to impact surface water resources by seeping into the surface water resources (gaining stream). It is, therefore, imperative that there is continued groundwater quality monitoring to detect pollution or contamination, if any, and to come up with solutions to treat them. The Department of Water and Sanitation (DWS) has therefore developed a groundwater monitoring network focusing on about twenty defunct coal mines in the North of KwaZulu Natal around the towns of Newcastle and Dundee (collectively known as Dundee AMD) where rehabilitation to various degrees has been conducted. The groundwater monitoring network consists of 51 monitoring boreholes designed so that one borehole is positioned upgradient, and two boreholes are located downgradient of the mining works in a triangular manner wide enough to obtain the flow direction reasonably. Samples are collected biannually, in May/June and September/October, and analysed for quality using the department's Resource Quality Information Services (RQIS) laboratory. The results indicate groundwater in the Dundee AMD monitoring network is slightly acidic to alkaline. Boreholes V3N0073 and V6N0004 show an increased NO₃ level due to human effects and agricultural activities. There is also an increase in F⁻ in groundwater of V3N0051 and V3N0045 that may be attributed to the geology of the host rocks. Continuous monitoring is recommended to determine the source of high concentrations of nitrate, fluoride and sulphate found in groundwater.

Keywords: AMD, groundwater monitoring network, quality

Rammutla, M., Modreck, G. Investigating the influence of stratification on groundwater chemistry, faecal coliforms and stable isotopes in a typical Karoo Fractured Sandstone Aquifer

Groundwater stratification influences the concentration and distribution of groundwater chemistry constituents. However, detailed field studies still need to demonstrate these influences. The study is ongoing at the University of Free State Campus Test Site to understand the vertical distribution of major ions, bacteriological parameters, and stable isotopes in typical fractured Karoo sandstone aquifers. Major cations and anions reflect groundwater-rock interactions, while nitrate and faecal coliforms indicate anthropogenic

influences. The deuterium and oxygen -18 isotopes provide insights about groundwater recharge. Fieldwork comprises electrical conductivity measurements, borehole profiling, and collection of multi-depth samples with a bailer in different boreholes. The geology of the area consists of alternating sandstones, siltstones and mudstones. The data was analysed for descriptive statistics using Window Integrated Software for Hydrogeologists (WISH) and IBM Statistical Package for the Social Science (SPSS). The groundwater types are Ca-HCO₃ and mixed (Ca-Na-HCO₃), and the dominant ions were Ca<Na<Mg<K and HCO₃<Cl<SO₄<NO₃.

Key Words: aquifer, bailer, groundwater sampling, hydrogeochemistry, stratification

Salom, N., Hamutoko, J., Muchingami, I. Application of passive geophysical methods and hydrochemistry analysis in characterising the groundwater occurrence in the sedimentary and crystalline basement aquifers in the lower Orange-Fish basin, Namibia

Improved knowledge of aquifer systems is crucial for effective management, thus enhancing their sustainable utilisation. Passive geophysical methods are increasingly used in groundwater exploration to identify drill sites and assess areas of high groundwater potential, particularly in Namibia's lower Orange-Fish basin, where there is limited understanding of the occurrence and spatial extent of aquifer systems. The study utilised passive geophysical methods and hydrochemistry to characterise groundwater in the lower Orange-Fish basin. Aeromagnetic data was analysed, and subsurface structures were identified through geophysical siting. Water samples were collected from boreholes, rivers, springs and pans within the study area. Hydrochemistry results show Ca-Mg-HCO₃ is the dominant water type, and the water quality varies from excellent to low-risk, implying the unsuitability of some water sources for drinking. Results from the passive geophysical methods have identified high groundwater potential in both the sedimentary and crystalline basement aquifer systems within the lower Orange-Fish basin. The ground telluric method has also identified geological features likely to control groundwater occurrence. The combination of lithological logs and passive geophysical methods led to a site-specific conceptualisation for both aquifer systems, demonstrating the potential for the applicability of passive geophysical methods in identifying higher groundwater potential zones.

Keywords: crystalline basement aquifers, ground telluric, groundwater, Karoo sedimentary aquifers, Orange-Fish basin

Shipanga, M., Uugulu, S., Hamutoko, J. Geochemical characterisation of water and sediments in Lake Oponona, Northern Namibia

Water quality and sediment composition in semi-arid regions like Northern Namibia are crucial for sustainable water resource management. Lake Oponona, an essential water body in the Cuvelai-Etoshia Basin, faces challenges from natural and anthropogenic factors affecting its hydrogeological dynamics. This study investigates the geochemical composition of water and sediments in Lake Oponona. The main objective is to understand the lake's hydrogeological dynamics, water quality, and sediment composition. The research involves comprehensive field sampling of water and sediment from various points in and around the lake, followed by laboratory analysis to determine their chemical and mineralogical compositions. Key findings indicate significant spatial and temporal variations in water quality parameters, including pH, electrical conductivity, and concentrations of major ions. The results highlight the influence of natural processes, such as seasonal changes and geological formations, and anthropogenic activities, such as agriculture and waste disposal, on the lake's water quality and sediment characteristics. This study provides essential data for developing targeted strategies to protect and manage water resources in the Cuvelai-Etoshia Basin, promoting water security and environmental sustainability in Namibia.

Keywords: geochemical characterization, water quality, Lake Oponona, hydrogeology, Cuvelai-Etoshia Basin, Namibia

Wanailonga, L., Hamutoko, J., Stuurmann, H., Muchingami, I. Hydrochemical characterisation of groundwater in IlKharas Region, Namibia

The IlKharas Region in southern Namibia faces significant water scarcity and quality issues, compounded by low and erratic rainfall, often less than 100 mm annually. Groundwater is the primary water source in this arid region. This study focuses on the hydrochemical evaluation of groundwater in the IlKharas Region, assessing its quality against Namibian and WHO standards and understanding the hydrochemical processes influencing its composition. Twenty (25) groundwater samples were collected from various groundwater sources, i.e. springs and boreholes. These samples were analysed for abundant major cations using Inductively Coupled Plasma-Atomic Emission Spectrometry (ICP-AES), and for major anions such as sulphate, the Continue Analysis Flow analysis (CFA) method was used.

In contrast, the Automated Ferricyanide method was used in the NAMWATER laboratories for chloride. Results showed significant variations in water quality. The groundwater in the study area is of potable quality and generally suitable for irrigation due to low to moderate

mineralisation and little influence of anthropogenic contamination. This research shows the need to regularly check and manage groundwater in this dry part of Namibia.

Keywords: Water quality, hydrochemistry



HARNESSING DATA

de Bruyn, C., Dennis, R. Exploring the unexplored: Data mining and machine learning of geohydrological datasets

Application of data mining and machine learning could revolutionise the analysis of geohydrological datasets, offering insights into complex environmental systems. Exploring advanced computational methods within a hydrogeological landscape could benefit areas where data is scarce and extrapolation is required. Identifying areas for drilling boreholes with high accuracy relative to water level and supply is key to ensuring valuable outcomes to this costly endeavour. The areas could be identified by leveraging datasets encompassing geological, hydrogeological, and climatological variables and implementing machine learning to classify relationships between borehole parameters and geological settings. Five machine learning algorithms were tested, and performances were compared to establish which algorithm yielded accurate results. It was established that the Random Forest Regression and Classification model yield, Support Vector Regression and Random Forest Classification could model static water levels. Three case study results indicated static water levels could be modelled with high accuracy, but yield modelling was challenging, and uncertainties remain as to what drives water strike yield. Through a comprehensive review of existing methods and the use of algorithms, the research contributes to the refinement of predictive models and decision-support systems for water resource management. This establishes a foundation for future research aimed at harnessing the potential of data mining in geohydrological sciences.

Keywords: data mining, machine learning, groundwater resource management, geohydrological datasets, data-driven modelling

Kitambo, B., Papa, F., Wongchuig, S., Tourian, M., Tshimanga, R., Paris, A., Blazquez, A., Frappart, F., Moreira, D., Fleischmann, A., Kileshye, J. The spatiotemporal variability of groundwater storage variation in the Congo Basin from space

Despite the abundant surface water within the Congo Basin (CB), groundwater is a crucial source of freshwater for most of CB's population. However, there is still a lack of scientific understanding of the CB's groundwater resources due to the absence of in situ data. This study aims to provide the spatio-temporal variability of groundwater in the CB. Here, we provide an unprecedented quantification of the temporal dynamics and spatial distribution of the Groundwater Storage Anomaly (GWSA) from 2002 to 2015. The method relies on decomposing the total Terrestrial Water Storage Anomaly (TWSA) measured by the Gravity Recovery and Climate Experiment (GRACE) mission. The study revealed that GWSA consists of 24%, 42%, 42%, 29%, 16%, and 19% of the TWSA from GRACE satellite, respectively, in Sangha, Ubangui, Kasai, Middle-Congo, Lower-Congo and Lualaba subbasins. Additionally, the contributions of each hydrological reservoir made of surface water storage (SWS), root-zone soil moisture, and GWSA represent around 18%, 59%, and 23% of the seasonal amplitude of TWSA ($\sim 365 \pm 105 \text{ km}^3$). This dataset on GWSA confirms the hydrogeological behaviour of the aquifer types of the main hydrogeological formation in the CB.

Keywords: Groundwater storage dynamics, hydrogeological formation, aquifer types, total Terrestrial Water Storage Anomaly, observation-based surface water storage

Kakoro, S., Mutchingami, I., Hamutoko, J. An investigation on groundwater occurrence in the Kalahari sand aquifer with case studies from Kavango West region, Namibia.

Even though it receives higher rainfall than other parts of Namibia, the Kavango West region has witnessed an increased reliance on groundwater utilisation. It faces a rising water demand due to several factors, such as population growth and climate change. The groundwater resource occurrence in the Kavango West region is often described as a flat-plane aquifer hosted in the Kalahari sands. Despite the Kalahari sand aquifer being utilised, the groundwater resource occurrence within the region has not been assessed, and mechanisms that control groundwater availability in the Kalahari sand aquifer are not understood. Therefore, this study aims to evaluate the occurrence of groundwater in the Kalahari sand aquifer using specific study sites from the Kavango West region. Geological mapping techniques were applied to identify hydrogeological structures and lithologies hosting groundwater in the Kalahari sand aquifers.

Additionally, passive hydrogeophysical assessment methods, namely ground telluric and aeromagnetic data analysis, were applied to investigate groundwater potential in the Kalahari Sand Aquifer. Furthermore, 16 water samples were collected from the 16 newly drilled boreholes within the study area to characterise and assess groundwater quality. Preliminary results suggest that the resource potential is significant, with groundwater and

good water quality and the middle aquifer being unconfined. In contrast, the lower aquifer is characterised as semi-confined within the study area.

Keywords: Kalahari sand aquifer, groundwater occurrence, groundwater potential, Kavango Basin

Mogatle, K. Harnessing Data to Promote Peace Across Borders Through Conjunctive Water Management

The SADC region faces critical water-related challenges, intensified by climate change and governance gaps. This study adopts a data-centric approach to address these issues, utilizing remote sensing, automatic monitoring, and Geographic Information Systems (GIS) to collect and analyze groundwater data. GIS-integrated simulation models and machine analytics were used to assess spatial and temporal impacts of water use, revealing that accurate and timely data enhances understanding of water-related risks. Integrating GIS and machine analytics proved effective in optimizing water resource management, enabling policymakers and water managers to identify high-risk areas, assess water usage impacts, and develop risk mitigation strategies. Such data-driven methods support a shared understanding of regional water challenges, fostering cooperation and peace among member states. This study advocates adopting these tools to improve water security, regional stability, and sustainable conjunctive groundwater management. The objectives were to demonstrate the role of data in identifying water-related risks, assess the effectiveness of ICT tools in groundwater data analysis, and propose strategies for data-driven groundwater management to support regional peace. Data was collected using remote sensing, automatic monitoring, and GIS technologies. GIS-based simulation models and analytics were applied to evaluate the impact of water use on shared resources. Data-driven approaches are essential for effective water management across the SADC region, supporting resilience, cooperation, and peace by providing a unified framework for addressing groundwater challenges.

Keywords: conjunctive water management, data harnessing, GIS, SADC, water security, peacebuilding

Mmese, M., Ranganai, R., Tafesse, N., Gomo, M. Hydrogeological conceptual model of the dolomitic portion of the Khakhea-Bray transboundary aquifer in Botswana.

The aim is to create a conceptual model of the Khakhea-Bray dolomite transboundary aquifer portion on the Botswana side by utilising primarily geophysical and geological investigations. 16 Vertical electrical sounding (VES) points and 10 telluric electric frequency section method (TEFSM) points were conducted along 3 survey profiles to create a geoelectrical 2D model. These profiles cut across the study area in a West-East direction as aeromagnetic data results revealed that geological structures that influence the occurrence of groundwater mainly had a North-South trend. This geoelectrical model will be correlated with the existing geological logs and drilling information, and hydrogeological logs will be produced to develop the hydrogeological conceptual model of the transboundary aquifer.

Geological and geophysical investigations revealed that fractured and karstic hydrogeological environments characterise the area with a multi-layered confined aquifer system. Physico-chemical parameters measured in 15 boreholes revealed that pH, TDS, EC and temperature of the groundwater ranges between 6.61-7.78, 380.25–1937mg/L, 585-2980 μ S/cm, and 19.8-20.2°C respectively. These reveal that the groundwater has a dissolution of carbonate minerals and is of good to poor quality.

Keywords: geophysical surveys, fractured medium, hydrogeological conceptual model, karstic medium, transboundary aquifer

Moropane, M., Dube, T. Mapping Groundwater-Dependent Invasive Species with Remote Sensing and Machine Learning in Heuningnes Catchment, Western Cape, South Africa

Groundwater-dependent invasive alien plants (GDIAP) evolved adaptive strategies to survive extreme arid conditions by exploiting groundwater resources. This adaptation gives them a competitive advantage over indigenous species, posing significant threats to biodiversity, ecosystem integrity, and water resources. While accurate, field-based methods of detecting GDIAP are labour-intensive and lack comprehensive spatial and temporal coverage. Advances in remote sensing techniques, cloud computing, and machine learning offer promising solutions to these problems. However, limited knowledge exists on the efficacy of satellite-based methods in delineating GDIAP. Thus, this study evaluates the effectiveness of Sentinel-2 and Landsat 8 data combined with Random Forest (RF), Classification and Tree Decisions (CART), Gradient Boosting Tree (GBT), Support Vector Machines (SVM) and Naïve Bayes (NB) algorithms in delineating GDIAP in the water-limited catchment. Sentinel-2 and Landsat-8 data processed with pixel-based RF achieved the highest overall accuracies of 98% and 94%, respectively, outperforming other algorithms. In object-based classifications, Sentinel 2 with GBT achieved the highest overall accuracy of 85%, outperforming RF, which achieved 82%. Regression analysis demonstrated that changes in GDIAP spectral signatures correlate with groundwater level variations between 2018 and 2020, indicating their influence on groundwater dynamics. This study underscores the potential of remote sensing, machine learning, and cloud computing in accurately detecting and monitoring GDIAP, essential for ecosystem protection, invasive species management, and water resource conservation, aligning with United Nations Sustainable Development Goal 15, Target 8.

Keywords: ecosystem function, groundwater management, invasive species, Sustainable Development Goals

Mwateuvi, R., Muchingami, I., Hamutoko, J. Hydrogeological characterisation of typical Nama and Karoo sedimentary aquifers in the ǀKharas Region, Namibia.

Namibia, one of the most arid areas in Southern Africa, has declared its southern region a water-scarce zone. The main water supply is groundwater abstraction from the underlying sedimentary aquifer units of the Karoo and Nama Group formation. Thus, estimating these aquifer systems' hydraulic parameters and hydrogeological characteristics is crucial. This study aimed to investigate the hydrogeological characteristics of the Karoo and Nama sedimentary aquifer systems in the ǀKharas Region, Namibia. The field procedures involved applying geological mapping techniques to identify hydrogeological structures controlling groundwater of the Nama and Karoo sedimentary aquifers, conducting pumping tests analysis to evaluate hydraulic parameters in specific boreholes within these sedimentary aquifer systems, and determining the aquifer parameters and sustainable yields of the selected boreholes. Preliminary results indicate that the sustainable yields for the aquifer units are variable. The sustainable yield results help maintain the long-term availability of groundwater resources in the ǀKharas Region by setting extraction limits that prevent over-pumping the boreholes.

Keywords: sustainable yield, Nama and Karoo basin, sedimentary aquifers, hydraulic parameters, ǀKharas Region, Namibia

Nthokwa, K., Tafesse, N., Alemaw, B., Ranganai, R. Water balance model of the Motloutse sub-basin, Limpopo Basin, Botswana

This study was conducted in the Motloutse sub-basin of the Limpopo Drainage Basin to analyse various water balance components and assess surplus water availability within the sub-basin by developing a water balance model. A 51-year monthly rainfall data from 1971 to 2022 were collected from a network of meteorological stations within and around the sub-basin. The areal depth of rainfall of the sub-basin was determined using the weighted average method along with other climatic data and discharge data at selected outlet gauging stations. A monthly water-balance model was applied and calibrated for rainfall-runoff transformation processes in the basin, with the optimal model parameters and performance tests conducted. The Nash-Sutcliffe model efficiency (R^2) for model calibration and validation modes are 60% and 58.4, respectively, and the corresponding correlation coefficient (r) between observed and model-simulated runoff values are 0.77 and 0.76, respectively. The calibrated water balance model results revealed that the mean annual soil moisture, actual evapotranspiration (AET), surplus and total annual runoff (RO) are found to be 2.59mm, 343.70mm, 38.26mm and 58.70mm, respectively.

Keywords: Motloutse sub-basin, rainfall, surplus water, discharge, water balance model

Olebetse, T., Tafesse, N., Bagai, Z and Kenabatho, P. General overview of the hydrogeology of the Khakhea-Bray transboundary aquifer

The Khakhea-Bray transboundary aquifer is one of the transboundary aquifers in the Southern African region shared by Botswana and South Africa. Currently, on both sides, the aquifer is a water source for domestic and agricultural uses. The different investigations conducted in this aquifer revealed that the aquifer is a fractured and karstified dolomite. The aquifer system is a multi-layered confined aquifer. Huge numbers of deep boreholes are drilled on this aquifer on both sides, and groundwater is exploited without a proper management scheme that considers the groundwater dynamics in the area. The investigations done by different scholars also revealed the importance of conducting a detailed investigation on the groundwater system and the water quality of the Khakhea-Bray transboundary aquifer for better management and sustainable usage. A hydrochemical investigation is proposed to be conducted in this transboundary aquifer for a better understanding of the quality and its dynamics, with the aim of contributing the resource information to manage and use this resource sustainably. Such investigation has not been conducted yet. This research output will boost the understanding of this transboundary aquifer to lay a foundation for better regional governance and management of this resource.

Keywords: aquifer, groundwater, hydrogeology, hydrochemical, transboundary aquifer

Seotla, T., Mahatane, M., Makoe, C., Pule, S. The importance of data, tools, and models in delivering sustainable water resources management, protection, development, and utilisation in Lesotho

This paper discusses the importance of data, tools, and models (DTM) in delivering sustainable water resources management in Lesotho. It highlights the challenges and opportunities faced by Lesotho in managing and allocating water resources due to limited capacity and resources, as well as a lack of data and information. The recently completed Capacity Needs Assessment (CNA) of the Department of Water Affairs (DWA), identified technical and institutional gaps in the DWA and provided recommendations which will be addressed while Implementing the Water Resources Management Planning Framework and developing the foreseen first round of Water Resources Management Plans (WRMPs) on the Mohokare catchment and subsequently the Senqu and Makhaleng catchments. A significant part of this CNA, which was based on the pilot application of the proposed WRMP framework to the Mohokare catchment, focussed on the assessment of available Data, Tools, and Models (DTMs) needed for the successful development of WRMPs. The DTM assessment covered each of the components of the proposed framework. It allowed the DWA to identify what data it needed and why, establish gaps, and determine how to address them. The CNA also allowed the identification of needs from other water sector stakeholders. This assisted in strengthening links and bringing in other actors to contribute to

planning. The results from the DTM assessment were generally positive. It was concluded that although there were gaps in available DTM, these did not prevent progress in developing the WRMPs. It also became clear to water sector stakeholders on their DTM contributions to support and collaborate with the DWA to deliver its mandate through the framework. The CNA also noted that as the gaps in the DTM are addressed, the expected but manageable uncertainties in the proposed first round of planning will be reduced in future WRMP cycles.

Keywords: Lesotho, water allocation, water resource management plans

Sonnekus, N., Du Toit, W., Lalumbe, L., Ramusiya, F. Review and update of hydrogeological map series of Polokwane and information brochure

Hydrogeological information products such as groundwater quality, groundwater yields, water strikes, depth to groundwater levels, and related maps are crucial in the planning and development of groundwater globally. This study's objectives were to review and update the 1: 500 000 hydrogeological map series and information brochure completed in 2002 and reduce the scale to 1: 250 000. This study combined the data used in the previous map with data from 2003 to 2024 to update parameters such as groundwater levels, quality, yields, groundwater allocation and abstraction volumes, and distribution of boreholes. This study managed to identify a new aquifer yield class of > 10 l/s by expansion of yield classes based on new datasets. Reducing scale led to the map subdividing into four map series with more aquifer classification. This study reviewed and updated the hydrogeological map series and information brochure of the Polokwane map, where the latest groundwater quality, use, and yield map were delineated based on the latest data and information. This study recommended reviewing all hydrogeological products every ten years to improve groundwater management, planning and decision-making.

Keywords: hydrogeological map, information, groundwater yield, groundwater quality, aquifers

Thum, T., De Vriendt, K., Bäuml R., Houben, G. New insights into the hydrogeology of Northern Namibia (to be introduced by Falco Kiowa)

The northern part of the semi-arid Cuvelai-Etoshia Basin (CEB), shared by Angola and Namibia, is geologically characterised by the paleo-megafan system of the Cubango River. Hydrogeologically, the basin contains a multi-layered aquifer system and is host to the deep Kalahari-Ohangwena 2 (KOH-2) freshwater aquifer. This aquifer has garnered significant

attention due to its potential to alleviate rewater supply shortages. However, due to the inherent complexity of the hydrogeologic system, combined with scarce and often poor-quality historical data, our understanding of recharge dynamics in this aquifer remains limited. Earlier assumptions suggested that seasonal fluctuations observed from logger data in the KOH 2 aquifer were due to recharge from the Angolan highlands. Although hydraulic gradients indicate recharge, evidence suggests that the fluctuations are caused by mechanical loading due to seasonal changes in soil moisture. Preliminary analyses suggest that the KOH-2 aquifer may act as a large-scale geological weighing lysimeter and provide insights into changes in soil moisture. Existing hydrochemical datasets from the CEB and available groundwater level data were also analysed to provide a picture of regional groundwater dynamics. The mapping of the hydrochemical facies also indicates large-scale cation exchange caused by the displacement of paleo-saline groundwater by infiltrating freshwater.

Keywords: Cuvelai-Etosa Basin, Ohangwena 2, groundwater recharge, large-scale weighing lysimeter

❖ ESTABLISHING INNOVATIVE GOVERNANCE STRUCTURES

Kadhila, A. The evolution of Namibia's water sector's governance and management frameworks

Namibia is the most arid country on the African continent. Due to its aridity, water resources are highly fragile and limited, requiring careful and sustainable management. Namibia's water challenges were intensified by the inheritance of pre-independence management practices, which were set up to benefit those then in power (and not all Namibians). Immediately after independence (in 1990), the Namibian government recognised the need to modify and reform the legislation and institutional structures within the water sector to allow for equitable, efficient, and environmentally sound allocation, utilisation, and management of its water resources. The process began with a Water Resources Management Review, which took place in 1998. The review took stock of the existing arrangements for managing Namibia's water resources and recommended new approaches and enhancements to address challenges facing Namibia in conserving its limited and vulnerable water resource base. These efforts resulted in developing policies, legislation, and institutional frameworks that govern/guide the development and management of water resources in Namibia. For instance, the National Water Policy 2000 and the Water Resources Management Acts 2004

(amended in 2013), to mention a few. Namibia's water sector and governance structures have thus reformed significantly to benefit the Namibian people since independence. The water reform has catered to surface and groundwater resources and unconventional water sources (such as treated wastewater and desalinated seawater).

Keywords: Namibia, water management, governance, reforms

Lukas, A. The threat of mining to transboundary water resources.

A worrying trend has emerged, with SADC member states awarding mineral exploration licenses to mining companies in critical transboundary aquifer systems. The exploration licenses were awarded despite poor environmental impact assessments and a lack of consideration for surface and groundwater resources. Either those professionals responsible for evaluating the impact assessments do not have the capacity to do so, or there is political pressure from higher up that forces the acceptance of these applications. Both scenarios pose an existential threat to important water resources. Some government officials openly state that water is meaningless to their people if they are poor. This statement demonstrates a lack of understanding of the severity of neglecting water security in water-scarce countries. This research consists of two case studies where mineral exploration licenses were awarded for the Kavango- and the Stampriet transboundary aquifers despite the applicants not providing sufficient evidence that their activities would not detrimentally affect the groundwater resources. These case studies demonstrate the importance of member states having personnel with the capacity to evaluate environmental impact assessments for groundwater resources.

Keywords: groundwater, mining impacts, transboundary aquifers

Mlonzi, V., Odume, N., Murata, C. Analysing the distributive, procedural, and contextual equity dimensions of water security challenges in the Nelson Mandela Bay Metropolitan Municipality

This study explores distributive, procedural, and contextual equity dimensions in relation to water security challenges within the Nelson Mandela Bay Metropolitan Municipality. Water security remains a critical issue globally, and its equitable distribution is paramount for sustainable development and social justice. Despite extensive research on water security, gaps remain in understanding how these equity dimensions specifically impact the Nelson Mandela Bay Metropolitan Municipality. The research addresses three main objectives: (1) examine the water security challenges in the Nelson Mandela Bay Metro, (2) examine the municipal responses to the water security challenges, and (3) analyse the equity dimensions of the water security challenges. The study utilised a mixed-methods approach, including semi-structured household interviews, surveys, and interviews with municipal officials.

Through these data collection methods, the study aims to provide a comprehensive understanding of the distribution of water resources, the procedural fairness of municipal responses, and the contextual factors affecting water security. The findings are expected to contribute valuable insights into the equity aspects of water management and inform the development of more equitable and effective water policies. By highlighting the interplay between equity dimensions and water security challenges, this research offers actionable recommendations for policymakers and stakeholders to enhance water management strategies in the Nelson Mandela Bay Metropolitan Municipality.

Keywords: Water security challenges, equity dimensions, water governance, drought

Museteka, L., Rau, S. Groundwater protection in Zambia - a Guideline

Groundwater protection is a critical element of sustainable groundwater management. As one of our most vital natural resources, a well-implemented protection strategy is needed to prevent overuse and contamination from anthropogenic activities that can seriously threaten water quality and availability. A groundwater protection guideline for Zambia has been developed jointly by several experts on water resources management to ensure a comprehensive groundwater protection strategy for the whole country. While the approach to groundwater protection differs between locations and well fields, delineating and implementing groundwater protection zones is always highly recommended to manage land use surrounding an abstraction point. A technical working group consisting of members from the Water Resources Management Authority (WARMA), the Department of Water Resources Development (DWRD), the Lusaka Water Supply and Sanitation Company (LWSC) and the German Federal Institute of Geosciences and Natural Resources (BGR), has developed a generic delineation model that provides a straightforward step-by-step approach that can be applied regardless of the availability of data. Additionally, a more detailed, scientific approach concerning the geological and hydrogeological setting of an area has been included in the guideline. It provides information on the data to be collected and the methods to archive a more detailed and customised groundwater protection strategy for a specific area.

Keywords: groundwater resources, groundwater protection, sustainability

Ngobe, T., Gomo, M. Transboundary issues on groundwater management in rural areas: A case study of Eswatini.

Transboundary Aquifers have increasingly become a global centre of attention for many researchers. However, few efforts have been made to improve the understanding of local groundwater transboundary issues where an aquifer is shared between two or more

subnational boundaries (communities/villages/ constituencies). Groundwater in the rural areas is still treated as a localised resource. As a result, several factors are not included in groundwater management in rural areas. Such factors include the groundwater recharge and delineation of protection zones around the source and recharge zones. Using Eswatini as a case study, the research provides an overview of these factors and discusses their implication for sustainable groundwater management in typical African rural areas. These factors compromise sustainable resource management and may contribute to the failure of the rural groundwater supply systems. Approaches that can be applied to advocate for change in groundwater management in rural areas are highlighted.

Keywords: contamination, groundwater recharge, Eswatini, borehole radius of influence, rural groundwater supply, transboundary aquifers

Pietersen, K., Sauramba, J. Catalysing sub-national institutions in transboundary governance and management

Much focus has been on the aquifer scale assessment of transboundary aquifer systems and their institutional arrangements, but sub-national institutions (formal and informal) have received less attention for prioritising cross-border implications. Creating an enabling environment for shared aquifer management through policy, legal and regulatory frameworks is one of the Southern African Development Community—Groundwater Management Institute (SADC GMI) aims. The work to support institutional building includes baseline assessments, strategic action planning through stakeholder engagements (focus group discussions and key informant interviews), gender equality and social inclusion (GESI) assessments, and the setting of groundwater institutions at the international, national, and sub-national levels. The findings show that the current data, information and knowledge on local groundwater conditions are inadequate for reliable diagnostics and optimal decisions regarding groundwater resources management policy and measures. The provisions for stakeholder participation at the sub-national levels in policy and legislation have not been enacted as a reflection of limited awareness of groundwater. The neglected role of sub-national institutions results in TBA priority settings weakly aligned with integrated development plans.

Keywords: sub-national institutions, governance mechanisms, transboundary aquifers

Stuurmann, H., Muchingami, I., Hamutoko, J. Citizen science as a tool for enhancing sustainable groundwater use in the arid IlKharas Region of Namibia

Citizen Science practice has gained momentum over the past decade, particularly in different fields of natural sciences, including groundwater research. The associated benefits include voluntary stakeholder participation, technical and scientific engagements and capacity building. This study presents the integration of the stakeholder engagement and citizen science approach towards sustainable groundwater resource utilisation and management for vulnerable rural populations in the arid IlKharas of Namibia. Preliminary results from a semi-structured needs assessment indicated quantitative and qualitative statistical outcomes, with interest in local water supply, groundwater availability, protection, volunteerism and citizen science in the 13 village communities dependent on groundwater. In conclusion, the study shows an intercorrelation between the availability and accessibility of groundwater and the nomadic culture of vulnerable communities. While demonstrating the significance of water access, its impact on resilience to drought and advancing sustainability through minimising water waste and maximising groundwater use in the region. Citizen science.

Keywords: Kharas region, groundwater-dependent communities

Tshingana, R. Adopting innovative governance structures in the Democratic Republic of Congo (DRC).

The key to groundwater management success in the DRC lies in its ability to calibrate international examples to its realities, such as water management by watershed in France or water sharing agreements in the Nile basin, which offer inspiring perspectives for the DRC. These models highlight the importance of participatory governance and highlight integrated water resources management strategies that could be adapted to the Congolese context. This could involve strengthening local capacities in water management, developing strategic partnerships with key players internationally, and investing in research and development to support innovative solutions tailored to specific challenges in the country. By adopting and/or improving innovative (existing) governance structures, the DRC can expect many benefits, such as improved resilience to extreme climate events, improved management, and enhanced regional cooperation on water issues. A commitment to these innovations promises to improve water management in the DRC and serve as a model for other nations facing similar challenges.

Keywords: institutional infrastructure, groundwater management