GROUNDWATER MANAGEMENT INSTITUTE

Enhancing Water and Food Security through Sustainable Groundwater Development in the SADC Region

3RD SADC GROUNDWATER CONFERENCE

24-26 NOVEMBER 2020

ENHANCING WATER AND FOOD SECURITY THROUGH SUSTAINABLE GROUNDWATER DEVELOPMENT IN THE SADC REGION

CONTENTS

WELCOME NOTE

JAMES SAURAMBA (SADC-GMI EXECUTIVE DIRECTOR)

Colleagues, partners and stakeholders, on behalf of the Organising Partners and the SADC-GMI Board, it is a privilege and honour to welcome you all to the 3rd Annual SADC Groundwater Conference. Due to the Covid-19 pandemic which has imposed restrictions on travel and physical gatherings, for the first time in our annual routines, this year the conference is hosted virtually under the theme "Enhancing Water and Food Security through Sustainable Groundwater Development in the SADC Region". The Covid–19 pandemic has transformed the entire world and forced us to adapt to new ways of engagement. We have adapted ourselves to embrace the new normal and continue with our engagements.

Water, energy, food and ecosystems are interlinked and require a joint planning in order to meet the daunting regional challenges related to water, energy and food security, and maintaining ecosystems' health and in this way reaching the Sustainable Development Goals (SDGs).

One thing we can never deny is that water is key to food security. This conference provides us with another opportunity to deliberate more on how to enhance water and food security through sustainable groundwater development in the region, especially in the face of climate change which has a negative impact on water and food security, not only in the SADC region but globally. If not effectively and strategically dealt with, the world will not be able to meet the demand for water, energy and food in the not too distant future.

Enhancing the contribution of groundwater in the Water, Energy, Food and Ecosystems (WEFE) Nexus requires that the understanding of hydrogeological systems is enhanced, the role of information systems in managing groundwater is brought to the fore, and groundwater governance frameworks are enhanced at both national and regional levels.

This conference seeks to advocate for a more central and pronounced role for groundwater in the WEFE Nexus dialogue as a way of minimising shocks, risks and vulnerability to climate change. The conference is aimed at rallying Africa's water sector towards a common voice as the world prepares for the 9th World Water Forum (9WWF) to be held in Dakar, Senegal in March 2021.

Our conference is organised into three sub-themes that speak directly to the contribution of groundwater to the enhancement of water and food security in the region. We are excited that the complexity and multi-dimensional nature of the conference discussions that we have assembled around highly accredited keynote speakers will talk to fundamental issues that relate to the role of groundwater resources in enhancing water and food security in the region, and the need for reliable groundwater data and information for tracking progress towards enhanced food security.

We are particularly honoured to have you gracing this special event and exchanging views and experiences with you. We also remain grateful to our organising partners and sponsors who continue to support us in making this event a reality during our relatively short history.

Thank you all for taking time to attend the 3rd SADC Groundwater Conference and I wish you all fruitful deliberations.

Mr James Sauramba
SADC-GMI Executive Director

MOT DE BIENVENUE DU DIRECTEUR EXÉCUTIF DE LA SADC-GMI

M. JAMES SAURAMBA

Chers collègues, partenaires et parties prenantes, au nom des partenaires organisateurs et du conseil d'administration de la SADC-GMI, c'est un privilège et un honneur de vous accueillir à la troisième conférence annuelle de la SADC sur les eaux souterraines. A cause de la pandémie de Covid-19 qui a imposé des restrictions sur les voyages et les rassemblements physiques, pour la première fois dans nos routines annuelles, cette année la conférence est accueillie virtuellement sous le thème « Améliorer la sécurité hydrique et alimentaire par le développement durable des eaux souterraines dans la région de la SADC ». La pandémie de Covid-19 a transformé le monde entier et nous a obligés à nous adapter à de nouveaux modes d'engagement. Nous nous sommes adaptés à la nouvelle normalité et poursuivons nos engagements.

L'eau, l'énergie, l'alimentation et les écosystèmes sont liés et nécessitent une planification commune afin de relever les défis régionaux redoutables liés à la sécurité hydrique, énergétique et alimentaire, et de maintenir la santé des écosystèmes et d'atteindre ainsi les ODD.

Une chose que nous ne pouvons jamais nier, c'est que l'eau est fondamentale à la sécurité alimentaire. Cette conférence nous offre une nouvelle occasion de débattre davantage sur la manière de renforcer la sécurité hydrique et alimentaire par le développement durable des eaux souterraines dans la région, en particulier face au changement climatique qui a un impact négatif sur la sécurité hydrique et alimentaire, non seulement dans la région de la SADC mais aussi dans le monde entier. Si cette question n'est pas traitée efficacement et stratégiquement, le monde ne sera pas en mesure de répondre à la demande en eau, en énergie et en nourriture dans un avenir pas si lointain.

L'amélioration de la contribution des eaux souterraines dans le cadre du lien entre l'eau, l'énergie, l'alimentation et les écosystèmes (EEAE) nécessite de mieux comprendre les systèmes hydrogéologiques, de mettre en avant le rôle des systèmes d'information dans la gestion des eaux souterraines et d'améliorer les cadres de gouvernance des eaux souterraines aux niveaux national et régional.

Cette conférence vise à plaider pour un rôle plus central et plus prononcé des eaux souterraines dans le dialogue de la relation EEAE afin de minimiser les chocs, les risques et la vulnérabilité au changement climatique. La conférence vise à rallier le secteur africain de l'eau à une voix commune alors que le monde se prépare au neuvième forum Mondial de l'eau (9WWF) qui se tiendra à Dakar, au Sénégal, en mars 2021.

Notre conférence est organisée en trois sous-thèmes qui traitent directement de la contribution des eaux souterraines à l'amélioration de la sécurité hydrique et alimentaire dans la région.

Nous sommes ravis que la complexité et la nature multidimensionnelle des discussions de la conférence que nous avons rassemblées autour d'orateurs hautement accrédités aborderont des questions fondamentales liées au rôle des ressources en eaux souterraines dans l'amélioration de la hydrique et sécurité alimentaire dans la région, ainsi qu'à la nécessité de disposer de données et d'informations fiables sur les eaux souterraines pour suivre les progrès réalisés en matière de sécurité alimentaire.

Nous sommes particulièrement honorés de vous accueillir pour cet événement spécial et d'échanger avec vous vos points de vue et vos expériences. Nous sommes également reconnaissants à nos partenaires organisateurs et à nos sponsors qui continuent à nous soutenir pour faire de cet événement une réalité au cours de notre histoire relativement courte.

Je vous remercie tous d'avoir pris le temps d'assister à la troisième conférence de la SADC sur les eaux souterraines et je vous souhaite à tous des délibérations fructueuses.

M. James Sauramba
Directeur Exécutif SADC-GMI

NOTA NOTA DE BOAS VINDAS DO DIRECTOR EXECUTIVO DA SADC-GMI

MR JAMES SAURAMBA

Colegas, Parceiros e Partes Intervenientes, em nome dos Parceiros Organizadores e do Conselho da SADC-GMI, é um privilégio e uma honra dar-vos a todos as Boas Vindas a 3ra Conferencia Anual de Agua Subterrânea da SADC. Devido a pandemia da Covide-19, que impôs restrições em viajar e reuniões físicas, pela primeira vez nas nossas rotinas anuais, este ano a conferencia é alojada virtualmente sobre o tema " Aumentar a Segurança Hídrica e Alimentar através do Desenvolvimento Sustentável das Aguas Subterrâneas na Região da SADC."

A pandemia Covide–19 transformou o mundo inteiro e forçou-nos a adaptarmo-nos a novas formas de envolvimento. Tivemos todos que nos adaptar para podermos aceitar uma vida normal nova e continuarmos com os nossos compromissos. Agua, energia, alimentos e ecossistemas são interligados e requerem planeamento em conjunto com água. Afim de responder aos assustadores desafios regionais relacionados com água, energia, segurança alimentar, saúde e mantendo os ecossistemas' e desta forma alcançar os SDGs.

Uma coisa que não podemos negar é que a água é a chave da segurança alimentar. Esta conferencia oferece-nos outra oportunidade de podermos deliberar mais sobre como melhorar a água e a segurança alimentar através do desenvolvimento sustentável da água subterrânea na região, especialmente encarando as alterações climáticas as quais tem impacto negativo na água e na segurança alimentar, não só na região da SADC mas também a nível global. Se não for enfrentado de uma forma eficaz e estratégica, o mundo não será capaz de atender à demanda de água, energia e alimentos num futuro não muito distante.

Melhorar a contribuição da água subterrânea nos Ecossistemas de Água, Energia e Alimentos (WEFE) Nexus requer que os conhecimentos sobre os sistemas hidrológicos sejam realçados e o papel dos sistemas de informação na gestão das águas subterrâneas seja trazido para o primeiro plano e as estruturas de governança das águas subterrâneas aprimoradas nos níveis nacional e regional.

Esta conferencia procura defender um papel mais central e pronunciado para as águas subterrâneas no diálogo WEFE Nexus como uma forma de minimizar choques, riscos e vulnerabilidade nas mudanças climáticas. A conferencia visa reunir o sector de água da África numa voz comum enquanto o mundo se prepara para a 9no Fórum Mundial de Água (9WWF) em Dakar, Senegal em Março de 2021.

A nossa conferencia está organizada em três subtemas que falam directamente sobre a contribuição das águas subterrâneas para melhoria da segurança hídrica e alimentar na região.

Estamos entusiasmados com a complexidade e natureza multidimensional das discussões da conferencia que reunimos em torno de oradores importantes altamente credenciados que falarão sobre questões fundamentais relacionadas com o papel dos recursos hídricos subterrâneos no aumento da segurança hídrica e a necessidade de dados e informações confiáveis sobre a água subterrânea para monitorar o progresso em direcção a uma maior segurança alimentar.

Sentimo-nos particularmente honrados por tê-lo agraciado com este evento especial e trocar opiniões e experiencias consigo. Também reafirmamos a nossa gratidão aos nossos parceiros organizadores e patrocinadores que continuam a nos apoiar para tornar este evento uma realidade durante a nossa relativamente curta historia.

Obrigado a todos por terem tempo para participarem na 3ra Conferencia da Agua Subterrânea da SADC e desejo-vos deliberações frutíferas.

Sr. James Sauramba
SADC-GMI Diretor Executivo

KEYNOTE SPEAKERS

DR KAREN G. VILLHOLTH

Principal Researcher, Coordinator – Groundwater IWMI, International Water Management Institute, South Africa. Coordinator of GRIPP

Karen G. Villholth is Principal Researcher at International Water Management Institute (IWMI, Southern Africa - Pretoria, South Africa. She heads up the Groundwater Program at IWMI and coordinates the Groundwater Solutions Initiative for Policy and Practice (GRIPP), a global partnership of 30 international organizations supporting sustainable development, use and management of groundwater. Karen G. Villholth has more than 25 years' experience in water research and management. She is Principal Researcher at International Water Management Institute (IWMI, Southern Africa - Pretoria, South Africa. She heads up the Groundwater Program at IWMI and coordinates the Groundwater Solutions Initiative for Policy and Practice (GRIPP), a global partnership of 30 international organizations supporting sustainable development, use and management of groundwater. Her portfolio embraced significant interdisciplinary approaches and partnerships in groundwater, with the aim to make groundwater science relevant and applicable and useful for decision makers, primarily in developing countries, with a particular focus on groundwater for food prodcution. Examples of partnerships include the African Minister's Council on Water (AMCOW) Pan-African Groundwater Program, Sustainable Water Future Program under Future Earth, Friends of Groundwater under UNEP's World Water Quality Program, the SuSanA Network on Sanitation, Advisory Committee for the Groundwater Project, Expert Group under FAO on Environmental Flows supporting SDG 6.4.2 FAO, Expert Group under UNECE on Handbook on Water Allocation in Transboundary Context, Global Groundwater Sustainability Statement and Call to Action, UN-Water Task Force on Unconventional Water Resources under UNU-INWEH, African Groundwater-Network, Rural Water Supply Network, etc. More information:
https://www.iwmi.cgiar.org/about/staff-list/karen-villholth/

DR KEVIN PIETERSEN

L2K2 Consultants (Pty) Ltd and Institute for Water Studies, University of the Western Cape

Dr Kevin Pietersen has over twenty-five years of experience in the groundwater field. He is an Extraordinary Senior Lecturer at the Institute for Water Studies at the University of the Western Cape and was formerly Director of SLR Consulting (South Africa), a leading international environmental consultancy, in South Africa. He has served as the president of both the Geological Society of South Africa and the Water Institute of Southern Africa. He has served as a specialist consultant for many prominent organisations, including the United Nations, the European Union, the World Bank, Southern African Development Community (SADC) and the SADC Groundwater Management Institute. He is currently the team leader for the consultancy services for Water Resources Management Research in the Eastern Kalahari Karoo Basin Transboundary Aquifer funded by the SADC-GMI. He is also the team leader for the Consultancy Services Assessment of Groundwater Resources Development Priority Intervention Areas in the SADC Region. He was also the Team Leader for the compilation of the SADC Hydrogeology Map. He holds a PhD in Hydrogeology from the University of the Western Cape in South Africa.

TECHNICAL COMMITTEE OF THE CONFERENCE:

Dr Kevin Pietersen: University of the Western Cape, South Africa

Professor Piet Kenabatho: University of Botswana

Professor Modreck Gomo: Institute for Groundwater Studies, University of the Free State, South Africa

Dr Kirsty Upton: British Geological Survey, the United Kingdom

Mr Brighton Munyai: SADC- GMI South Africa

Dr Karen Villholth: International Water Management Institute (IWMI), South Africa

Ms Raquel Sousa: International Groundwater Resources Assessment Centre (IGRAC), The Netherlands

Ms Winnie Kambinda: SLR, Namibia

Dr Kawawa Banda: University of Zambia

Mr James Sauramba: SADC- GMI South Africa

Mr Bertram Swartz: Ministry of Agriculture, Water, and Land Reform, Namibia

Ms Franziska Wende: BGR, Germany

Mr Brighton Munyai: Conference Rapporteur

Having trouble joining the **Online Conference**?

CLICK HERE FOR ASSISTANCE

3rd SADC Groundwater Conference - Day 1

Tuesday 24 November 2020

DAY 1 – PROGRAMME MANAGER – FEDZISANI RAMUSIYA (DWS-SOUTH AFRICA)	
08:00-08:30	**Registration of participants**
08:30-09:15	**Official opening programme** **Facilitator:** Phera Ramoeli Official opening: • Welcome by the Executive Director of the SADC-GMI • SADC Secretariat • Chair of SADC (Mozambique)
09:15–09:35	**Opening Keynote Address:** Dr Kevin Pietersen
09:35-09:45	**COMFORT BREAK**
Sub-theme 1: Sustainable Groundwater Use for a Food Secure SADC region	
	Session Chair: Piet Kenabatho **Rapporteur:** Modreck Gomo
09:45-10:00	Hector Chilimani, Muthi Nhlema, Steve Kumwenda, Given Nyasulu, Edward Maferano, Nicholas Mannix, Shaun MacLeod, Jamie Rattray, Helen Robinson and Robert Kalin. **'Doing So Much More'- Maximizing Artesian Groundwater for Community-Led Sustainable Agriculture: A Case Study from the Jordani Project, Malawi.**
10:00-10:15	Vanessa Lusuekikio. **The Hydrochemical characterization of Otavi dolomite aquifer, Northwest Namibia.**
10:15-10:30	Syed Md Touhidul Mustafa, Oluwaseun Franklin Olabode, Luis Artur, Zareen Bharucha, Annatoria Chinyama, Farisse Chirindja, Rosie Day, Fulvio Franchi, Josie Geris, Stephen Hussey, Edward Nesamvuni, Alcino Nhacume, Alfred Petros, Hanne Roden, Melanie Rohse, Sithabile Tirivarombo, Anne Van Loon and Jean-Christophe Comte. **Increasing resilience to floods and droughts in the Limpopo river basin: development of a basin scale hydrological model to support sustainable groundwater management.**
10:30-10:45	Marcus Fahle and Mumba Kolala. **Trends of irrigated land in the Kafulafuta Catchment and Mpongwe Karst, Zambia, in recent years.**
10:45-11:00	Mabvuso Christopher Sinda, Kawawa Banda and Richard Owen. **Preliminary investigation of Ground Water Response to Conservation Agriculture Practices on Maize-Legume Intercrop Systems.**
11:00-11:20	**QUESTION AND ANSWER SESSION**
11:20-11:35	**COMFORT BREAK**
	Session Chair: Trevor Shongwe **Rapporteur:** Sivashni Naicker
11:35-11:50	Daina Mudimbu, Kawawa Banda, Christopher S. Mabvuso, Willy Namaona, Richard Owen, Bentje Brauns, Dan J. Lapworth and Alan M. MacDonald. **Review of comparative studies on estimating groundwater recharge under conservation agriculture versus conventional tillage**
11:50-12:05	Zaheed Gaffoor, Ashley Gritzman, Kevin Pietersen, Nebo Jovanovic, Antoine Bagula and Thokozani Kanyerere. **Localising transboundary data sets using Big Data Analytics : A case study of the Ramotswa/NW Dolomitic aquifers.**
12:05-12:20	Lars Skov Andersen, **Significant danish advances in groundwater management and use**
12:20-12:35	Kwazikwakhe Majola, Yongxin Xu and Thokozani Kanyerere, **Reviewing the assessment of impacts of global change on groundwater-dependent ecosystems in reference to the Tuli-Karoo transboundary aquifer.**
12:35-12:50	Shoopala Uugulu and Heike Wanke. **An isotopic study of groundwater at Waterberg, Namibia**
12:50-13:00	**QUESTION AND ANSWER SESSION**
13:00-13:30	**LUNCH**

SPECIAL SESSION: KNOWLEDGE SHARING WORKSHOP FOR FOCAL POINTS AND RBOS/TBAS: DISSEMINATION OF LESSONS LEARNT FROM STAMPRIET AND RAMOTSWA TRANSBOUNDARY AQUIFERS **Session Chair:** Brighton Munyai **Session Rapporteur:** Muchaneta Munamati	
13:30-13:40	Brighton Munyai: **Welcome remarks**
13:40-14:00	Prof Piet Kenabatho, University of Botswana **- Overview of the GRETTA Phase 1 and 2**
14:00-14:30	Dr Alice Aureli, Chief Groundwater Systems and Settlements Section, UNESCO – IHP **Overview of the GGRETA Phase 3.**
14:30-14:50	**Panel Discussion: Lessons learnt from GGRETA Phase 2: Discussion with National Coordinators.** Moderated by James Sauramba
14:50-15:40	**Panel Discussion:** **How to replicate lessons learnt from STAS in other RBOs/TBAs** **Panel: IGRAC, IWMI, Hans Beekman, SADC-Secretariat, South Africa, ORASECOM, ZAMCOM.** Moderated by Brighton Munyai
15:40-16:00	**James Sauramba: Conclusions of the workshop and way forward**

3rd SADC Groundwater Conference - Day 2

Wednesday 25 November 2020

DAY 2 – PROGRAMME MANAGER – MICAH MAJIWA (SADC-GMI)	
Sub-theme 2: The Climate Change Challenge for Urban Water and Food Security: Threats and the Role of Groundwater	
08:30-08:45	Jessie Mzati Kanyerere and Sumaya Israel. **Assessing the Effectiveness of Groundwater Remediation Technology to Improve Water Security in Urban Coastal Aquifers.**
08:45-09:00	Silas David, **Production Boreholes water quality evaluation using GIS based Geostatistical algorithms in Windhoek**
09:00-09:15	Raquel Sousa, Arnaud Sterckx, Stefan Siepman, Richard Taylor, James Jackson and John Thompson: **The Groundwater Game – a serious game to foster a shared understanding of sustainable and equitable groundwater management**
09:15-09:30	Lindelani Lalumbe and Thokozani Kanyerere. **Assessing concentration level of contaminants in groundwater in the Soutpansberg region, South Africa.**
09:30-09:45	Laurica Afrikaner, Liberty Moyo and Elise Mbandeka. **Evaluation of temporal and spatial variations of groundwater quality of the Swakop-upper Omatako Basin in Namibia.**
10:00-10:20	**QUESTION AND ANSWER SESSION**
10:20-10:30	**COMFORT BREAK**
Sub-theme 2: The Climate Change Challenge for Urban Water and Food Security: Threats and the Role of Groundwater	
	Session Chair: Kawawa Banda **Rapporteur:** Lindelani Lalumbe
10:30-10:45	Nadia Chambal, Paulo Saveca and Cesário Cambaza, **Evaluation of hydrochemical processes and groundwater quality in the dry bed of the Limpopo River for agricultural irrigation in Macarretane, Mozambique.**
10:45-11:00	Ndubuisi Igwebuike, Innocent Muchingami, Nebojsa Jovanovic and Thokozani Kanyerere. **Using hydrogeophysics and derivatives analyses for improved groundwater security, Western Cape, South Africa.**
11:00-11:15	Lindelani Lalumbe and Fhedzisani Ramusiya. **Groundwater quality status in South Africa for SDG 6.3.2: A case study of the Free State Province.**
11:15-11:30	Kevin Pietersen, Maryna Storie, Verno Jonker, Traci Reddy, Deepti Maharaj, Chiedza Musekiwa, Zaheed Gaffoor, Anya Eilers and Erika Braune. **Assessment of Groundwater Resources Development Priority Intervention Areas in the Southern African Development Community (SADC) Region.**

11:30-11:45	Chiedza Musekiwa, Zaheed Gaffoor, Kevin Pietersen and Luc Chevallier. **Revising the Groundwater Drought Risk Map: Role of GRACE data in mapping groundwater drought in the Southern African Development Community.**
11:45-12:05	**QUESTION AND ANSWER SESSION**
12:05-12:15	**COMFORT BREAK**
	Session Chair: Kasonde Mulenga **Rapporteur:** James Manda
12:15-12:30	Silas David. **Evaluation of Interpolation Methods for mapping pH for Windhoek Municipal Boreholes.**
12:30-12:45	Abongile Xaza, Thokozani Kanyerere and Sumaya Israel. **Application of integrated geochemical approach to evaluate hydrogeochemical processes influencing groundwater quality, Western Cape, South Africa.**
12:45-13:00	Sivashni Naicker and Sue Janse van Rensburg, **Maputaland – The Perfect Storm.**
13:00-13:15	Thandilizwe Bengeza. **The use of basement water in urban areas.**
13:15-13:30	**QUESTION AND ANSWER SESSION**
13:30-14:00	**LUNCH**
SPECIAL SESSION: GROUNDWATER FOR FOOD IN AFRICA – CURRENT OPPORTUNITIES AND CHALLENGES	
14:00-14:20	Karen Villholth (IWMI). **Groundwater for Food in Africa – Aiming for Sustainability and Equity**
14:20-14:40	Riccardo Biancalani/ Livia Peiser (FAO). **The food-water-energy nexus: the role of technology in the management of groundwater resources**
14:40-15:00	Moshood Tijani and Paul Orengo (AMCOW). **AMCOWs Pan-African Groundwater Program – Addressing Food Security**
15:00-15:20	Marcus Wijnen, Aleix Serrat-Capdevila, Natalia Limones Rodríguez, Javier Marzo Artigas, and Bruno Petrucci (World Bank and University of Sevilla). **Water for Food in Central and Southern Angola - Role of Groundwater.**
15:20-15:40	Barbara van Koppen (IWMI). **Recognizing customary water tenure in groundwater development and regulation to achieve the Sustainable Development Goals in Africa**
15:40-16:00	Open Discussion

3rd SADC Groundwater Conference - Day 3

Thursday 26 November 2020

DAY 3 – PROGRAMME MANAGER – MWANYIKA MWANAMUKUU

Sub-theme 3: Enhancing the Contribution of Groundwater in the WEFE Nexus through Effective Groundwater Governance at National and Transboundary level

	Session Chair: Fedzisani Ramusiya **Rapporteur:** Mkhuzo Chongo
08:30-08:45	Luigi Simeone, **The Compilation of a Geodatabase from the Hydrogeological Map of Lesotho**
08:45-09:00	Ester Gustavo and Winnie Kambinda, **Groundwater management tools that enhance the role of groundwater governance in water supply and security in Namibia.**
09:00-09:15	**Rennie Chioreso, Bertram Swartz and Ramon Brentführer. The Country Support Tool: A process to increase the contribution of groundwater to economical development and livelihoods in Africa.**
09:15-09:30	Vuyelwa Mvandaba, Evison Kapangaziwiri and Justinus Shadung. **Assessment of wastewater pollution of water resources in the Cradle of Humankind World Heritage Site, South Africa.**

09:30-09:45	Andersen, M., Aureli, A., Blake, D., Boving, T., Chambel, A., Delaire, C., Dottridge, J., Duerr, H., Hartog, N., Jawitz, J., Kebede Gurmessa, S., Klingbeil, R., Kreamer, D., Kukuric, N., Lapworth, D., Liu, J., Lytton, L., Misstear, B., Ouedraogo, I., Podgorski, J., Poulin, C., Qadir, M., Riemann, K., Ruz Vargas, C., Scrinzi, L., Simmons, C., Smedley, P., Villholth, K., Wagner, F. **Groundwater Quality within the World Water Quality Assessment and its Relevance for the SADC Region.**
09:45-10:00	**QUESTION AND ANSWER SESSION**
10:00-10:10	**COMFORT BREAK**
SPECIAL SESSION: MAINSTREAMING WATER AND FOOD SECURITY INTO TRANSBOUNDARY WATER COOPERATION	
10:10-10:20	**IUCN Alejandro Iza** - Welcoming words
10:20-10:40	**IUCN Water Programme** - The need for practical approaches to ensure water and food security
10:40-11:00	**IUCN Environmental Law Centre** - Ensuring environmental conservation, peace and regional integration in transboundary river basins.
11:00 -11:40	**IUCN** - Guided interactive discussion on the need for cooperation to ensure water and food security (Includes guiding questions).
11:40-12:00	**IUCN** - Reflections on the guided discussions (Building a way forward to address water and food security).
12:00-12:10	**IUCN** - Closing remarks.
12:10-12:40	**LUNCH BREAK**
SPECIAL SESSION: CROSS-LEARNING ON SHARED GROUNDWATERS: THE TULI KAROO AND EASTERN KALAHARI KAROO AQUIFERS **Session Chair:** Emmanuel Magombeyi **Session Rapporteur:** Micah Majiwa	
12:40-12:55	Brighton Munyai - **Welcome and Framing**
12:55-13:25	**Projects and TDA** Jonathan Lautze **- Tuli Karoo Transboundary Aquifer – TDA** Hans Beekman **- Eastern Kalahari - Karoo Transboundary Aquifer – Transboundary Diagnostic Analysis**
13:25-13:55	**Hydrogeology and Monitoring** Sam Sunguro **- Hydrogeology of the Eastern Kalahari-Karoo Transboundary Aquifer** Girma Ebrahim **- Designing a Groundwater Monitoring Network for the Tuli Karoo**
13:55-14:25	**Lessons Learned Panel Discussion** Moderated by Patience Mukuyu and Kevin Pietersen **Panellists: Brief intro and profile of each panellist by moderators then round of specific questions (5 mins each) followed by 15 minutes Q&A discussion etc.** • **Zione Uka** (Ministry of Agriculture, Irrigation, and Water Development - Malawi) – Experience on developing the SAP for the Shire Basin • **Rapule Pule** (ORASECOM) - Modalities for transboundary aquifer assessments in RBOs institutional arrangements? • **Piet Kenabatho** (University of Botswana) Common features and interventions across the, Eastern Kalahari, Stampriet, Tuli Karoo TBAs • **Leonard Magara** (CRIDF) – Planning integrated groundwater monitoring and development in Zimbabwe – Tuli Karoo
14:25-14:40	**Jonathan Lautze** - Final thoughts and Thank you
14:40-14:50	**COMFORT BREAK**
	CLOSURE PROCEEDINGS **Facilitators: Bertram Swartz**
14:50-15:05	M. Gomo Publication Consideration.
15:05-15:20	Chief Conference Rapporteur: Overview of the 3rd SADC-GMI Conference.
15:20-15:30	Vote of Thanks: SADC Secretariat

Sub-theme 1: Sustainable Groundwater Use for a Food Secure SADC Region

'Doing so much more' - maximising artesian groundwater for community-led sustainable agriculture: a case study from the Jordani project, Malawi

Authors: *Muthi Nhlema[1], *Hector Chilimani[1], Steve Kumwenda[1], Given Nyasulu[1], Edward Maferano[1], Nicholas Mannix[2], Shaun MacLeod[2], Jamie Rattray[2], Helen Robinson[2], Robert Kalin[2]*

Correspondence: *hector@baseflowmw.com*

Keywords: *groundwater; artesian borehole; sustainable agriculture; ecosystems services; multiple-use*

Abstract

STATEMENT OF THE PROBLEM

Malawi has 33 artesian wells that are flowing, non-stop, without remediation. This contravenes the Water Resources Act of 2013 which requires every artesian borehole be efficiently cased, capped or furnished with proper flow controlling mechanisms. Artesian flows are often celebrated, as they give the appearance of unlimited supply of water. However, there are significant problems associated with allowing artesian boreholes to flow uncontrolled including depletion of groundwater resources causing neighbouring boreholes to dry up and huge volumes of water being wasted rather than being utilised for productive purposes.

OBJECTIVE

BASEflow and University of Strathclyde embarked on a project in Jordani village in Malawi to provide an exemplar of how artesian water, once controlled, could be maximised for sustainable agriculture. Jordani's artesian well had been flowing, uncontrolled, since 2007.

METHODOLOGY

The Jordani project combined a chronology of technical and social development approaches, done in collaboration with local government, which included:

- Full borehole forensics assessment;
- Artesian well remediation and well-head construction;
- Community training and engagement;
- Community-run sustainable agriculture activities;
- Artesian pressure checks;
- Developmental evaluation of project's social sustainability.

RESULTS

The Jordani artesian well was successfully capped registering a pressure of 0.75 bar after capping completion, though subsequent months saw a significant decline to as low as 0.2 bar. Additionally, the community engagement work, despite intra-community frictions, registered positive outcomes including construction of 3 fish farms (one with community's own resources), an irrigation scheme, and a water kiosk. The community is currently in the process of registering as a cooperative with the Ministry of Trade.

CONCLUSION

The Jordani project has provided valuable lessons regarding the nexus between the technical and the social aspects of community-run ecosystems services. These lessons provide a robust foundation for shaping a replicable intervention design for Malawi's artesian boreholes.

[1] BASEflow, P.O. Box 30467, Blantyre, Malawi

[2] Department of Civil & Environmental Engineering, University of Strathclyde, Glasgow G1 1XJ, UK

Sub-theme 1: Sustainable Groundwater Use for a Food Secure SADC Region

The hydrochemical characterisation of Otavi Dolomite Aquifer, northwest Namibia

Authors: *VJ Lusuekikio[1] F Soetaert[2]*
Correspondence: *vanessalusuekikio@hotmail.com; fanny.soetaert@total.co.za*

Abstract

Namibia has been battling drought and water scarcity for decades, which threatens the Namibian population and the environment.

Namibia is still mostly sustained by groundwater. An area like Northwest Namibia, with a low mean annual rainfall ranging from 200 mm/a to 350 mm/a, and evaporation rates as high as 3000 mm/a requires better water infrastructure to accommodate its growing population. Therefore, it is crucial to study and understand the mechanisms that govern the groundwater.

A hydrogeochemical characterisation was conducted in Northwestern Namibia in order to understand groundwater dynamics. The water quality is not frequently assessed nor are there sustainable measures managing the use of these water sources. The objectives of the study were to characterise the groundwater chemistry in the study area and utilise hydrogeochemical techniques to suggest a possible water flow direction, additionally, to analyse and understand the spatial variations in water quality of the Otavi dolomite aquifer.

A total of 23 samples were collected and analysed for major anions with titration and ion chromatography, and for major cations with inductively coupled plasma optical omission spectrometry (ICP-OES). Bicarbonate and sulphate are the dominating anions, whereas the dominant cations are dominated sodium and calcium. Groundwater is mostly fresh with the following ranges: 6.49-7.54 pH, 561-1121 mg/L of TDS, and 0.62-7.38 mg/L of dissolved oxygen and it flows from the East to the West. The result attained from this study will provide an essential baseline for future studies in the area and other areas with similar hydrogeological characteristics. Additionally, the results can contribute to the construction of sustainable groundwater schemes.

Sub-theme 1: Sustainable Groundwater Use for a Food Secure SADC Region

Increasing resilience to floods and droughts in the Limpopo River Basin: development of a basin scale hydrological model to support sustainable groundwater management

Authors: *[*]Syed Md Touhidul Mustafa[1], Oluwaseun Franklin Olabode[1], Luis Artur[2], Zareen Bharucha[3], Annatoria Chinyama[4], Farisse Chirindja[2], Rosie Day[5], Fulvio Franchi[6], Josie Geris[1], Stephen Hussey[7], Edward Nesamvuni[8], Alcino Nhacume[9] , Alfred Petros[10] , Hanne Roden[11] , Melanie Rohse[3], Sithabile Tirivarombo[6], Anne Van Loon[12], and Jean-Christophe Comte[1]

Correspondence: syed.mustafa@abdn.ac.uk

Keywords: Limpopo River Basin (LRB), groundwater management instrument, sustainability, resilience, hydrological extremes

Abstract

The Limpopo River Basin (LRB) is highly vulnerable to hydrological extremes (floods and droughts). Groundwater may play an important role in building resilience to hydrological extremes in the Limpopo River Basin (LRB), as an essential resource for sustainable development and already the primary source of water for more than 70% people in the region. Identification of appropriate water management strategies is important to ensure groundwater sustainability and to improve resilience to hydrological extremes. The objective of this study is to develop a transboundary basin-scale management instrument based on groundwater modelling to identify appropriate management solutions in this context. The groundwater model (MODFLOW) is currently being set-up using the existing hydro(geo)logical monitoring databases and remotely sensed data. Our modelling approach uses an iterative, co-production process to incorporate local and regional expert knowledge in the modelling process through stakeholders' workshops, including communities and governance. After successful model calibration and validation using observed groundwater level data, different management scenarios (e.g. managed aquifer recharge, reservoirs management, and abstraction scenarios) under projected increased in floods and droughts magnitude and frequency will be implemented and evaluated. In order to improve the reliability, accuracy and robustness of the proposed decision support tool, the uncertainty arising from model inputs, including boundary conditions, parameters and conceptual structure, will be quantified using Integrated Bayesian Multi-model Uncertainty Estimation Framework (IBMUEF). Thereby, appropriate sustainable groundwater management strategies will be identified in the LRB along with provision of a reliable decision-support tool to further assist policy makers in long term planning.

[1]University of Aberdeen, United Kingdom
[2] Eduardo Mondlane University, Maputo, Mozambique
[3] Anglia Ruskin University, United Kingdom
[4] National University of Science and Technology, Zimbabwe
[5] University of Birmingham, United Kingdom
[6] Botswana International University of Science & Technology, Botswana
[7] Dabane Trust, Zimbabwe
[8] University of Free State, South Africa
[9] Directorate of Water Supply and Sanitation, Government of Mozambique
[10] Department of Water and Sanitation, Government of Botswana
[11] German Red Cross, Mozambique
[12] Vrije Universiteit Amsterdam, Netherlands

Sub-theme 1: Sustainable Groundwater Use for a Food Secure SADC Region

Trends of irrigated land in the Kafulafuta catchment and Mpongwe Karst, Zambia, in recent years

Authors: *Marcus Fahle[1], Mumba Kolala[2]*
Correspondence: *marcus.fahle@bgr.de*
Keywords: *Irrigation agriculture, Remote Sensing, Upper Kafue Sub-Catchment, Zambia*

Abstract

Before strengthening agrarian economy in SADC countries by extending irrigated areas, an assessment of the existing extent of irrigation is a necessary step to evaluate remaining potential. Remote sensing techniques provide cheap and easy-to-use ways to gain up-to-date information on irrigated land. The objective of our study within the framework of the Groundwater Resources Management Support Programme (GReSP) project was to assess groundwater users in a study area of the Copperbelt Province, Zambia. In the area under investigation, which comprised the Kafulafuta catchment and the Mpongwe Karst area, agriculture is one of the main water users. To estimate irrigation water demand, we first applied freely-available Google Earth and Landsat-8 data to determine areas under irrigation. Secondly, crop water requirements were estimated using Cropwat, applying data for average climatic conditions delivered by the Climwat database. Analysis was conducted for the years 2014 to 2019 in order to determine recent trends. The area under irrigation during this period increased from 50.6 km² to 55.5 km², i.e., by 9.7%. A share of 56.8 % of the irrigated area was sustained by groundwater from the Mpongwe Karst aquifers and a related sinkhole, while 30.1 % and 13.1 % were supplied by the Kafue River and reservoir water, respectively. Total irrigation water demand in 2019 was estimated to be around 55 hm³ per dry season but is subject to high uncertainty. In general, area under irrigation and irrigation water demand is expected to further rise in the study area in the upcoming years as a major water infrastructure within the area, the Kafulafuta Dam, is about to be completed.

[1] Federal Institute for Geosciences and Natural Resources (BGR), Germnay
[2] Water Resources Management Authority, Zambia

Sustainable groundwater use for a food secure SADC region

Authors: *M. C. Sinda[1], K. Banda[2], R. Owen[3], D. Mudimbu[3], B. Brauns[4], D. J. Lapworth[5], A. M. MacDonald[6], W. Namaona[7]*
Correspondence: *mabvuso.sinda@unza.zm*
Keywords: *conservation agriculture, groundwater, groundwater recharge, sub-Saharan Africa*

Abstract

The advent of climate change has resulted in negative impacts on terrestrial water resources in some regions, for instance, increased seasonal variability and more frequent occurrence of flooding and drought which impact negatively on water retention and groundwater recharge. Water availability and reliability are essential for drinking purposes and food security. The linkage of water resources to food security is a function of several factors including access to water, water production functions and field management practices. With regard to the latter, in agriculture, one of the responses to climate change is therefore the promotion of climate resilient agriculture, such as conservation agriculture (CA). CA involves several practices such as zero/minimum tillage, mulching, and early planting, which are considered more water conserving than conventional agriculture because of reductions in evaporation. The prospect of water saving through adoption of CA could unlock water resources for increasing food production or for other uses. While a number of studies have been undertaken on the beneficial effects of CA on soil health, fertility, and soil moisture retention in the upper layers, there is limited data on the impacts of CA practices like conservation tillage on soil moisture propagation into the deeper layers and on how this affects groundwater recharge. To fill this gap, we set up a plot-scale study in three countries (Malawi, Zambia and Zimbabwe) to monitor groundwater recharge and to identify differences in recharge patterns and amount under CA in comparison to conventional tilled fields. The monitoring approach includes different physical monitoring methods, as well the evaluation of hydrochemical and isotopic changes in groundwater at different depth over time. The objective of the study is to quantify measurable effects on groundwater, which arise from adopting CA practices. This presentation intends to present the set-up and preliminary results from the three study sites.

[1] Department of Geology, School of Mines, University of Zambia, P.O. Box 32379, Lusaka, Zambia
[2] Department of Geology, School of Mines, University of Zambia, P.O. Box 32379, Lusaka, Zambia
[3] Department of Civil Engineering, School of Engineering, University of Zimbabwe, Harare, Zimbabwe
[4] British Geological Survey, Keyworth, NG12 5GG, UK
[5] British Geological Survey, Wallingford, OX10 8BB, UK
[6] British Geological Survey, Edinburgh, EH14 4AP, UK
[7] Lilongwe University of Agriculture and Natural Resources, Malawi

Sub-theme 1: Sustainable Groundwater Use for a Food Secure SADC Region

Review of comparative studies on estimating groundwater recharge under conservation agriculture versus conventional tillage

Authors: *D. Mudimbu[1], K. Banda[2], S. Mabvuso[3], W. Namaona[4], R. Owen[5], B. Brauns[6], D. J. Lapworth[7], A. M. MacDonald[8]*

Correspondence: *deemudimbu@gmail.com*

Keywords: *Conservation agriculture, Conventional tillage, Groundwater recharge, Africa, Literature review*

Abstract

Along with the expansion of groundwater-irrigated agriculture, conservation agriculture (CA) is one of the key policies promoted in the SADC region to safeguard and enhance agricultural production because of its positive effects on water conservation and soil fertility. The effects of CA on groundwater recharge however are not clearly understood, and there is a lack of systematic evaluation of research studies that have investigated this topic. To fill this gap, we have undertaken a literature review on comparative groundwater recharge studies on CA versus conventional tillage (CT). Specific attention was given to the methods used for soil water measurements or groundwater fluxes. Infiltration, deep drainage and percolation were used as proxy indicators of potential groundwater recharge where actual recharge estimates were not calculated.

The study yielded 34 manuscripts (22 sites and 12 reviews), and in 55% of the studies, potential groundwater recharge was higher under CA compared to 32% of the studies in which it was higher under CT. 14% of the studies concluded that there was no difference between CA and CT practices. Except for two of the site studies, all reviewed research was based on data collected in the unsaturated zone, combined with a calculation of infiltration rates. This indirect monitoring can lead to an estimation of "potential" recharge to the groundwater rather than "actual" recharge. The review also revealed that results of soil water fluxes in CA treatments are greatly influenced by a number of factors such as the specific combination and degree of the applied CA principles, timing of the data collection, and underlying soil type and climatic conditions. This compounded the challenges of comparing the results of the studies. The key conclusion of our review is that there is a research gap on the influence of CA on groundwater recharge derived from direct monitoring methods.

[1] *Geology Department, Faculty of Science, University of Zimbabwe, Harare, Zimbabwe*

[2] *Department of Geology, School of Mines, University of Zambia, P.O. Box 32379, Lusaka, Zambia*

[3] *Department of Soil Science, School of Agricultural Sciences, University of Zambia, P.O. Box 32379, Lusaka, Zambia*

[4] *Lilongwe University of Agriculture and Natural Resources, Malawi*

[5] *Department of Civil Engineering, School of Engineering, University of Zimbabwe, Harare, Zimbabwe*

[6] *British Geological Survey, Keyworth, NG12 5GG, UK*

[7] *British Geological Survey, Wallingford, OX10 8BB, UK*

[8] *British Geological Survey, Edinburgh, EH14 4AP, UK*

Sub-theme 1: Sustainable Groundwater Use for a Food Secure SADC Region

Localising transboundary data sets using big data analytics: a case study of the Ramotswa/nw dolomitic aquifers

Authors: *Zaheed Gaffoor[1,2], Ashley Gritzman[2], Kevin Pietersen[3], Nebo Jovanovic[1,4], Antoine Bagula[5], and Thokozani Kanyerere[1]
Correspondence: zaheed.gaff@gmail.com
Keywords: Machine learning; Remote sensing; GRACE data; Groundwater levels

Abstract

In the Southern African Development Community (SADC), the beneficial use of groundwater is well documented. However, the sustainable management of groundwater is impacted by a number of issues, that includes the lack of relevant data at a local scale. Big Data Analytics has the potential to generate locally relevant information, through the use of various downscaling applications. In this research, a machine learning model is presented that can generate relatively high resolution maps of groundwater level changes. A Gradient Boosting Decision Tree algorithm is developed that ingest a number of regional scale hydroclimatic (e.g. precipitation, evapotranspiration, GRACE groundwater storage), land surface (e.g. land cover, geology), and groundwater level datasets, to predict 30 days changes in groundwater levels. The model is applied to the Ramotswa/NW Dolomitic aquifer of Botswana and South Africa, where the monthly groundwater level changes are modelled for years 2002 – 2019 across the study area. The results indicate a significant decline in groundwater levels year on year across the study area, which is consistent with actual observed groundwater level changes. The modelled groundwater level changes are validated using actual observed groundwater level changes, where the mean absolute error (prediction error) is ~27cm. This research demonstrates the potential for regional scale datasets, such as from remote sensing and land surface modelling to support sustainable local groundwater management. In addition the potential of Big Data Analytics as a useful tool to leverage large datasets is demonstrated.

[1] Department of Earth Science, University of the Western Cape, Cape Town 7535, South Africa; zaheed.gaff@gmail.com (Z.G.); njovanovic@uwc.ac.za (N.J.); tkanyerere@uwc.ac.za (T.K)
[2] IBM Research, Africa Labs, Johannesburg 2000, South Africa; ashley.gritzman@za.ibm.com (A.G)
[3] Institute for Water Studies, University of the Western Cape, Cape Town 7535, South Africa; kpietersen@mweb.co.za
[4] Council for Scientific and Industrial Research, Stellenbosch 7600, South Africa
[5] Department of Computer Science, University of the Western Cape, Cape Town 7535, South Africa; abagula@uwc.ac.za

Sub-theme 1: Sustainable Groundwater Use for a Food Secure SADC Region

Significant Danish advances in groundwater management and use

Authors: *Lars Skov Andersen[1]*
Correspondence: *chinarm@mail.dk*
Keywords: *Air-borne groundwater survey and mapping, Groundwater-based rural water supply, Nature-based village level wastewater treatment*

Abstract

Denmark often prides itself of having the best groundwater management in the World. This is both a necessity and a virtue, because we rely 100% on groundwater for all our uses and therefore take extreme care in protection of our groundwater. The systematic use of groundwater-based water supply began in Copenhagen in response to the cholera epidemics in the mid 1800's. The modern era started after World War II, when young entrepreneurs in the countryside started production of pumps, valves and meters that have developed into the world-wide brands Grundfos, AVK and Kamstrup. The next major step was taken in response to the EU Water Framework Directive, which came into force in 2000 and demanded mapping of groundwater resources. The Danish response was SkyTEM, a helicopter-borne geophysical method for rapid regional survey and mapping of groundwater aquifers, which in 2005 was used to find pockets of fresh groundwater in the Okavango Delta. Recently, a ground-based version for local mapping and quantification of groundwater resources has been developed and among other places tested in both Tanzania and South Africa. On the supply side, solar-driven submersible pumps were put in the market - outside Denmark - in the 1980's and today supports water-kiosks in many parts of Africa, where the rapidly increasing mobile networks enable mobile payment for water. Another recent advance is Blue Control, which makes it possible to monitor and operate an entire groundwater-based rural water supply system from a mobile phone or tablet.

[1] *China Resources Management*

Sub-theme 1: Sustainable Groundwater Use for a Food Secure SADC Region

Reviewing the assessment of impacts of global change on groundwater-dependent ecosystems in reference to the Tuli-Karoo Transboundary Aquifer

Authors: *Kwazikwakhe Majola[1,2], Yongxin Xu[1,3], Thokozani Kanyerere[1]
Correspondence: MajolaK@dws.gov.za
Keywords: *Groundwater-dependent ecosystems, global change impacts, transboundary aquifers, Tuli-Karoo*

Abstract

The effects of global changes on groundwater-dependent ecosystems (GDEs) are a function of interaction mechanisms between aquifers and their unique hydraulic properties, and ecosystems. It is currently near-impossible to determine the magnitude and direction of impacts of global changes on GDEs, and to adequately protect and achieve integrated management of groundwater resources in southern Africa. This is partly attributed to most impact assessment studies on groundwater not incorporating GDEs. The purpose of this paper is to review existing global knowledge regarding the resilience of GDEs to external shocks in reference to transboundary aquifer (TBA) settings. This includes methods/models, their applicability, and reliability of outputs. Evidently, most assessment studies were conducted on global, regional, and national scales; thus, limiting catchment level decision-making due to shortage of specific information. Many reviewed studies highlighted output uncertainties stemming from e.g. coarse scale Global and Regional Climate Models and (in)compatibility with coupled hydrological models. Numerous studies focused on aquifers along riparian zones, largely disregarding terrestrial GDEs. Therefore, a study has been initiated in the Tuli-Karoo TBA of the semi-arid Limpopo Basin with sub-tropical ecoregion comprising freshwater aquatic and terrestrial ecosystems. The area is characterized by shallow alluvium aquifer systems of the Karoo sandstones and basalts of shallow to medium depths; an environment unique from reviewed studies. Groundwater accessibility to GDEs is defined by flow dynamics driven by properties of this lithology. Thus, to understand groundwater processes controlling the effects of global change-induced impacts on GDEs, an eco-hydrogeological conceptual model will be developed, and subsequently, integrated modelling for global change (mainly groundwater abstraction and climate change components) impact assessments.

[1] *Department of Earth Sciences, University of the Western Cape, Private Bag X 17, BELLVILLE, 7535, South Africa*
[2] *Department of Water and Sanitation, Private Bag x 313, PRETORIA, 0001, South Africa*
[3] *Institute of Africa water & Environment, Hebei University of Engineering, Handan, Hebei, China*

Sub-theme 1: Sustainable Groundwater Use for a Food Secure SADC Region

An isotopic study of groundwater at Waterberg, Namibia

Authors: *˚S. Uugulu1 and H. Wanke[2]*
Correspondence: *suugulu@unam.na*
Keywords: *Waterberg; isotopic values; precipitation; groundwater*

Abstract

Precipitation is the main input in the hydrological cycle and plays a big role in groundwater recharge, and eventually a role into the sustainability of the aquifer. To understand the isotopic fingerprint of groundwater, it is important to first comprehend the isotopic signature of precipitation, usually the mother source. Isotopic composition of both precipitation and groundwater was determined at Waterberg area that receives about 450 mm/a. Precipitation samples were collected during the rainy season from 2017 to 2018. A total number of 29 precipitation samples were collected as rain events. Groundwater in the study area was sampled from boreholes and spring during, after and before rainy seasons and a total number of 25 samples were collected. Both Precipitation and groundwater samples were analysed using a Los gatos water stable isotope spectro-analyser at the hydro-lab, University of Namibia. Precipitation isotopic values for δ18O (‰) range from -15.96 to 5.09 for Waterberg, while δ 2H (‰) isotopic values range from-117.5 to 40.6. Groundwater isotopic values for δ18O (‰) range from -10.85 to -8.60, while that for δ2H (‰) range from -69.4 to -61.2. Local meteoric water line (LMWL) equation for Waterberg was obtained using a linear regression method as δ2H = 7.3748 δ18O + 5.7704, R2 = 0.9713. Groundwater plots on the global meteoric water line as well as on the LMWL indicating absence of evaporation and probably a fast infiltration due to secondary porosity of aquifer. Such findings are good to ensure the sustainability of the aquifer.

[1] Department of Geology, Faculty of Science, University of Namibia, Windhoek, Namibia
[2] Department of Geography and Environmental Management, University of the West of England, Bristol, United Kingdom

Sub-theme 2: The Climate Change Challenge for Urban Water and Food Security: Threats and the Role of Groundwater

Assessing the effectiveness of groundwater remediation technology to improve water security in urban coastal aquifers

Authors: *J.M. Kanyerere[1], S. Israel[1]
Correspondence: 3400708@myuwc.ac.za
Keywords: *Aquachem, Cape Town South Africa, Concentration levels, Contaminant Removal Efficiency, Reverse Osmosis*

Abstract

Globally, groundwater contamination remains a known problem for most users of such water. In most urban areas where groundwater serves as an alternative source to surface water supply sources, which are declining due to climate change effects and increasing demand for developmental needs for water, contaminants in groundwater sources need to be remediated. In this study, appropriate remediation technology for groundwater contaminants were piloted and evaluated in terms of its effectiveness in removing contaminants in urban coastal aquifers. Selected boreholes within the Cape Flat Aquifer System in Cape Town, South Africa, were used as a case study. The argument is that effective remediation technologies exist for groundwater contaminants to improve water security in urban coastal aquifers despite the limited implementation of such technologies. Field and laboratory study approach was used. Primary and secondary data were collected and analysed using descriptive and inferential statistics methods from Aquachem software. Water samples in the areas were sampled and concentration levels of contaminants from such boreholes were measured and compared to SANS 241 and WHO guidelines for water quality. Reverse Osmosis (RO) remediation technology was identified as the most common method due to the broad spectrum of contaminants it is able to remove. It was applied to test its effectiveness in removing identified contaminants from groundwater. Confirmatory data analysis showed that RO remediation technology was effective when removing contaminants from groundwater. Finally, a specific site model for groundwater flow system was applied to describe movement of contaminants in line with the direction of groundwater flow system, which revealed indicative areas of the aquifer system that may require remediation schemes. Results provided a basis for promoting the use of RO technology for remediation and for designing targeted boreholes for monitoring and remediation, for abstraction and providing a recommendation on where the treatment can be placed.

[1] *Department of Earth Sciences, University of the Western Cape*

Sub-theme 2: The Climate Change Challenge for Urban Water and Food Security: Threats and the Role of Groundwater

Production boreholes water quality evaluation using gis based geostatistical algorithms in Windhoek

Authors: *Silas Davids[1]
Correspondence: silasdavid071@gmail.com
Keywords: Production Boreholes, Water Quality, Geo-statistics, GIS

Abstract

The contemporary threats of climate change have however prompted the dependency on production boreholes as a sustainable supply for domestic water in Windhoek. Therefore, maintaining the production boreholes water quality has however remained a vital intervention for a city like Windhoek. The aim of this project is to provide an overview for evaluation of water quality for production boreholes in Windhoek, through applying geographic Information system and geostatistical algorithms. Furthermore, the production boreholes water quality parameters, chloride, Iron, temperature, pH and electrical conductivity were all sampled and analyzed from existing production boreholes; maps of each parameter were created using geostatistical (kriging) approach. Experimental semivariogram values were tested for different ordinary kriging models to identify the excellent fitted for the five water quality parameters and the exceptional models were selected on the basis of mean square error, average standard error, root mean square error and root mean square. The results showed that this method is an appropriate tool for environmental spatial distributed parameters. However, pro-active measures must be taken into consideration before the water of the production boreholes are used domestically, as the water is not save at certain areas of Windhoek due to high temperature causing bacteriological contamination to occur.

[1] Namibia University of Science and Technology

Sub-theme 2: The Climate Change Challenge for Urban Water and Food Security: Threats and the Role of Groundwater

The groundwater game – a serious game to foster a shared understanding of sustainable and equitable groundwater management

Authors: *˚Raquel Sousa[1], Arnaud Sterckx[1], Stefan Siepman[1], Richard Taylor[2], James Jackson[3], John Thompson[3]*
Correspondence: *raquel.sousa@un-igrac.org*
Keywords: *common-pool, groundwater, governance, management, capacity-building*

Abstract

The Groundwater Game, a participatory activity supported by computer simulations, was conceived and created by IGRAC in 2008 with the following aims: (1) to improve participants' understanding of groundwater resources; (2) to foster a deeper understanding of the impact of collective actions; (3) to improve awareness to the challenges inherent to regulating groundwater use; and (4) to promote discussion of the challenges of sustainable and equitable development of groundwater resources. Following a series of innovations to the Groundwater Game, it was played as a stakeholder engagement tool in Ethiopia, Niger, and Tanzania, under the GroFutures project. The positive feedback from these sessions led to the development of an improved interface, which is now available (released in 2020) as downloadable Android and Windows game apps. The Groundwater Game engages with the challenges and dilemmas that result from the collective impact and consequences of individual decisions and actions surrounding the use of common-pool resources (e.g. The Tragedy of the Commons). It has been applied in a range of contexts including as part of training and capacity-strengthening exercises as well as groundwater governance. The game's setting is within a rural community where participants play the roles of farmers exploring groundwater, a common-pool resource. Players engage with potential conflicts of interest between their individual use and collective use by their community. These includes overuse of groundwater and its environmental consequences. To win, players consider a range of strategies that best manage this common-pool resource and secure the highest profit from crop production. The game provides opportunities to learn and explore concepts such as drawdown, common pool resources, groundwater governance, management and collective action.

[1] International Center for Groundwater Resources Assessment (IGRAC)
[2] UCL Department of Geography
[3] Institute of Development Sciences

Sub-theme 2: The Climate Change Challenge for Urban Water and Food Security: Threats and the Role of Groundwater

Assessing concentration level of contaminants in groundwater in the Soutpansberg region, South Africa

Authors: *L. Lalumbe[1], T. Kanyerere[2]
Correspondence: lindelanilalumbe@ymail.com
Keywords: Drinking water standards, Groundwater Contaminants, Human Health, Hydrogeochemical processes, rural livelihood

Abstract

Groundwater augments water supply sources for most rural areas in South Africa due to challenges with surface water infrastructure. Groundwater is used for domestic and irrigation purposes in most rural areas. Such use has benefits and hazards for human health and their livelihoods because the groundwater is being used without treating it despite the lack of knowledge about its quality. This study used historical groundwater quality monitoring data from 14 boreholes in the Soutpansberg region to determine the concentration of various parameters and compare them with SANS: 241 (2015) and WHO (2011) drinking water standards. This study determined that 50% of the boreholes are within the drinking water standards. EC and Nitrates seems to be the dominant contaminants in groundwater. This study recommended that the source of groundwater contaminants should be determined in order to understand hydrogeochemical processes controlling groundwater quality in the Soutpansberg region.

[1] Department of Water and Sanitation. Private Bag X313, Pretoria 0001, South Africa
[2] Department of Earth Sciences, University of the Western Cape, Cape Town, South Africa

Sub-theme 2: The Climate Change Challenge for Urban Water and Food Security: Threats and the Role of Groundwater

Evaluation of temporal and spatial variations of groundwater quality of the Swakop-upper Omatako Basin in Namibia

Authors: *`Laurica Afrikaner[1], Liberty Moyo[2], Elise Mbandeka[1]*
Keywords: *Groundwater, Groundwater quality, Uranium, Arsenic*

Abstract

Groundwater pollution is more serious than surface water pollution, because the residence times for the pollutants are longer in groundwater. This study evaluated the quality of groundwater in the Swakop-Upper Omatako basin of Namibia. Activities in the catchment have a potential to impact groundwater resources. Sixteen (16) boreholes were monitored from 2010-2017 for physical and chemical quality parameters. The results were compared to the Namibian water quality guidelines for portable water, South African water quality standard and WHO Guideline for drinking water quality since the water is used for domestic purposes without prior treatment. The data was analysed using correlation analysis and ANOVA. Correlation analyses were performed on the means of the water quality parameters to determine the relationship between them and with the distance between boreholes. The results show that the boreholes closer to major land use activities in the study area had higher levels of uranium concentrations ranging between 0.01-0.18 mg/L which exceed both the Namibia water quality guidelines and WHO water quality guidelines, which is <0.015 mg/L and 0.03mg/L respectively. A variation of 0.01-0.04 mg/L in Arsenic concentrations was detected spatially and temporally. Mean concentrations of turbidity of the boreholes water varied between 2.42-18.44 NTU, which is above the acceptable standard of the Namibia water quality standards for potable water which is <2 NTU for group B drinking water. Electrical conductivity (EC) in the study area ranged between 367-2 578 mS/m which is above the acceptable Namibia water quality guideline for portable water which is <300 mS/m. It can be concluded that the levels of some parameters are above the maximum acceptable drinking water quality hence, it is recommended that treatment of water from the boreholes be considered before using it for domestic purposes.

[1] Ministry of Agriculture, Water and Land Reform, P. Bag 13193, Windhoek, Namibia
[2] Department of Civil and Environmental Engineering,Namibia University of Science and Technology, P. Bag 13388, Windhoek, Namibia

Sub-theme 2: The Climate Change Challenge for Urban Water and Food Security: Threats and the Role of Groundwater

Evaluation of hydrochemical processes and groundwater quality in the dry bed of the Limpopo River for agricultural irrigation in Macarretane, Mozambique

Authors: **N.E.S Chambal[1], P.S.L. Saveca[1], C.M. Cambaza[1]*
Correspondence: *nadiachambal016@gmail.com*
Keywords: *Groundwater hydrochemistry, Limpopo River, Mozambique*

Abstract

Sub-Saharan Africa's socio-economic development and food security are affected by water scarcity and prolonged droughts. In the Limpopo Hydrographic Basin, the degree of water mineralization associated with the spatial and temporal variability of hydrological conditions creates risk and uncertainties in agricultural production and productivity. This study aims to evaluate the hydrochemical processes and the quality of groundwater that occurs in the dry bed of the Limpopo River for agricultural irrigation. Between October / 2019 to January / 2020, the degree of mineralization of surface and groundwater (at 7.84 m depth) was monitored, as well as the measurement of the water table level, using the conductivimeter and the electric probe, respectively. The main ions were analyzed in the IGS-University of the Free State laboratory, using the Inductively Couple Plasma (ICP) methods for cations and Iron Chromatography (IC) for anions. For the determination of hydrogeochemical processes, the ion ratio method was used, while for the hydrochemical faces the Piper diagram in the WISH 3.0.2 program. The results indicate that there are two hydrogeochemical processes, the weathering of carbonates in groundwater and weathering of silicates in surface water. The predominant hydrogeochemical face is of the HCO3-Ca / Mg type and the Stiff diagram showed similarity in the geometric configuration of the ions, which may show the existence of interaction between surface and underground water. In groundwater, cations abound in the order Ca> Mg> Na> K and HCO3> Cl> SO4 anions. The quality of water for irrigation is classified as C2S1, which means that the groundwater that occurs in the dry bed of the Limpopo River can be used as an alternative source in the production of locally predominant crops, in periods of water scarcity, without risk of sodicity and soil salinity or crop loss.

[1] Instituto Superior Politécnico de Gaza, Faculdade de Agricultura, Campus de Lionde, Caixa Postal 1, Distrito de Chókwè-Moçambique

Sub-theme 2: The Climate Change Challenge for Urban Water and Food Security: Threats and the Role of Groundwater

Using hydrogeophysics and derivatives analyses for improved groundwater security, Western Cape, South Africa

Authors: *˚Ndubuisi Igwebuike[1], Innocent Muchingami[2]*
Correspondence: *3770426@myuwc.ac.za*
Keywords: *Derivative analysis, Flow regime, Groundwater modelling, Hydrogeophysical data, West Coast aquifer system*

Abstract

The need to improve groundwater security remains critical especially in urban areas where demand for groundwater as an alternative source of water supply increase. The declining trends in availability of surface water as a result of climate change effects further exacerbates problems of water supply shortage to meet the increasing for water, thereby groundwater as an alternative source of fresh water supply. The argument is that most of groundwater models have been developed in absence of geophysical data and the use of derivative analysis in understanding the groundwater flow regime. The expectation is that interpretation of the refined hydrogeophyiscal model will provide improved representation of water table dynamics from existing groundwater models when geophysical data and derivative analysis are used. It is expected that science-led communication path way will be established to inform science-led practice from proposed managed aquifer schemes in West Coast area of Cape Town. We argue that the use of geophysics data and derivative analyses enhance interpretations of observed and modelled results on groundwater resource thereby making models useful for groundwater monitoring and utilization. We used derivative analysis to 1] identify important flow regimes encountered during a pumping test, 2] detect aquifer boundaries, 3] highlight heterogeneity in local aquifer characteristics and 4] to select appropriate aquifer models. Thereafter, we delineated groundwater units using an appropriate surface geophysical method and estimated aquifer parameters. We determined flow regime of aquifer system using derivative analysis. Finally, we combined hydrogeophysical data and output derivative analysis identify appropriate groundwater conceptual model that informs practical sustained measures for improved groundwater monitoring and utilisation. We concluded that the inclusions of hydrogeophysical data and derivative analyses remain critical for groundwater modelling if such models are to inform feasible measures that improves groundwater security.

[1] UNESCO Chair centre in Groundwater, Department of Earth Sciences, University of the Western Cape, South Africa
[2] Geophysics Research Group, National University of Science and Technology, Zimbabwe

Sub-theme 2: The Climate Change Challenge for Urban Water and Food Security: Threats and the Role of Groundwater

Groundwater quality status in South Africa for sdg 6.3.2: a case study of the Free State province

Authors: *L. Lalumbe[1], F. Ramusiya[2]
Correspondence: lindelanilalumbe@ymail.com
Keywords: Pollution, Compliance, Groundwater quality, Monitoring

Abstract

Groundwater plays a vital role in rural and urban areas of South Africa due to decaying surface water infrastructure. Anthropogenic and natural processes influence groundwater quality. As part of the United Nations Sustainable Development Goal 6.3.2; Proportion of bodies of water with good ambient water quality, the developed groundwater quality baselines in South Africa were compared with the 2017 and 2020 data to determine the level of compliance on three parameter which are EC, pH, Nitrate and Sulphate using a customised reporting methodology and data from the National Groundwater Monitoring Programme in South Africa. This study determined that the overall National / country compliance status for SDG 6.3.2 reporting 2020 was at 72.9%. The results show that 27.1% of non-compliance is due to elevated concentration of Nitrate in groundwater within some of the hydrogeological units. This study recommended that there is a need to investigate the potential sources of high nitrate and pilot an appropriate groundwater remediation technology where possible.

[1] Department of Water and Sanitation. Private Bag X313, Pretoria 0001, South Africa
[2] Department of Water and Sanitation, Private Bag X313, Pretoria 0001, South Africa

Sub-theme 2: The Climate Change Challenge for Urban Water and Food Security: Threats and the Role of Groundwater

Assessment of groundwater resources development priority intervention areas in the Southern African Development Community (SADC) region

Authors: *Kevin Pietersen[1], Maryna Storie[2], Verno Jonker[3], Traci Reddy[2], Deepti Maharaj[2], Chiedza Musekiwa[4], Zaheed Gaffoor[1], Anya Eilers[3], Erika Braune[3]*

Correspondence: *kpietersen@mweb.co.za, maryna@pegasys.co.za, verno.Jonker@zutari.com, traci@pegasys.co.za, deepti@pegasys.co.za, cmusekiwa@geoscience.org.za, zaheed.gaff@gmail.com, anya.Eilers@zutari.com, Erika.Braune@zutari.com*

Keywords: *Groundwater drought risk, Surface water drought risk, Population vulnerability, Water supply interventions*

Abstract

The SADC-region is prone to recurring droughts causing problems such as crop failure, food shortages, famine and epidemics. The Southern African Development Community Groundwater Management Institute (SADC-GMI) is implementing the project: Assessment of Groundwater Resources Development Priority Intervention Areas in the Southern African Development Community (SADC) Region (SADC GMI-GDRI) which seeks to bring the role of groundwater in securing water supply during periods of droughts to the forefront and provide for proactive planning, recommendations and management of groundwater and surface water systems. The project identifies areas that are prone to drought in the SADC region by revising the current Groundwater Drought Risk (GDR) map of the region together with an analysis of surface water risk and population vulnerability in a move towards practical assessment of water resources which can be quickly mobilised to support sustainable water supply investments in underserved areas in the region. The study makes use of the existing geospatial, hydrological and hydrogeological datasets and delivers a revised GDR map of the SADC region as well as a surface water risk map and population vulnerability map. Using the three maps, the study identifies hotspots in the SADC region that are most vulnerable to drought. A suite of technical inventions will be identified for each of these hotspots, and through a prioritisation process, a list of targeted interventions will be identified to improve the resilience within these hotspot areas, with the ultimate aim of building resilience communities within the SADC region.

[1] L2K2 Consultants, South Africa
[2] Pegasys, South Africa
[3] Zutari, South Africa
[4] Council for Geoscience, South Africa

Sub-theme 2: The Climate Change Challenge for Urban Water and Food Security: Threats and the Role of Groundwater

Revising the Groundwater Drought Risk Map: role of Grace data in mapping groundwater drought in the Southern African Development Community

Authors: *Chiedza Musekiwa[1], `Zaheed Gaffoor[2,3], Kevin Pietersen[4], Luc Chevallier[5]*
Correspondence: *zaheed.gaff@gmail.com*
Keywords: *GRiMMS, GRACE Groundwater Drought Index, Multi-criteria Decision Analysis, Composite Mapping Overlay*

Abstract

providing fresh water to both rural and urban populations. However, the security provided by groundwater is adversely impacted by prevalent and recurring droughts in the region. Understanding the occurrence of drought and the risk thereof contributes towards better planning in water supply and management across the region. To this end, the Groundwater Drought Risk Mapping and Management System (GRiMMS) was developed in 2013 to map the groundwater drought risk across the region. In this research a revised version of the GRiMMS method is presented that brings together updated geospatial, meteorological, hydrological & hydrogeological datasets. In addition, a new factor representing the groundwater storage risk is included. The new factor evaluates the applicability of Gravity Recovery and Climate Experiment (GRACE) datasets in mapping groundwater storage changes or sensitivity over time and at the regional level. The GRACE Groundwater Drought Index (GGDI) is calculated and used to characterise the total length, average intensity and trend, in groundwater storage drought conditions. These three factors are used to define a new layer, Groundwater storage sensitivity, that is used as input into the revised GRiMMS algorithm. The inclusion of the GRACE derived groundwater storage sensitivity further highlights regions of known hydrological drought, emphasising the impact groundwater storage plays in mitigating drought risk. In conclusion, GRACE provides a unique tool that can be used to map the impact of drought across the SADC region.

[1] Council for Geoscience, Bellville, Cape Town 7535, South Africa; cmusekiwa@geoscience.org.za (C.M)
[2] Department of Earth Science, University of the Western Cape, Cape Town 7535, South Africa; zaheed.gaff@gmail.com (Z.G.)
[3] IBM Research, Africa Labs, Johannesburg 2000, South Africa
[4] Institute for Water Studies, University of the Western Cape, Cape Town 7535, South Africa; kpietersen@mweb.co.za
[5] Private consultant, Cape Town 7535, South Africa; luc.chevallier32@gmail.com

Sub-theme 2: The Climate Change Challenge for Urban Water and Food Security: Threats and the Role of Groundwater

Evaluation of interpolation methods for mapping ph for Windhoek municipal boreholes

Authors: *Silas David[1]
Correspondence: silasdavid071@gmail.com
Keywords: Groundwater, Boreholes, GIS, Geostatistics

Abstract

Groundwater is one of the most significant spatial phenomena in the world, where its quality and quantity is threatened on. pH is a basic water quality parameter whereby the biological available of chemical elements and solubility are determined by it. Therefore, mapping the contemporary condition of groundwater quality in boreholes offers a better management in Windhoek Municipal boreholes. Furthermore, the Interpolation techniques used provide a platform to accurately predict values at un-sampled points and produce a continuous dataset of spatial distributions. In this research, spatial and Geostatistic analytic tools were used to accurately compare the different interpolation methods based on groundwater (pH) spatial pattern in Windhoek, using ArcGIS 10.6. Fifty five municipal boreholes were selected to assess groundwater pH. Moreover, deterministic interpolation methods such as kriging were used in both geostatistical and spatial analysis. Additionally, Empirical Bayesian kriging was used for geostatistical analysis. The method which shows least average standard error, root mean square standardised error, root mean square error and mean square error was selected as the best method to interpolate the spatial variation for pH in boreholes. A conclusion can be made that geostatistical interpolation is a superlative method than the deterministic interpolation method for mapping pH.

[1] Excel Dynamic Solutions (Pty) Ltd, Namibia

Sub-theme 2: The Climate Change Challenge for Urban Water and Food Security: Threats and the Role of Groundwater

Application of integrated geochemical approach to evaluate hydrogeochemical processes influencing groundwater quality, Western Cape, South Africa

Authors: *Abongile Xaza[1], Thokozani Kanyerere[1], Sumaya Israel[1]*
Correspondence: *3469797@myuwc.ac.za, tkanyerere@uwc.ac.za, sisrael@uwc.ac.za*
Keywords: *bivariate correlation plots, Coastal aquifer, Factor Analysis, Gibbs plot, Hydrogeochemical processes*

Abstract

In this study we investigated hydrogeochemical processes that control evolution of groundwater chemistry and assessed their influence on water quality. We used Heuningnes catchment in the Western Cape of South Africa as a case study. We argued that limited application of integrated geochemical approach to explore key hydrogeochemical processes leads to limited knowledge in the influence for observed groundwater quality in aquifer systems. With increasing effects of climate change on surface water resource and the increasing demand for water use, using groundwater remains an alternative water source. However, the reported poor quality of groundwater remains a challenge. Nevertheless, improved understanding on what influences groundwater quality can lead to innovation that can be used either to purify such waters for the benefit of water users. We followed quantitative approach to conduct a spatiotemporal assessment. We sampled groundwater from boreholes during four occasions. Sampled boreholes were allocated from the upper to lower catchment and were chosen randomly for spatiotemporal analysis. In situ and laboratory analyses were conducted on major ions including hierarchical cluster analysis and factor analysis. We used graphical methods such as Piper diagram to classify the main water types. We applied correlation and stoichiometric analysis to identify hydrogeochemical processes influencing groundwater chemistry. For example, evaluation of water-rock interaction was identified using stoichiometry analysis and bivariate correlation plots, inverse geochemical modelling and statistical analysis. Results showed that Na-Cl type water was the major hydrochemical facie. In addition, Cation exchange, weathering of carbonates, sulphates and silicate minerals were identified as processes that influence the chemistry of groundwater. Application of Gibbs plot revealed that rock-water interaction was the major hydrogeochemical process followed by evaporation and precipitation processes that influence groundwater chemistry. Although these processes did not show how they influence groundwater quality, results provided insight as baseline information for future studies.

[1] University of the Western Cape

Sub-theme 2: The Climate Change Challenge for Urban Water and Food Security: Threats and the Role of Groundwater

Maputaland – the perfect storm

Authors: *S. Naicker[1], S.J. van Rensburg[2]*
Correspondence: *naickers@dws.gov.za, sue@saeon.ac.za*
Keywords: *Groundwater, Lake Sibaya, Maputaland*

Abstract

Maputaland forms part of the W70A quaternary catchment located in northern KwaZulu-Natal and forms the Coastal Sedimentary Transboundary Aquifer between South Africa and Mozambique. The Maputaland region is characterized by a number of ecologically important coastal lakes. These coastal lakes, such as Lake Sibaya, are important hydrological features which have great ecological and economic value. Lake Sibaya, the largest natural inland freshwater lake in South Africa (RAMSAR site), is utilised for urban and rural water supply. Lake Sibaya and its catchment are intrinsically linked to the primary aquifer, with the lake itself being an expression of the groundwater table and provides a vital source of fresh water, from which the ecology and local community depend on. A significant decline in lake levels has been experienced over the last decade, dropping from approximately 20 m above mean sea level (amsl) in early 2000 to approximately 14 m amsl at present. The drop has resulted in the southern portion of the lake splitting off and dropping a further 7.5m below the main lake level. The Resource Quality Objectives for Lake Sibaya states that the median lake level over a 30 year period should be ≥17.39 m and that the drought threshold is 16.5 m. The Maputaland Coastal Aquifer System is the PERFECT storm, whereby causes and effects of the Lake Sibaya water level decline remain a hotly debated topic; some of the primary drivers include:

- Decreased rainfall and drought conditions (climate change),
- Increased groundwater abstraction,
- Absence of mega rainfall events (cyclonic rainfall from the Mozambique channel) and associated recharge,
- Geological controls,
- Eucalyptus forestry and the increase thereof

[1] Department of Water and Sanitation, Private Bag X313, Pretoria, 0001, South Africa
[2] South African Environmental Observation Network, 1 Peter Brown Drive, Pietermaritzburg, 3202, South Africa

Sub-theme 2: The Climate Change Challenge for Urban Water and Food Security: Threats and the Role of Groundwater

The use of basement water in urban areas

Authors: *T. Bengeza[1]
Correspondence: Bengezat@dws.gov.za, t.n.bengeza@gmail.com
Keywords: Basement water, urban areas, buildings

Abstract

South Africa is a water scarce country and is amongst the 30 driest countries in the world (DWS, 2015). Urban areas have high water demand due to population growth and increased urbanisation (UNEP, 2015). Most of the urban areas use surface water, and is fully allocated (DWS, 2015). There is an urgent need to investigative alternative water sources to meet the rapid water demand in urban areas (DWS, 2015). Urban areas comprise of a number of underground structures such as buildings with basement parking lots, deep foundations, and tunnels. To maintain dry basement structure conditions, groundwater dewatering of the basements is implemented in each building. This basement water in the City of Tshwane is removed and discharged into municipal stormwater systems (Stavridis et al., 2017). Instead of disposing basement water into stormwater system, this water can be efficiently used for other purposes that do not require compliance to potable water quality standards. The main aim of the case study is to promote beneficial use of basement water, and encourage more buildings to use the basement water rather than discharge with no beneficial use. The case study investigates buildings which have been affected by groundwater leakage. Data collection was undertaken by measuring the volume of basement water and water samples were collected and submitted to an accredited laboratory for quality analysis. A Business case was also conducted for 3 buildings to determine whether the use of basement water to augment their current source of supply will be economically feasible. Five case studies investigated the feasibility of the use of basement water for five buildings and the results revealed that each building has significant volumes of basement water ranging from 4.3 kl/d to 155 kl/d. The basement water is generally discharged into stormwater systems and none of the buildings are using the basement water to its benefit. At State Theatre building in CoT, up to 75% of the water demand is used for air conditioning system, and the feasibility of replacing this demand with basement water was investigated. The capital cost to implement the use of basement water for the cooling system is estimated to be around R1.5 million, which would be recovered in a 3 year period. A Hydrocensus of the other buildings in Central Business District of CoT was conducted leading to an estimated total basement water yield of 1.1 – 2.3 Ml/d.

The implementation of the basement water use innovation across the city of Tshwane (on a regional scale) could alleviate some of the City's water demand in a sustainable manner and reduce reliance on limited surface water resources. All MMs should amend their by-laws to discourage the discharge of basement water to ensure beneficial use.

[1] Department of Water and Sanitation, Pretoria, South Africa

Sub-theme 3: Enhancing the Contribution of Groundwater in the WEFE Nexus through Effective Groundwater Governance at National and Transboundary level

The compilation of a geodatabase from the hydrogeological map of Lesotho

Authors: *Luigi Simeone*
Correspondence: *luigisimeone@yahoo.it*

Abstract

Geographical Information Systems can be successfully employed for the management and analysis of hydrological and geological data saved in paper maps. Maps compiled before the “digital era” can be the sources of a wealth of georeferenced data. Old maps can be digitized and data retrieved for comparison with fresh data. The work described in this paper was carried out with data digitized from the published Hydrogeological Map of Lesotho and from the published technical notes accompanying the map. The (digital) Hydrogeological Map of Lesotho (1994 – G. Arduino, P. Bono, P. Del Sette, Department of Water Affairs of the Kingdom of Lesotho) was imported into a GIS and georeferenced according to the geographical projection of the map. The hydrological data have been digitised and stored into a geodatabase. Data have been analysed and compared. The hydrological data were digitized into “feature classes” (points, lines and polygons), these are: Rainfall (Rainfall stations storing mean annual precipitation, mean annual Evapotranspiration, mean annual Effective Precipitation); Geological Dikes; Geological Formations; Rivers; Hydrological Basins; Linear Springs; Contours of Mean Annual Precipitation; Contours of Mean Annual Effective Precipitation; Hydrostations for the measurement of Runoff; Location of rural settlements.

Sub-theme 3: Enhancing the Contribution of Groundwater in the WEFE Nexus through Effective Groundwater Governance at National and Transboundary level

Groundwater management tools that enhance the role of groundwater governance in water supply and security in Namibia

Authors: *E.M. Gustavo[1], W. Kambinda[2]
Correspondence: egustavo@slrconsulting.com
Keywords: *Groundwater, governance, monitoring, groundwater models*

Abstract

Groundwater supply and security goes beyond its availability and accessibility. It encompasses the aspects of groundwater quantity as well as the groundwater quality. Groundwater resource supply and security is stifled in the absence of groundwater management tools that enhance the understanding of hydrogeological systems which improves information systems. Tools such as groundwater monitoring and modelling minimise shocks, risks, and vulnerability of the resource. On the aspect of groundwater quality monitoring, evidence from SLR (Namibia) projects within west flowing rivers of the Swakop and Khan Rivers shows the valuable contributions that water quality data collection has in supporting decision making when applying for water and environmental related permits. The security of the groundwater quantity is ensured by groundwater modelling tools, which provide the governing authorities a scientific backing upon which decisions can be made. Further evidence is drawn from projects within the Swakop-Khan River basin where groundwater monitoring and modelling at various mines in the uranium province such as such Langer Heinrich Uranium Mine and Swakop Uranium Mine has provided protection of groundwater against pollution derived from mining activities and maintained quality of groundwater for downstream users. Subsequently, abstraction permits were allocated competently with the support of model results. However, these tools are still in the hands of industry and mining companies which limits access for regulators. Namibia has embraced the principles of integrated resource management which addresses multi-stakeholder resource planning which will bridge this gap. Collaborative effort must be encouraged elsewhere in the country to emulate success from current groundwater monitoring and modelling in the river basins to benefit governance structures. Recommendations are to have comprehensive groundwater quality database for the uranium province and river basins; for greater investments to be made in the area of water quality data collection and finally strengthening of collaboration between River Basin Organisations and stakeholders must be pursued.

[1] SLR Environmental Consulting (Namibia) (Pty) Ltd, Geohydrology, Windhoek, Khomas Region, Namibia; egustavo@slrconsulting.com
[2] SLR Environmental Consulting (Namibia) (Pty) Ltd, Geohydrology, Windhoek, Khomas Region, Namibia; wkambinda@slrconsulting.com

Sub-theme 3: Enhancing the Contribution of Groundwater in the WEFE Nexus through Effective Groundwater Governance at National and Transboundary level

The country support tool: a process to increase the contribution of groundwater to economical development and livelyhoods in Africa

Authors: *Rennie Chioreso[1], *Bertram Swartz[2]*
Correspondence: *Bertram.Swartz@mawf.gov.na*
Keywords: *Participatory Process, Strategic Planning, Investments, Policies, Governance*

Abstract

Groundwater is a crucial resource for most African countries to meet water demand of growing populations, agriculture and economy. In many countries, there is still much potential to enhance water supplies from groundwater, while other countries or regions struggle to implement sustainable groundwater management practices that protect the resource from overexploitation and contamination. However, groundwater issues tend to play a minor role in National Water Strategies and Planning, with the effect that measures and investments in groundwater are fragmented and remain minor. One of the core deliverables of the Groundwater Programme of the African Ministers Council on Water (APAGroP) is a Groundwater Country Support Tool, aimed to support member states to make of most of their groundwater resources by setting up programs to enhance sustainable groundwater development and management. The aim was a development of such a tool and its pilot test on Namibia. Due to the climatic conditions, Namibia is a water scarce country. The only perennial rivers are located at the borders in the North, South and Northeast. There are, however, significant groundwater resources that could provide drinking water for many citizens across the country. While some groundwater projects are underway and new opportunities have been identified, a strategic planning of policies and investments that fit and feed into general water sector strategies is lacking.

The Concept consists of four main steps:

1. An Inceptions Report as a detailed refined work plan and streamlined tasks, deliverables, timelines and milestones.
2. A Diagnostic Report that includes an analysis of the role of groundwater within the water resources context of the country and its development.
3. A Consultative Meeting to present and discuss the outcomes of the diagnostic report
4. An Action Plan that proposes measures to address the identified needs of management, governance and investments in groundwater.

[1] RFM Consulting, Namibia
[2] Ministry of Agriculture, Water and Land Reform, Namibia

Sub-theme 3: Enhancing the Contribution of Groundwater in the WEFE Nexus through Effective Groundwater Governance at National and Transboundary level

Assessment of wastewater pollution of water resources in the Cradle of Humankind World Heritage site, South Africa

Authors: *V. Mvandaba[1], E. Kapangaziwiri[1], J. Shadung[1]*
Correspondence: *mvandabav@gmail.com*
Keywords: *Integrated water resources management, Karst hydrology, River health assessment, Surface water-groundwater interactions, Urban groundwater*

Abstract

Water pollution in the Cradle of Humankind World Heritage Site has largely been characterised by the impacts of acid mine drainage from the West Rand mining activities on the water resources of the dolomitic environment. However, in recent years municipal effluent from upstream wastewater treatment plants has become the immediate threat to the quality of water resources in the area. Subsequently, the World Heritage status of the renowned cultural and scientific attraction and more importantly, the health of the environment and its local community, are at risk. Quarterly monitoring and sampling, assessing both surface and groundwater resources has revealed apparent severe bacteriological contamination from the Percy Stewart Wastewater Treatment Works via the Blougat Spruit into the Bloubank Spruit. Total coliform and E.coli values routinely exceed a most probable number count of 2419.6 per 100 mL of water sampled. Surface water and groundwater support agricultural, recreational and domestic activities in the region. Results from water samples analysed against the South African National Standard for Drinking Water Quality (SANS 241:2015) indicate deteriorating water quality. Given the extensive surface water-groundwater interactions in the karst landscape, water resources at the Sterkfontein Cave have shown compromised microbiological quality. The outcomes of the biannual aquatic biomonitoring surveys, which comprise macroinvertebrate biomonitoring and toxicity screening assays, at two downstream sites of the Bloubank Spruit river system provide a slight acute hazard rating, further indicating degradation of the river health. This paper traces and reports on the trends of water quality and river health observed at six surface water and five groundwater sites. Recommendations for remediation of the pollution crisis include continued monitoring of affected sites, improved and accountable water resources management from all stakeholders.

[1] Council for Scientific and Industrial Research, Smart Places, Water Centre, PO Box 395, Pretoria, 0001, South Africa

Sub-theme 3: Enhancing the Contribution of Groundwater in the WEFE Nexus through Effective Groundwater Governance at National and Transboundary level

Groundwater quality within the World Water Quality Assessment and its relevance for the SADC region

Authors: *M. Andersen[1], A. Aureli[2], D. Blake[3], T. Boving[4], A. Chambel[5], C. Delaire[6], J. Dottridge[5], H. Duerr[7], N. Hartog[8], J. Jawitz[9], S. Kebede Gurmessa[10], *R. Klingbeil[11], D. Kreamer[5], N. Kukuric[12], D. Lapworth[5], J. Liu[13], L. Lytton[14], B. Misstear[15], I. Ouedraogo[16], J. Podgorski[17], C. Poulin[6], M. Qadir[18], K. Riemann[3], C. Ruz Vargas[12], L. Scrinzi[2], C. Simmons[19], P. Smedley[20], K. Villholth[21], F. Wagner[11]*

Correspondence: *ralf.klingbeil@bgr.de*

Keywords: *Groundwater, Quality, World Water Quality Assessment, Africa, SADC Region*

Abstract

Based on the United Nations Environment Assembly (UNEA) Resolution 3/10 on "Addressing Water Pollution to Protect and Restore Water-related Ecosystems" (2017) a global multi-stakeholder network of approximately 100 institutions jointly with UN Environment established the World Water Quality Alliance that aims to develop a World Water Quality Assessment (WWQA). Within the scope of the WWQA, the "Friends of Groundwater" (FoG), a group of approximately 30 members from 20 organizations intends to assist addressing the groundwater quality related aspects of WWQA. As a first step, FoG is developing a global perspective paper on the assessment of groundwater quality. The purpose of the paper is to highlight the importance of groundwater, the many threats to groundwater quality from human activities and natural pollutants and the challenges in trying to monitor and assess groundwater quality – especially in relation to the 3-D nature of groundwater flow, the link to land use, the long timescales involved in pollutant transport, and a lack of data in many regions. This paper also sets the stage for the development of an unified approach that allows tailored assessment of groundwater quality, depending on local and regional conditions, scale and data availability. The paper exemplifies approaches based on existing sources of data, including field sampling data, earth observation data and models, and offers suggestions on how to conduct a global framework/approach for the assessment of groundwater quality. It is being written for an audience of policy makers and others that not necessarily are groundwater specialists and is intended to form the basis of the main contribution on groundwater to the WWQA to be delivered to the UNEA-5 assembly in February 2021. It will also form a valuable contribution on groundwater quality to the next UN World Water Development Report as well as other upcoming reports and processes. This presentation aims to inform the SADC groundwater community about the WWQA process and the global perspective paper on the assessment of groundwater quality. It will also discuss the relevance of groundwater quality for Africa and the SDAC region and provide an entry point for further contributions from SADC countries to the global assessment..

[1] National Centre for Groundwater Research and Training (NCGRT) / University of New South Wales (UNSW), Australia, [2] United Nations Educational, Scientific and Cultural Organization, International Hydrological Programme (UNESCO-IHP), France, [3] UMVOTO, South Africa, [4] University of Rhode Island (URI), USA, [5] International Association of Hydrogeologists (IAH), Great Britain / Portugal / USA, [6] The Aquaya Institute, Great Britain / Kenya, [7] Ruhr-Universität Bochum (RUB, Germany, [8] KWR Water Research Institute, The Netherlands, [9] University of Florida, USA, [10] University of KwaZulu Natal, South Africa [11] Federal Institute for Geosciences and Natural Resources (BGR), Germany, [12] International Groundwater Resources Assessment Centre (IGRAC), The Netherlands, [13] School of Environment, Southern University of Science and Technology (SUSTech), China, [14] The World Bank, USA, [15] Trinity College Dublin, The University of Dublin (TCD), Ireland, [16] University of Fada N'Gourma (UFDG), Burkina Faso, [17] Swiss Federal Institute of Aquatic Science and Technology (EAWAG), Switzerland, [18] United Nations University, Institute for Water, Environment and Health (UNU-INWEH), Canada, [19] National Centre for Groundwater Research and Training (NCGRT) / Flinders University, Australia, [20] British Geological Survey (BGS), Great Britain, [21] International Water Management Institute (IWMI), South Africa.

SPECIAL SESSIONS

Sub-theme 1

Knowledge-sharing workshop for focal points and RBOs/TBAs: dissemination of lessons learnt from Stampriet and Ramotswa Transboundary Aquifers

Day 1, 24 November 2020

13:30-16:00 SAST

"The present ineffective and unsustainable use of groundwater throughout Africa requires national, regional and international actions on a number of fronts. There are many challenges associated with the use of groundwater ranging from overexploitation of the resource to water quality degradation mostly as a result of weak or absence of regulatory and institutional frameworks to improve governance and management of groundwater resources. UNESCO-IHP through the SDC-funded project "Governance of Groundwater Resources in Transboundary Aquifers (GGRETA)" has been building capacity on groundwater governance as well as supporting the development of tools and policies. The project is currently in its third phase and is aimed at strengthening regional stability, cooperation and peace through the establishment of cooperative frameworks for transboundary groundwater governance in River Basin Organisations (RBOs), Regional Commissions (RCs) and selected aquifers systems in Africa, Central America and Central Asia. The Stampriet Transboundary Aquifer System, the project's pilot project in Southern Africa, provides the only permanent and dependable source of water in the area. By strengthening capacity and implementing collective measures at national and regional level, this third phase continues to provide policy advice and support to the stakeholders of this valuable resource, contributing also to the operationalization of the Stampriet Multi-Country Cooperation Mechanism (nested in ORASECOM as a result of previous phases). By promoting the exchange of lessons learned between African RBOs, the project also aims at building a solid base towards the establishment of regional management strategies. It aims at validating, consolidating and upscaling the results already achieved as well as introducing some innovations to help implement changes and strengthen governance, policies and practices, improving capacities (technical and managerial) on the governance of transboundary aquifers.

To follow up on the gains of GGRETA Phase 1 (when a science-based understanding of groundwater resources was established) and 2 (when cross-border dialogue was enhanced and shared management tools were developed), UNESCO in partnership with the SADC-GMI will be coordinating a knowledge-sharing session at the virtual SADC-GMI Groundwater Conference for focal points and River Basin Organisations (RBOs)/Transboundary Aquifers (TBAs) in order to disseminate lessons learnt from projects implemented in Stampriet and Ramotswa Transboundary Aquifers".

SPECIAL SESSIONS

Sub-theme 2

Groundwater for food in Africa – current opportunities and challenges

Day 2, 25 November 2020

14:00-16:00 SAST

This Special Session will address the current opportunities and challenges of groundwater for sustainable food production and food security in a changing environment, with focus on SADC and Africa.

Groundwater provides a strategic resource, with great opportunities to sustain climate resilience as well as water and food security, which is evident from most parts of the world, and in particular in arid and semi-arid regions. The imperative for increased food production, which is coming along with population growth and changing food preferences, on the one hand opens up for opportunities for increased groundwater reliance in areas where the resource is underdeveloped and well replenished, but, on the other hand, puts the resource under increasing pressure in areas where the resource is either poorly replenished or already exploited to a significant degree. This session will provide a contemporary view on the role of groundwater in food security in SADC and beyond, in order to learn about the possible ways to best benefit from the vast opportunities groundwater holds, while avoiding unsustainable trajectories in food production systems at various scales, from smallholders to larger scale.

The session is organised by Groundwater Solutions Initiative for Policy and Practice (GRIPP) and represents distinguished speakers from AMCOW, FAO, World Bank, and IWMI.

Special Session: Groundwater for food in Africa - current opportunities and challenges

Groundwater for food in Africa – aiming for sustainability and equity

Authors: *Karen G. Villholth*[1]

Keywords: *Groundwater, Food, Irrigation, Africa, Sustainable development, Livelihoods, Equity*

Abstract

Groundwater is central to sustainable development in Africa. Its role in agriculture and food security is particularly critical as the imperative for food security tightens in response to population growth, urbanization, and climate change. In addition, irrigated agriculture inherently has disproportionate footprints on consumptive water uses, and can lead to unintended negative resource depletion and associated core livelihood and water security issues as evidenced from intensive use areas in other parts of arid and semi-arid regions of the world. However, while the potential for further development is generally regarded as not fully exploited, with large growth prospects in sub-Saharan Africa, the knowledge and understanding of the potential and current contribution of groundwater towards broader goals of food and water security, livelihoods, and resilience is limited. This paper presents a contemporary review of the current knowledge and presents the diverse options and typologies of groundwater-based agriculture, present status, and various initiatives aimed at achieving sustainable and equitable outcomes from groundwater development for food in Africa.

[1] ***International Water Management Institute (IWMI), Pretoria, South Africa***

Special Session: Groundwater for food in Africa - current opportunities and challenges

The water-energy-food nexus: the role of technology in the management of groundwater resources

Authors: *Riccardo Biancalani[1], Livia Peiser, FAO[1]*
Keywords: *Water-Food-Energy Nexus, SDG 6, Irrigation, Earth Observation*

Abstract

The Water-Energy-Food Nexus framework has been recognized during the past decade as one of the most interesting tools for convening power across and within sectors by clearly recognizing interdependencies, conditions and constraints, capable to support the establishment of dialogue among stakeholders. In the context of its activity aimed at supporting the achievement of the Sustainable Development Goal (SDG) 6 of the Agenda 2030, FAO is implementing a project to foster water productivity in Near East and North Africa. The Nexus approach is being used to define the "safe boundaries" for water use. A stepwise and iterative approach is adopted in the project to integrate public dialogue and technical surveys and modelling, including quantitative hydro-economic sophisticated modelling scenarios; value chain analyses and qualitative resource accounting or a combination of them. Earth Observation (EO) technology can provide useful inputs to support the Nexus approach. While it can directly monitor land use and land and water productivity, it can provide useful information for assessing the potentiality of several technologies to be used on the ground, such as solar powered irrigation, bio-energy crops and hydropower. The WaPor initiative of FAO makes use of a combination of techniques from EO and mobile communications in order to give to farmers and decision makers information on the use of water for irrigation, supporting the efforts to the achievement of SDG Goal 6.

[1] Food and Agriculture Organization of the United Nations, Rome , Italy

Special Session: Groundwater for food in Africa - current opportunities and challenges

AMCOWs Pan-African Groundwater Programme – addressing food security

Authors: *Moshood N. TIJANI 1* and Paul ORENGOH 1*
Correspondence: *mtijani@amcow-online.org*
Keywords: *Water Security, Food Security, Groundwater, Sustainable Development, APAGroP, Africa*

Abstract

Africa and indeed sub-Saharan Africa suffers from greater levels of water stress than many other regions in the world with about 64 percent of the population relying on water that is limited and highly variable. However, in the face of impacts of climate change, exploiting the potential of the vast groundwater resources in Africa is a key to meeting water demands for drinking and sanitation in line with SDG-6. In addition, food insecurity in Africa can be largely attributed to sub-optimal performance, with 96 percent of the agriculture largely dependent on rainfed. However, while irrigation development has been identified as a key intervention, the significant potential of groundwater to improve agricultural growth had been underrated. Arising from the above background and against a backdrop of rapid population and urban growth as well as future shocks, including from climate change, there is the need integrate sustainable groundwater development and management within the framework of water and food security in Africa. In furtherance of this need, AMCOW within its mandate to support member states to develop, manage, and utilize water resources to assure water, food, and energy security, recently launched a flagship groundwater program termed APAGroP. The intent of this paper is to highlight the key aspects of the APAGroP programme as a priority intervention area of AMCOW intended to ensure sustainable conjunctive groundwater use and management at national and transboundary levels and encourage knowledge sharing, joint cooperation, peace and security within the riparian member states. Furthermore, the paper presents the key thematic intervention areas of the APAGroP programme while also highlighting the significant contribution of groundwater to enhancing water and food security through sustainable exploitation, utilization, and management within the framework of strategies for groundwater governance among member states.

[1] African Minsters' Council on Water (AMCOW), Abuja - Nigeria.

Special Session: Groundwater for food in Africa - current opportunities and challenges

Water for food in central and southern Angola - role of groundwater

Authors: *Marcus Wijnen3*, Aleix Serrat-Capdevila[1], Natalia Limones Rodríguez[2], Javier Marzo Artigas[3] and Bruno Petrucci[3]*
Correspondence: *mwijnen@worldbank.org*
Keywords: *Groundwater, Drought, Climate Resilience, Water Security, Water Harvesting, Angola*

Abstract

The work presented here is part of a broader effort by the Government of Angola and World Bank to increase access to reliable water resources for rural water supply and agro-pastoralism in the South of Angola and to strengthen the institutional capacity to manage water-related risks. South Angola suffered a long and severe drought between 2012 and 2019. The impacts of the drought were exacerbated by the widespread disrepair of water points and a lack of drought-resilient infrastructure. The study combines satellite rainfall data, to characterize the meteorological drought, and census data at commune level, to characterize access to water, to identify priority communes. A framework to select appropriate water resources investments for priority communes is presented, based on hydrologic, geomorphologic and hydrogeologic information. Where available, groundwater development is given priority since it is less likely to be affected by drought, though in many areas, other alternatives may be the only option. This study presents an assessment of the potential for two types of water resource investments: (i) surface water harvesting through improved chimpacas (tanks) and cisterns, and (ii) sand dams and managed small-scale aquifer recharge. A hydrologic and hydrogeologic assessment of the Cuvelai basin in Cunene province confirmed that surface water represents the largest available resource, and that its harvesting can be expanded. The potential for sand dams and managed aquifer recharge in Namibe province was evaluated and a number of sites were identified and characterized. The assessment shows that to provide increased water security, especially during extended droughts, water harvesting solutions need to be complemented by wells and groundwater potential should be further explored. Groundwater at shallow to intermediate depths (less than 200 m) is expected to have limited potential and the presence of deep groundwater resources needs to be confirmed.

[1] *The World Bank*
[2] *Universidad de Sevilla, Department of Physical Geography*
[3] *Independent consultants*

Special Session: Groundwater for food in Africa - current opportunities and challenges

Recognising customary water tenure in groundwater development and regulation to achieve the Sustainable Development Goals in Africa

Authors: *Barbara van Koppen* [1]
Correspondence: *b.vankoppen@cgiar.org*
Keywords: *Groundwater, Sustainable Development Goals, water legislation, customary water tenure, self-supply, multiple use infrastructure, basic needs*

Abstract

African states have committed to developing water infrastructure to meet basic human needs and to regulating the sharing of water resources at various scales, supporting the achievement of the Sustainable Development Goals (SDGs). This paper unravels how the potential groundwater contribution to SDGs can be unlocked by the legal recognition of living customary (community-based) water tenure, as derived from a literature review of over 100 empirical case studies across Africa of the CGIAR Policies, Institutions and Markets Research Program.

Water tenure refers to the relationship, whether legally or customarily defined, between people, as individuals or groups, with respect to water resources sharing. Rural communities seek to meet their multiple domestic and productive (food) water needs through multi-purpose infrastructure investments. They conjunctively manage multiple water sources to that end. Even when irrigation agencies or the Water, Sanitation and Hygiene sectors design public schemes for a single use, communities alter these into de facto multiple use schemes. Communities have applied IWRM since time immemorial. Governments can harness these advantages by supporting self-supply for multiple uses.

During growing competition for groundwater in Sub-Saharan Africa, state regulation can benefit from customary water tenure. However, current permit systems, as adopted in four of five African countries, override customary water law. A new form of 'hybrid water law' can overcome this legacy, mostly by reinterpreting existing legal tools as locally relevant. First, permits can be targeted at the relatively few high-impact investors, who should follow due process and enable all customary and other existing users, who risk being affected by the new plans, to object, share in benefits or be compensated. Conditions to the permits should be set and enforced. Second, all lower-impact customary and other users should be exempted from permit application and be protected at equal legal status as permits. The assessment and recording of the uses and sources will be key to success. Importantly, priorities in water sharing should be in line with constitutional commitments, so the highest priority will not only be for basic domestic needs (as already stipulated in most legislation), but also for water that contributes to everyone's basic food security.

[1] *1 IWMI, International Water Management Institute, Pretoria, South Africa*

SPECIAL SESSIONS

Sub-theme 3

Mainstreaming water and food security into Transboundary Water Cooperation

Day 3, 26 November 2020

10:10-12:10 SAST

Water is under increasing pressure around the globe. Population growth, pollution, climate change and weak governance is putting at risk the availability and integrity of waters worldwide. Weak water governance has the potential to affect water and food security in transboundary river basins due to inadequate or inexistent policies, laws and institutions regulating the management of waters. IUCN has developed a variety of approaches, training packages and tools that have promoted the inclusion of water and food security concerns in rivers and lakes in Latin America, Asia and Africa.

This session will provide an overview of key approaches and tools to mobilise cooperation, facilitate dialogues, support the development of agreements and strengthen water institutions to increase water and food security in transboundary river basins.

Cross-learning on shared groundwaters: the Tuli-Karoo and Eastern Kalahari Karoo Aquifers

Day 3, 26 November 2020

12:40-14:40 SAST

Groundwater provides a key resource for satisfaction of basic needs and enhancing resilience, and many aquifers from which groundwater is abstracted constitute transboundary aquifers. A growing body of work, has now identified and delineated more than 30 transboundary aquifers in the SADC Region and many more in Africa as a whole. While on the-ground cooperation on SADC's shared aquifers is currently low, managing them cooperatively and conjunctively – i.e., linking their management with pre-existing cooperative surface water frameworks – can foster progress towards the region's development goals including strengthening resilience, improving agricultural production, enhancing water security and achieving sustainable growth. The importance of both transboundary water management, and ground and surface water management, are recognized in the SADC Regional Strategic Action Plan (RSAP 2016-2020). Further, policies in most national governments in the region emphasize the need to cooperate on shared waters but cooperation related to transboundary aquifers is currently low.

Two Transboundary Aquifer projects are currently under implementation in the SADC region i.e. in the Tuli- Karoo and in the Eastern Kalahari Karoo Basins. The latter is led by the SADC-GMI while IWMI is leading the Tuli Karoo Basin project. The broad objectives of the projects is to enhance the capacity in SADC and its member states to manage integrated groundwater and surface water resources. The projects seek to identify and apply innovative solutions for conjunctive water management in transboundary river-aquifer systems. In particular, the projects will identify issues and solutions that support the achievement of equitable, sustainable and resilience-strengthening water use, based on conjunctive management.

This session will showcase the work done to date in these two TBAs and their associated surface water systems, explore opportunities for cross learning between the projects, while also drawing lessons from previous projects such as the Shire Alluvial TBA, Ramotswa TBA and the Stampriet TBA. As we look toward advancing cooperation on the more than 25 shared aquifers in the region on which work has not yet been initiated, it is important that we learn from these initial efforts.

Sponsors and Organisers

We would like to thank the organising partners and Sponsors for their contribution in making the 3rd SADC Groundwater Conference a huge success. Your support continued support is highly appreciated.

SADC - Groundwater Management Institute

SADC-GMI is a subsidiary structure of the SADC Secretariat. SADC-GMI's core mandate is to promote sustainable groundwater management and provides solutions to groundwater challenges in SADC through creating an enabling policy, legal and regulatory environment; capacity building; advancing research, supporting infrastructure development; and enabling dialogue and accessibility of groundwater information. www.sadc-gmi.org

IUCN - International Union for Conservation of Nature

The IUCN is a membership Union uniquely composed of both government and civil society organisations. It provides public, private and non-governmental organisations with the knowledge and tools that enable human progress, economic development and nature conservation to take place together. The IUCN Water Programme aims to inspire evidence-based and adaptive change in water resource management that benefits nature and people. In Eastern and Southern Africa, the water programme provides nature based solutions to unlock water management and governance challenges and opportunities, investments in natural infrastructure and water for development, while mainstreaming knowledge management, climate change, gender and indigenous peoples 'rights in all our solutions. www.iucn.org

BRIDGE - Building River Dialogue and Governance

BRIDGE (Building River Dialogue and Governance) supports the capacities of countries sharing river or lake basins to implement effective water management arrangements through a shared vision, benefit-sharing principles and transparent and coherent institutional frameworks. Its goal is to enhance cooperation among riparian countries by applying water diplomacy at multiple levels.

University of Strathclyde, Glasgow, Scotland

The University of Strathclyde is a public research university located in Glasgow, Scotland. Founded in 1796 as the Andersonian Institute, it is Glasgow's second-oldest university, having received its royal charter in 1964 as the first technological university in the United Kingdom. Taking its name from the historic Kingdom of Strathclyde, it is Scotland's third-largest university by number of students, with students and staff from over 100 countries.

The institution was named University of the Year 2012 by Times Higher Education and again in 2019, becoming the first university to receive this award twice.

IWMI - International Water Management Institute

International Water Management Institute is a non-profit, scientific research organization focusing on the sustainable use of water and land resources in developing countries, IWMI works in partnership with governments, civil society and the private sector to develop scalable agricultural water management solutions that have a real impact on poverty reduction, food security and ecosystem health. IWMI is a member of CGIAR, a global research partnership that unites organizations engaged in research for sustainable development, and leads the CGIAR Research Program on Water, Land and Ecosystems. www.iwmi.cgiar.org

UNESCO - International Hydrological Programme (IHP)

UNESCO-IHP is the only intergovernmental programme of the UN devoted to water research, water resources management, and education and capacity building. Through one of its flagship programmes, the Internationally Shared Aquifer Resources Management (ISARM), more than 70 transboundary aquifers have been identified in Africa of which 28 are shared between two or more SADC Member States. www.unesco.org.

IGRAC - International Groundwater Resources Assessment Centre

IGRAC (International Groundwater Resources Assessment Centre) facilitates and promotes international sharing of information and knowledge required for sustainable groundwater resources development and management worldwide. Since 2003, IGRAC provides an independent content and process support, focusing particularly on transboundary aquifer assessment and groundwater monitoring. www.un-igrac.org

IGS - Institute for Groundwater Studies

IGS aims to be the preeminent groundwater institution in Africa for academic training and research. IGS is the leading groundwater research group in Africa on aspects related to fractured rock aquifers, industrial and mining contamination, groundwater governance, and groundwater resources. The institute conducts contract research on a wide variety of water-related topics, including mining and industrial sectors in terms of water management, minimisation of pollution, as well as understanding the nature and behaviour of South Africa's aquifers.

BGR - Federal Institute for Geosciences and Natural Resources

The Federal Institute for Geosciences and Natural Resources (Bundesanstalt für Geowissenschaften und Rohstoffe or BGR) is a German agency within the Federal Ministry of Economics and Technology. It acts as a central geoscience consulting institution for the German federal government. The headquarters of the agency is located in Hanover. The BGR, the State Authority for Mining, Energy and Geology and the Leibniz Institute for Applied Geophysics form the Geozentrum Hanover. All three institutions have a common management and infrastructure, and complement each other through their interdisciplinary expertise.

University of Botswana

The University of Botswana, popularly known as UB, was established in 1982 as the first institution of higher education in Botswana. The university has three campuses: one in the capital city Gaborone, one in Francistown, and another in Maun. The university is divided into six faculties: Business, Education, Engineering, Humanities, Science and Social Sciences and the University of Botswana School of Medicine, a collaboration with the University of Melbourne in Australia.