GROUNDWATER MANAGEMENT INSTITUTE

5th SADC GROUNDWATER CONFERENCE
16 – 18 NOVEMBER 2022
WINDHOEK, NAMIBIA

GROUNDWATER: Making the invisible visible for socio-economic development

ASSESSMENT OF GROUNDWATER POTENTIAL OF THE KALAHARI AQUIFERS IN KAVANGO EAST AND WEST REGIONS, NAMIBIA

Presenter: Anna David

Supervisor: Tamiru Abiye

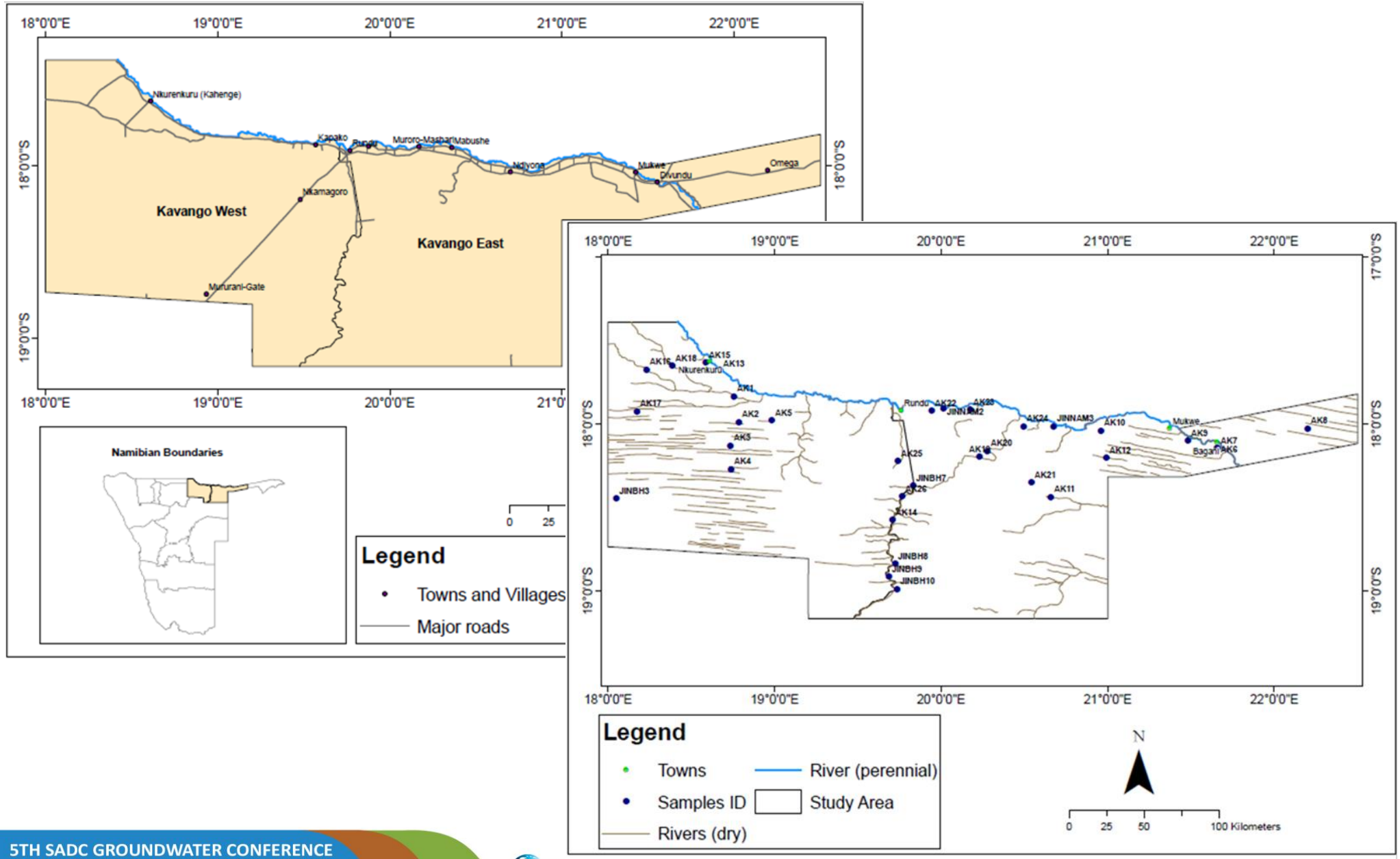
Content

- Introduction
- Study area
- Methodology
- Result
- Recomendation

Introduction

- Groundwater is often overlooked in areas with surface water bodies
- Kavango West and East Regions are situated in the north-eastern Namibia
- Population of the two Kavango Regions- 223,352 (2011 Census)
- Rural Occupants centered along the River – use surface water
- Inhabitants away from the River- Use groundwater
- Most bulk water users along the river have boreholes for their water supply
- Drought in the regions is common-drought relief boreholes are drilled to sustain communities.
- Kalahari 1 and Kalahari 2 aquifer system

Study area


18°0'0"E
19°0'0"E
20°0'0"E
21°0'0"E
22°0'0"E
18°0'0"S
19°0'0"S
17°0'0"S
Nkurenkuru (Kahenge)
Kapako
Rupara
Mororo-Mashari
Mabushe
Ndiyona
Mukwe
Divundu
Omega
Nkamagoro
Kavango West
Kavango East
Mururani-Gate
Namibian Boundaries
0
25
Legend
Towns and Villages
Major roads
AK15
AK18
AK16
AK13
AK1
AK17
AK2
AK5
AK3
AK4
JINBH3
Rundu
AK22
AK23
JINNAM2
AK24
JINNAM3
AK10
AK9
AK7
Bagani
AK6
AK8
AK25
AK19
AK20
AK12
JINBH7
AK26
AK14
AK21
AK11
JINBH8
JINBH9
JINBH10
Legend
Towns
Samples ID
Rivers (dry)
River (perennial)
Study Area
N
0
25
50
100 Kilometers

Methodology

- 53 water samples were collected-33 boreholes (Stable isotopes, major ions)
- Three (3) samples were collected from the Okavango River- (Upstream, middle, downstream)
- Twelve (12) samples were collected from both boreholes and the Okavango River and analyzed for Tritium.
- The Cooper-Jakob Straight Line Pumping Test Analysis (Pongmanda & Suprapti, 2020) was used to determine the storativity/specific yield.
- Reviewed over 100 borehole completion reports from Growas II
- Calculated elevation difference to determine aquifer thickness.

Methodology

- Quantified recharge using the Chloride Mass Balance Method
- Groundwater storage in the Kalahari aquifers V=∑⟦A S ΔH⟧.
- A basic water-balance approach was used for the potential calculations (DWAF, 2006).

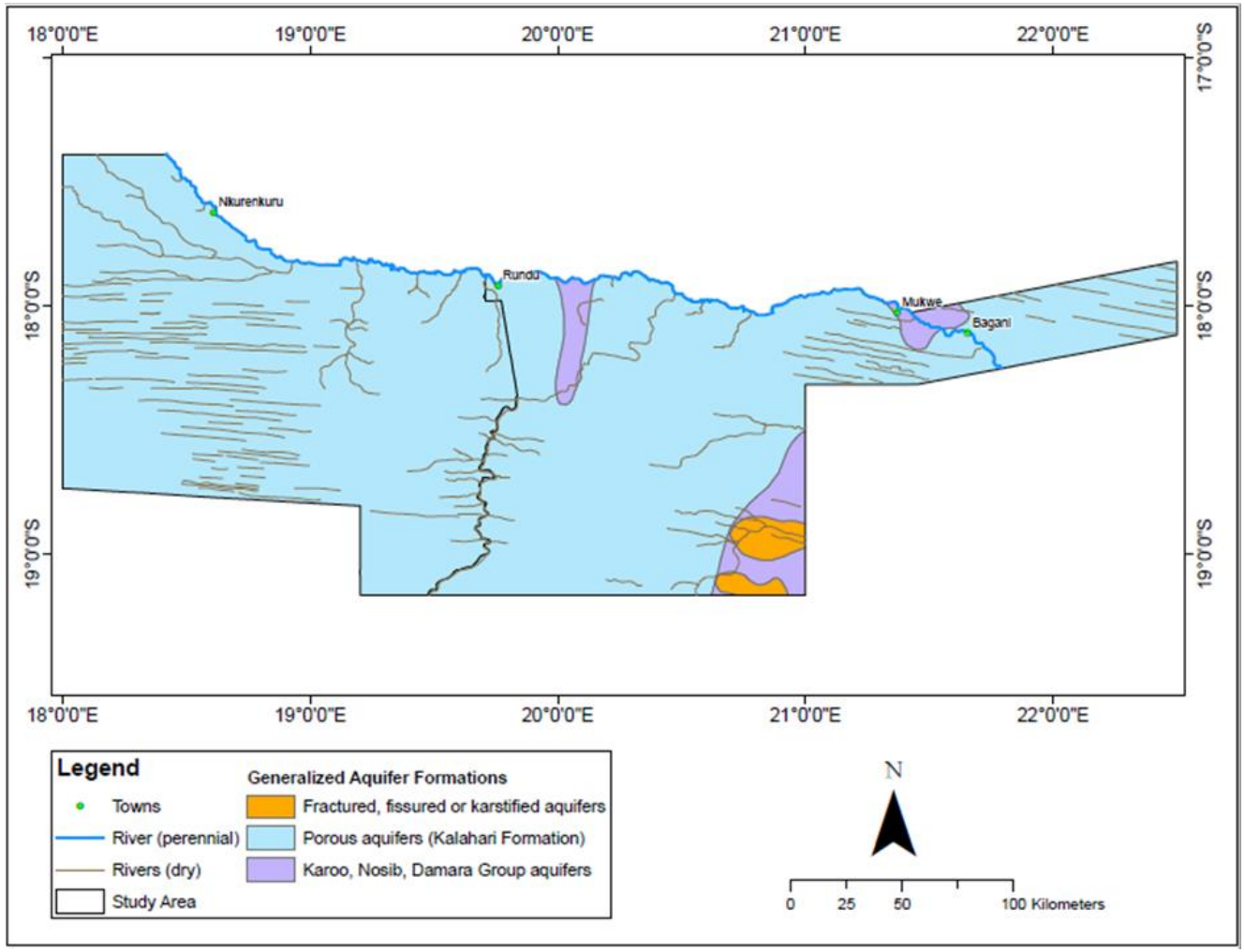
- **Resource potential =** $\boldsymbol{R_e + \left({}^{S_v}/_{D_i}\right) - B_f}$

Where, R_e= Mean Annual Potential Recharge (m/a)

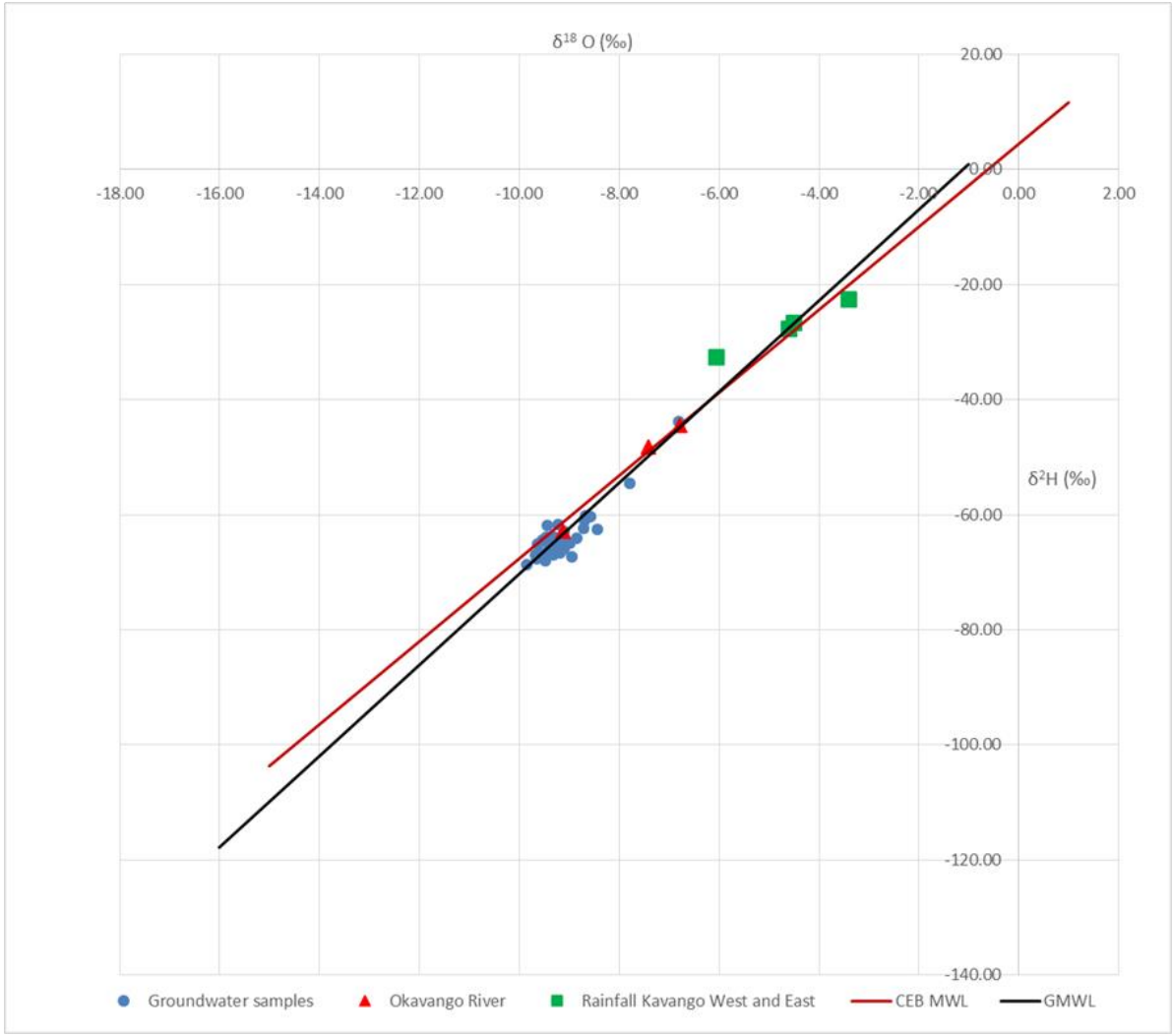
S_v= Mean Volume of Water stored in Aquifer (m^3)

D_i= Drought Index- Output of Harvest Potential (Baron et al., 1998)

B_f= Mean Annual contribution to River Baseflow- Okavango River


18°0'0"E
19°0'0"E
20°0'0"E
21°0'0"E
22°0'0"E
17°0'0"S
18°0'0"S
19°0'0"S
Nkurenkuru
Rundu
Mukwe
Bagani
Legend
Towns
River (perennial)
Rivers (dry)
Study Area
Generalized Aquifer Formations
Fractured, fissured or karstified aquifers
Porous aquifers (Kalahari Formation)
Karoo, Nosib, Damara Group aquifers
N
0
25
50
100 Kilometers

Results


δ18 O (‰)
20.00
0.00
-20.00
-40.00
-60.00
-80.00
-100.00
-120.00
-140.00
-18.00
-16.00
-14.00
-12.00
-10.00
-8.00
-6.00
-4.00
-2.00
0.00
2.00
δ2H (‰)
Groundwater samples
Okavango River
Rainfall Kavango West and East
CEB MWL
GMWL

Sample ID	Locality	Tritium (T. U)		Residence time (Years)
AKT1	Nyangana	0.2	±0.2	46.9
AKT2	Sambiu	0.8	±0.2	22.0
AKT3	Satoka	0.4	±0.2	34.4
AKT6	Nkambe	0.2	±0.2	46.9
AKT7	Omega	0.9	±0.2	19.9
AKT9	Nkurenkuru	0.7	±0.2	24.4
AKT10	Kahenge	0	±0.2	-
AKT12	Shamapiri	0.5	±0.2	30.4
AKT4	Okavango river (Andara site)	1.8	±0.3	7.5
AKT5	Okavango river (Poppa Falls)	1.8	±0.3	7.5
AKT8	Okavango river (Rundu site)	1.5	±0.3	10.7
AKT11	Okavango river (Nkurenkuru site)	1.8	±0.3	7.5

Sample ID	Sample location	Latitude	Longitude	Tritium (TU)	
AKT1	Nyangana	-18.0151	20.6754	0.2	±0.2
AKT2	Sambiu	-17.9071	20.0139	0.8	±0.2
AKT3	Satoka	-18.9176	19.6863	0.4	±0.2
AKT4	Okavango river (Andara site)	-18.0630	21.4480	1.8	±0.3
AKT5	Okavango river (Poppa Falls)	-18.1222	21.5807	1.8	±0.3
AKT6	Nkambe	-18.1288	18.7344	0.2	±0.2
AKT7	Omega	-18.0286	22.1992	0.9	±0.2
AKT8	Okavango river (Rundu site)	-17.8727	19.8027	1.5	±0.3
AKT9	Nkurenkuru	-17.6322	18.5864	0.7	±0.2
AKT10	Kahenge	-17.6761	18.6724	0.0	±0.2
AKT11	Okavango river (Nkurenkuru site)	-17.6214	18.6152	1.8	±0.3
AKT12	Shamapiri	-18.0149	20.4940	0.5	±0.2

Groundwater potential

Group/ Sequence	Lithology	Total Area (Km^2)	Groundwater Storage (Mm^3)	Drought Index (Years)	Recharge (Mm^3/a)	Baseflow (Mm^3/a)	Groundwater Resource Potential (Mm^3/a)	Annual Groundwater Resource Potential (m^3/km^2)
Middle Kalahari	Sandstone, Sand & Clay	45920.5	168 500.68	1.25	784.32	177.11	135 407.75	2948 742.93
Lower Kalahari	Marl and Clay	45920.5	10 702.69	1.25	654.37	177.11	9039.41	196 849.11
	Sandstones, Conglomerate & Gravel							
Total							144 447.16	3145 592.04

The likely availability of accessible groundwater per borehole per km^2 in the Kalahari aquifers.

Group/ Sequence	Lithology	Total Area (Km^2)	Recharge (Mm^3/a)	Groundwater Resource Potential (Mm^3/a)	Groundwater Availability			
					Average Borehole Yield (m^3/a)	Annual Borehole Yield (m^3/km^2)	% of Recharge	% of Resource Potential
Middle Kalahari	Sandstone, Sand & Clay	45 920.5	784.32	135 407.75	74 738.37	1.627	0.009	0.00005
Lower Kalahari	Marl and Clay	45 920.5	654.37	9 039.41	133 595.79	2.909	0.02	0.001
	Sandstones, Conglomerate & Gravel							

Recommendation

- More environmental Isotopes analysis be conducted to determine the exact gw-surface water interaction
- Water sampling for isotope analysis be included in the future groundwater/surface water quality sampling schedule.
- Delineate all the aquifers in the regions.
- Transboundary system similar studies be carried out in both Riparian states.
- Monitoring network be developed.

Thank you