Investigating the feasibility of a 3-tier groundwater exploration approach in basement aquifers.

A case of Mudzi District, Zimbabwe.

BY

Goodson Chitsa [1,*], Zvikomborero Hoko[1], Webster Gumindoga[1], Maideyi L. Meck [2]

[1]Department of Construction and Civil Engineering, Box MP 167, Mt Pleasant, Harare, Zimbabwe

[2]University of Zimbabwe, Geology Department, Box MP 167, Mt Pleasant, Harare, Zimbabwe

**Presenter : E-Mail:goodson.chitsa@gmail.com ; Tel +263777092576*

4th SADC GROUNDWATER CONFERENCE: 10th - 12th November, 2021.

PRESENTATION OUTLINE

1. BACKGROUND
2. PROBLEM STATEMENT
3. OBJECTIVES
4. STUDY AREA

6. MATERIALS AND METHODS
7. RESULTS AND DISCUSSIONS
8. CONCLUSIONS AND
9. RECOMMENDATIONS

4th SADC GROUNDWATER CONFERENCE
10th - 12th of November 2021
VIRTUAL CONFERENCE

Background

- Groundwater(GW) exploration in basement aquifers is linked to low drilling success rates and boreholes of poor water quality(**Muchingami et al., 2019**).
- Conventional methods for GW exploration, include geophysical surveys, test drilling, and laboratory water quality testing (**Shemasanga et al., 2018**).
- Other recent scientific methods to explore groundwater include Earth Observation (EO) techniques (**Das et al., 2019; Omolaiye et al., 2020; Tolche, 2021**).
- Indigenous Knowledge Systems(IKs) have also been used to explore groundwater especially where conventional methods are expensive (**Shemasanga et al., 2018**).

Problem Statement

- Conventional groundwater exploration approaches lack integration of other scientific methods such as EO and IKs **(Adeyeye et al., 2019; Omolaiye et al., 2020).**
- The exclusive use of a single conventional groundwater exploration method is vulnerable to errors **(Bayewu et al., 2017; Muchingami et al., 2019).**

Main Objective

- To investigate the potential for integration of Earth Observation techniques, geophysics and IKS to enhance groundwater exploration accuracy, minimize costs and save time.

Specific Objectives

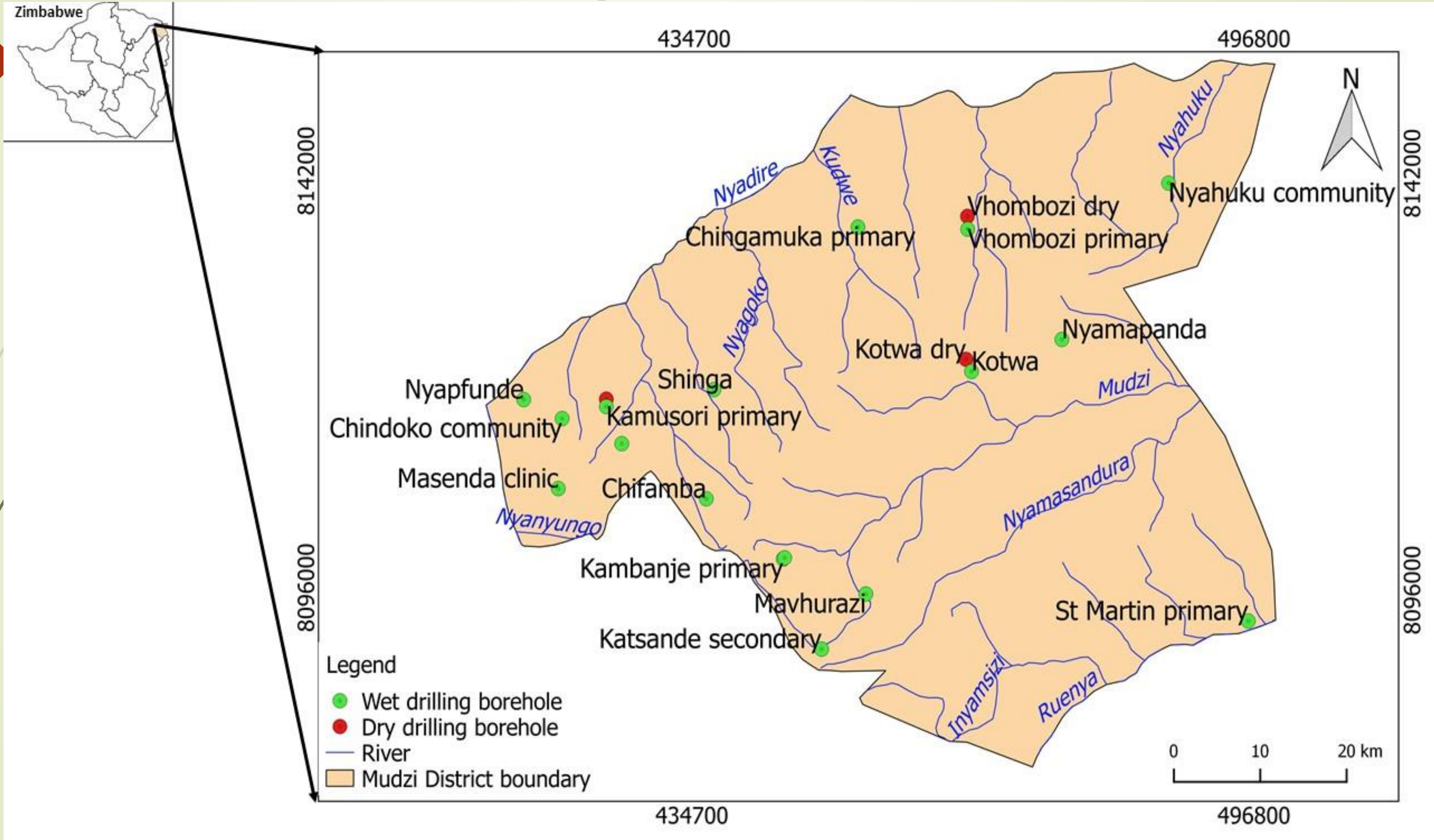
(i) To delineate groundwater potential in the study area using GIS and Remote Sensing techniques.

(ii) To assess groundwater potential and quality in the study area using Indigenous Knowledge Systems (IKS).

(iii) To evaluate the groundwater potential and quality of the study area using geophysical methods.

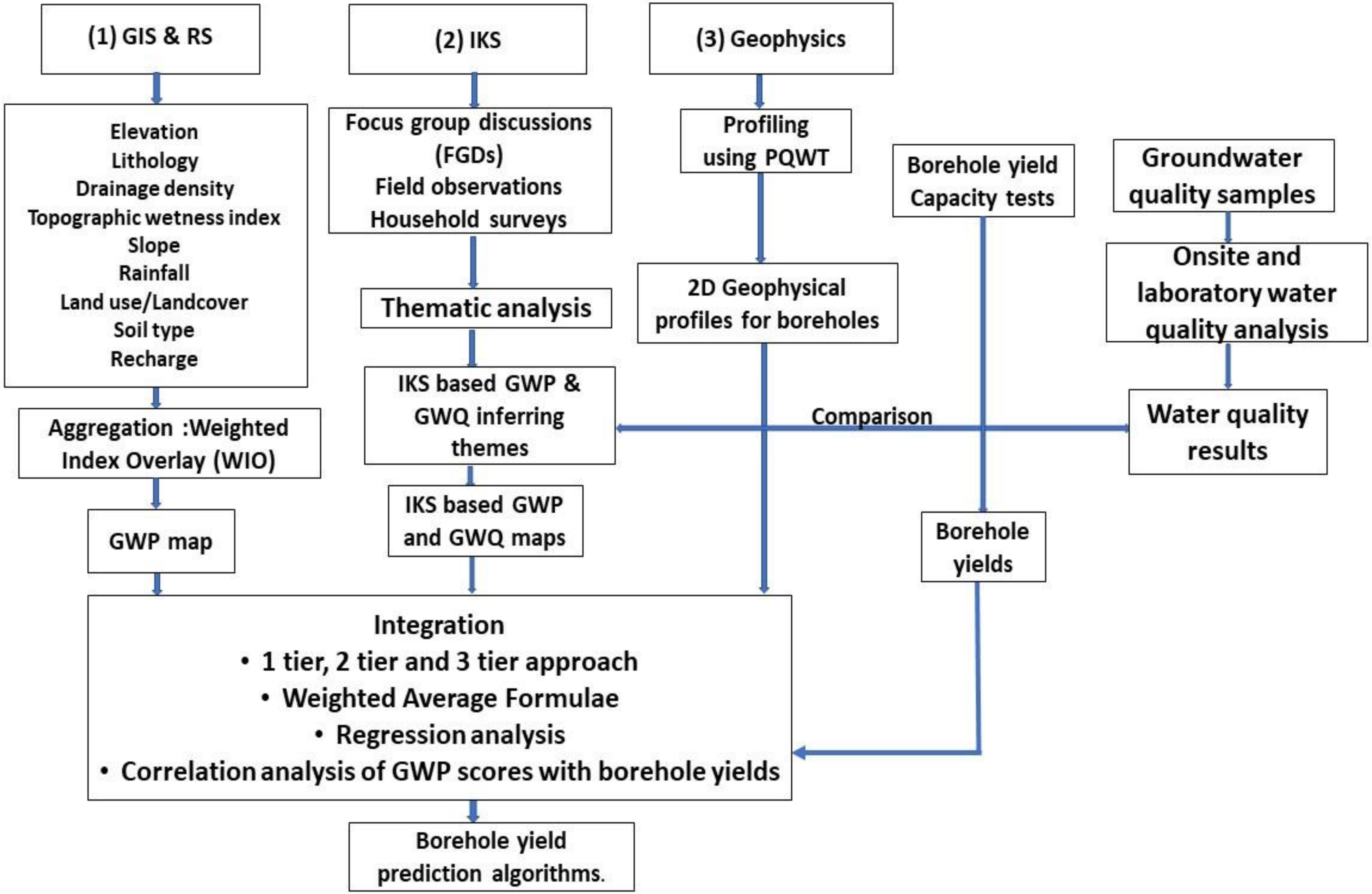
(iv) To develop a groundwater exploration approach that enhance exploration accuracy based on linkages between Earth Observation, IKS and geophysical techniques.

Study Area



Zimbabwe
434700
496800
8142000
8096000
N
Nyadire
Kudwe
Nyahuku
Nyahuku community
Vhombozi dry
Vhombozi primary
Chingamuka primary
Nyagoko
Nyamapanda
Kotwa dry
Kotwa
Mudzi
Shinga
Nyapfunde
Kamusori primary
Chindoko community
Masenda clinic
Chifamba
Nyanyungo
Nyamasandura
Kambanje primary
Mavhurazi
Katsande secondary
St Martin primary
Inyamsizi
Ruenya
Legend
Wet drilling borehole
Dry drilling borehole
River
Mudzi District boundary
0
10
20 km

Materials & METHODS

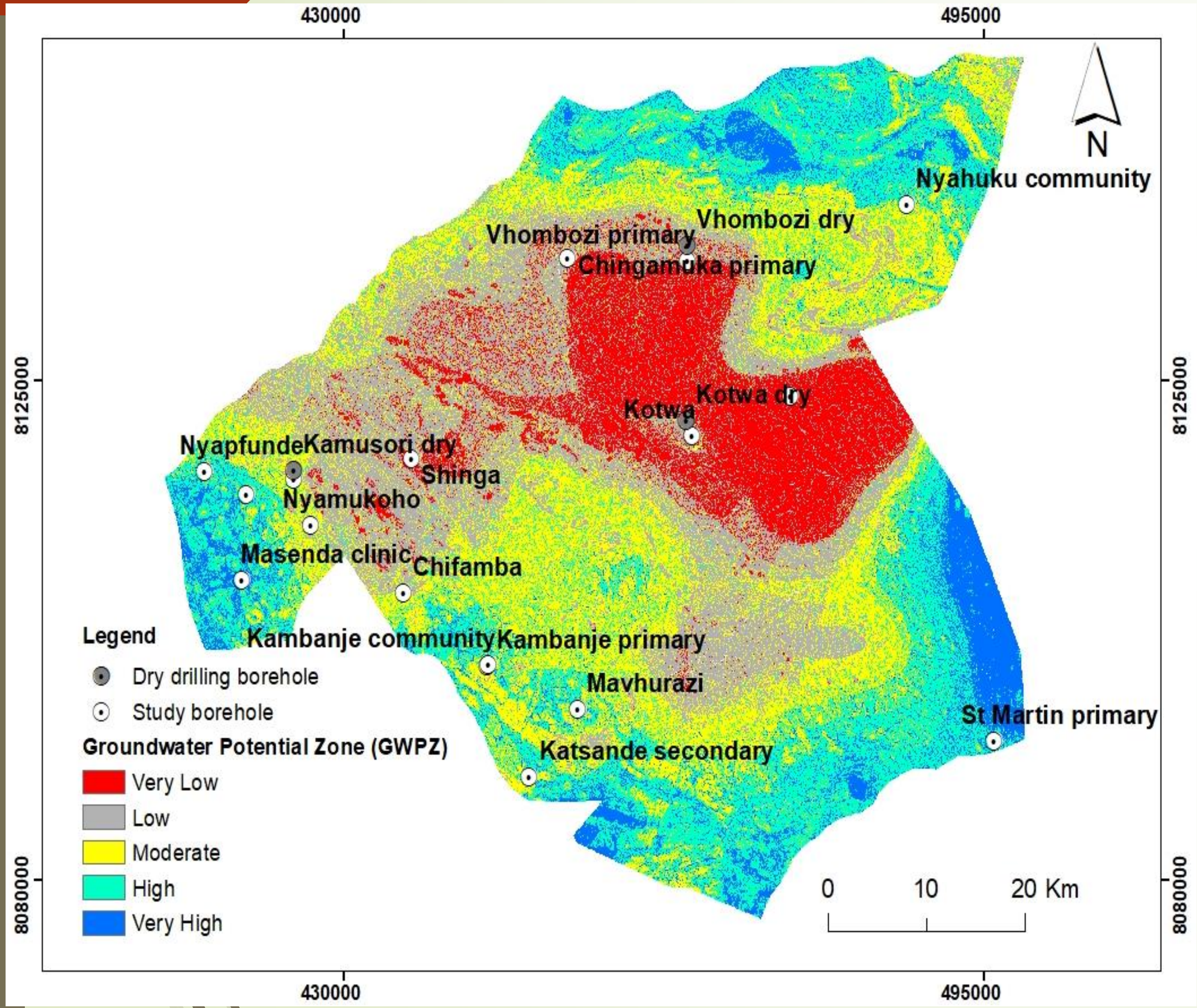


FIELD PHOTOS: Geophysical Survey and Onsite Water quality assessment

(a) Vhombozi site **(b) Chindoko site**

Results & Discussions

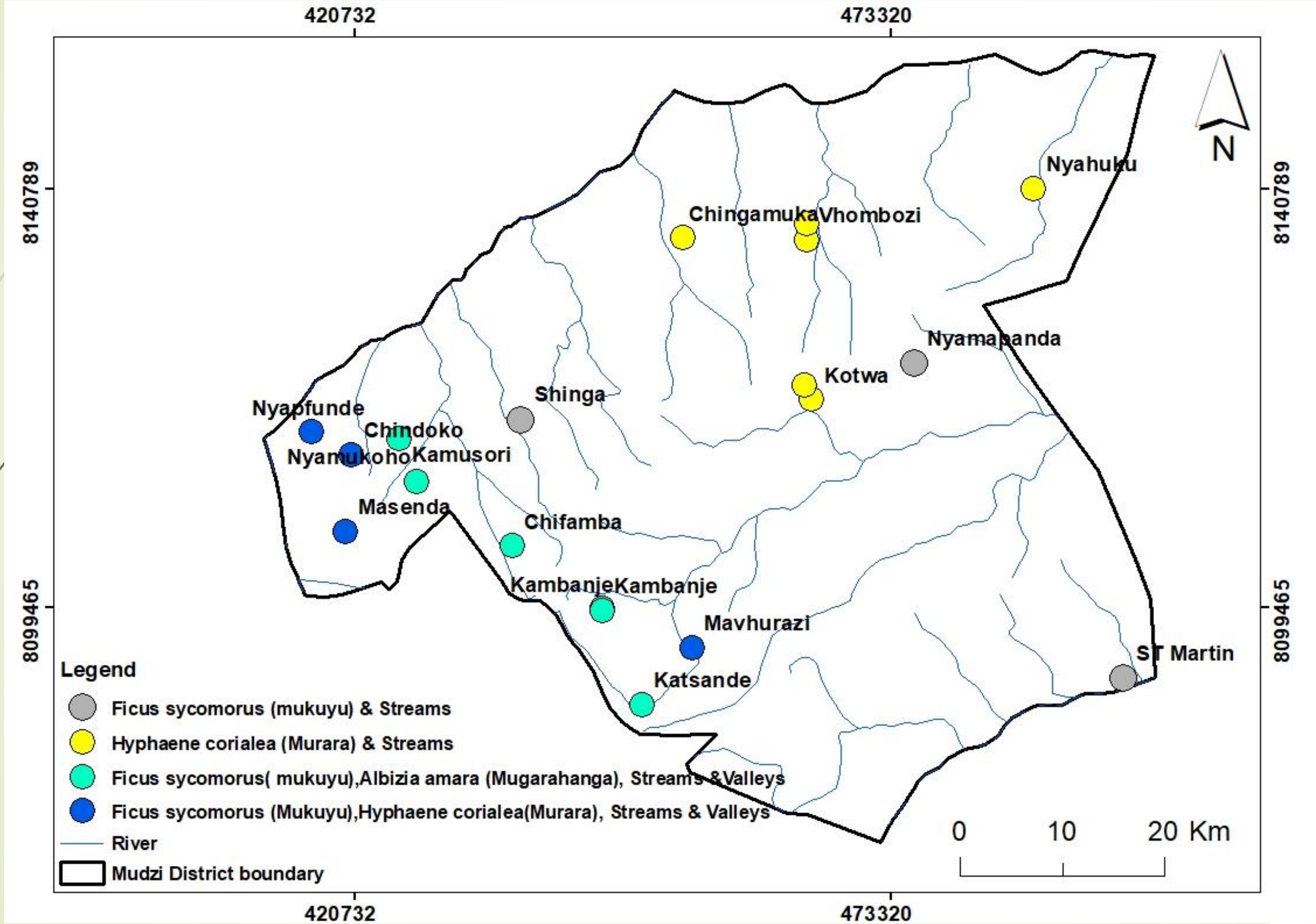
EO-based Groundwater Potential Map



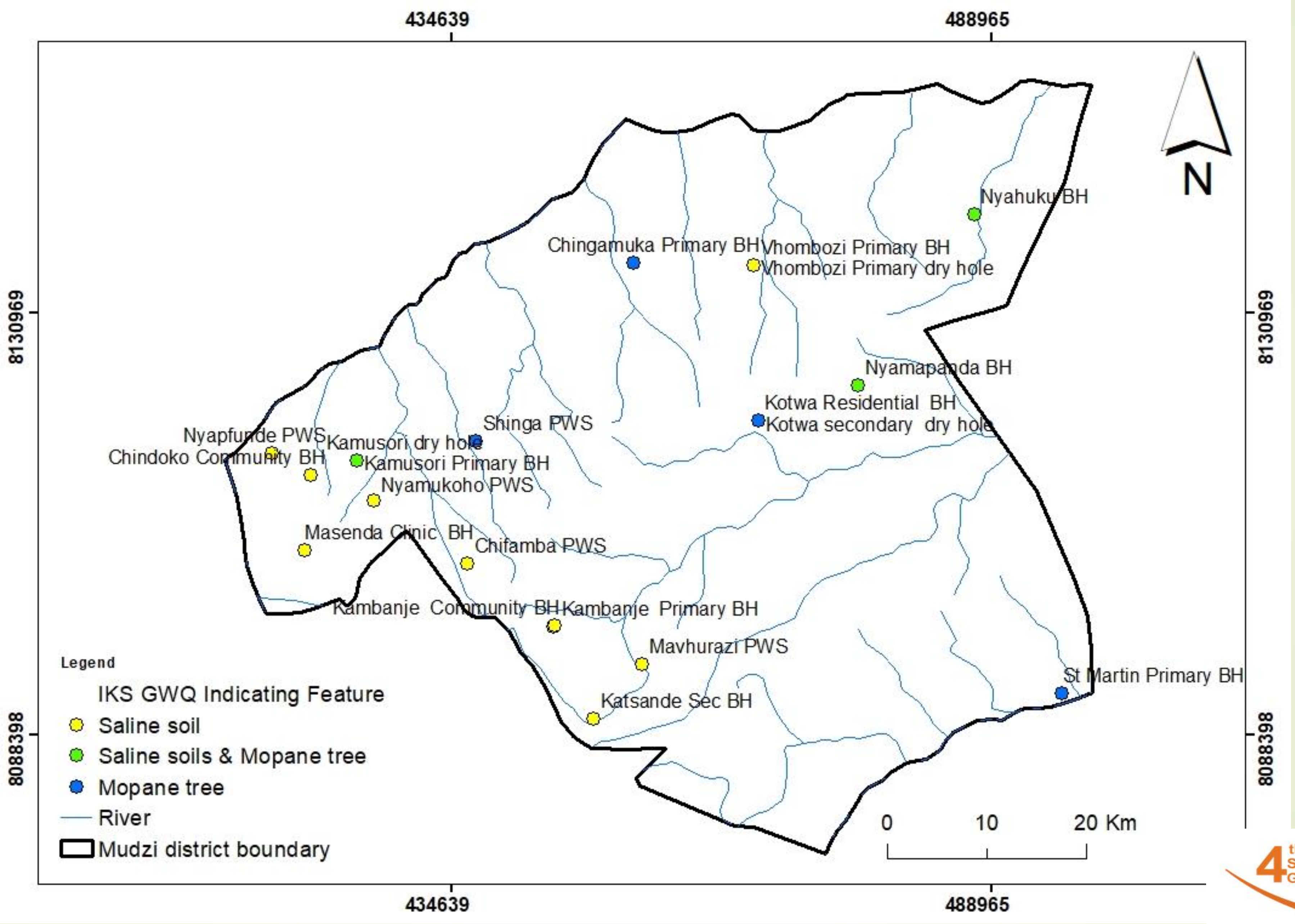
GWP Zone	Yield (L/s)	Percentage (%) Area
Very Low	< 0.35	5.48
Low	0.35 ≤ Y < 0.7	12.85
Moderate	0.7 ≤ Y < 1.0	34.53
High	1.0 ≤ Y < 1.4	35.66
Very High	Y > 1.4	11.48

4th SADC GROUNDWATER CONFERENCE
10th - 12th of November 2021
VIRTUAL CONFERENCE

IKs Based GWP Map

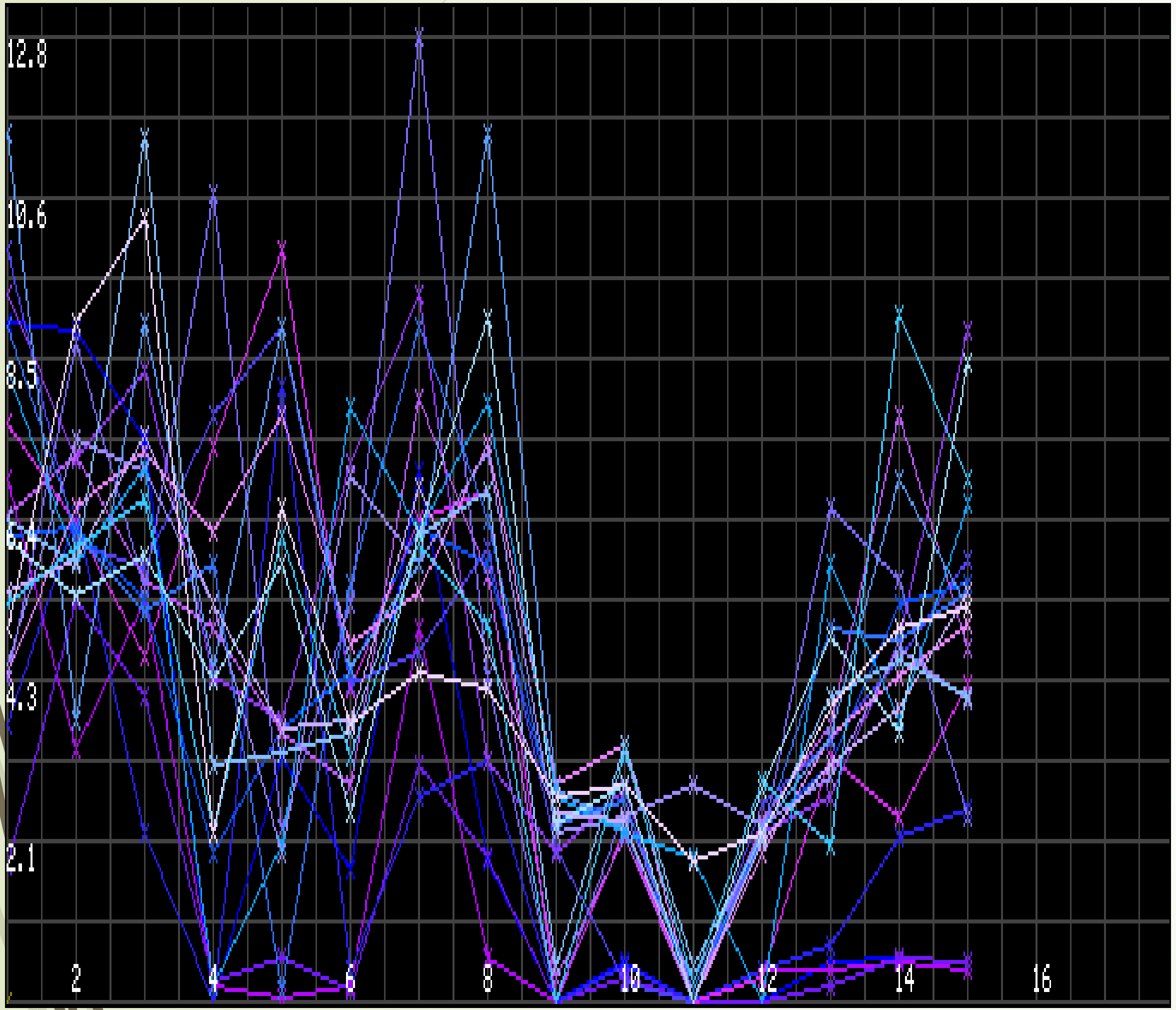


IKs Based GWQ Map



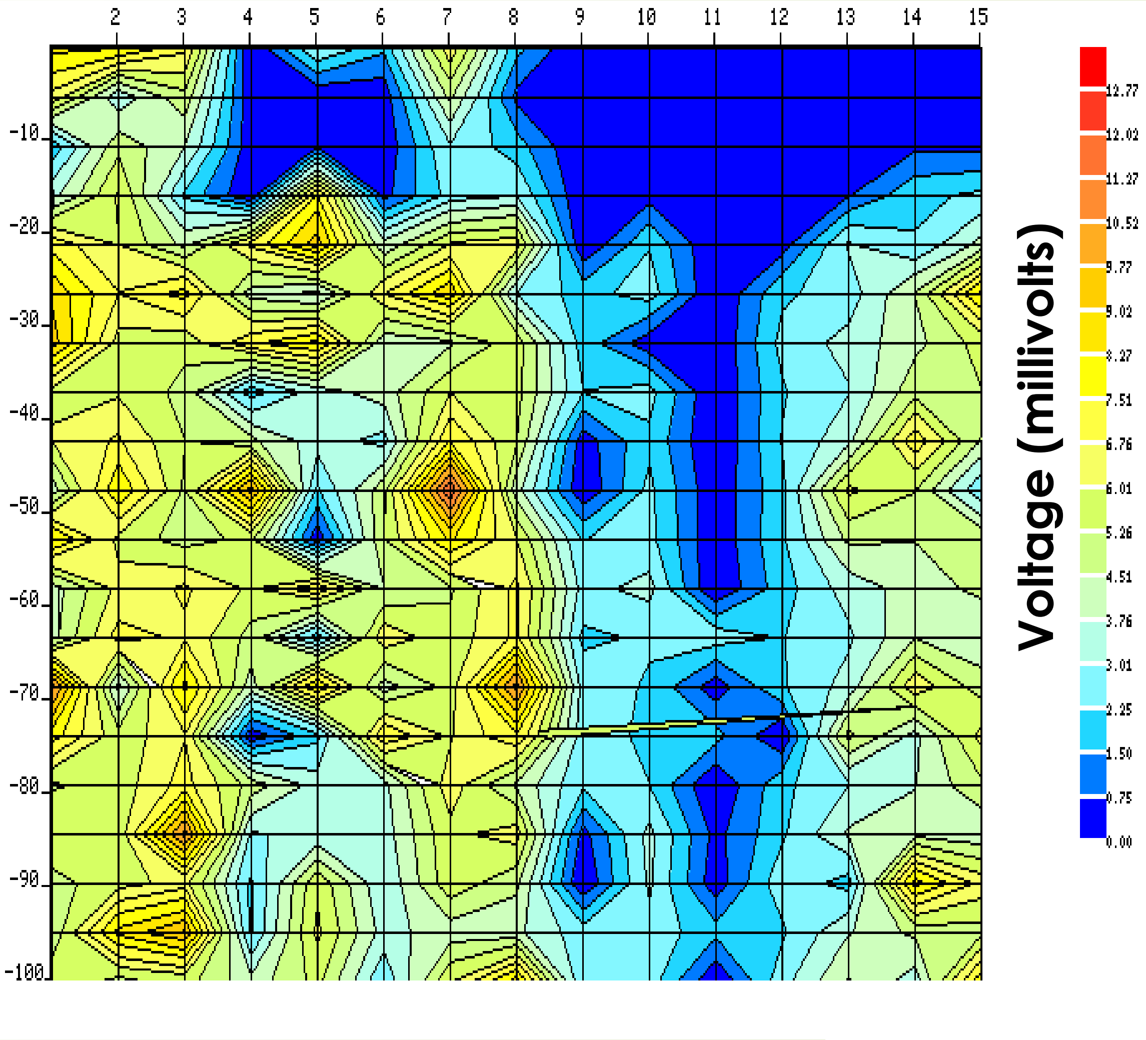
Nyapfunde Community Borehole 2D Geophysical Survey Profile (GWP Classification : High)

Frequency (Hz)



Horizontal Distance along Profile

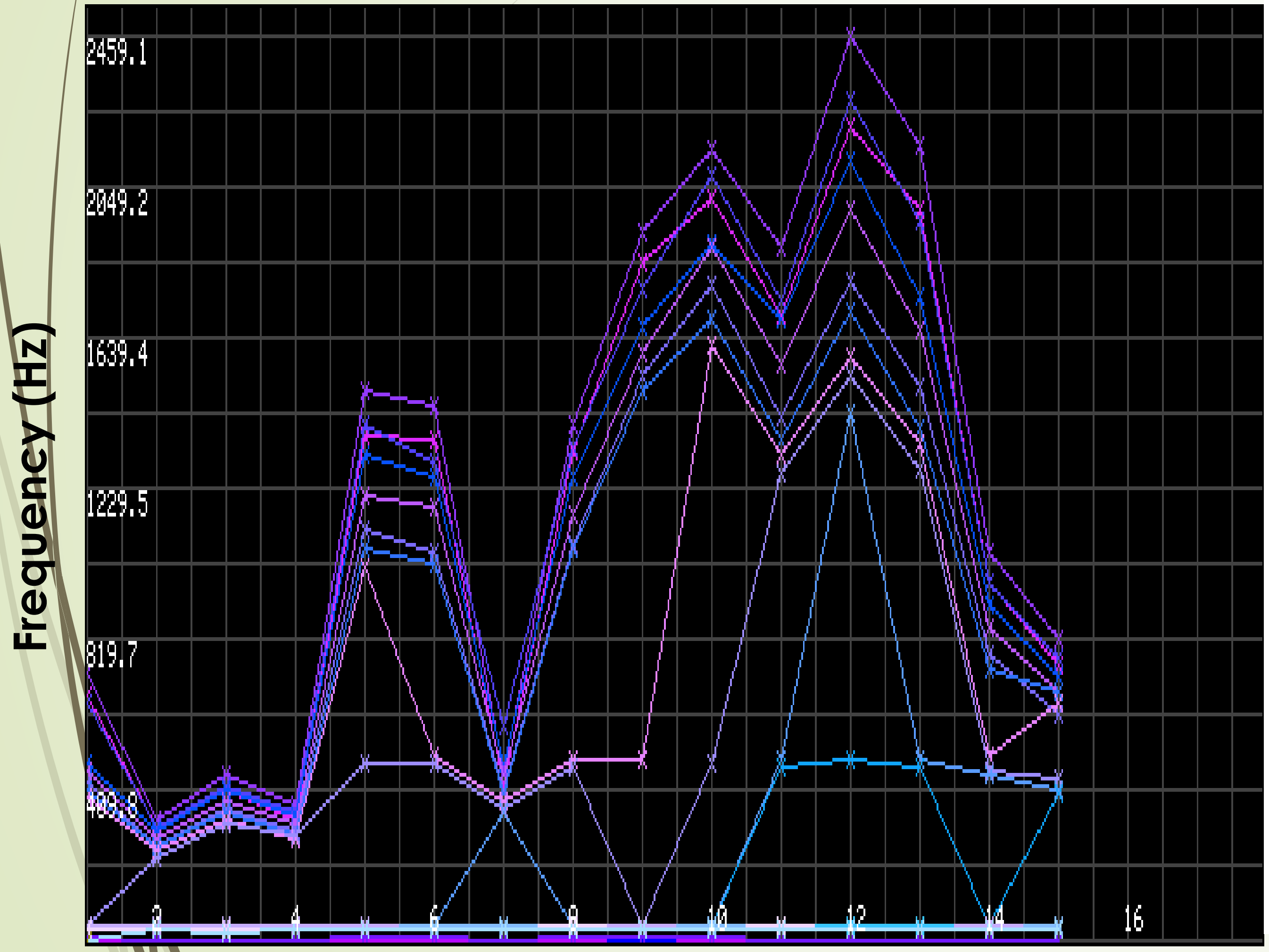
Depth (m)



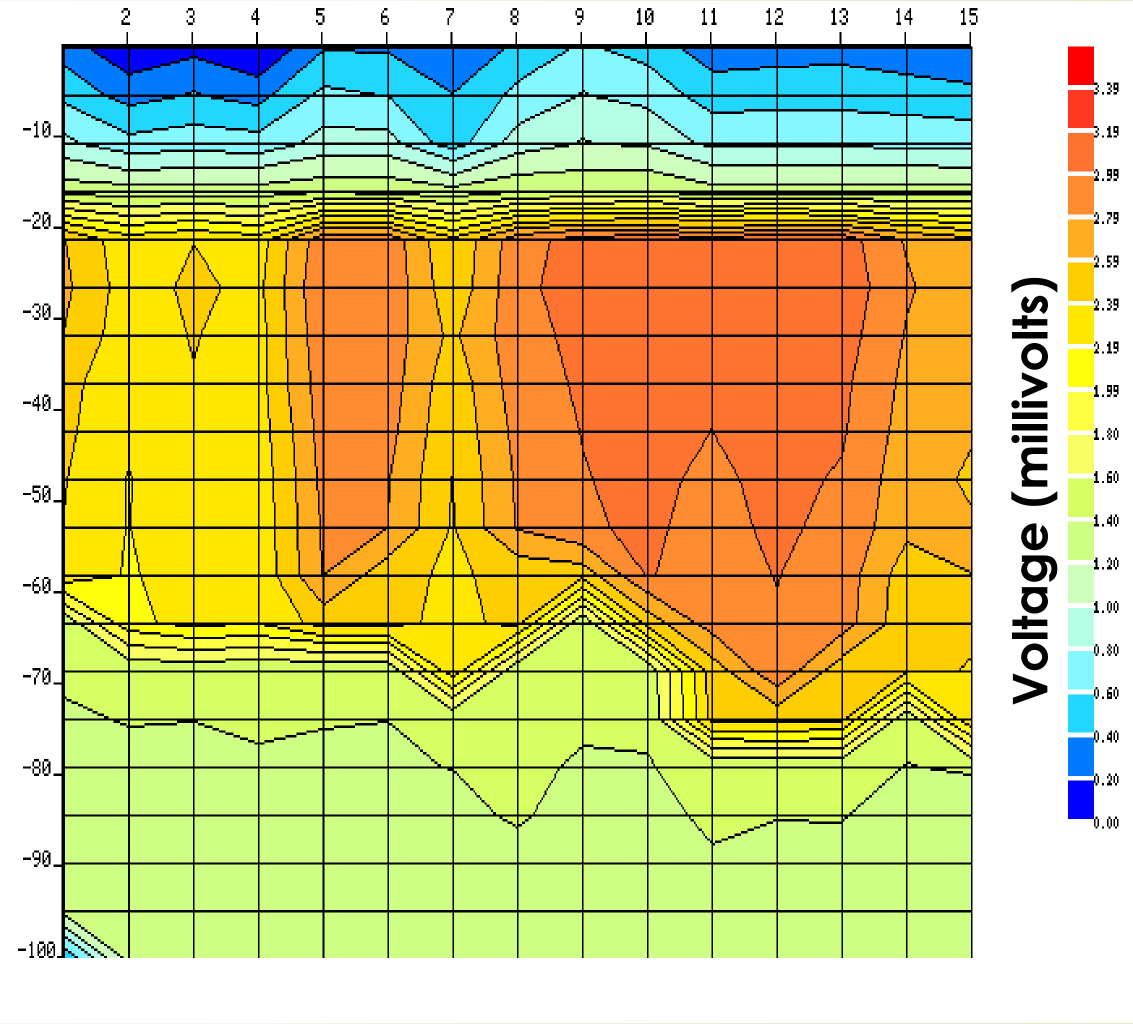
Borehole position: point 4

4th SADC GROUNDWATER CONFERENCE
10th - 12th of November 2021
VIRTUAL CONFERENCE

Kotwa Residential Borehole 2D Geophysical Survey Profile (GWP Classification: Very Low")



Horizontal Distance along Profile



Borehole position: Point 3

Correlation and regression algorithms($p<0.05$)

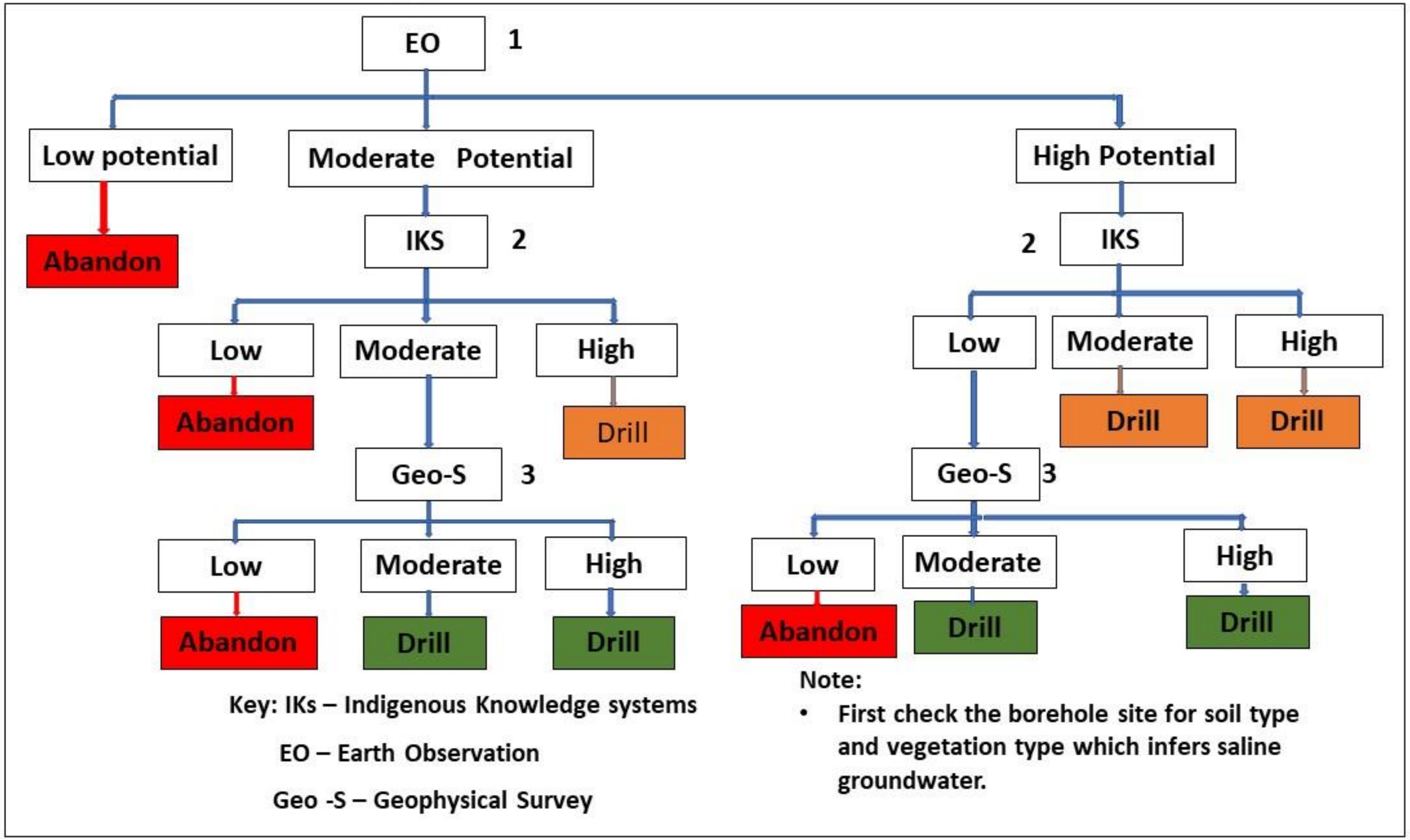
Groundwater Exploration method	Spearman Correlation coefficient (rho)	Borehole yield prediction algorithm
EO based techniques (1 tier)	0.78	Y= 0.27**GWP**+ 0.10
IKs based method (1 tier)	0.63	Y= 0.25**GWP** + 0.16
Geophysics based (1 tier)	0.83	Y= 0.35**GWP** - 0.22
EO and IKS (2 tier)	0.82	Y= 0.35**GWP**- 0.10
Integrating EO and Geophysics (2 tier approach)	0.88	Y= 0.35**GWP**- 0.18
Integrating IKs and Geophysics (2 tier)	0.90	Y= 0.40**GWP**- 0.36
Integrating EO,IKs and geophysics (3 tier approach)	0.92	Y = 0.41**GWP** – 0.32

Conclusion(s)

- A three tier groundwater exploration approach of integrating EO techniques, IKS and geophysics has potential to improve accuracy in semi-arid regions underlain by basement aquifers.
- integrated EO and geophysics can be used to enhance the accuracy of exploring groundwater potential in areas where IKs cannot be easily established.
- Indigenous knowledge systems can be used to infer groundwater quality of salinity and hardness at borehole siting stage.

Recommendation

THE CHITSA PROPOSED THREE (3) TIER GROUNDWATER EXPLORATION APPROACH



THANK YOU!!!