

4th SADC GROUNDWATER CONFERENCE

10th -12th of November 2021
VIRTUAL CONFERENCE



Investigating groundwater contamination in St. Mary's suburb of Chitungwiza, Zimbabwe

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British
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Introduction

- ❑ Unsafe drinking water causes more than 1.5 million deaths, largely in children under the age of 5 ([WHO/UNICEF, 2017](#)).
- ❑ Groundwater is now a preferred water source in Sub-Saharan Africa to meet demand ([Pantaleo *et al.*, 2018](#)).
- ❑ In Zimbabwe over 68% of the population depend on groundwater ([Dzvairo *et al.*, 2006](#)).
- ❑ Chitungwiza having water challenges because doesn't have it's own water source.
- ❑ Ageing water infrastructure failing to meet the growing demand.

Problem statement

- ❑ Insufficient data on groundwater quality in St. Mary's, Chitungwiza.
- ❑ Earlier efforts on groundwater quality assessment lack spatial variation.
- ❑ Inadequacy of supportive scientific knowledge blocking groundwater utilisation and protection. (Broderick, 2012) .
- ❑ Need to reduce the health and environmental risks.

OBJECTIVES

Main Objective

To investigate groundwater contamination in St. Mary's suburb of Chitungwiza.

Specific Objectives

- i.To analyse the Physico-chemical and microbiological groundwater quality for selected boreholes and wells in St. Mary's suburb of Chitungwiza and assess its conformity to SAZ standards and WHO drinking water guidelines.
- ii.To assess the spatial variation of the quality aspect of groundwater in St. Mary's.
- iii.To determine the aquifer vulnerability to pollution in St. Mary's using Remote Sensing techniques.

Study area

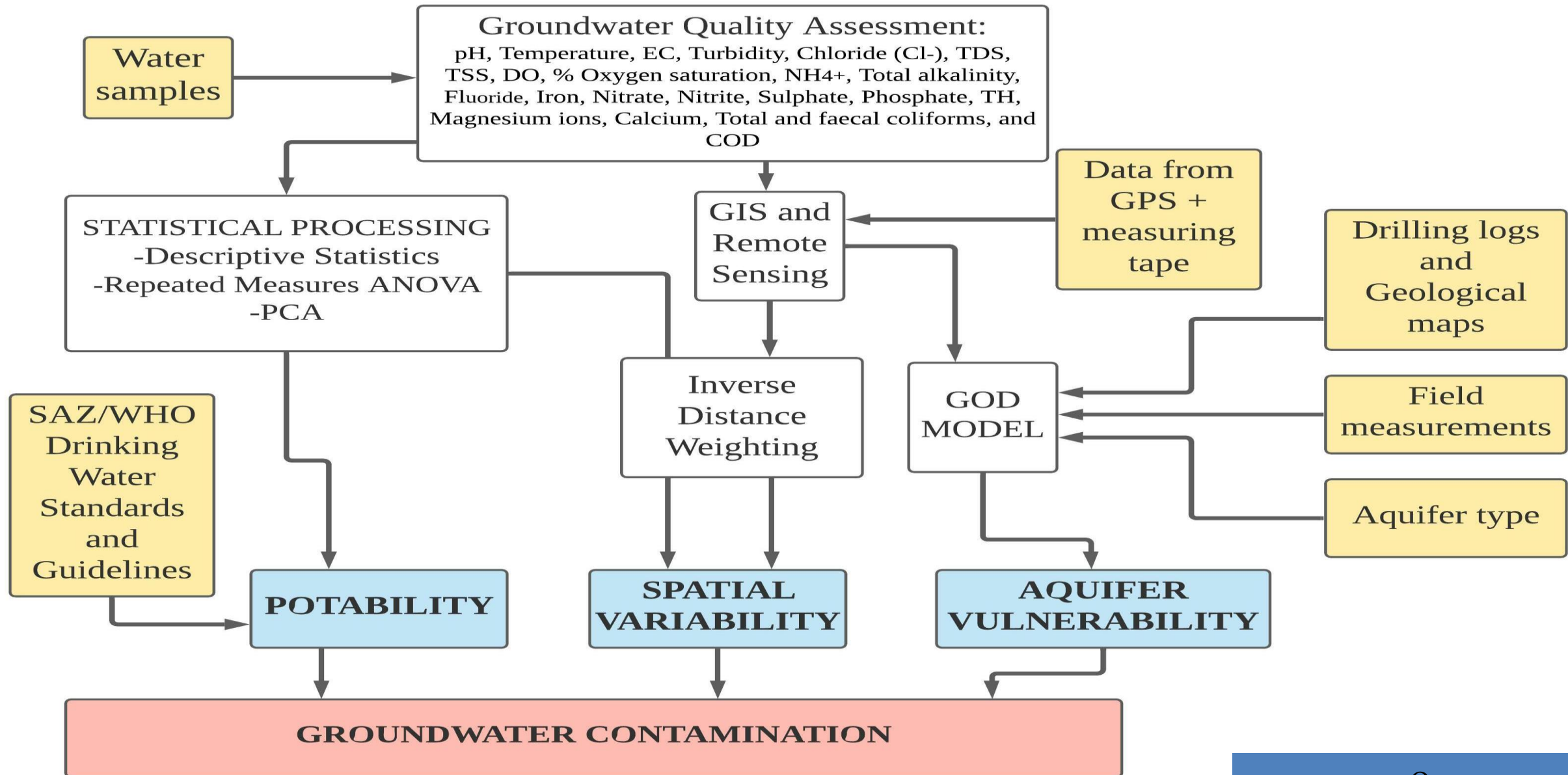
Description

- ❑ Chitungwiza lies 30 km to the south of the capital city, Harare at Latitude: $-18^{\circ} 00' 45.86''$ S and Longitude: $31^{\circ} 04' 31.98''$ E.
- ❑ St. Mary's - Oldest suburb in Chitungwiza.
- ❑ Experiencing intermittent water supply (Zvobgo,2020) .
- ❑ Reliance on groundwater of unknown quality for drinking.

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Materials and Methods



Results and Discussion

Parameter	N	Mean±Std. Dev	SAZ standards	WHO
pH	40	6.81±0.57	6.5-8.5	6.0-9.0
Temperature (°C)	40	23.62±2.37	20-30	
Electrical cond. (µS/cm)	40	948.10±325.65	700	3000
TSS (mg/L)	40	19.33±62.94	10	100
Total Dissolved Solids (mg/L)	40	605.33±230.16	100-1500	2000
Total hardness (mg/L)	40	226.48±78.74	20-300	500
Calcium (mg/L)	40	93.30±57.47	60	120
Magnesium (mg/L)	40	133.15±50.25	70	100

Exceeds both SAZ standards and WHO guidelines
No. Exceeds only SAZ standards

Results and Discussion

Parameter	N	Min	Max	Mean±Std. Dev	SAZ standards	WHO
Total Alkalinity (mg/L)	40	18.00	680.00	135.18±110.22	20	200
Turbidity (NTU)	40	0.00	186.00	11.83±29.37	1	5
Fluoride (mg/L)	40	0.05	0.27	0.14±0.06	<1.5	
Iron (mg/L)	30	0.02	5.10	0.80±1.63	0.3	1
Chloride (mg/L)	30	27.00	201.00	127.17±37.20	<250	
Nitrite (NO ₂) (mg/L)	40	0.02	1.00	0.20±0.30	1	
Nitrate (NO ₃) (mg/L)	40	10.10	414.00	145.70±91.66	10	50
Sulphates (mg/L)	40	5.00	150.00	52.47±37.47	100	250

 Exceeds both SAZ standards and WHO guidelines

No. Exceeds only SAZ standards

Results and Discussion

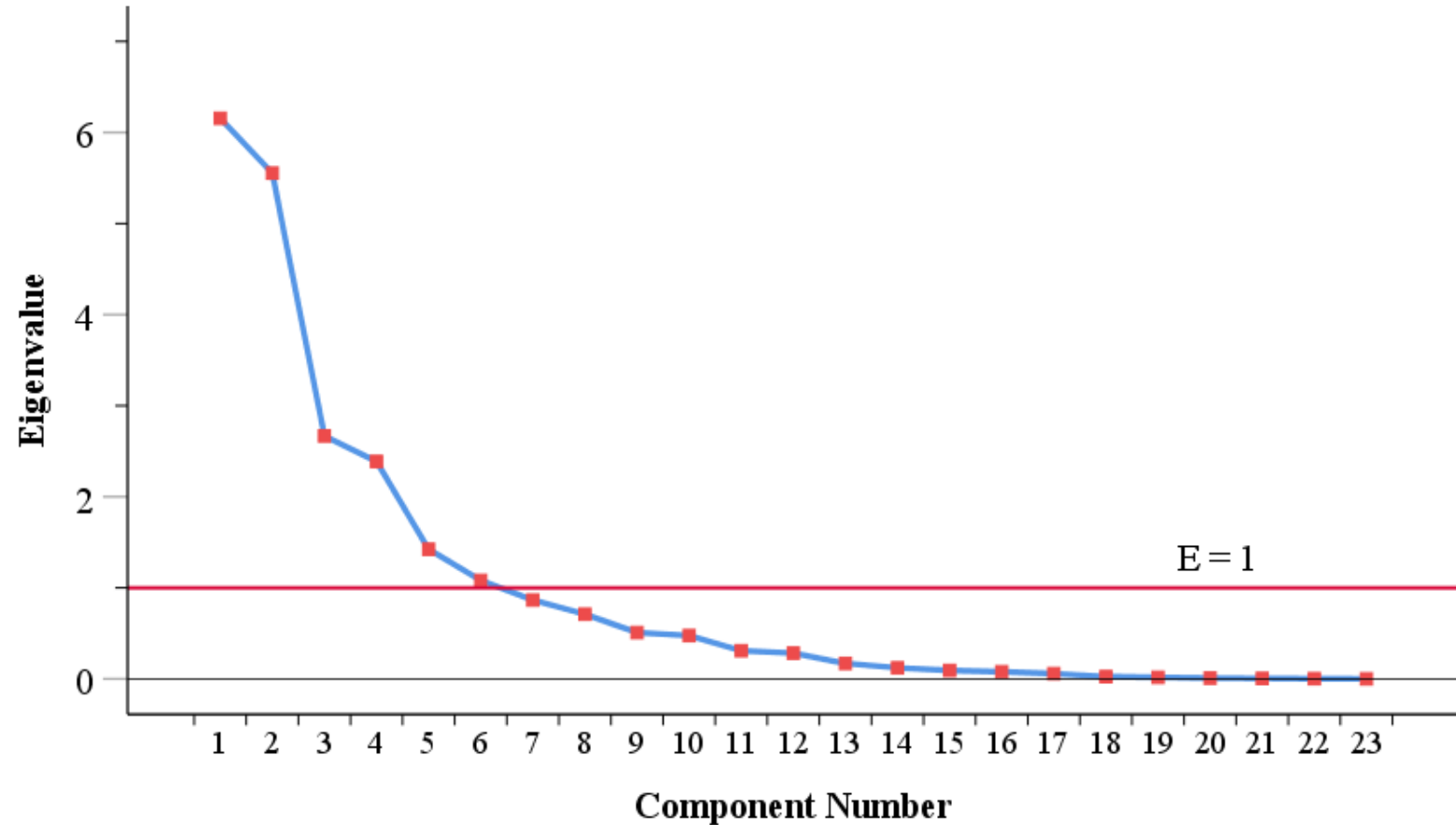
Parameter	N	Min	Max	Mean±Std. Dev	SAZ standards	WHO
Phosphates (mg/L)	40	0.05	0.35	0.10±0.07	0.5	5
DO (mg/L)	40	2.28	7.56	5.29±1.35	-	-
Percentage Oxygen	40	34.50	99.60	69.21±17.34	75	15
NH ₄ ⁺ (mg/L)	40	0.02	53.50	6.50±15.10	0.5	2
Total Coliform (cfu/100 ml)	40	8.00	110.00	53.2±27.50	Absent	Absent
Faecal Coliform (cfu/100 ml)	40	0.00	69.00	24.00±18.50	Absent	Absent
COD (mg/L)	30	0.00	202.00	38.79±73.72		

 Exceeds both SAZ standards and WHO guidelines

No. Exceeds only SAZ standards

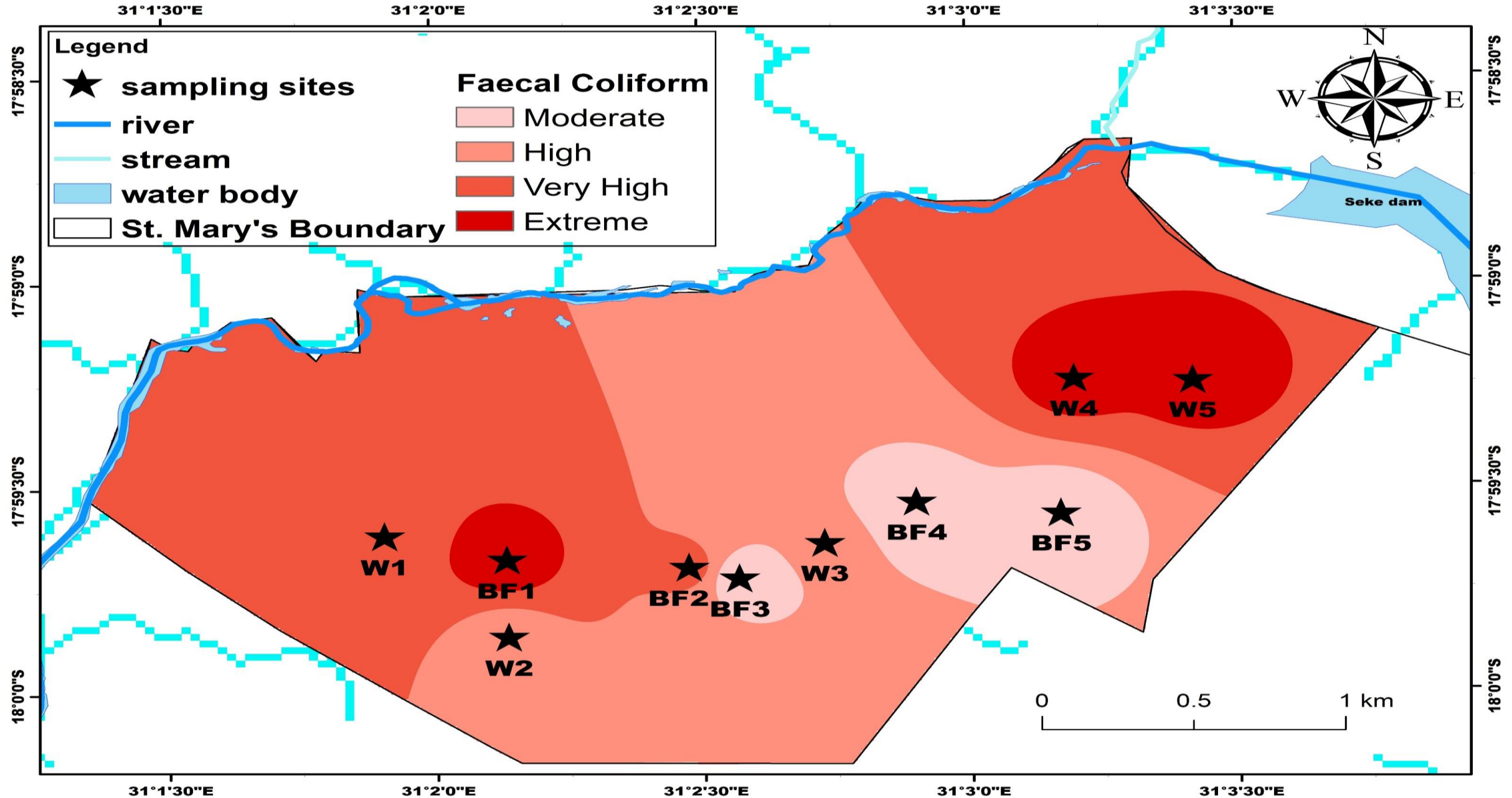
Extraction of key parameters using the PCA

- ❑ PCA used for dimensional reduction.
- ❑ 6 PCs extracted, 84% of the cumulative variance.
- ❑ PC1 had 27 %, PC2 had 24%, PC3 12%, PC4 10%, PC5 6% & PC6 5%.
- ❑ predominant parameters: temperature, EC, TSS, turbidity, chloride, magnesium, phosphates, TC, FC, nitrate and total hardness.



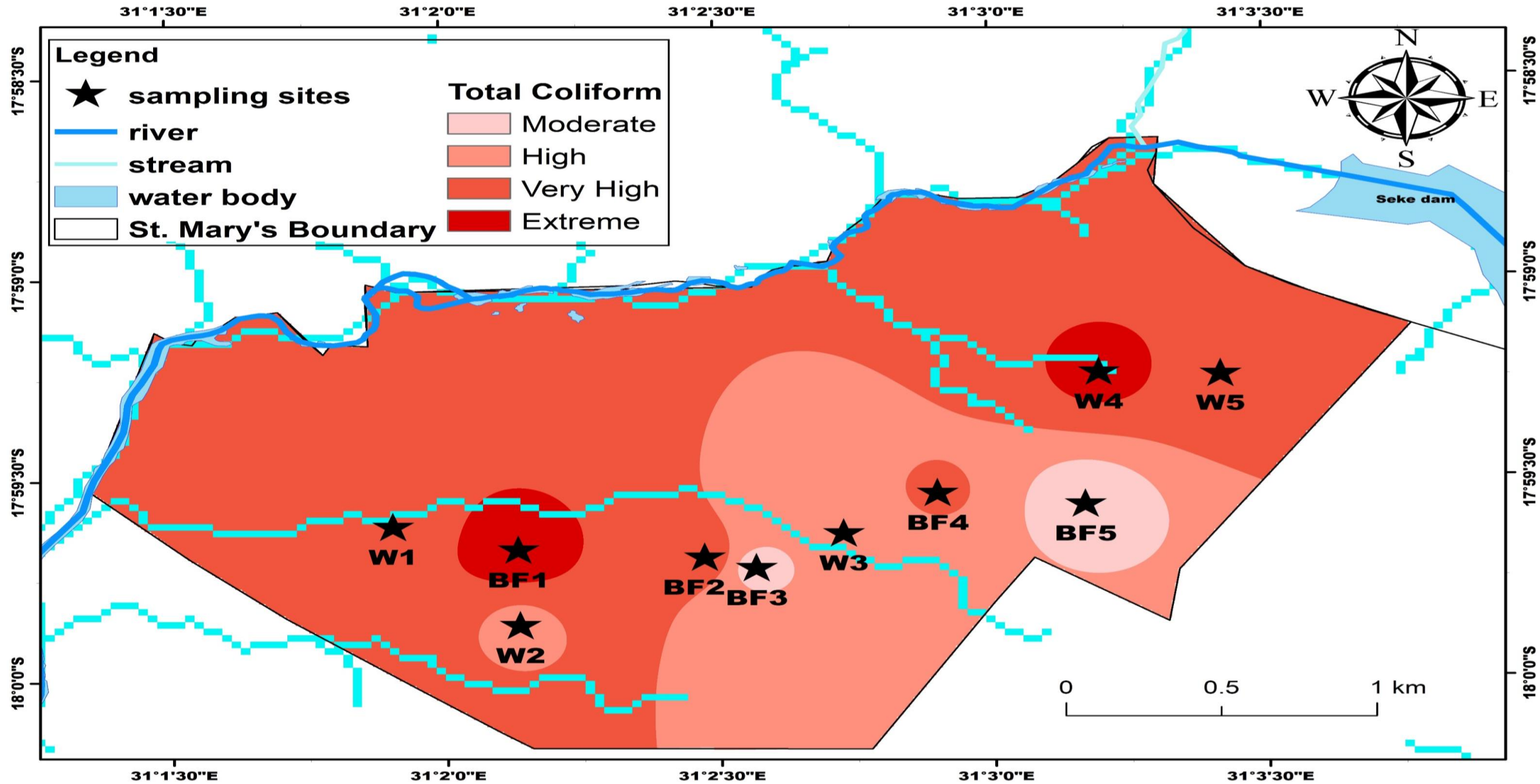
Spatial Variation of Faecal Coliform

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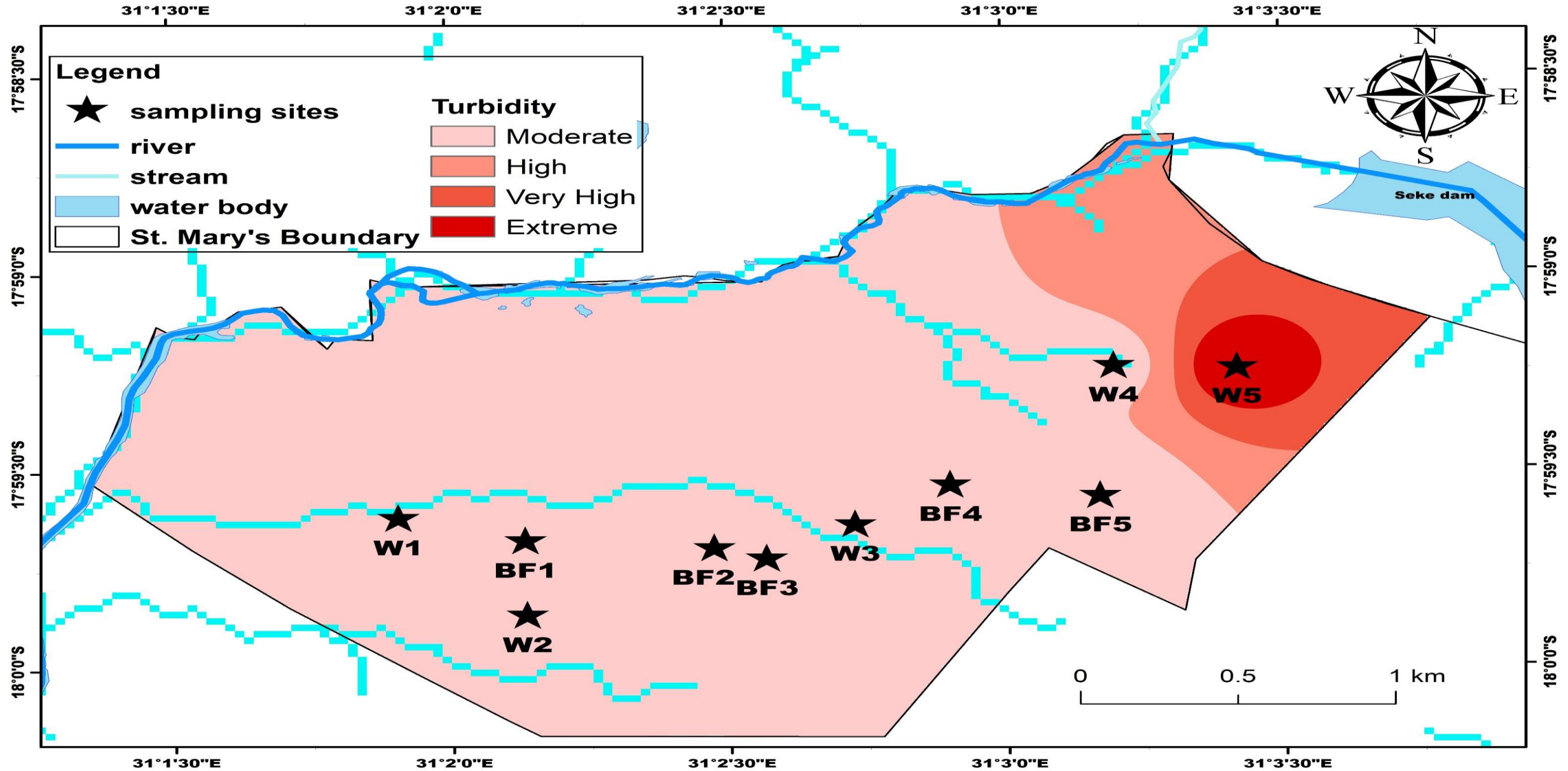
Spatial Variation of Total Coliform

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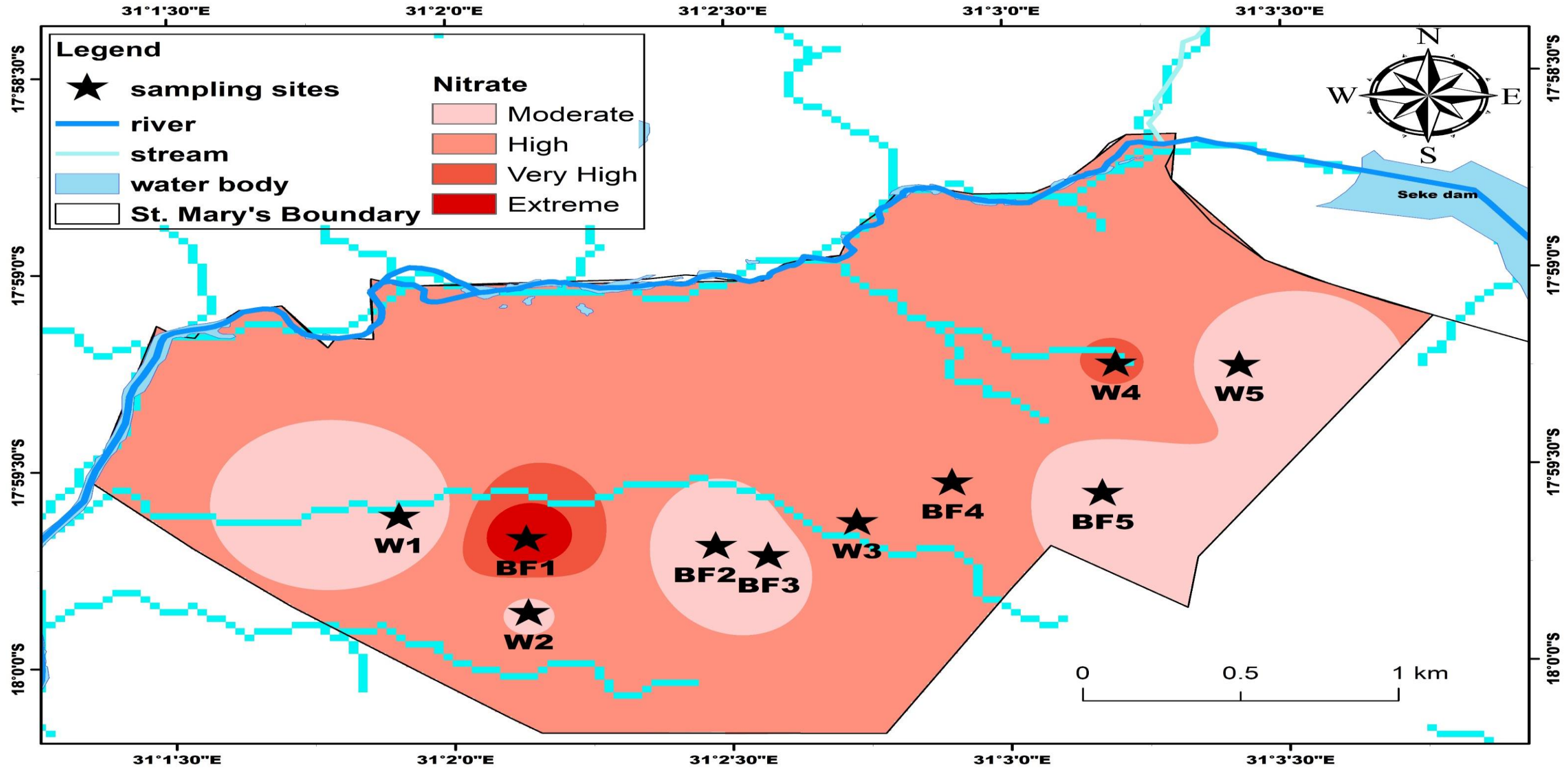
Spatial Variation of Turbidity

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Spatial Variation of Nitrates

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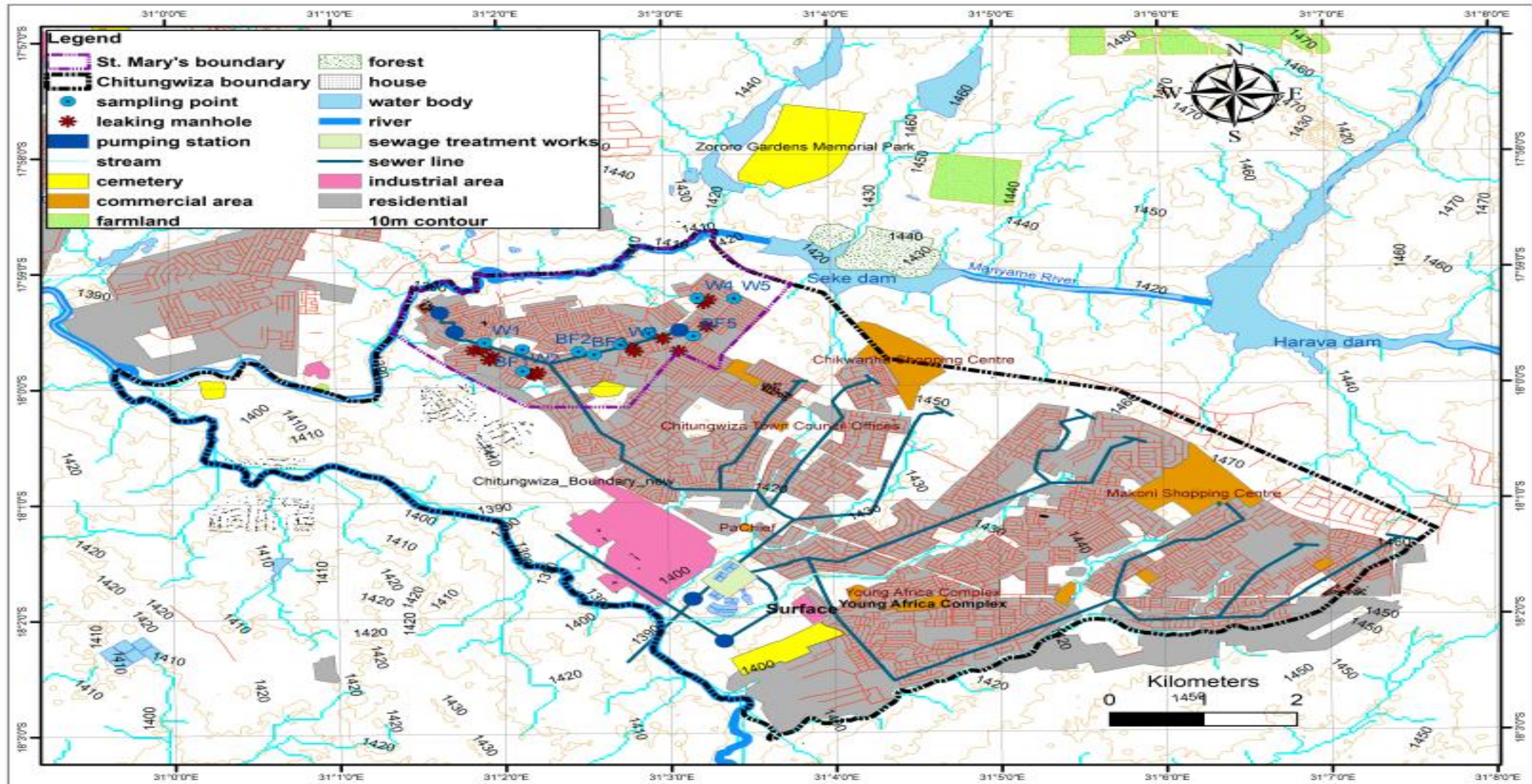


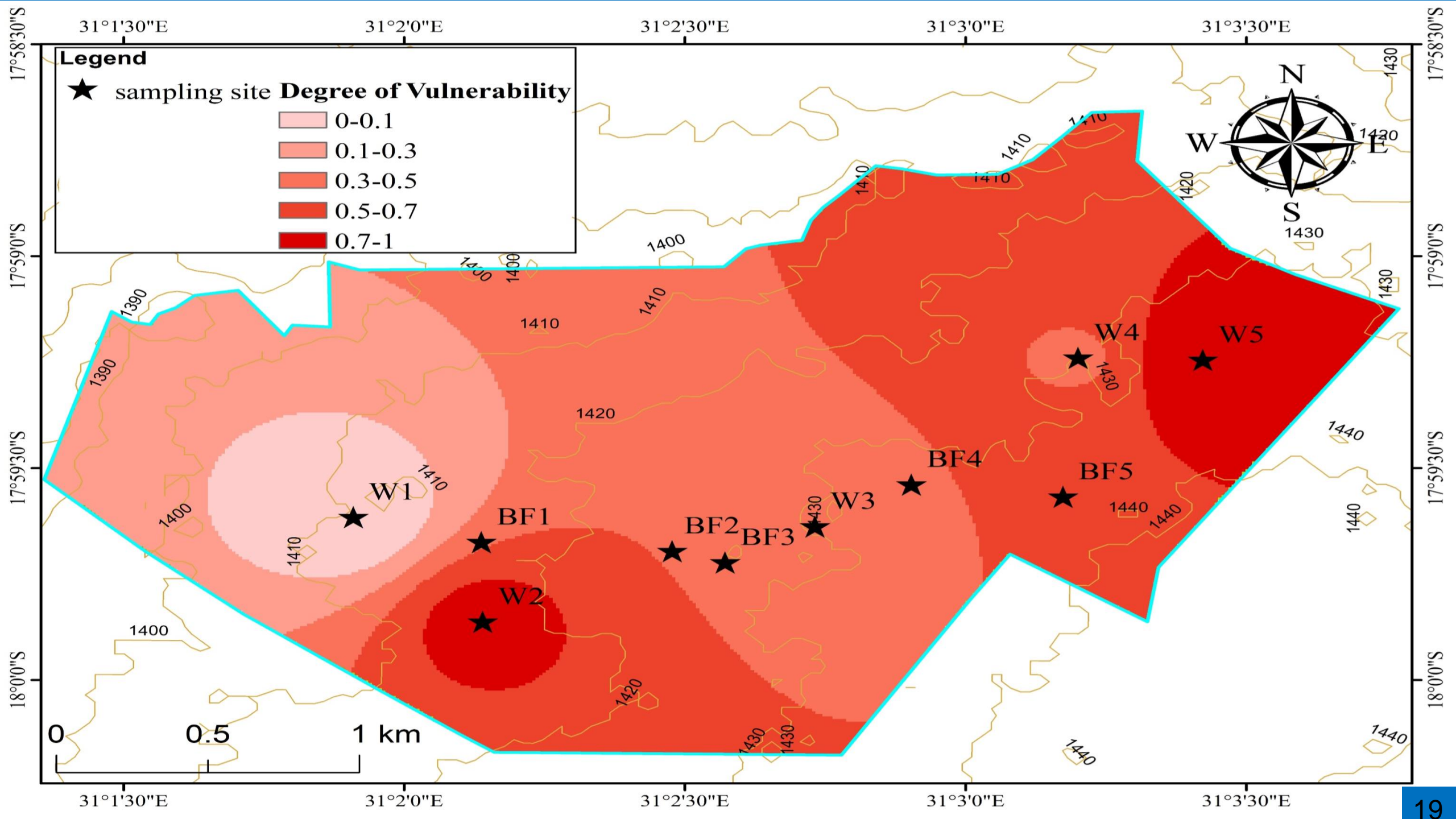
Vulnerability Mapping

Using the GOD Model

- ☐ Aquifer type (G)
- ☐ Lithology (O)
- ☐ Depth to the groundwater surface (D)

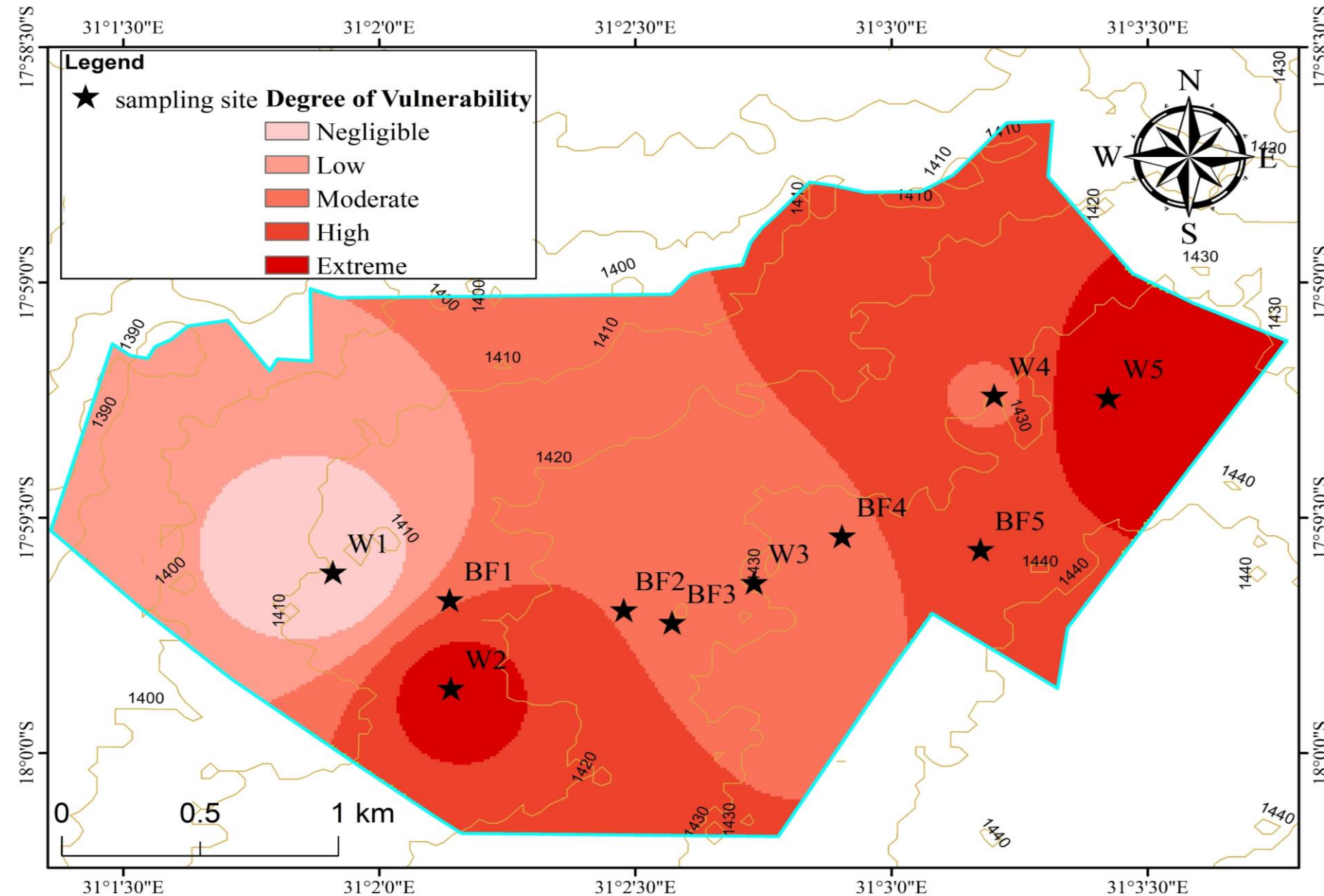
Potential pollution sources areas





Vulnerability Map

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Ratings

0-0.1 Negligible

0.1-0.3 Low

0.3-0.5 Moderate

0.5-0.7 High

0.7-1 Extreme

Conclusion

- I. Groundwater quality in St. Mary's suburb is not suitable for potable use without treatment.
- II. Spatial variation of groundwater quality across sampling sites showed the complexity of pollutants as a result of anthropogenic activities.
- III. There is variable degree of Vulnerability across St. Mary's, from negligible to extreme vulnerability.

Recommendations

- I. Treatment of water before use.
- II. Follow-up work increasing number of sampling points and campaigns.
- III. Need for setting up groundwater monitoring network covering Chitungwiza & upgrading the sewer system.

**THANK
YOU**

