Water Quality Assessment
Dry Season Results

Layout

- Background

- Project progress

- Study area

- Sampling procedures or methods

- Results: Water and sediments/soil samples
                Bore holes and well water

Background

- Water quality assessment.
- Effects of household, industrial, and agriculture pollutions on water quality.
- Treatment of groundwater quality expensive.
- Thus the importance of water quality monitoring in catchment areas.

Background cont...

- Types of industries generating waste in Windhoek

- Food processing industries such as:

-         i) Meatco,

-         ii) NamBreweries,

-         iii)NamBeverages etc

- Construction & Cottage Industries

- Non-point pollutants such as grazed animal waste, discarded solid waste, household waste etc.
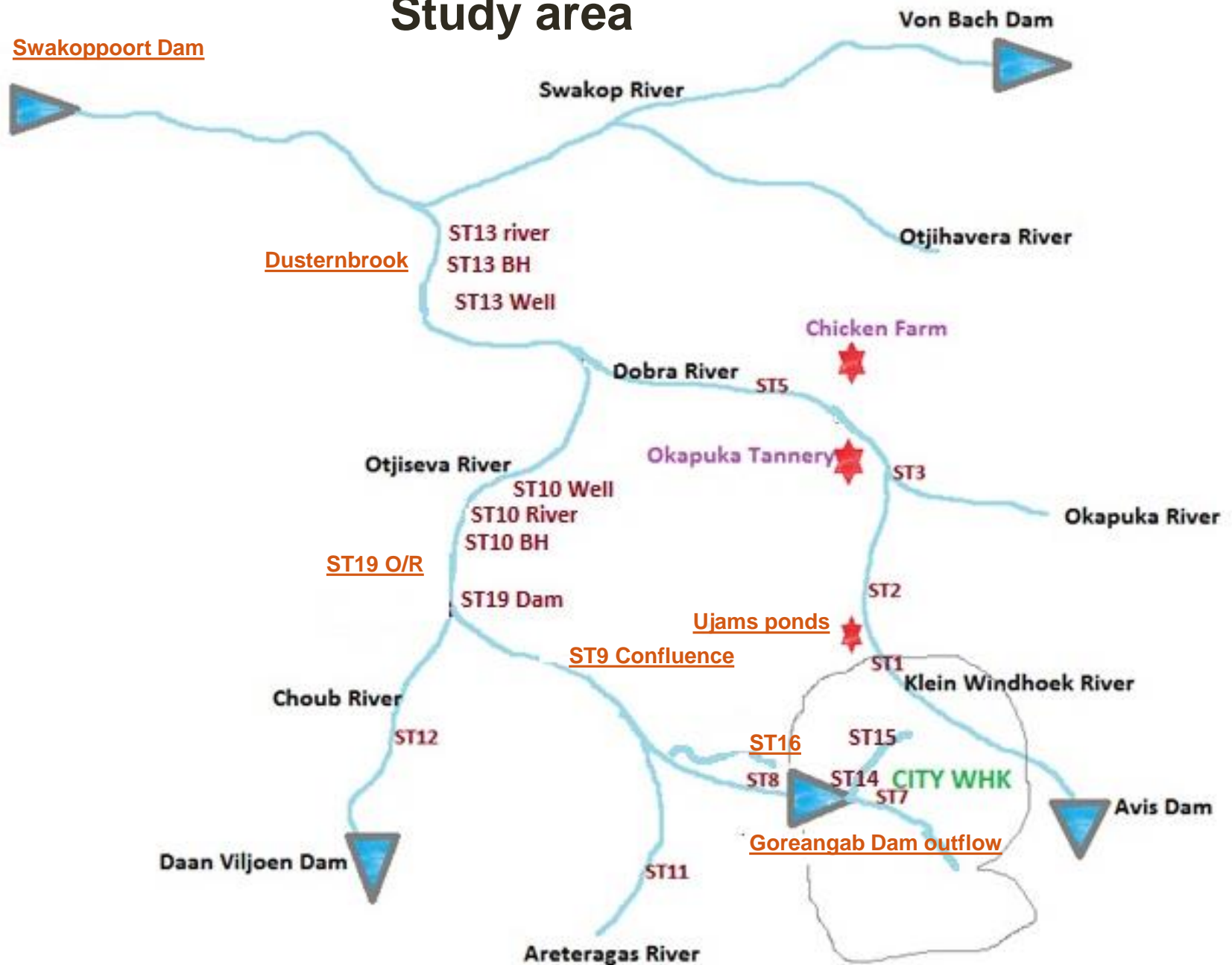
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Background cont...

- Windhoek Goreangab Operating Company (Pty) Ltd (WINGOC) treat the water from Goreangab Dam and sell the water to the City of Windhoek.

Project Progress

- Dry season water and soil sampling completed.

- Samples were analysed by Analytical Laboratory Services.

- Results obtained.

- Wet season sampling pending.

Study area

Sampling procedures or methods

- Grab sampling method was used for water samples.

- Grab sampling consist of a single sample taken at a specific time.

- Stream Bank sampling method was used for sediment or soil samples.

- Stream Bank sampling involves cutting a vertical channel or mini-trench with a trowel in approximately 15 cm long increments.

- Sediment and water samples were collected at the same sites.

WATER SAMPLES COLLECTION

SAMPLES COLLECTION (cont)

Taking water sample at Goreangab Dam

Taking Soil Sample at Goreangab Dam

Results for water and soil samples

Water Samples Results (all in mg/l)

Parameters	ST14	ST15	ST8	ST16	ST9	ST12	ST19 River	ST19 Dam	ST10 River
Dissolved Oxygen as O_2	0.1	0.1	3.85	4	0.95	2.05	0.2	8.4	6.75
p H	7.45	7.3	8.7	7.75	4	8.9	7.8	9	8.8
Conductivity (mS/m)	68.7	95.6	123.1	112.5	58.9	122.85	170.4	159.6	193.65
Turbidity (NTU)	226.5	115	42	6.5	17.5	7.45	15	21	2.05
BOD as O_2	16.5	121.5	7.25	0.8	5.4	3.375	6.3	6.8	2.5
Sulphate as SO_4	93.5	97.5	162.5	116	74	1	106	164	178
Total Phosphate as P	1.85	4.7	1.15	1.1	0.3	0.3	3.8	0.3	0.95
Chloride as Cl	72	82.5	142.5	125	70	99	248	229	285.5
Nitrate as N	0.5	0.5	0.9	2.2	0.35	0.5	0.5	0.5	0.5
Nitrite as N	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1
Ammonia Nitrogen as N	3.8	40.5	0.05	0.02	0.42	0.02	2.7	0.02	0.1
Kjeldahl Nitrogen as N	8.9	40.5	3.45	2.3	2.6	2.55	4.3	1.9	1.35
Sodium as Na	80.5	89	177.5	156.5	82	198	244	259	295
Copper as Cu	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Zinc as Zn	0.06	0.04	0.01	0.02	0.01	0.01	0.01	0.01	0.01
Cadmium as Cd	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Lead as Pb	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

Water Samples Results cont….

Parameters	ST2	ST3	ST5	ST13 River
Dissolved Oxygen as O_2	0.4	4.45	0.2	5.95
p H	8.2	8.75	9.05	9.35
Conductivity	259.5	541	514.5	200.7
Turbidity	25	2.95	100.5	29.3
BOD as O_2	17.25	5.175	19.5	5.1
Sulphate as SO_4	151	873.5	802	292
Total Phosphate as P	11.5	3.6	3.2	0.45
Chloride as Cl	434	874	856	225.5
Nitrate as N	0.55	0.5	0.5	0.5
Nitrite as N	0.1	0.15	0.1	0.1
Ammonia Nitrogen as N	68	0.16	15.5	0.165
Kjeldahl Nitrogen as N	68	3.1	19	3.55
Sodium as Na	408.5	1099.5	1037.5	339
Copper as Cu	0.01	0.015	0.015	0.03
Zinc as Zn	0.01	0.01	0.01	0.01
Cadmium as Cd	0.01	0.01	0.01	0.01
Lead as Pb	0.01	0.01	0.01	0.01

Soil or Sediments Samples Results (all in mg/kg)

Parameters	ST14	ST15	ST8	ST16	ST11	ST9	ST12	ST19 River	ST10 River
Sampling points									
pH (H$_2$O)	7	7.8	8.7	8.4	8.55	7.3	8.15	8.3	7.85
Conductivity (mS/m)	55.53	34.05	105.95	54.75	25.175	49.05	19.01	11.05	43.4
Organic carbon	2.16	0.59	1.59	0.28	0.40	0.17	1.34	0.34	1.48
Phosphorus	1878.13	1075.27	2502.27	839.15	1118.10	869.58	1271.80	514.44	1277.58
Total Nitrogen	2316.15	866.79	1858.64	634.83	590.34	1366.81	796.91	210.97	1663.18
Nitrate	89.97	14.07	2.35	5.37	2.58	2.17	4.334	3.40	2.00
Ammonium	16.52	47.73	27.90	20.14	4.77	3.65	4.527	4.85	48.43
Sodium	191	109.2	846.5	244	215.35	186	176.5	42.35	263.5
Chloride	216.5	120.5	635	144.5	187.5	126.5	77.5	36	161
Sulphate	333.5	149	237.5	445	60	406.5	1286	163	327
Copper	49.93	15.94	103.22	5.15	12.89	16.74	19.78	8.65	20.21
Zinc	153.36	49.79	55.87	16.84	33.47	32.87	56.02	30.22	53.35
Cadmium	3.65	2.81	2.59	1.02	2.31	2.29	3.18	2.09	3.12
Lead	7.26	5.23	15.18	0.16	1.90	1.79	1.11	0.52	1.20

Soil or Sediments Samples Results cont….

Sampling Points				
Parameters	**ST1**	**ST2**	**ST3**	**ST5**	**ST13 River**
pH (H_2O)	7.8	7.6	8.25	9.05	8.2
Conductivity	101.25	105.5	78.6	45.85	52
Organic carbon	0.18	2.03	2.13	0.18	0.56
Phosphorus	364.16	1514.77	1545.01	569.84	515.71
Total Nitrogen	337.49	2186.68	2076.81	569.48	515.65
Nitrate	2.60	142.21	9.61	2.97	2.78
Ammonium	30.35	18.64	30.66	3.48	5.60
Sodium	54.5	417.5	613.4	239.5	212
Chloride	81.5	637.5	437	159.5	169.5
Sulphate	281	131	365	231.5	250
Copper	5.69	42.47	53.51	4.40	5.76
Zinc	22.69	108.21	86.26	16.47	22.87
Cadmium	1.22	3.99	3.00	1.09	1.36
Lead	0.40	7.80	22.42	0.15	0.83

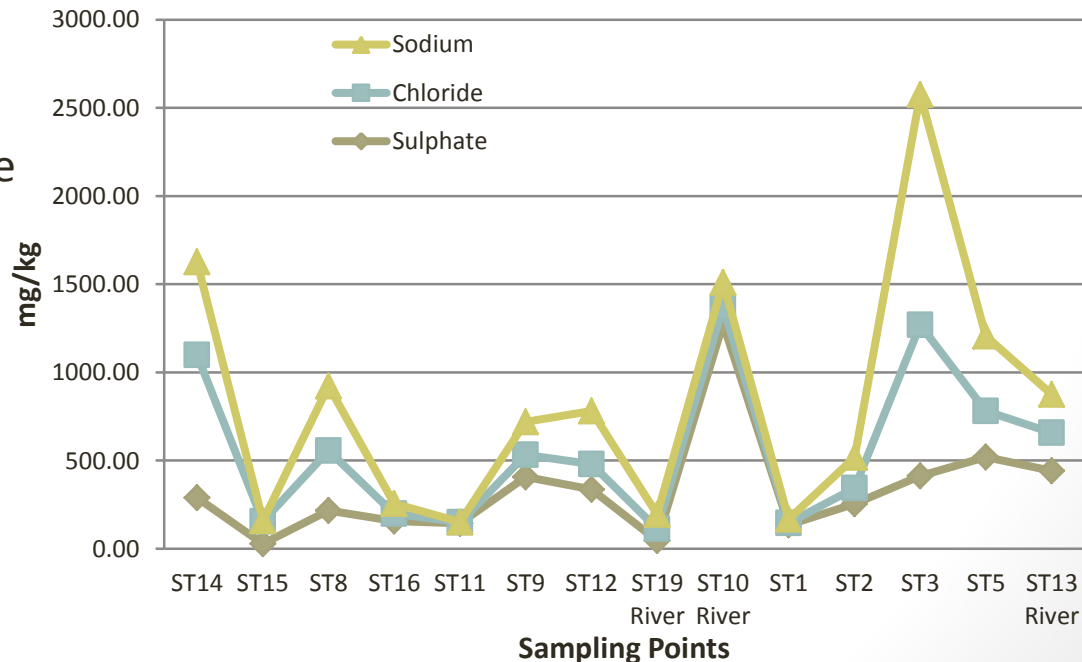# Mineral salts behaviour

(a) Water Sample
The mineral salts
Content high at ST3
and ST5
Okapuka tannery and
Chicken farm. This indicate an
increase in salinity level as shown in
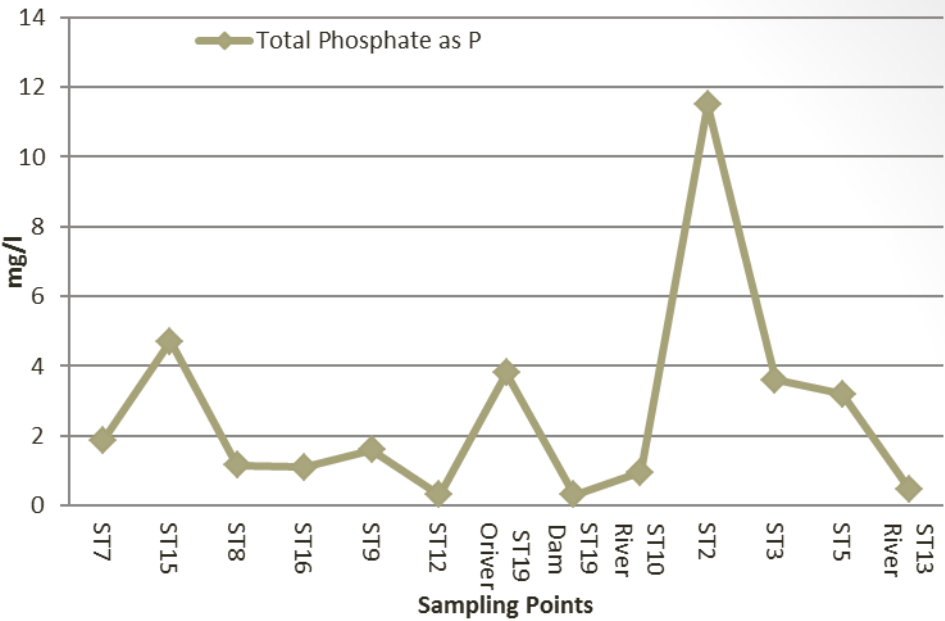the conductivity graph
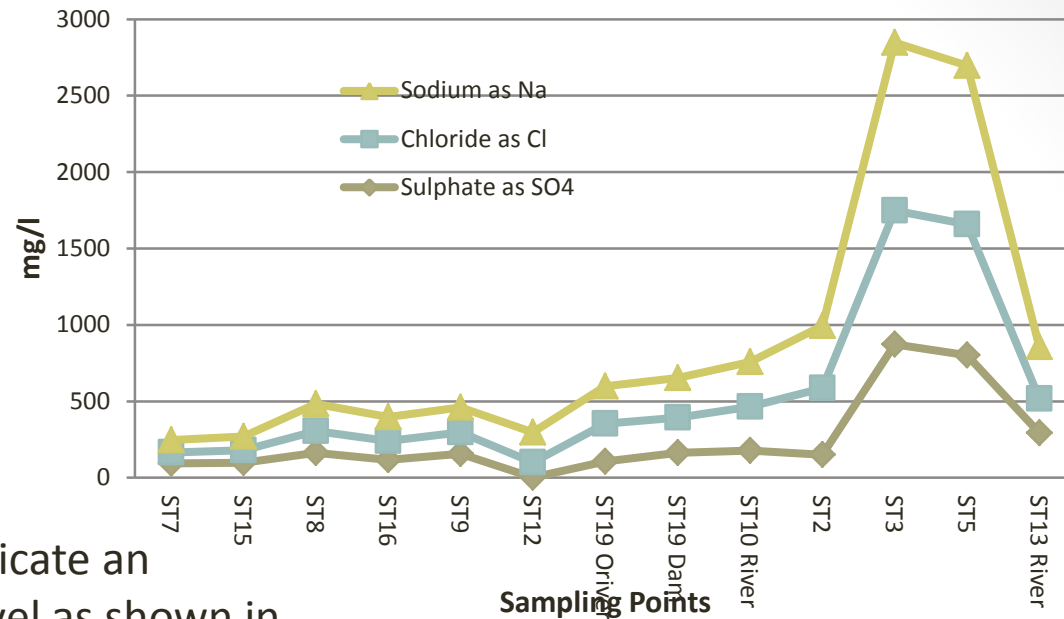
(b) Soil/sediments sample

Soil samples at ST3, ST5
And ST10
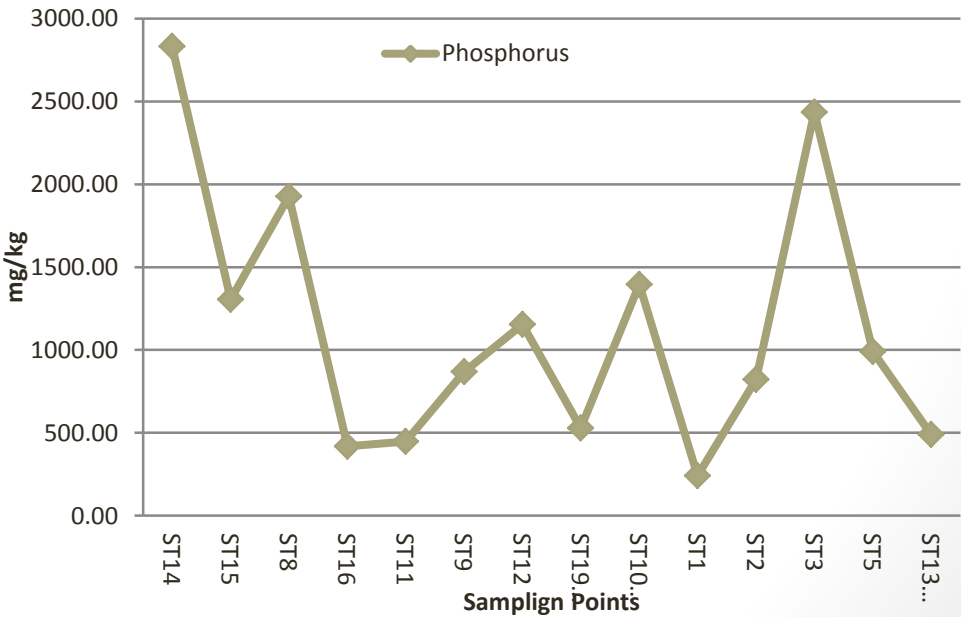Recorded a high sodium
and chloride level.

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Nutrients in the water and soil

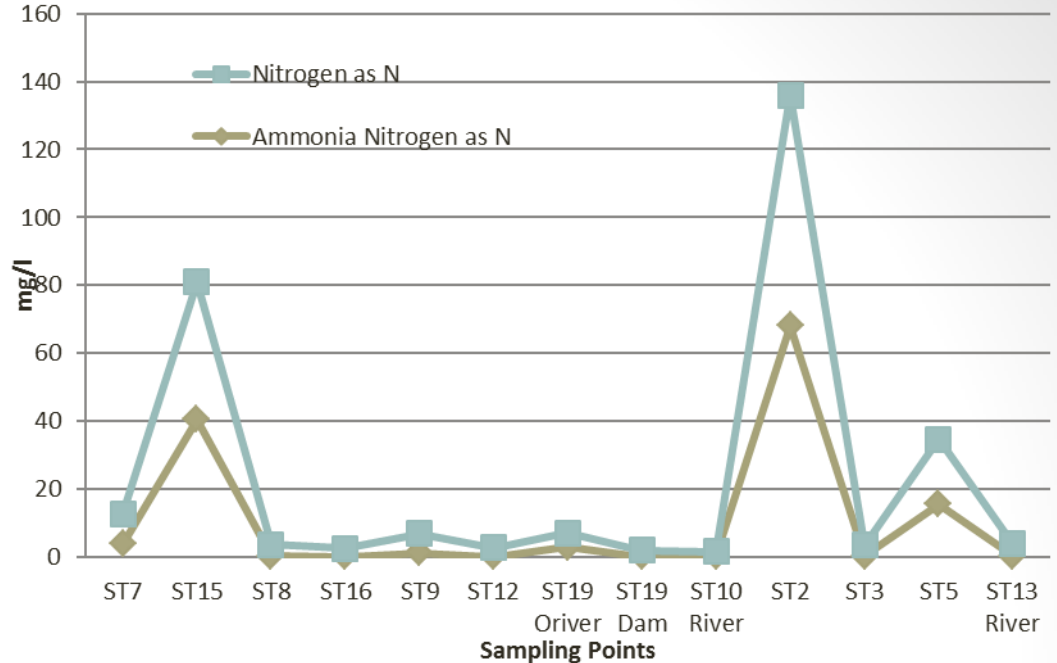(a) Total phosphorus in water TP was high after ujams ponds at ST2 .

(b) Total phosphorus in the soil TP was high at the inflow into GD and at ST3.

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Nutrients in the water and soil cont..

(a) TN and NH3 in water
TN and NH3 was high after Ujam pond at ST2

(b) TN and NH3 in soil

TN and NH3 was high at the Inflow into GD and at ST3

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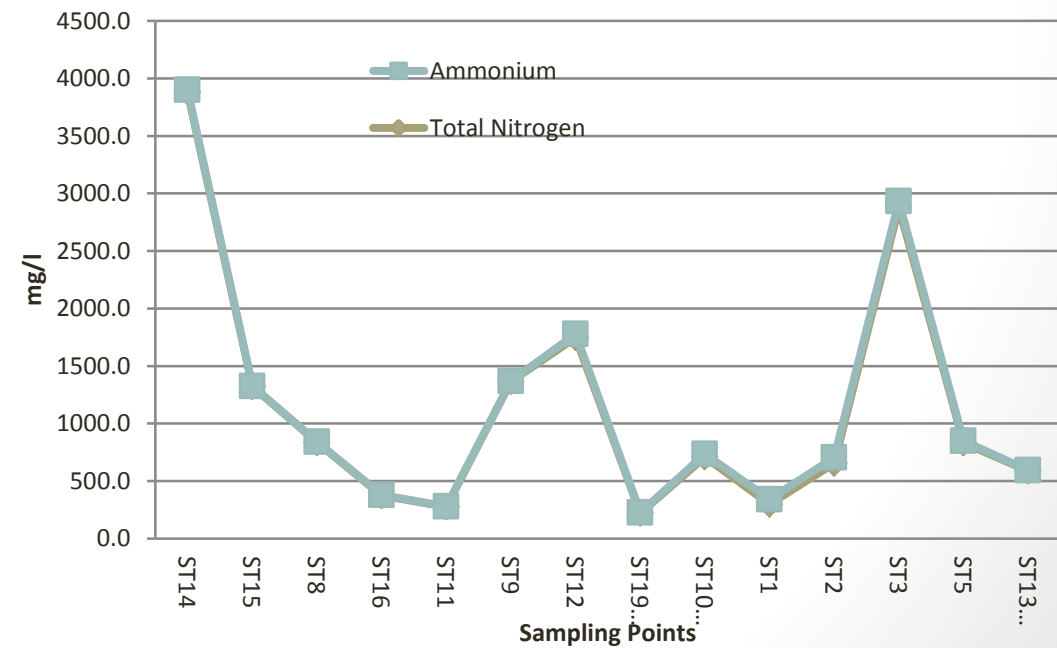
Trace element or heavy metals in the soil
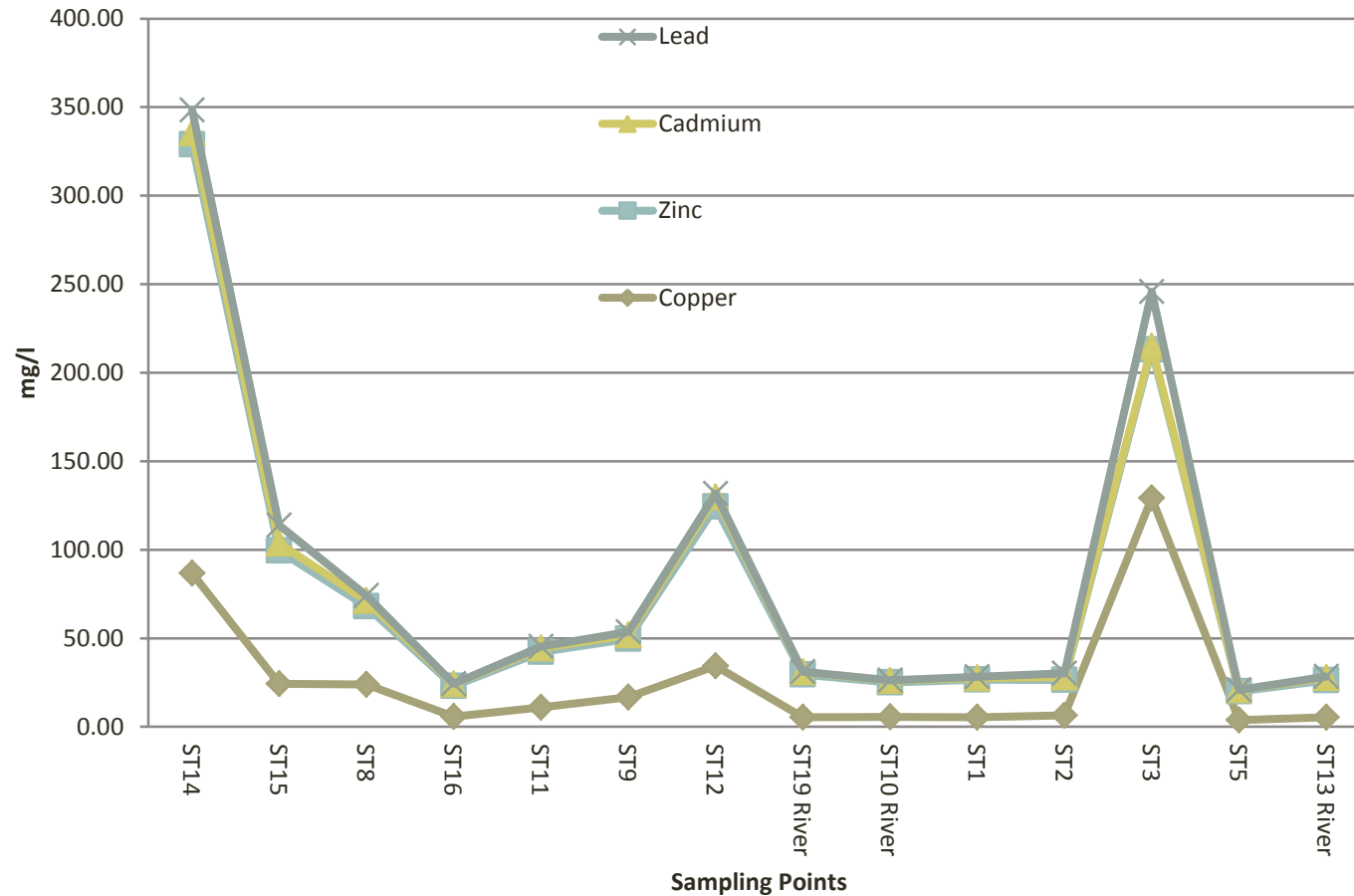
Boreholes and well samples results

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Groundwater Quality

- Groundwater is vulnerable to contamination from industrial, agricultural, and changes in land-use.

  Major threats to groundwater quality include:
- salinity
- acidity
- nutrients
- contaminants such as heavy metals, industrial chemicals and pesticides.

PUMPING & STORING G/W

BOREHOLES

Well at ??   **Borehole at ??**

MORE BOREHOLES ??

??   ??

Water Samples from the Wells

Water Parameters	Wells				Classification groups, *MAWF standard*			
	ST 10	Class	ST 13	Class	Group A	Group B	Group C	L/watering
p H	7.2	A	7.3	A	6-9	5.5 - 9.5	4.0-11.0	4.0-11.0
Electrical conductivity	275	B	263	B	150	300	400	
Total dissolved solids (det.)	1687		1796					6000
Turbidity	1.0	A	1.0	B	1	5	10	
Colour	<10		<10		20			
Sulphate as SO_4	308	B	297	B	200	600	1200	1500
Chloride as Cl	530	B	448	B	250	600	1200	3000
Fluoride as F	0.2	A	0.3	A	1.5	2.0	3.0	6.0
Nitrate as N	2.8	A	8.0	A	10	20	40	100
Nitrite as N	0.2		1.4					10
T-Hardness as $CaCO_3$, cal.	611	B	535	B	300	650	1300	
Sodium as Na	374	B	363	B	100	400	800	2000
Potassium as K	35	A	36	A	200	400	800	
Magnesium as Mg	49	A	45	A	70	100	200	500
Calcium as Ca	164	B	140	A	150	200	400	1000
Manganese as Mn	<0.01	A	<0.01	A	0.05	1	2	10
Iron as Fe	0.01	A	<0.01	A	0.1	1	2	10
Copper as Cu	0.01	A	0.01	A	0.5	1.0	2.0	
Zinc as Zn	0.02	A	0.16	A	1	5	10	
Cadmium as Cd	<0.01	A	<0.01	A	0.01	0.02	0.04	
Lead as Pb	<0.01	A	<0.01	A	0.05	0.1	0.2	

Boreholes water samples

Water	Boreholes						Classification groups, *MAWF standard*			
Parameters	**ST17**	**Class**	**ST18**	**Class**	**ST19**	**Class**	**Group A**	**Group B**	**Group C**	**L/watering**
p H	7.0	A	7.6	A	7.2	A	6-9	5.5 - 9.5	4.0-11.0	4.0-11.0
Electrical conductivity	182.8	B	143.9	A	205	B	150	300	400	
Total dissolved solids (det.)	1090		846		1159					6000
Turbidity	0.45	A	2.2	B	0.20	A	1	5	10	
Colour	11		<10		11		20			
Sulphate as SO_4	108	A	98	A	215	B	200	600	1200	1500
Chloride as Cl	164	A	96	A	301	B	250	600	1200	3000
Fluoride as F	0.3	A	0.4	A	0.3	A	1.5	2.0	3.0	6.0
Nitrate as N	16	B	7.8	A	0.6	A	10	20	40	100
Nitrite as N	1.4		<0.1		1.7					10
T-Hardness as $CaCO_3$, cal.	627	B	412	B	441	B	300	650	1300	
Sodium as Na	187	B	183	B	304	B	100	400	800	2000
Potassium as K	23	A	16	A	12	A	200	400	800	
Magnesium as Mg	71	B	46	A	38	A	70	100	200	500
Calcium as Ca	134	A	89	A	114	A	150	200	400	1000
Manganese as Mn	0.02	A	0.02	A	0.04	A	0.05	1	2	10
Iron as Fe	0.03	A	0.14	A	<0.01	A	0.1	1	2	10
Copper as Cu	0.01	A	0.03	A	<0.01	A	0.5	1.0	2.0	
Zinc as Zn	0.07	A	0.05	A	0.05	A	1	5	10	
Cadmium as Cd	<0.01	A	<0.01	A	<0.01	A	0.01	0.02	0.04	

Boreholes water samples cont….

Water Parameters	ST10	Class	ST13	Class	Group A	Group B	Group C	L/watering
		Boreholes				**Classification groups, *MAWF standard***		
p H	7.2	A	7.0	A	6-9	5.5 - 9.5	4.0-11.0	4.0-11.0
Electrical conductivity	126.4	A	263	B	150	300	400	
Total dissolved solids (det.)	846		1668					6000
Turbidity	0.50	A	0.50	A	1	5	10	
Colour	11		11		20			
Sulphate as SO_4	120	A	204	B	200	600	1200	1500
Chloride as Cl	210	A	566	B	250	600	1200	3000
Fluoride as F	0.1	A	0.2	A	1.5	2.0	3.0	6.0
Nitrate as N	<0.5	A	20	B	10	20	40	100
Nitrite as N	<0.1		5.8					10
T-Hardness as $CaCO_3$, cal.	446	B	721	C	300	650	1300	
Sodium as Na	90	A	278	B	100	400	800	2000
Potassium as K	11	A	26	A	200	400	800	
Magnesium as Mg	27	A	58	A	70	100	200	500
Calcium as Ca	134	A	193	B	150	200	400	1000
Manganese as Mn	<0.01	A	0.26	A	0.05	1	2	10
Iron as Fe	<0.01	A	<0.01	A	0.1	1	2	10
Copper as Cu	<0.01	A	<0.01	A	0.5	1.0	2.0	
Zinc as Zn	<0.01	A	0.01	A	1	5	10	
Cadmium as Cd	<0.01	A	<0.01	A	0.01	0.02	0.04	
Lead as Pb	<0.01	A	<0.01	A	0.05	0.1	0.2	

Conclusion

- High concentration of micro salts in soil or sediment.

- High concentration of nutrient and heavy metal in the soils.

- BH/Well water in good quality

- Goreangab Dam, ujams ponds, okapuka tannery, and chicken farms.

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Carelessly Discarde Undegradable Plastic Waste

Carelessly Discarded Building Waste (cont)

Sources of More Non-point Pollutants

Carelessly Discarded Solid Waste   **Animal Dung and Urea**

WATER SAMPLES COLLECTION

Collecting samples from Farm Otjiseva??