Geochemical and Hydrogeological monitoring and assessment of the buffer zone of Limpopo National Park

SAPIENZA
UNIVERSITÀ DI ROMA

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Water Team

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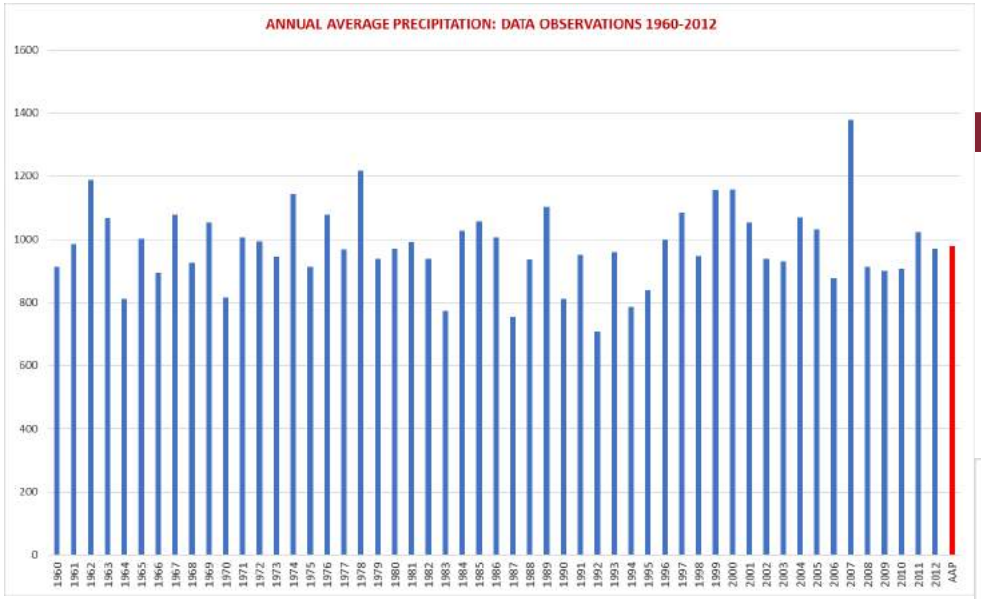
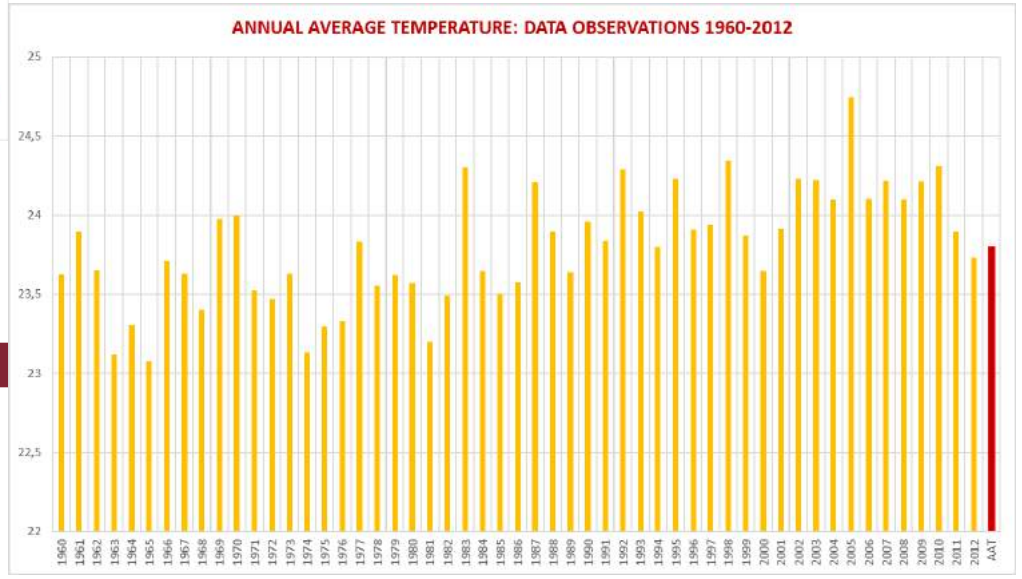
METEOROLOGICAL DATA (WORLD BANK GROUP), : Precipitation and Temperature observations data 1960-2012



ANNUAL AVERAGE PRECIPITATION
AAP = 978,7 mm



ANNUAL AVERAGE TEMPERATURE
AAT= 23,8° C

The methodology of Reverse Groundwater Balance technique : from precipitation to effective infiltration

- The present study is related to the application of the reverse water balance technique, in order to estimate the effective Infiltration. This methodology gives us a general assessment of potential water resources in areas where there is a scarcity of data
- The Effective Infiltration is assessed from the hydrological balance performed for the study area, taking in consideration the mean pluviometric and thermometric data and the surficial lithology.

Hydrological Balance P = ET + R + I

Hydrogeological Inverse Budget in the focus area: LIMPOPO NATIONAL PARK

Limpopo National Park Area

P= 973,3 (mm/y)

Q= 109,8 (mm/y)

ETR= 863,48 (mm/y)

P = I + Etr + R

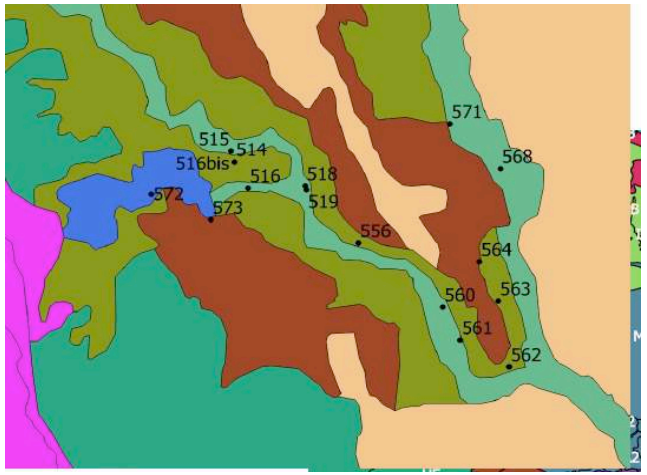
P: Precipitations (mm/y)

Q: Effective Precipitation (mm/y) = P-ETR

I: Effective Infiltration= Q χ (mm/y)

R: Runoff = Q-I (mm/y)

the Potential Infiltration Index χ



Study area

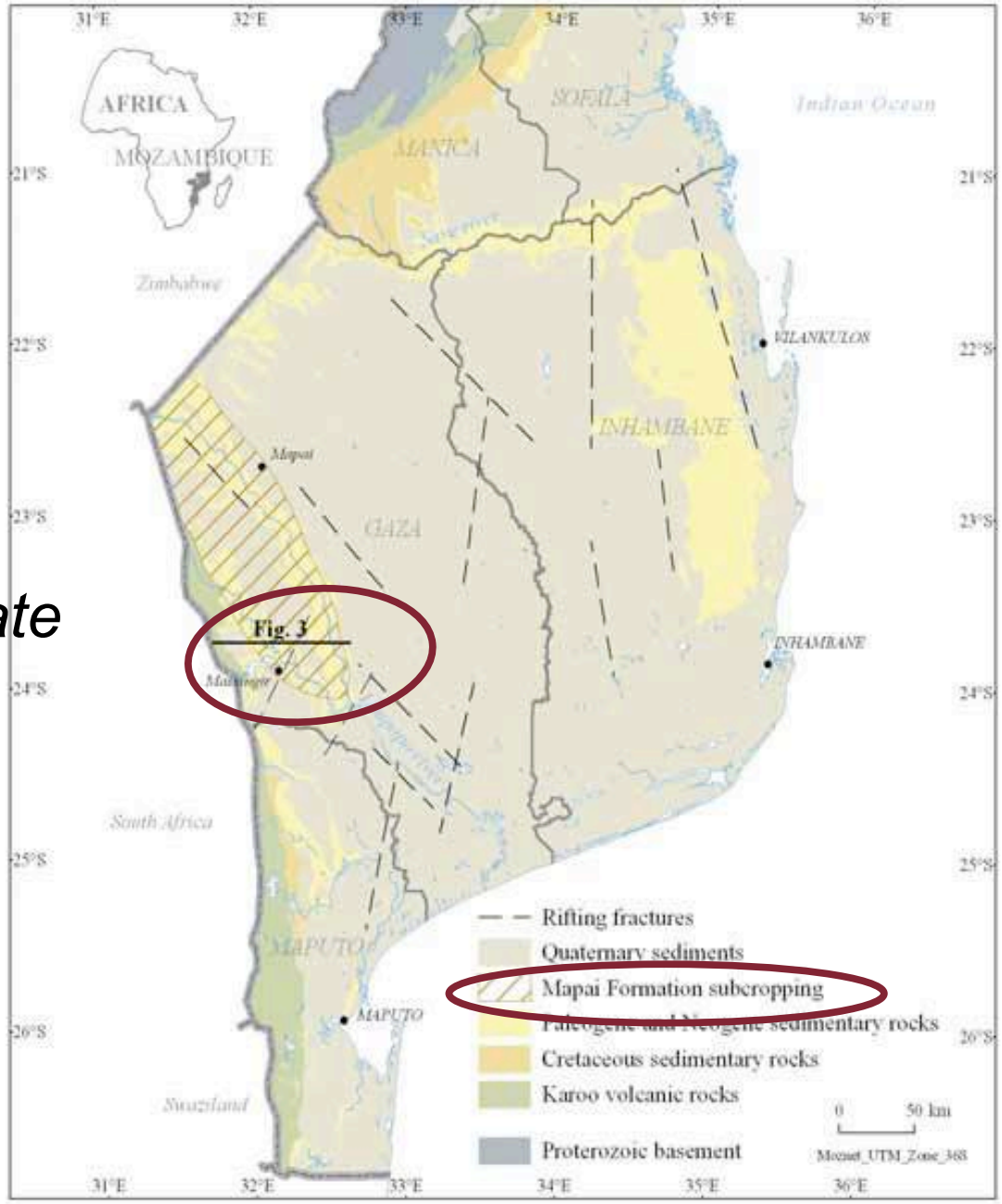
✓ ***Mapai Formation (SC2):***

Limestone
Sandstone → *Upper*

Sandstone
Limestone → *Intermediate*

Sandstone
Limestone → *Lower*

Geological Survey of Finland (GTK, 2002-2006)



Study area

✓ ***Mapai Formation:***

Limestone
Sandstone → *Up*

Sandstone
Limestone → *Inte*

Sandstone
Limestone → *Lov*

Geological Survey of Finland
2002-2006)

Study area

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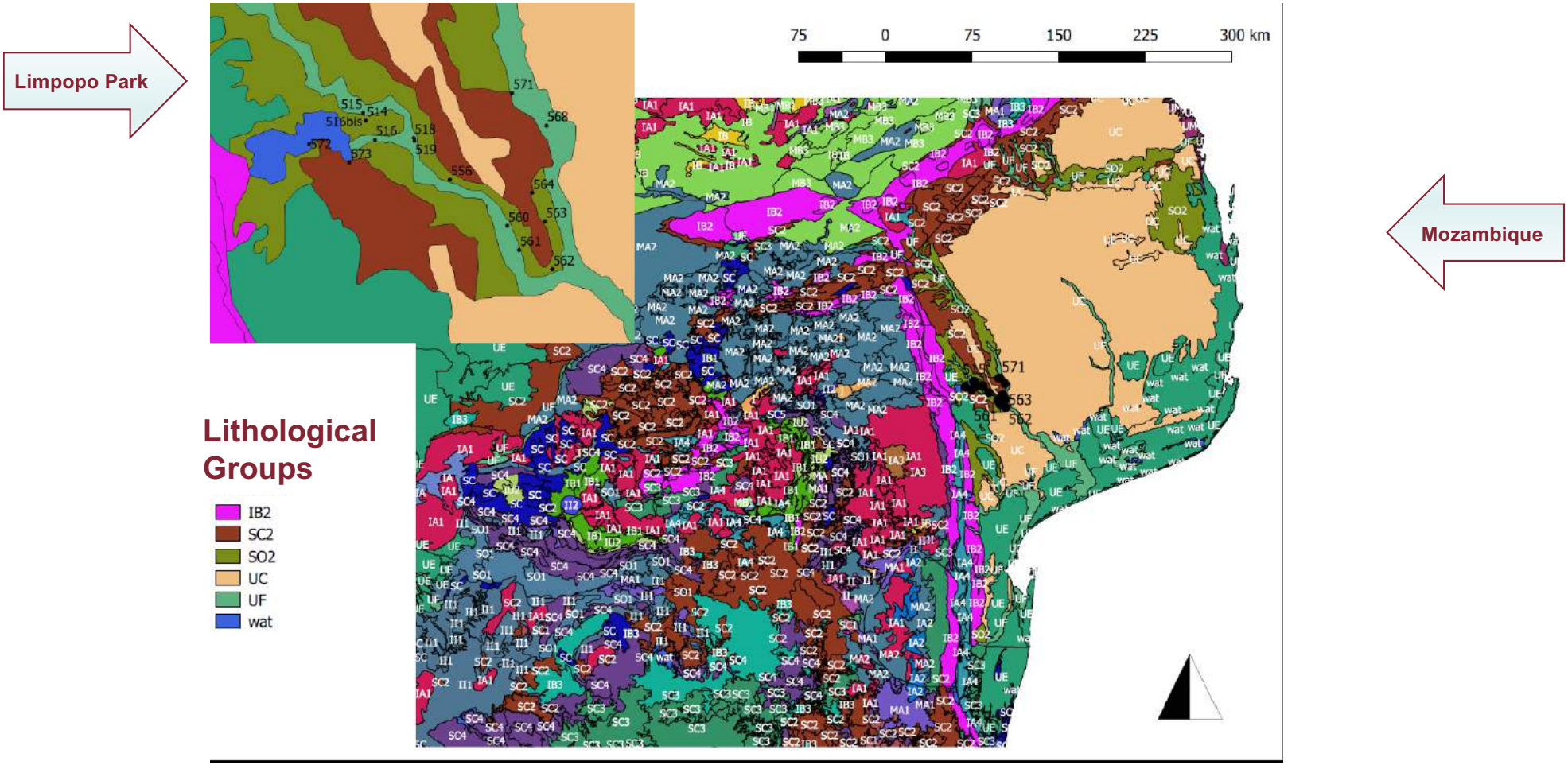
Limestone
Sandstone → *Upper*

Sandstone
Limestone → *Intermedi*

Sandstone
Limestone → *Lower*

Geological Survey of Finland (GTK, 2002-2006)

Lithological map of Mozambique and Limpopo Park



Soil and Terrain database (SOTER) for Southern Africa

The methodology of Hydrogeological Inverse Budget: Limpopo National Park

Group	χ	Q (mm/y)	I (mm/y)	ETR (mm/y)	R (mm/y)
UF	0,15	109,81	16,5	863,4839365	93,34
UC	0,65	109,81	71,4	863,4839365	38,43
UE	0,15	109,81	16,5	863,4839365	93,34
IB2	0,75	109,81	82,4	863,4839365	27,45
SC2	0,3	109,81	32,9	863,4839365	76,86
SO2	0,1	109,81	11,0	863,4839365	98,83

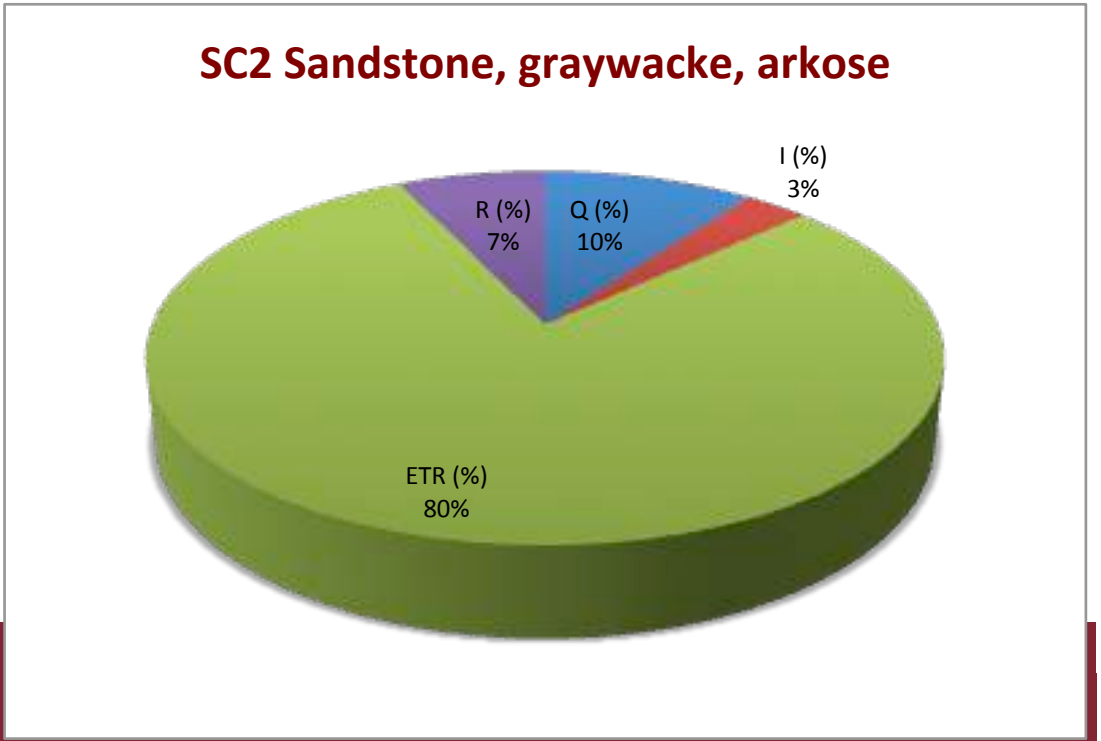
P = I + Etr + R

P: Precipitations (mm/y)

Q: Effective Precipitation (mm/y) = P-ETR

I: Effective Infiltration= Q χ (mm/y)

R: Runoff = Q-I (mm/y)



Limpopo National Park Area

P= 973,3 (mm/y); Q= 109,8 (mm/y); ETR= 863,48 (mm/y) and I= 32,9(mm/y)

Water Geochemical Assessment

Groundwater and surface water quality have a great importance to:

✓ Preservetion and conservation of biodiversity;

✓ Water purposes;

✓Irrigation;

↓

Environmental healt: Human, Animal and Plants

UNESCO

buffer zone "an area that should ensure an additional level of protection to areas recognized as a World Heritage sites“

Kruger National Park

Parque Nacional do Limpopo

Results Water Team

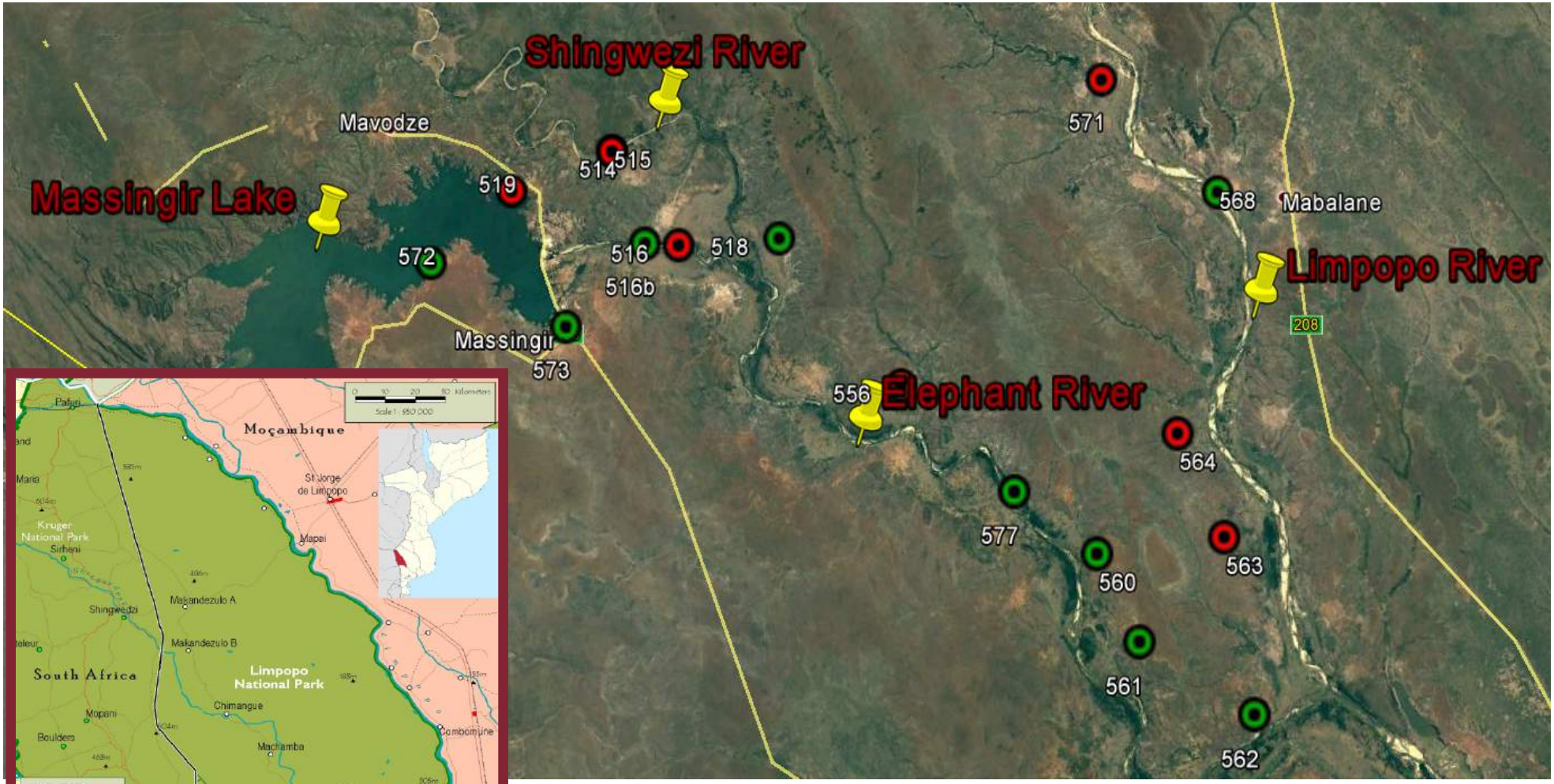
Two hydrogeochemical surveys:

✓*First during October 2016 (Dry season)*
✓*Second during March 2017 (Wet season)*

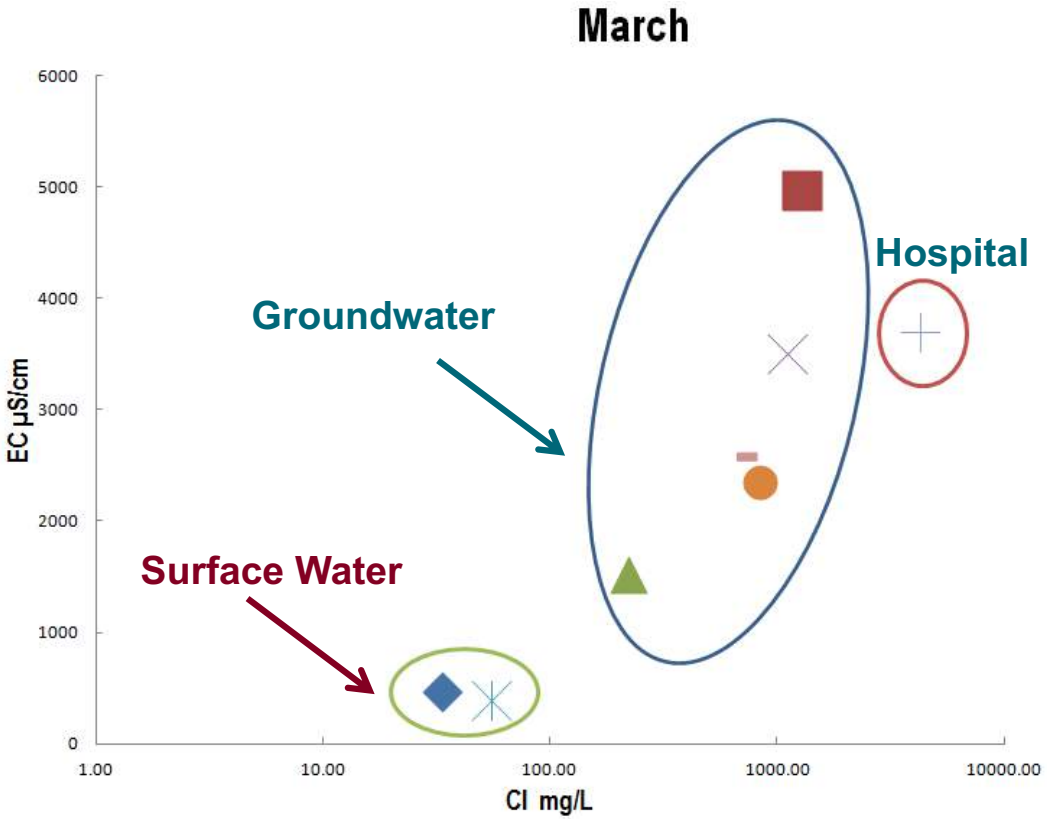
Were analysed Ionic concentrations and trace elements to highlights:

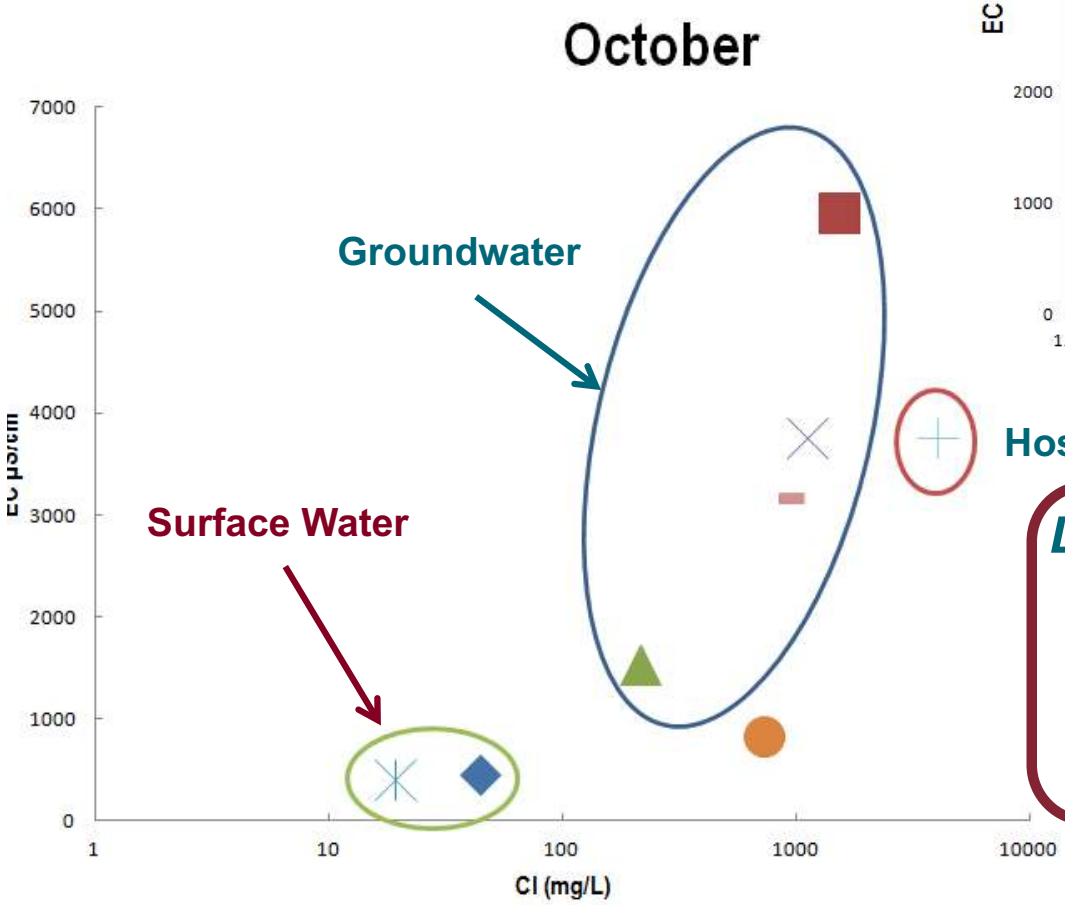
✓*Possible elemental anomalies*
✓*Geochemical characteristics of water*
✓*Difference between surface water and groundwater in relation to season (Wet and Dry) to evaluate importance of infiltration on the chemical characteristics of water*

Study area, Sampling events



Results: Cl/EC

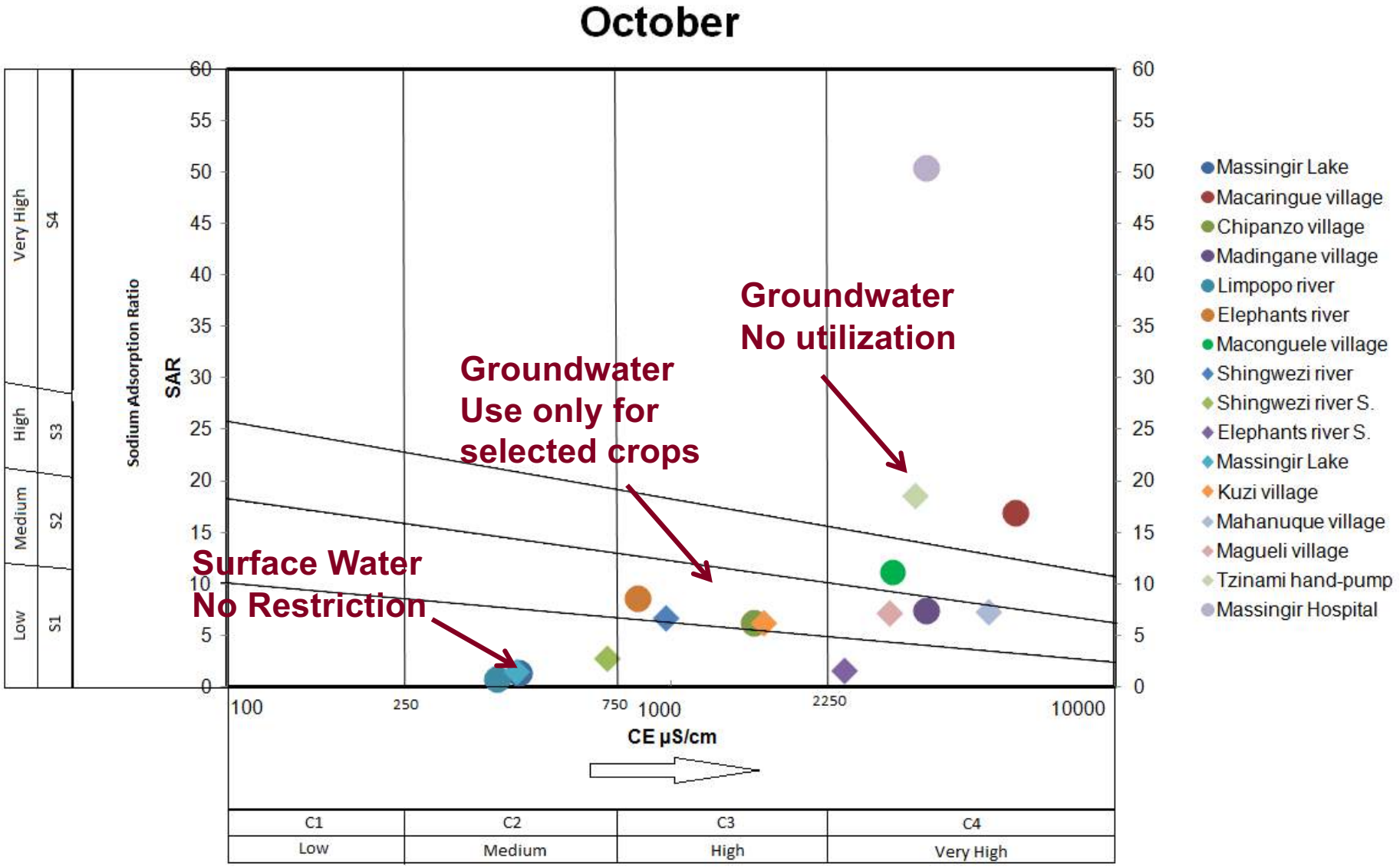




Limpopo River and Massingir lake show lower salinity respect to groundwater

During March surface water present lower salinity respect to October

Results: SAR (Sodium adsorption ratio) used to evaluate groundwater suitability for irrigation purpose)



Hypothesis …

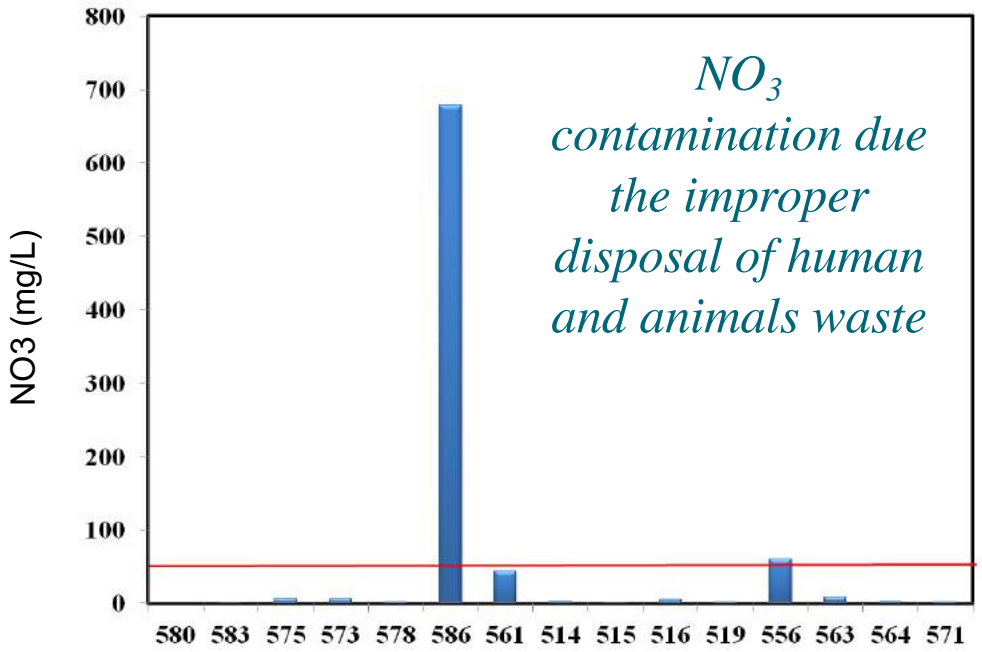
Brakish groundwater
High Na^+ and Cl^-

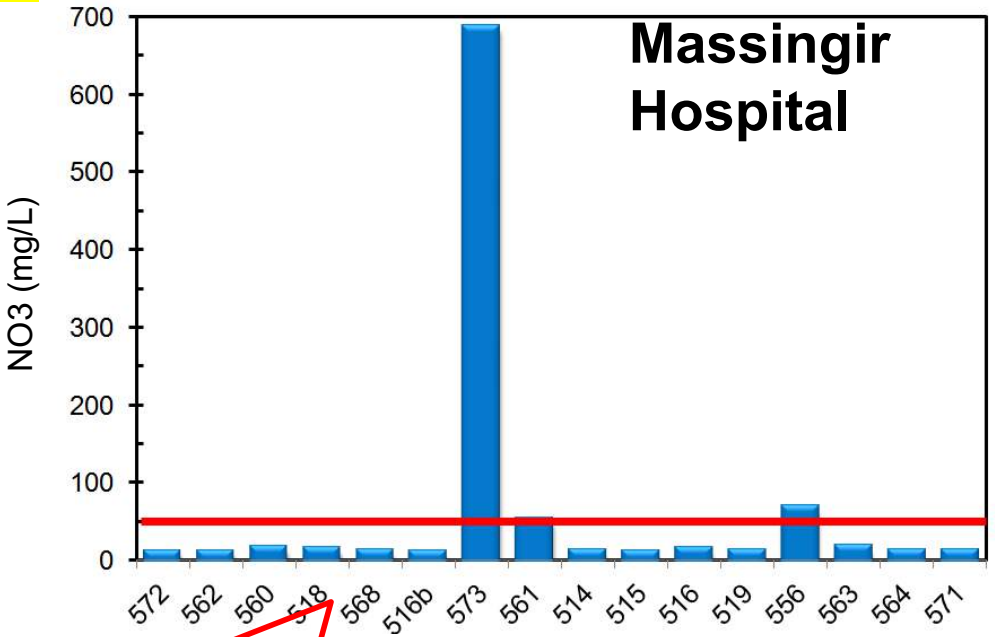
Results from minor and trace elements: nitrate concentrations

Warning!!

Well used during dry season
NO_3 contamination due the improper disposal of human and animals waste

Results: Nitrate Concentration

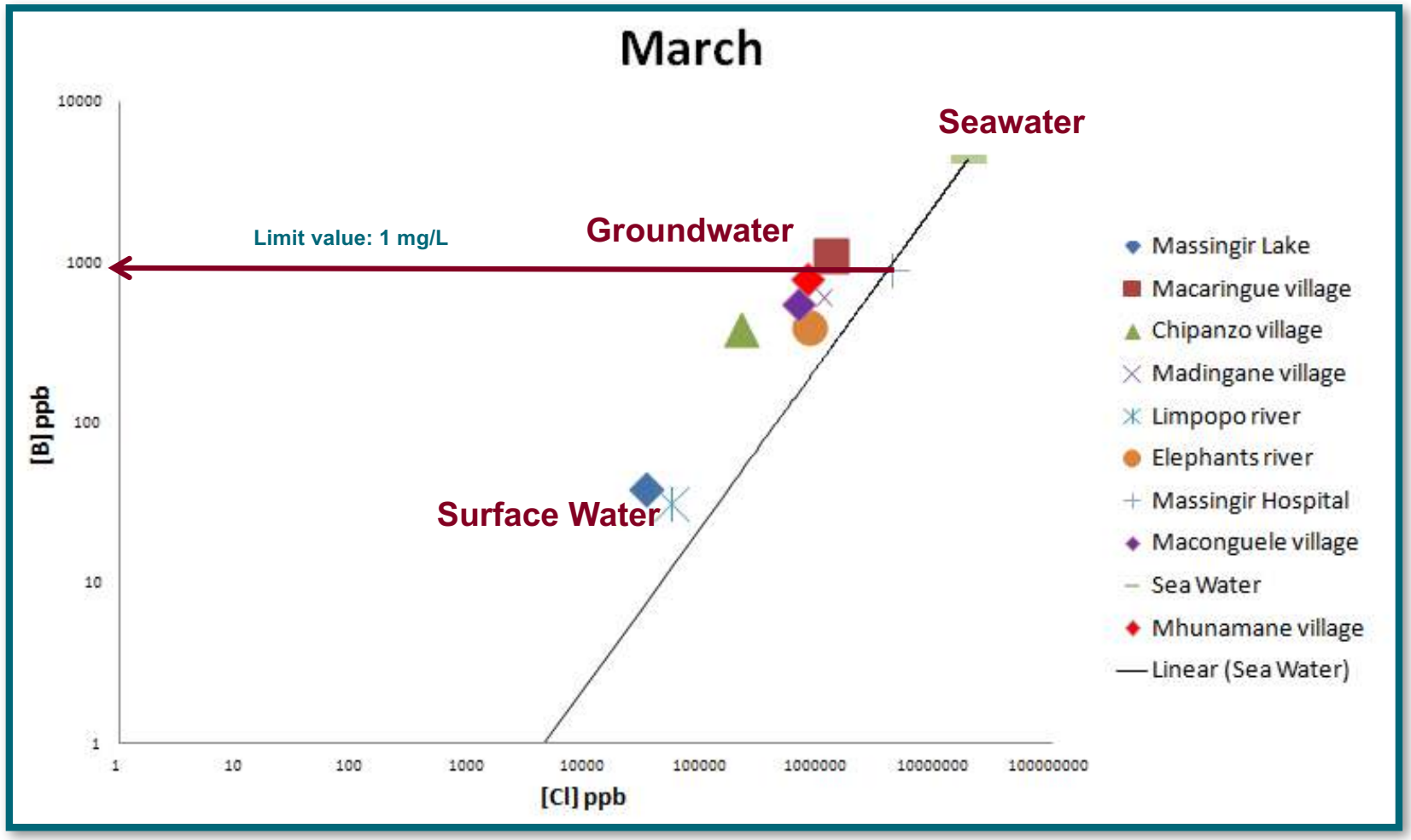




Warning!!!
NO_3 values in four well are higher than WHO limit

Samples are: Massingir Hospital, Muhamane, Maconguele and Kuzi Village

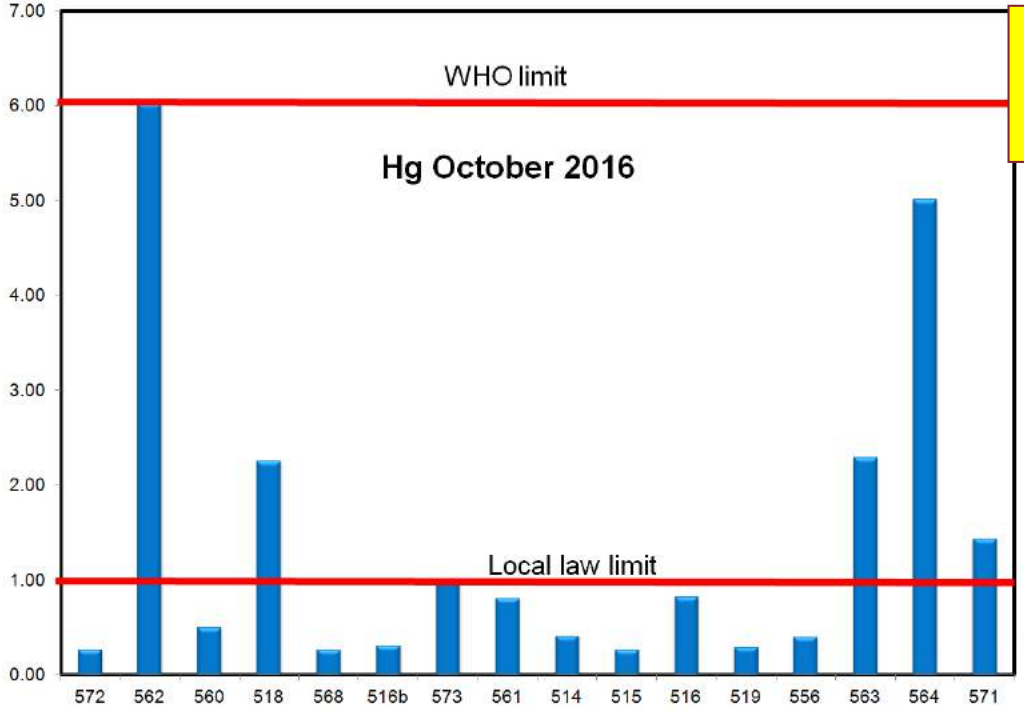
Results from minor and trace elements: boron concentrations



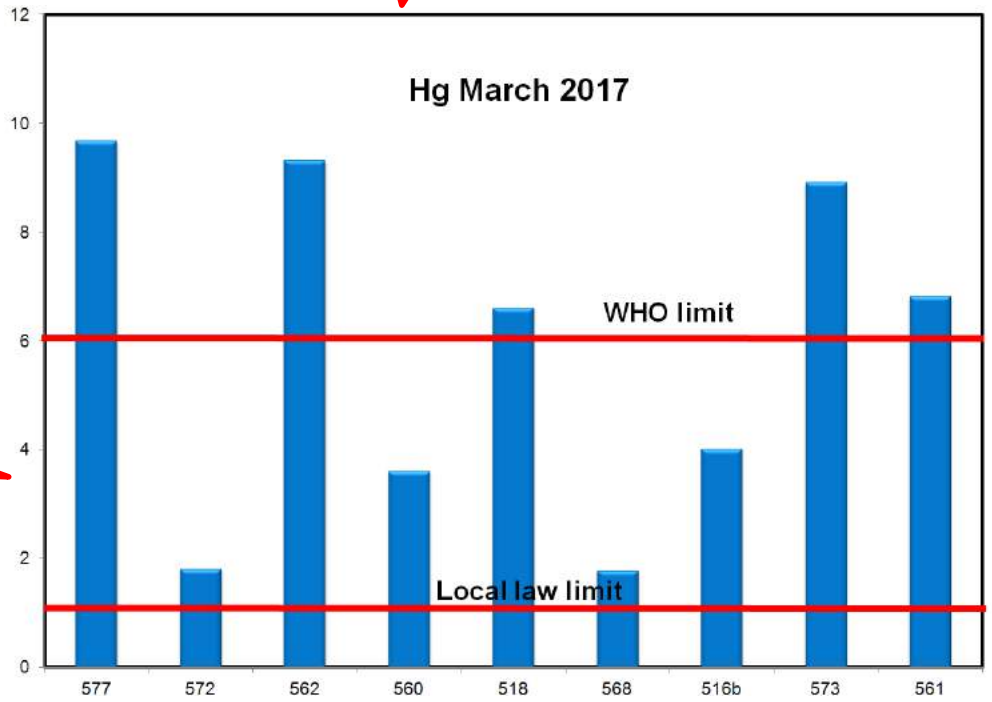
B/Cl values indicates possible fossil water

Geogenic source of B or from wastewater and fertilizer inputs

Results from minor and trace elements: mercury concentrations

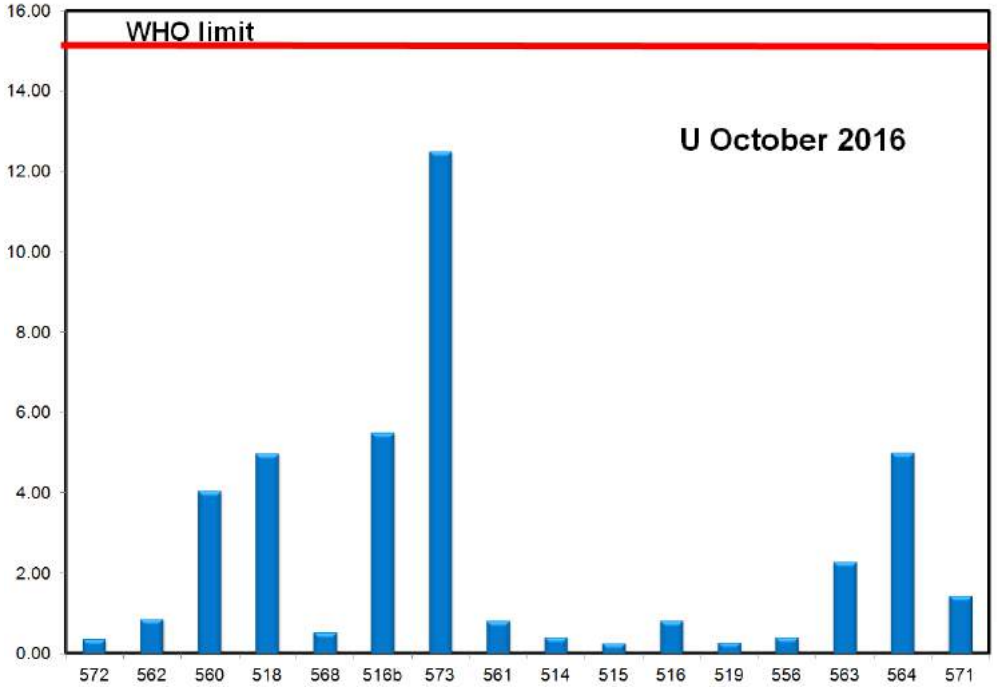


High mercury concentration



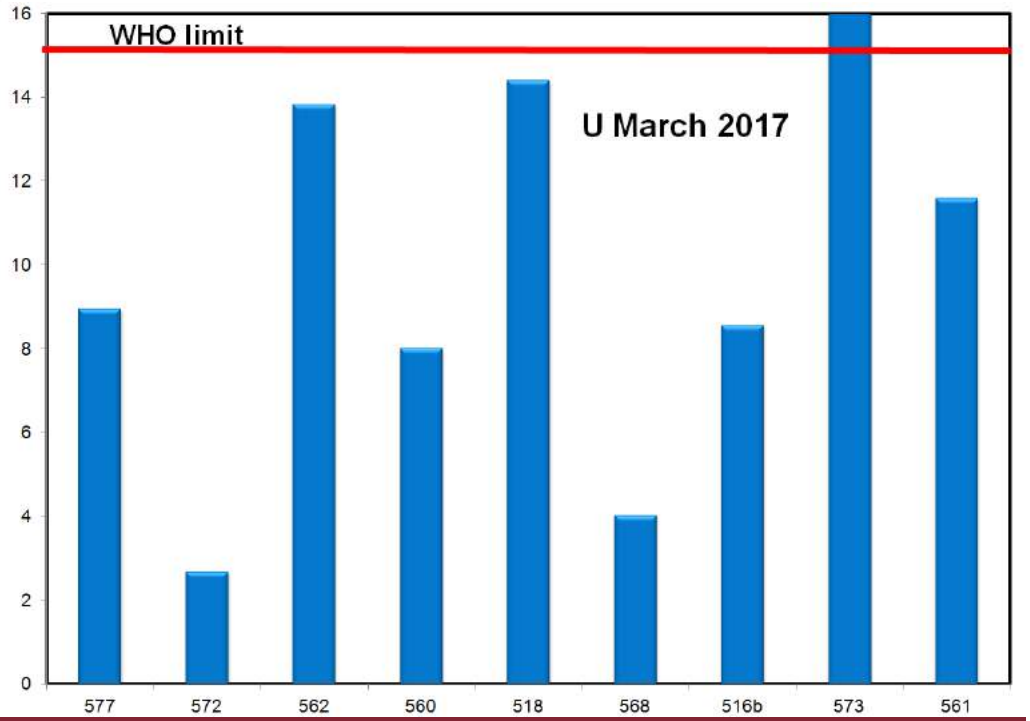
Values exceeds Local limit in all samples in March

Results from minor and trace elements: uranium concentrations



U values show high concentration expecially in March 2017

Only sample 573 shows value which exceed WHO limit



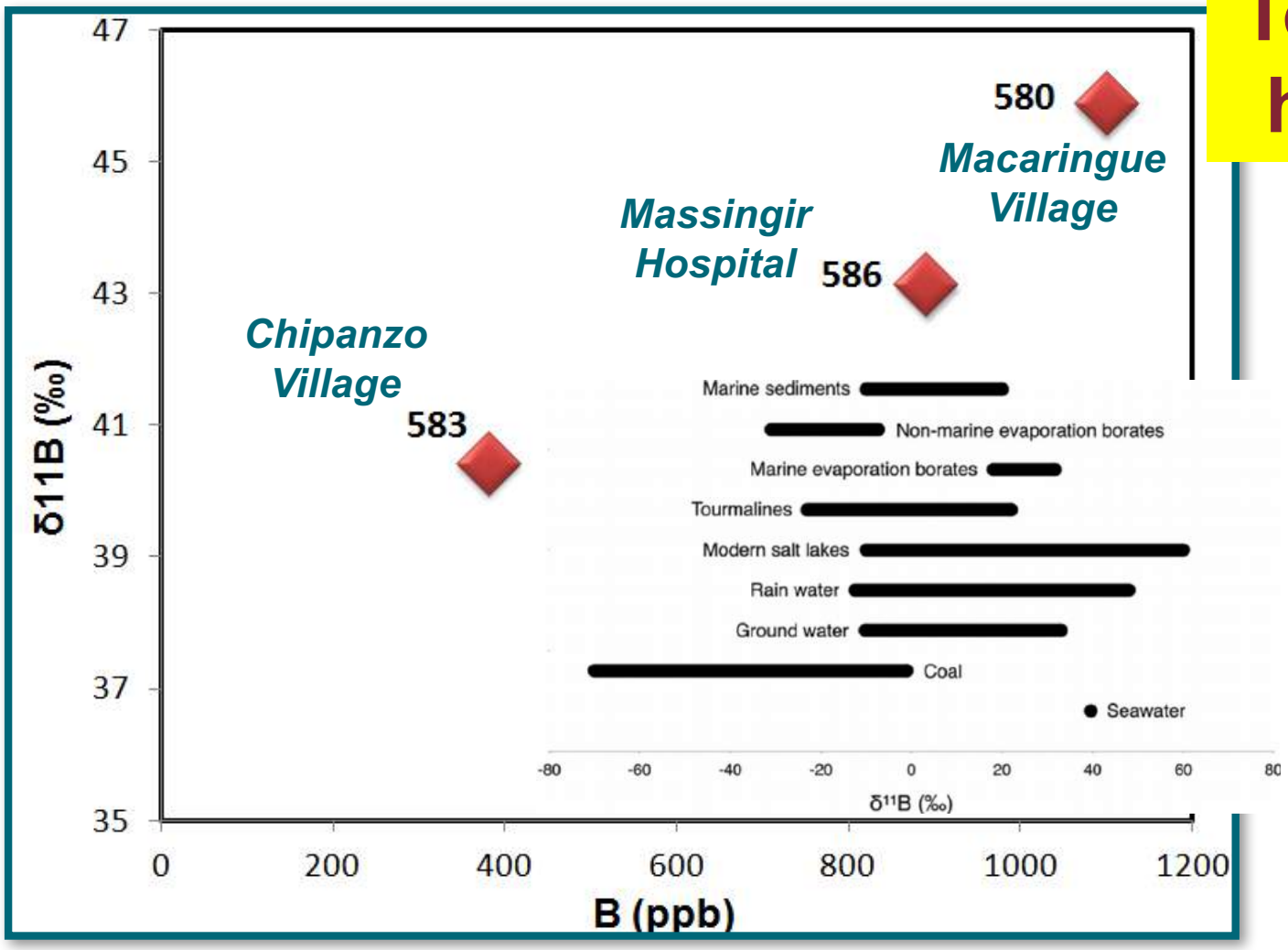
Results: Mercury (Hg) and Uranium (U)

Hg content is due to groundwater geogenic source

Salinity of groundwater
Fossil groundwater

U content can be associated to:
✓ Oxidized and containing carbonates water
✓ High organic matter content

To evaluate the hypothesis …



Results: $\delta^{11}B$

✓ *$\delta^{11}B$ values are similar to sea water (about 40‰)*

✓ *Geogenic source of Boron*

Values typical of saline groundwater of costal areas (Vengosh et al., 1994)
Probable Fossil water – Trapped groundwater with low circulation

The final goal of the activity research

The overall objective of this study is to design an integrated approach for Limpopo Park groundwater characterization and management, based on a tiered and complex program, which will include :

- *An assessment phase*
- *An operative phase*

Assessment phase

- *Preliminary field study*
- *Knowledge of the current state of water resources (groundwater and surface water)*
- *Review of existing monitoring plan*
- *Data existing collection*
- *Fill potential gap and lack of data*
- *Understand how water quality is managed and how should be managed*

Operative phase

Fields measurements and sampling

Chemical and isotopic analysis

Operative phase

✓*Next step Geochemical survey during July*

✓ *Evaluate possible geochemical variations on the characteristics of groundwater during the months that following wet season*

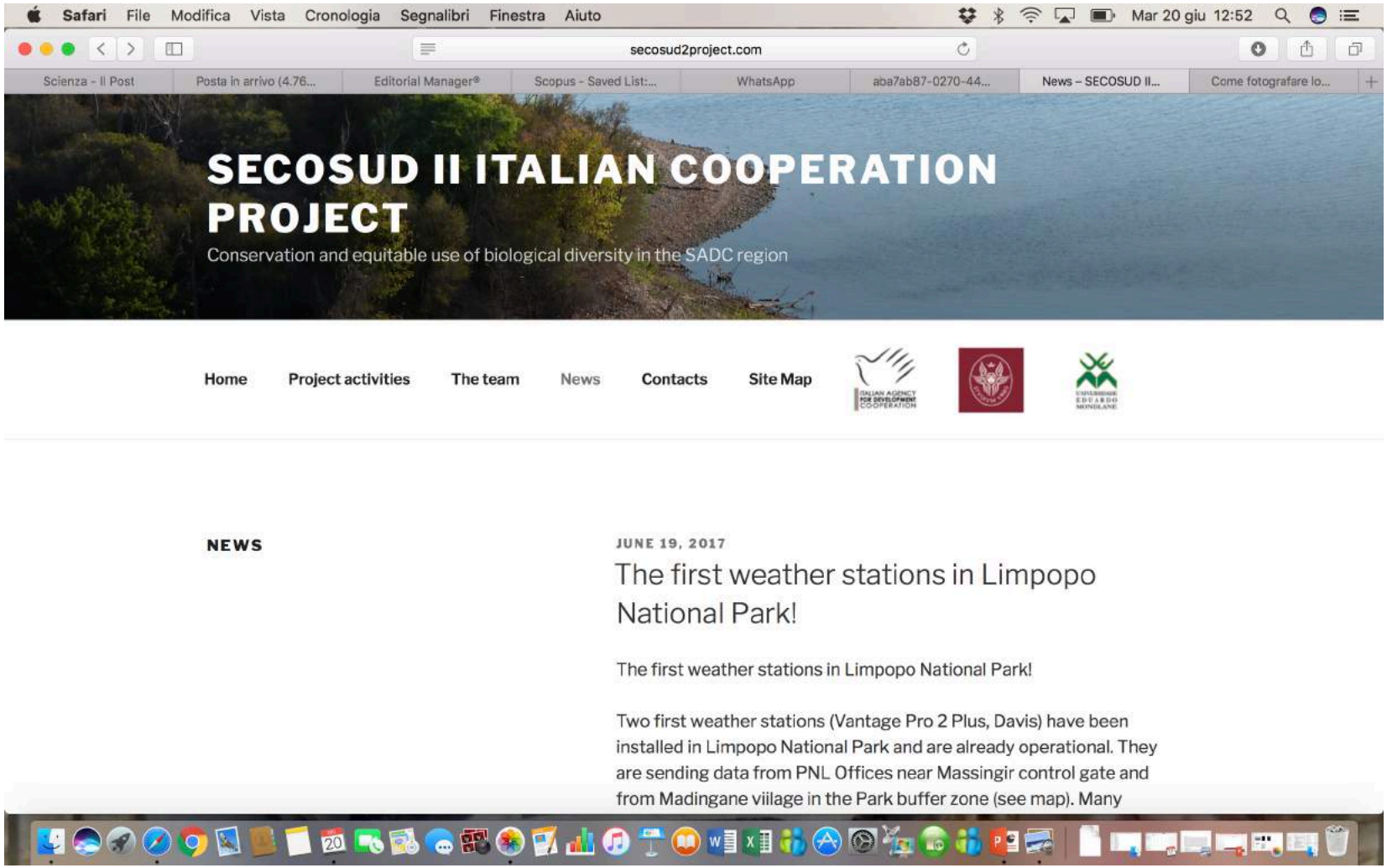
Operative phase

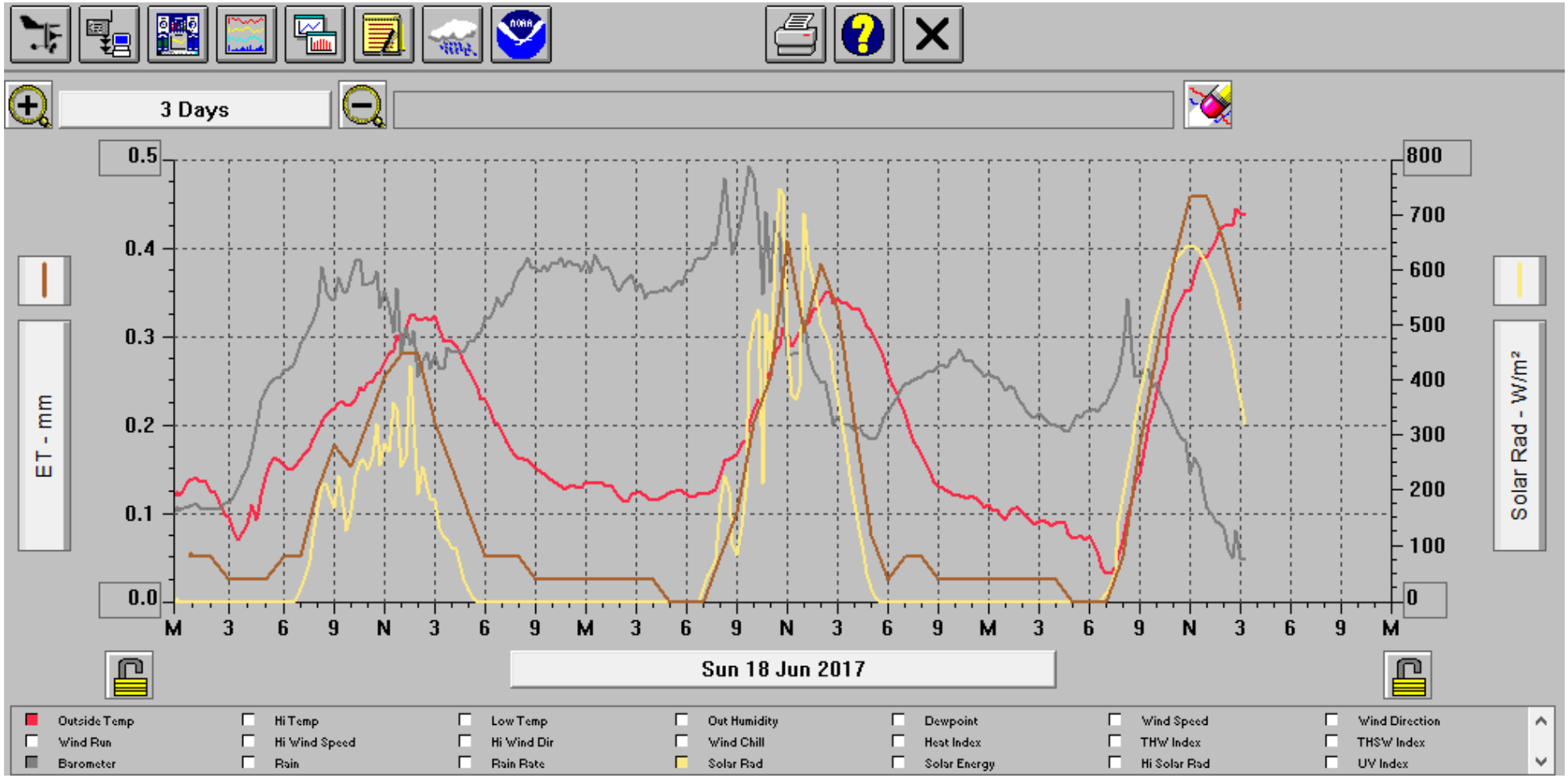
Implementation plans and reports

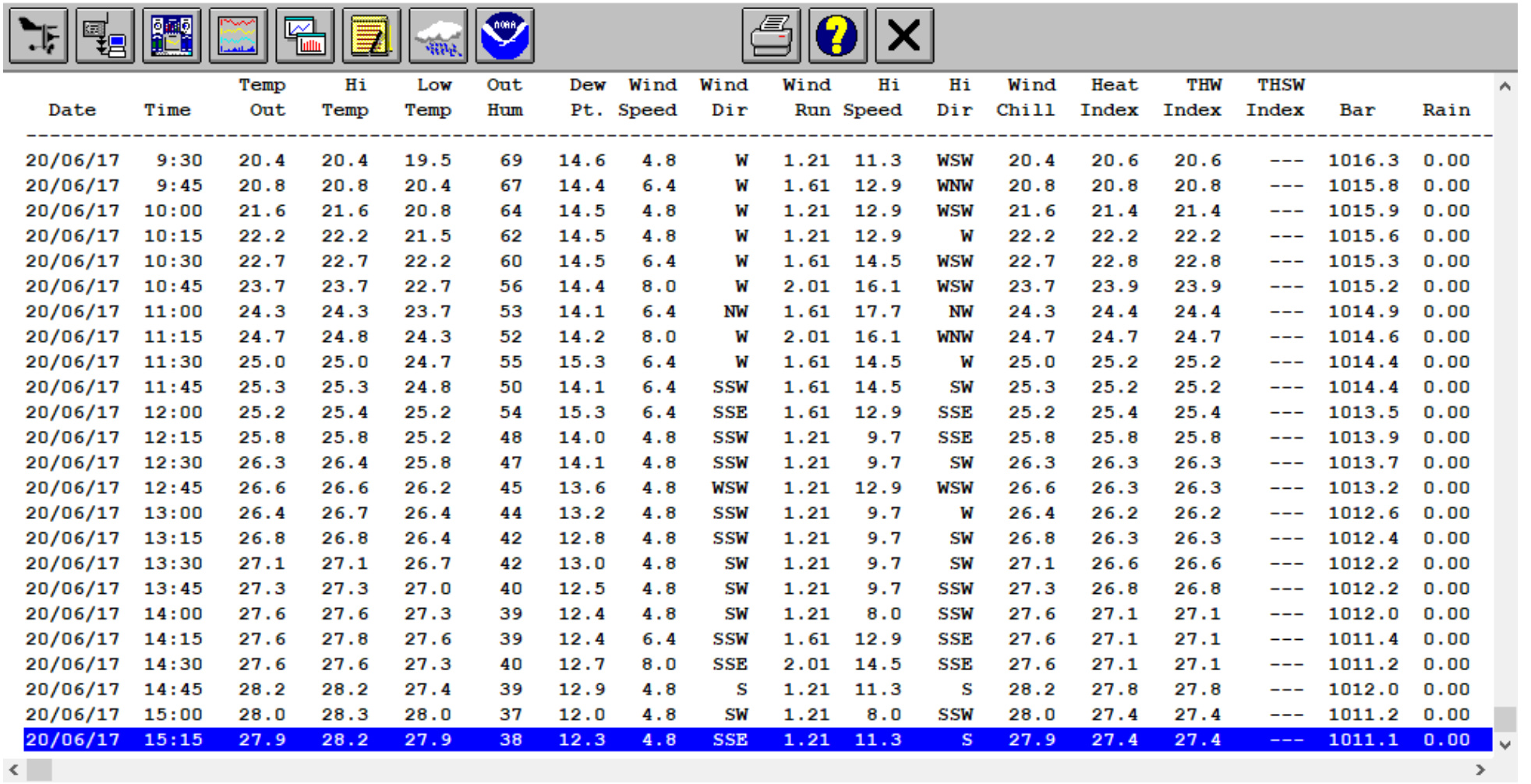
The monitoring systems will be supported by processing procedures, step by step, implementing a GIS database.

Set up an integrated monitoring network for the collection of hydrological data of the area of Limpopo National Park. The operational network consists of at least 9 continuous weather monitoring stations, equipped with The Vantage Pro2™ (6152, 6153) and Vantage Pro2™ Plus

and… now the first weather stations on line:




3 Days
0.5
0.4
0.3
0.2
0.1
0.0
ET - mm
800
700
600
500
400
300
200
100
0
Solar Rad - W/m²
M 3 6 9 N 3 6 9 M 3 6 9 N 3 6 9 M 3 6 9 N 3 6 9 M
Sun 18 Jun 2017
Outside Temp
Wind Run
Barometer
Hi Temp
Hi Wind Speed
Rain
Low Temp
Hi Wind Dir
Rain Rate
Out Humidity
Wind Chill
Solar Rad
Dewpoint
Heat Index
Solar Energy
Wind Speed
THW Index
Hi Solar Rad
Wind Direction
THSW Index
UV Index



Date	Time	Temp Out	Hi Temp	Low Temp	Out Hum	Dew Pt.	Wind Speed	Wind Dir	Wind Run	Hi Speed	Hi Dir	Wind Chill	Heat Index	THW Index	THSW Index	Bar	Rain
20/06/17	9:30	20.4	20.4	19.5	69	14.6	4.8	W	1.21	11.3	WSW	20.4	20.6	20.6	---	1016.3	0.00
20/06/17	9:45	20.8	20.8	20.4	67	14.4	6.4	W	1.61	12.9	WNW	20.8	20.8	20.8	---	1015.8	0.00
20/06/17	10:00	21.6	21.6	20.8	64	14.5	4.8	W	1.21	12.9	WSW	21.6	21.4	21.4	---	1015.9	0.00
20/06/17	10:15	22.2	22.2	21.5	62	14.5	4.8	W	1.21	12.9	W	22.2	22.2	22.2	---	1015.6	0.00
20/06/17	10:30	22.7	22.7	22.2	60	14.5	6.4	W	1.61	14.5	WSW	22.7	22.8	22.8	---	1015.3	0.00
20/06/17	10:45	23.7	23.7	22.7	56	14.4	8.0	W	2.01	16.1	WSW	23.7	23.9	23.9	---	1015.2	0.00
20/06/17	11:00	24.3	24.3	23.7	53	14.1	6.4	NW	1.61	17.7	NW	24.3	24.4	24.4	---	1014.9	0.00
20/06/17	11:15	24.7	24.8	24.3	52	14.2	8.0	W	2.01	16.1	WNW	24.7	24.7	24.7	---	1014.6	0.00
20/06/17	11:30	25.0	25.0	24.7	55	15.3	6.4	W	1.61	14.5	W	25.0	25.2	25.2	---	1014.4	0.00
20/06/17	11:45	25.3	25.3	24.8	50	14.1	6.4	SSW	1.61	14.5	SW	25.3	25.2	25.2	---	1014.4	0.00
20/06/17	12:00	25.2	25.4	25.2	54	15.3	6.4	SSE	1.61	12.9	SSE	25.2	25.4	25.4	---	1013.5	0.00
20/06/17	12:15	25.8	25.8	25.2	48	14.0	4.8	SSW	1.21	9.7	SSE	25.8	25.8	25.8	---	1013.9	0.00
20/06/17	12:30	26.3	26.4	25.8	47	14.1	4.8	SSW	1.21	9.7	SW	26.3	26.3	26.3	---	1013.7	0.00
20/06/17	12:45	26.6	26.6	26.2	45	13.6	4.8	WSW	1.21	12.9	WSW	26.6	26.3	26.3	---	1013.2	0.00
20/06/17	13:00	26.4	26.7	26.4	44	13.2	4.8	SSW	1.21	9.7	W	26.4	26.2	26.2	---	1012.6	0.00
20/06/17	13:15	26.8	26.8	26.4	42	12.8	4.8	SSW	1.21	9.7	SW	26.8	26.3	26.3	---	1012.4	0.00
20/06/17	13:30	27.1	27.1	26.7	42	13.0	4.8	SW	1.21	9.7	SW	27.1	26.6	26.6	---	1012.2	0.00
20/06/17	13:45	27.3	27.3	27.0	40	12.5	4.8	SW	1.21	9.7	SSW	27.3	26.8	26.8	---	1012.2	0.00
20/06/17	14:00	27.6	27.6	27.3	39	12.4	4.8	SW	1.21	8.0	SSW	27.6	27.1	27.1	---	1012.0	0.00
20/06/17	14:15	27.6	27.8	27.6	39	12.4	6.4	SSW	1.61	12.9	SSE	27.6	27.1	27.1	---	1011.4	0.00
20/06/17	14:30	27.6	27.6	27.3	40	12.7	8.0	SSE	2.01	14.5	SSE	27.6	27.1	27.1	---	1011.2	0.00
20/06/17	14:45	28.2	28.2	27.4	39	12.9	4.8	S	1.21	11.3	S	28.2	27.8	27.8	---	1012.0	0.00
20/06/17	15:00	28.0	28.3	28.0	37	12.0	4.8	SW	1.21	8.0	SSW	28.0	27.4	27.4	---	1011.2	0.00
20/06/17	15:15	27.9	28.2	27.9	38	12.3	4.8	SSE	1.21	11.3	S	27.9	27.4	27.4	---	1011.1	0.00

Would geochemical and hydrogeological monitoring help the science of land planning and management of natural resources????

1) Hydraulic regulation

2) Water quality assessment

3) Planning Projects: managing and properly using of the resource


Thanks for the attention!!!