Preliminary results from selected estuaries monitored as part of the National Estuarine Monitoring Programme: the Breede River

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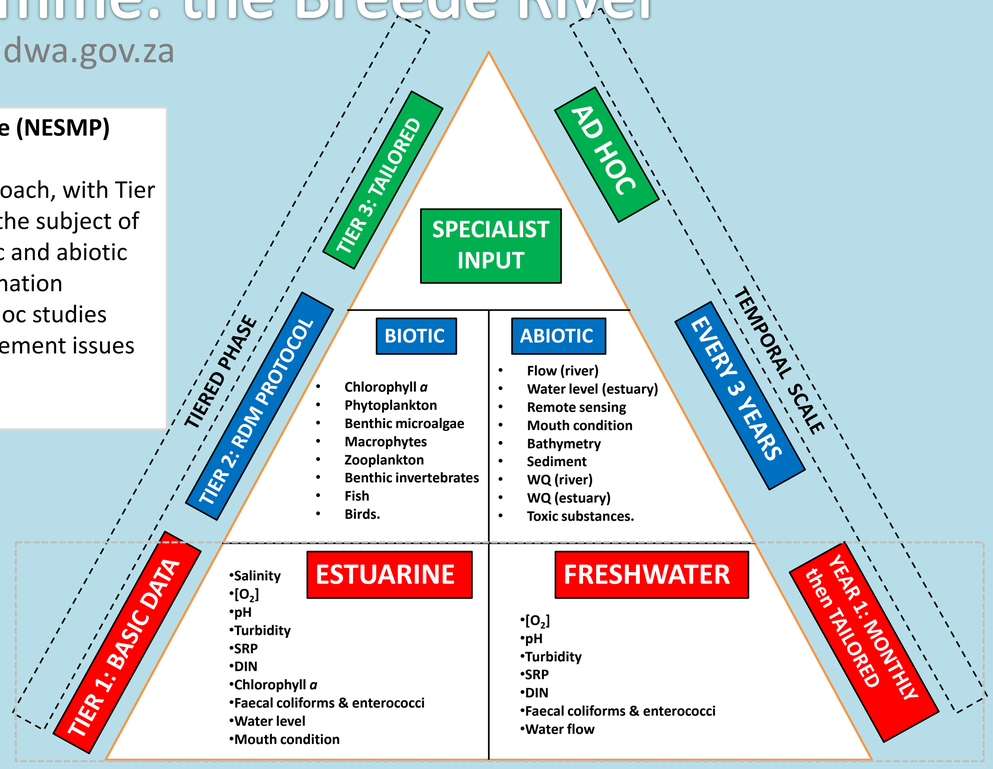
INTRODUCTION

The design of the National Estuarine Monitoring Programme of the Department of Water and Sanitation was initiated in 2008 and has progressed to pilot testing on selected South African estuaries. This programme is anchored in the National Water Act (Act No. 36 of 1998) which mandates the DWS to collect long term water quantity and quality data of South African water resources. At the same time it is also anchored in the Integrated Coastal Management Act (Act No. 24 of 2008) which recognizes the co-operative governance of coastal resources.

The National Estuarine Monitoring Programme (NESMP)

The monitoring programme takes a tiered approach, with Tier 1 entailing the collection of basic abiotic data (the subject of this poster) Tier 2 covering more detailed biotic and abiotic data in line with the estuarine reserve determination methods (DWAF 1999) and Tier 3 covering ad hoc studies required for addressing estuary specific management issues such as fish kills and pollution incidents.



Giving effect to the NESMP

The programme is founded on collaboration with different role players who are jointly responsible for the management of each estuary. This collaborative management is entrenched in the estuary management plans as mandated through the Integrated Coastal Management Act (Act No. 24 of 2008).

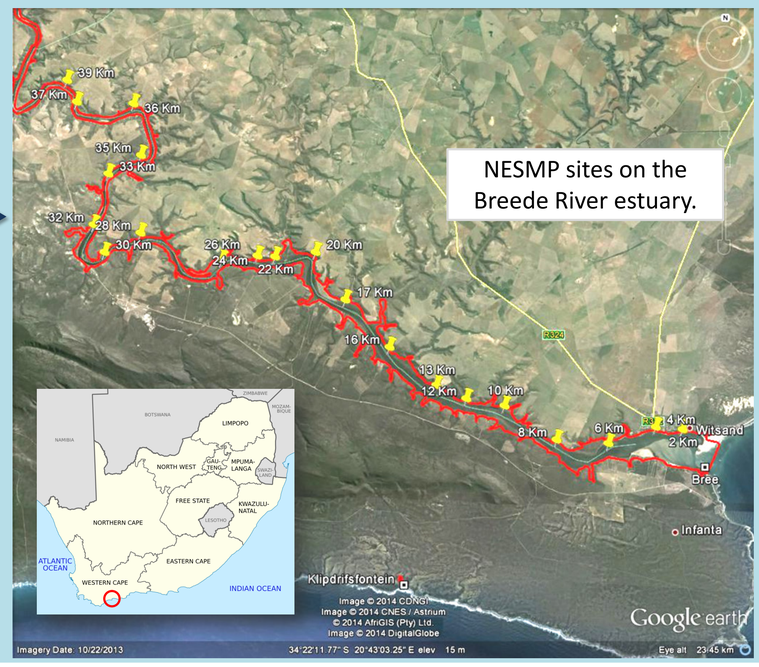
The Department of Water and Sanitation provides support in the form of sampling equipment, training, data management and information dissemination, while various stakeholders provide the manpower for the collection of physico-chemical data and water samples. Currently Tier 1 data is collected on 21 estuaries across the entire South African Coastline (Table 1).

Estuaries where the NESMP is being pilot tested, showing the Tier 1 water quality parameters that are collected.

ESTUARY	YEAR COMMENCED	COLLABORATING PARTIES	NUMBER OF SITES	
			BOAT BASED SALINITY RUNS • Salinity, temperature • depth • pH • oxygen concentration	PERMANENT PROBES • Salinity, • water level • temperature
St Lucia	2013	SAEON, iSimangaliso, Ezemvelo / KZN Wildlife	5	2 (& 5 by SAEON)
Mfolozi	2012	Ezemvelo / KZN Wildlife, SAEON	0	2 (& 2 by SAEON)
Mlalazi	2012	Ezemvelo / KZN Wildlife	11	0
Zinkwazi	2012	Lower Tugela Conservancy	5	0
Mdlotana	2013	Lower Tugela Conservancy	4	0
Nonoti	2012	Lower Tugela Conservancy	4	0
Mhlanga	2013	Ezemvelo / KZN Wildlife	6	0
Mgeni	2013	Ezemvelo / KZN Wildlife	10	0
Mpenjati	2012	Ezemvelo / KZN Wildlife	6	0
Mtamvuna	2013	Ezemvelo / KZN Wildlife	10	0
Keurbooms	2014	DWS, Eden District Municipality	0	1
Kromme	2012	SAEON	4	0
Gamtoos	2012	SAEON	1	0
Knysna	2012	SANPARKS	6	0
Swartvlei	2012	SANPARKS	6	0
Breede	**2012**	**Lower Breede River Conservancy Trust**	**21**	**2**
Klein	2014	Cape Nature	0	1
Bot	2014	Cape Nature	0	1
Berg	2012	West Coast District Municipality	6	2
Verlorenvlei	2013	West Coast District Municipality	6	1
Olifants	2013	West Coast District Municipality	8	1

CASE STUDY - BREEDE RIVER ESTUARY, WESTERN CAPE

The Breede River Estuary is a large permanently open estuary that stretches from 10km upstream of Malgas to the mouth at Witsand, a distance of approximately 52 km (DWAF, 2003). The catchment area is 12 625 km^2. It is one of the longest estuaries in South Africa with substantial seasonal freshwater inflow, resulting in an extensive salinity gradient. The system has high flows and major floods during the winter months (June to August) and low flows during summer (February to March). The depth of the channel of the estuary ranges from 3 to 6 m. These factors result in it being one of the most important estuaries in South Africa (DWAF, 2003).



MATERIALS AND METHODS

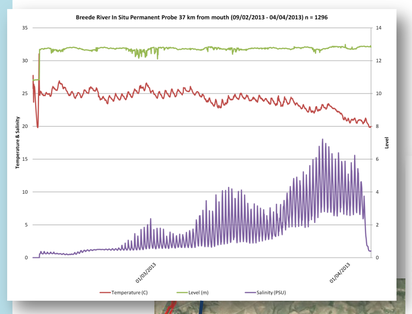
Permanent salinity probes: An AquaTroll 200 permanent probe was deployed at the mouth and 36 km upstream from the mouth, measuring hourly **temperature**, **salinity** and **water levels**. The probes were cleaned, calibrated and the data downloaded once a month. In August 2013, after flood damage, the upstream probe was moved to a site 34 km from the mouth.

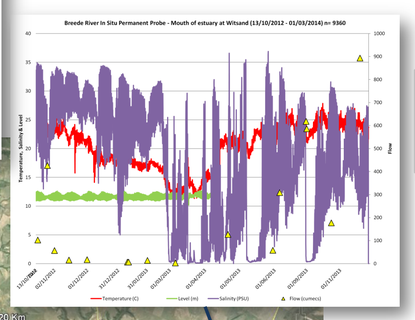
Salinity runs: **Oxygen** concentration, **pH**, **temperature**, **electrical conductivity**, **TDS** and **salinity** were measured at 0.5 metre depth intervals between February 2012 and December 2013 from a boat on the Breede River estuary at 21 sites. Collection took place on an incoming spring tide when possible with a hand held Aquaread multiparameter instrument.

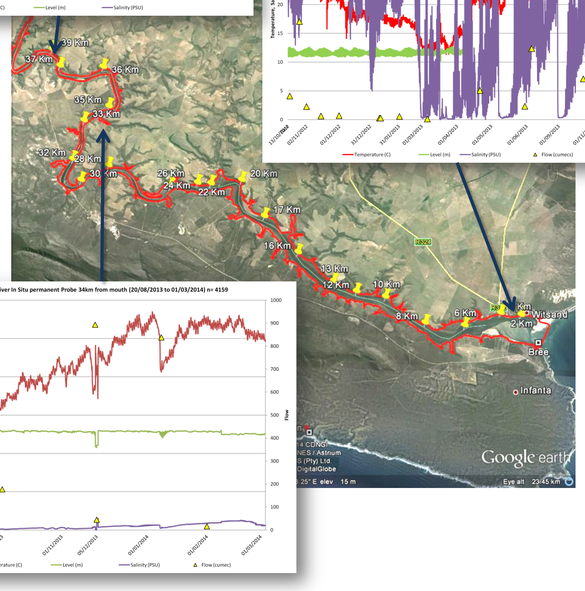
Nutrient samples: Water samples were collected at two sites (30 and 36 km from the mouth at Malgas) at a depth of 0.5 metres during February, May, June, July, October and December 2013. Total **ammonia**, **nitrate**, reactive **phosphorus** and reactive **silica** were determined using accredited methods.

The **Tier 1 physico-chemical data** collected between February 2012 and December 2013 and nutrient data collected during six months in 2013 were compared with information on the different states from the Breede River RDM study (DWAF, 2003). The simulated position of the River-Estuarine-Interface zone (REI) as proposed in the RDM study was also compared to the data collected in this study. The REI is the productive zone at the interface between seawater and fresh water where the mean salinity is usually < 10 ppt.

RESULTS







Results from the Breede River estuary monitoring programme for 2012 to 2013 compared with the results from the Breede River Estuary RDM study (DWAF, 2003), showing the physico-chemical components of five different states of the system.

	Breede River Estuary RDM Study (2003)					Observed (2012 to 2013)	
Variable	**State 1** Strongly freshwater dominated (winter)	**State 2** Freshwater dominated with saline intrusion (winter)	**State 3** Balanced marine & freshwater influence, well developed REI (summer)	**State 4** Marine dominated, REI varies & are smaller than State 3 (summer)	**State 5** Strongly marine dominated, no REI (summer)	**Winter** (Flow data n = 182; Physico-chemical data n = 702; Nutrient data n = 3)	**Summer** (Flow data n = 171; Physico-chemical data n = 931; Nutrient data = 3)
Typical flow pattern	> 20 m^3/s	10 - 20 m^3/s	3 - 10 m^3/s	0.5 - 3 m^3/s	< 0.5 m^3/s	2012: 7 - 614 (Mean: 70) 2013: 9 - 566 (Mean:108)	2012: 0.072 - 20 (Mean: 3) 2013: 0.15 - 127 (Mean: 6)
Temperature (ºC)	15 - 17	15 - 17	21 - 25	21 - 25	21 - 25	11 - 19	18 - 27
pH	7 - 8	7 - 8	7 - 8	7 - 8	7 - 8	7 - 9	3 - 9
Suspended Solids	Not available	Not available	< 10	< 10	< 10	No data	No data
Dissolved Oxygen	Well oxygenated	Well oxygenated	Well oxygenated	Well oxygenated	Reduced levels due to limited flushing	68.7 - 117.9 %	58.3 - 147.5 %
Nitrite-N (mg/l)	0.2 - 0.5	0.2 - 0.5	0.02 - 0.2	0.02 - 0.2	0.02 - 0.2	No data	No data
Nitrate-N (mg/l)	0.2 - 0.5	0.2 - 0.5	0.02 - 0.2	0.02 - 0.2	0.02 - 0.2	0.25 - 0.7	<0.05 - 0.3
Total Ammonia-N (mg/l)	<0.02	<0.02	<0.02	<0.02	<0.02	<0.05	<0.05 - 0.1
Reactive Phosphorus-P (mg/l)	<0.02	<0.02	<0.02	<0.02	<0.02	0.03 - 0.1	0.02 - 0.05
Reactive Silica-Si (mg/l)	1.5 - 2.0	1.5 - 2.0	0.7 - 1.2	0.7 - 1.2	0.7 - 1.2	0.83 - 0.99	0.25 - 0.41
REI	0 - 40 km	12 - 50+ km	16 - 50+ km	30 - 50+ km	50+ km	6 Km - 50km	13km - 50km

DISCUSSION

1. **Permanent Probes**: Salinity, level and temperature changes as a result of the tidal exchange are observed from the probe at the mouth of the estuary. Three flood events are reflected by the decrease in salinities from marine to freshwater. The upstream sites data indicate an increase in the salinity during summer when the tidal prism extends further inland as a result of decreased freshwater inflow into the estuary. The water column temperature increases from the winter to the summer months at both sites. Changes in the water level as a result of tidal exchange are also reflected in the probe data. Tidal variation is not as distinct during flood events, which tend to even out the water level variation.
2. **Salinity runs and nutrient data**: The observed **winter flow** varied from 7 to 614 m^3/s in 2012 and 9 to 566 m^3/s in 2013. This suggests a freshwater dominated state 1 and freshwater dominated with saline intrusion state 2. The observed **summer flow** ranged from 0.072 to 20 m^3/s in 2012 and 0.15 to 127 m^3/s in 2013. This is indicative of the state 3 to 5 of for the low flow summer months, with a fresh water pulse in April 2013 resulting in the maximum observed summer flow of 127 m^3/s.
3. The observed **temperatures** throughout the year were in a slightly broader range than proposed in the RDM study, with the lower and upper limits both differing by 2°C.
4. The observed **pH** values also seem to be in a broader range (7 to 9 in winter and 3 to 9 in summer) than proposed in the RDM study. A pH of 3 was observed in January 2013 at Malgas, approximately 40km upstream from the mouth. This low pH was only observed in the lower 2.5 metres of the water column, which may indicate a site specific anomaly.
5. **Oxygen** levels suggest a well oxygenated system as proposed in the RDM study.
6. Observed **nitrate** levels were within the proposed range with slightly higher maximum observed values of 0.7 mg/l in winter and 0.3 mg/l in summer. Possible sources are agricultural activities in the catchment or leaking septic tanks at Malgas.
7. **Ammonia** levels were also within the RDM range, except for one incident when a concentration of 0.1 mg/l was observed at a site 33 km upstream of the mouth during winter. This site is situated immediately downstream of Malgas and the high value could possibly be the result of leaking septic tanks.
8. Reactive **phosphorus** levels were also slightly higher than the RDM range with maxima of 0.1 mg/l during winter and 0.05 mg/l during summer. Possible sources are agricultural activities in the catchment or leaking septic tanks at Malgas.
9. The general increase in **nutrients** during the winter is probably a result of increased runoff from the catchment associated with the higher rainfall.
10. Observed reactive **silicate** levels were within both the winter and summer ranges.
11. The observed **River-Estuarine-Interface** zone where the average salinity is <10 ppt (for the freshwater dominated state 1), based on the salinity run data, does not seem to start at the mouth as indicated by the RDM study, but 6 km from the mouth. The permanent salinity probe at the mouth does however indicate that the mouth becomes fresh during extreme flood events, supporting the RDM results. The observed summer REI for state 2 seems to be 3 kilometres higher than the 12km proposed in the RDM study. This agrees with the observation from the RDM study that the REI may be more dynamic than initially postulated (DWA 2003).

CONCLUSIONS

1. The NESMP is **generating extensive datasets** on selected estuaries that can be used to detect changes in the main ecological drivers of estuarine systems. These datasets can be used for supporting future comprehensive estuarine reserves and for auditing existing estuarine reserves.
2. The NESMP has been **successfully implemented in the Breede River** through strong collaboration with the Lower Breeder River Conservancy Trust. This collaboration should be built upon and strengthened.
3. The preliminary data from the NESMP indicates that the proposed **resource directed measures on the Breede River Estuary are met to an extent**. Data collection should continue on the Breede River Estuary in order to get a more detailed picture of the functioning of the system and the effectiveness of the implementation of the reserve. The data will also indicate how the system reacts to increased water abstraction and water quality deterioration in the catchment.
4. **Data collection should continue** on existing estuaries where the NESMP is pilot tested, within the limitations of available funds.
5. The **NESMP should be expanded** to cover other priority estuaries in South Africa. Additional funds should be provided for this and relevant parties engaged in order to set the scene for strong collaboration between government departments, conservation bodies, NGOs and the public.

REFERENCES

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