water affairs
Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA

SOUTH AFRICAN ENVIRONMENTAL HEALTH MONITORING PROGRAMME

MINI TECHNICAL REPORT: July 2010
MZIMVUBU RIVER BIOMONITORING TRENDS

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EXECUTIVE SUMMARY

The main objective of the South African National River Health Programme (NRHP) combines both physiochemical and Biomonitoring data in order to get an impression about the state of the rivers. Biomonitoring makes use of the instream and riparian biological communities like the fish, macro invertebrates and vegetation to assess the ecological health or condition of rivers. These biological communities are always found in rivers and they are often affected by any disturbance that occurs in the river ecosystem.

This draft report provides the results of the Mzimvubu River Biomonitoring winter survey that was undertaken from 19 July to 29 July 2010. The draft report also provides for overall trends between period March 2008 and July 2010. Field indices used for data collection included the Geomorphology (GAI), South African Scoring System version 5.0 (SASS5) for Macro invertebrates, Water Quality (Both onsite and laboratory detail physiochemical analysis).
The Fish Assemblage Integrity Index for fish (FAII) was not done due to faulty fish shocker. The final report will include the latest physiochemical data from Talbot & Talbot Laboratories

Table 1: 16 Biomonitoring sites were selected in the Mzimvubu River system; this includes three sites in the Pot, Gatberg, Kinira, Tina, Mzintlava and Tsitsa Rivers River (tributaries to Mzimvubu River) and they are:

Site	Description	Coordinates	Site Code
1	Tsitsa Hewerspruit wetland	S30o52.313, E28o10.895	T3TST-TVALE
2	Pot River Pass	S30o53.427, E12.509	T3TINA-R316R
3	Tina Head Waters	S30o39.556, E28o12.530	T3POTR-PASS
4	Mzimvubu @ Jones Bridge	30o09.475, E29o06.850	T3MZIM-JOANS
5	Kinira Mabua	S30o11.504, E28.35.810	T3KINI-MABUA
6	Mzintlava @ Franklin Vlei	30o23.648, E29o26.908	T3MZIN-FRANK
7	Mzimvubu @ Springfontein	S30o28.633, E29o03.946	T3MZIM-SPRIN
8	Tina River @ Tsolobeng	S30o37.813, E28o28.945	T3TINA-TSOLO
9	Gatberg River @ forest	*S31.24621, E28.11843*	T3GATB-FOREST
10*	Kinira River Drift	S30o28.896, E28o37.335	T3KINI-GWEIR
11	Mzintlava @ Ntshakeni	30o49.608, E29o19.897	T3MZIN-NTSHA
12	Mzimvubu River @ N2 Road	S30o51.046, E29o04.182	T3MZIM-N2ROA

13	Tina River @ N2 Road	S30o04.419, E28o53.750	T3TINA-N2ROA
14	Tsitsa River @ Laleni	S31o14.707, E28o54.100	T3TSIT-LALEN
15	Mzintlava River @ Kupoyi	S31o06.129, E29o23.989	T3MZIN-KUPOY
16	Mzimvubu River @ Bhuje	S31o26.338, E29o17.660	T3MZIM-BHUJE

Overall trends in the Mzimvubu River basin indicate that the system has good buffering, dilution and transport capacity. Survey also indicates siltation problems (Mzimvubu Main stem) and emerging ammonia problems in the main stem, Mzintlava River.
Survey also indicates fair surplus of water and huge alluvial sand mining potential in this catchment.

GOALS AND OBJECTIVES OF BIOMONITORING

The goal of the South African National Aquatic Environmental Health Monitoring Programme (NAEHMP) is to obtain information on the ecological state of South Africa's river ecosystems in order to make proper management decisions regarding natural resources.

The main objective is to measure and assess; as well as to detect and report on spatial and temporal trends in the ecological state of aquatic ecosystems. This assists in identifying emerging problems regarding the aquatic ecosystems.

INTRODUCTION

DWAF Eastern Cape Resource Protection involves the use of Biomonitoring tools to determine the health of the aquatic ecosystems. The Programme aims to promote standardized and continuous monitoring and reporting on the Eastern Cape rivers health. Mzimvubu River system is one of the systems monitored in the Eastern Cape, hence, monitoring survey was conducted and this report provides information on its current state (using geomorphology, water chemistry, macro invertebrates and 2008 fish data).

Table 2: Biological and physical indicators used during biomonitoring (Murray, 1999)

ECOSYSTEM COMPONENT	RELEVANCE TO BIOMONITORING
Fish	Fish comprise one of the main biological components of aquatic ecosystems. Because they are relatively long-lived and mobile, they can indicate long-term influences (years) and general habitat conditions in a river reach. They represent a variety of trophic levels and hence integrate effects of environmental changes.
Geomorphology	Geomorphological processes determine river channel morphology which provides the physical environment within which stream biota live. Changes to channel form occurs both naturally and as a result of man-made changes to rivers or their catchments (e.g. impoundments, water transfers, agriculture).
Water quality	Aquatic ecosystems and their biota are affected by turbidity, suspended solids, temperature, pH, salinity, concentrations of dissolved ions, nutrients, oxygen, biocides and trace metals. Changes in these due to pollution, geomorphological or hydrological factors can have detrimental or even lethal effects on aquatic organisms.
Macro-Invertebrates	Invertebrate communities respond relatively quickly to localized conditions in a river, especially water quality, though their existence also depends on habitat diversity. They are common, have a wide range of sensitivities, and have a suitable life-cycle duration that indicate short- to medium-term impacts of water quality.

Table 3: Meanings of Present Geomorphological state (PGS) categories A to F (Rowntree, 2003)

CATEGORY	GEOMORPHOLOGICAL CHANGE	ANTHROPOGENIC INDICATORS
A: unmodified natural	No changes, erosion and deposition within reach are in balance.	No human impacts identified in the catchment.
B: largely natural	Short-term changes that can be reset within the frequency of the 'bankfull' flood.	Human impacts identified, but no clear evidence of channel response.
C: moderately modified	Slow trajectory of change, can be reset within five to ten 'bank full' events by restoring natural flow / sediment regime and bank stability.	Significant human impacts, changes to bed structure evident, localised bank erosion and channel widening, or deposition and narrowing. Changes reversible in the short term.
D: largely modified	Well into the trajectory of change, may be difficult to restore natural conditions; river adjusting its form to the current sediment load and flow regime.	Major human impacts resulting in significant long term changes to channel geometry, pattern or reach type that may be irreversible.
E: seriously modified	Engineering intervention required for rehabilitation.	Channel structure largely engineered, but bed perimeter includes some natural materials that can be worked by fluvial processes (includes gabions, engineered bank stabilisation, channel straightening or re-alignment, bulldozing.
F: critically modified	Major engineering intervention required for rehabilitation.	Totally engineered channel, no natural material in the channel perimeter.

For the purposes of state-of-rivers reports which are produced from technical reports, PGS categories 'A' to 'F' are reduced to four larger classes, namely **Natural**, **Good**, **Fair** and **Poor**. PGS categories are translated to these four classes in a standardized way as follows:

A	=	Natural
A/B, B + B/C	=	Good
C, C/D + D	=	Fair
E + F	=	Poor

Water Quality:

Physiochemical assessment for Freshwater Aquatic Ecosystem:

South African Water Quality Guidelines (DWA, 2008, version 4.1) are a series of documents which provide main information about the water quality requirements for different purposes. The document gives Target Water Quality Ranges (TWQR) for the most parameters which are assessed for different water requirements (e.g. domestic, fresh water aquatic ecosystem, industrial, agriculture, etc). These target water quality values are compared with the actual on site or laboratory test results.

Table 4: Summary of South African Water Quality Guidelines (Field Guide: Volume 8)

Parameter (mg/l)	Target Water Quality Range for:	
	Domestic use	Aquatic ecosystems
Ammonia (mg/l)	0 – 1.0	0.007
Chemical oxygen demand (mg/l)	Not Applicable	Not Applicable
Electrical Conductivity at 25 ºC in mS/m	0 – 70	Not applicable
Total dissolve solids at 180 °C (mg/l)	0 – 450	TDS concentrations should not be changed by > 15 % from the normal cycles of the water body under unimpacted conditions at any time of the year
Oxygen absorbed (mg/l)	Not listed	Not listed
pH at 25 °C	6.0 – 9.0	pH values should not be allowed to vary from the range of the background pH values for a specific site and time of day, by > 0.5 of a pH unit, **or** by > 5 %, **and should be assessed by whichever estimate is the more conservative**.
Nitrate/Nitrite mg/l	0 – 6	Not mentioned
Orthophosphate (mg/l)	0 – 1	Inorganic phosphorus concentrations should not be changed by > 15 % from that of the water body under local, unimpacted conditions at any time of the year;
Turbidity (NTU)	0 – 1	Not mentioned
Mercury (ug/l)	0.001	0.00004 or (0.04ug/l)
Dissolved cadmium (mg/l)	0 – 5 ug/l	0.15ug/l
Dissolved lead (mg/l)	0 0.01	0.0002
Suspended solids (mg/l)	Not applicable	Not applicable
Dissolved Oxygen (%)	Not applicable	Must be between 80 – 120 % of saturation.
Aluminium (mg/l)	0 – 0.15	0.005
Fluoride (mg/l)	0 – 1	0.75

And for the purpose of water quality reporting for Mzimvubu River catchment, the following symbols will be used for reporting compliance or non-compliance with TWQR:

C – Compliance with TWQR
NC- Non compliance with TWQR

Macro-Invertebrates (SASS 5)

Table 4: The river health classification system used in the NRHP (adapted from Roux, 2003)

RIVER HEALTH CLASS	ECOLOGICAL PERSPECTIVE	MANAGEMENT PERPECTIVE
Natural	No or negligible modification of instream and riparian habitats and biota.	Protected rivers; relatively untouched by human hands; no discharges or impoundments allowed.
Good	Ecosystem essentially in good state; biodiversity largely intact.	Some human-related disturbance, but mostly of low impact potential.
Fair	Sensitive species may be lost; lower abundances of biological populations are likely to occur: or sometimes, higher abundances of tolerant or opportunistic species occur.	Multiple disturbances associated with need for socio-economic development, e.g. impoundment, habitat modification and water quality degradation.
Poor	Habitat diversity and availability have declined; mostly only tolerant species present; species present are often diseased; population dynamics have been disrupted.	Often characterized by high human densities or extensive resource exploitation. Management intervention is needed to improve river health, e.g. to restore flow patterns, river habitats or water quality.

Table 5: Default benchmark river health class boundaries for SASS5

CLASS BOUNDARY	RANGE OF ASPT SCORES
Natural	7
Good	6
Fair	5
Poor	< 5

SITE SELECTION FOR BIOMONITORING OF THE MZIMVUBU RIVER

Mzimvubu River system has four main tributaries (Mzintlava, Kinira, Tina and Tsitsa Rivers). 16 sites were selected for Biomonitoring of this river system.

Site selection for monitoring surveys was based on the following information:

- Ecoregion Level II delineation of the catchment, produced by RQS, DWAF (Figure 2.2).

- Aerial video of the catchment and major tributaries flown by Dana Gobbler and Kululwa Mkosana
- These units were selected on the basis of Ecoregion and therefore ecological homogeneity, as well as usefulness for management purposes.

16 sites were selected in the Mzimvubu River which also represent all thee Eco-regions in the T3 catchment. 9 sites chosen in the Upper reaches), four site was chosen from the Middle reaches), other three sites were chosen from the Lower reaches).

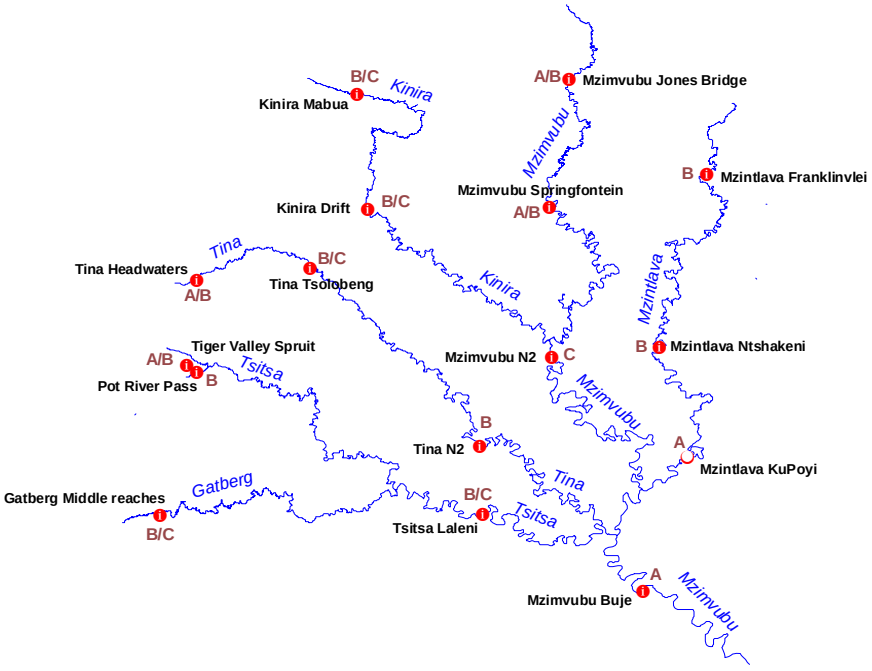


Figure 1: Biomonitoring sites, Geomorphological classes.

Study Area

NATURAL FEATURES

Topography

Mzimvubu River Basin has a catchment area of 19 852km^2 and has four major Tributaries Tsitsa, Kinira, Tina and Mzintlava, all have their headwaters in the Drakensberg Mountains .This River flows through the deep incised river valleys into the coastal belt before it discharges into the Indian Ocean at Port St Johns.

Elevation Map (meters above sea level)

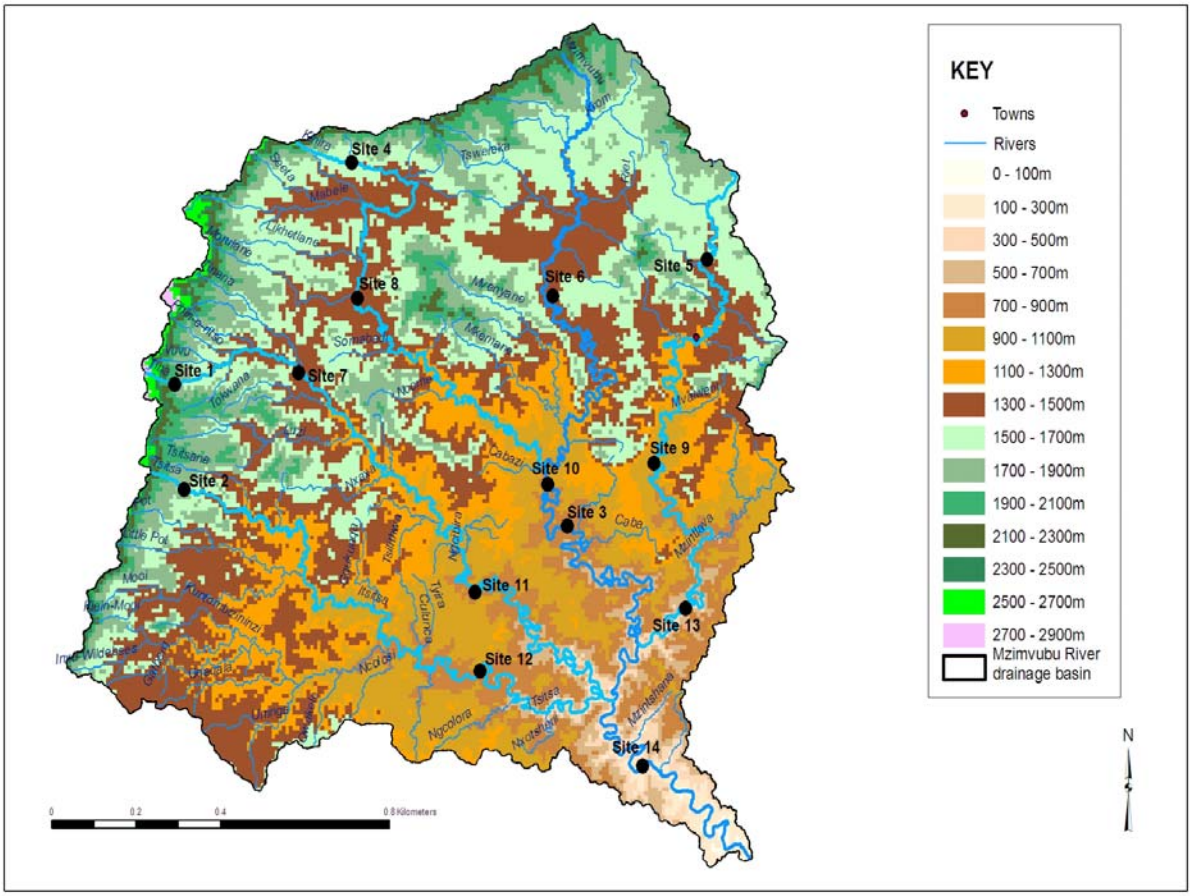


Figure 2: Elevation profile (meters above sea level) of Mzimvubu River catchment from source (Drakensburg Mountains to Indian Ocean)

Ecoregion Map

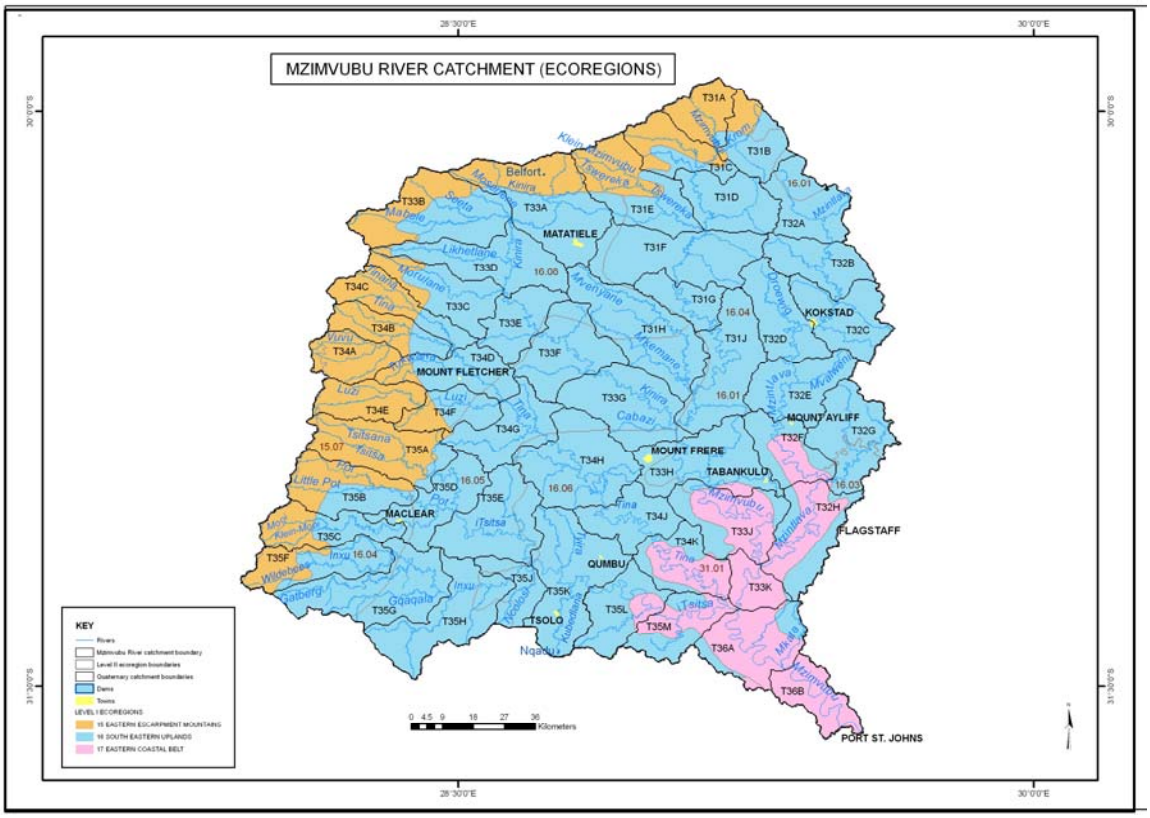


Figure 3: Map showing three topographic zones/Eco-Regions in the Mzimvubu River Catchment.

4.1.2 Climate and Rainfall (Hydrology)

MAP (mm) (modifying) - 400 to 1000
Coefficient of Variation (% of annual precipitation) - <20 to 35
Rainfall concentration index - <15 to 50
Rainfall seasonality - Early to very late summer to all year
Mean annual temp. (°C) - 16 to 20
Mean daily max. temp. (°C): February - 24 to 28
Mean daily min. temp. (°C): February – 14 to 20
Mean daily max. temp. (°C): July – 18 to 22
Mean daily min. temp. (°C): July – 4 to >10
Median annual simulated runoff (mm) for quaternary catchment – 20 to >250

4.1.3 Vegetation type

Coastal Bushveld\Grassland (Limited); Eastern Thorn Bushveld;
Valley Thicket; Dune Thicket (limited); Short Mistbelt Grassland (limited); Coastal Grassland. Patches Coastal forest and Patches Afromontane Forest

4.1.4 Geology and Soils

Predominant rock formations in this catchment are sandstone, and mudstone
Categories of the soils in this basin

1. Moderately deep to deep clay soils in the steep slopes of the Drakensburg
2. Moderately deep clayey loams on the steep of the foothills of the Drakensburg
3. Sandy loams east of the and as far as the coast

The soil here is prone to erosion because of the fact that these soils are dispersive and that emanates from the weathering parent rocks.

Overgrazing has exacerbated erosion.

4.1.4 Land Use, Settlement Patterns and Economy of this catchment

Land use Map

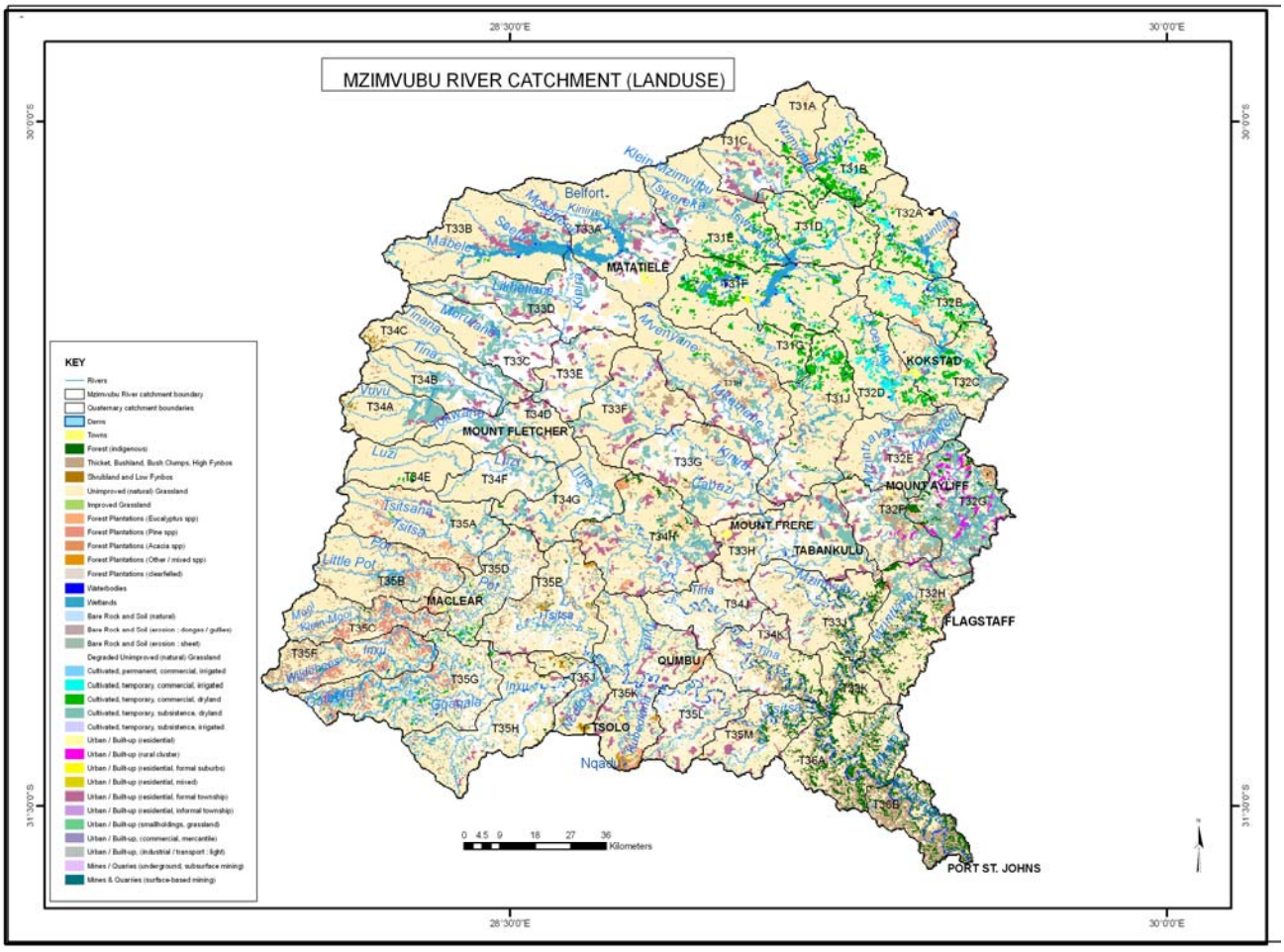


Figure 4: Map showing land use patterns of the Mzimvubu River basin (data adapted from GIS coverage RQS)

There are a number of scattered villages and there is dry land cultivation taking place and there are number of farms within the catchment used for commercial agriculture in Matatiele, Ugie and Maclear. A greater portion of this basin is suffering from severe

erosion and this resulting in the formation of dongas. Invasive plants are problematic in this catchment and these can occupy an area of about 20 000 ha (RHP EC aerial survey 2005)
Economic activities in this catchment subsistence farming, commercial agriculture and commercial forestry,
Economic activities in the lower reaches include commercial tea horticulture, coastal resorts, fishing, home crafting, retail and food stores.

MATERIALS AND METHOD

The Geomorphological Assessment Index (GAI), which was used to assess the Present Geomorphological State of a river at a particular reach.
On site physiochemical analysis was done using Hanna pH & EC Combo tester and grab samples were send to Talbot and Talbot Laboratories for physiochemical analysis. Sampling of fish macro invertebrates was conducted at some Biomonitoring site. Macro invertebrates were sampled using SASS 5 method and fish were sampled using a seine-net. Fish caught were identified to species level with the number of juveniles and abnormalities recorded (Fish survey was done only in march and July of 2008).

Results

Winter Survey and Historical Trends (from March 2008 to July 2010)

Geomorphology: Driver component**,** first assessment (Site one, upper reaches)

Site one: Tiger Valley Spruit below Wetland (upper reaches)

Plate 1: Tiger Valley Wetland

Altitude: 1736 masl.

No changes had taken place at a site. This site is situated just below a Hillslope wetland that is groundwater recharged and has very low flows (seeps). Cattle farming occur on the catchment, but have negligible impacts with minor erosion at a local scale. The Geomorphological Assessment Index (GAI) model shows that the site is at A/B class in terms of its present ecological state.

Water Quality Trends on a river reach scale: Driver component

Site one, upper reaches: **Tiger Valley Wetland**

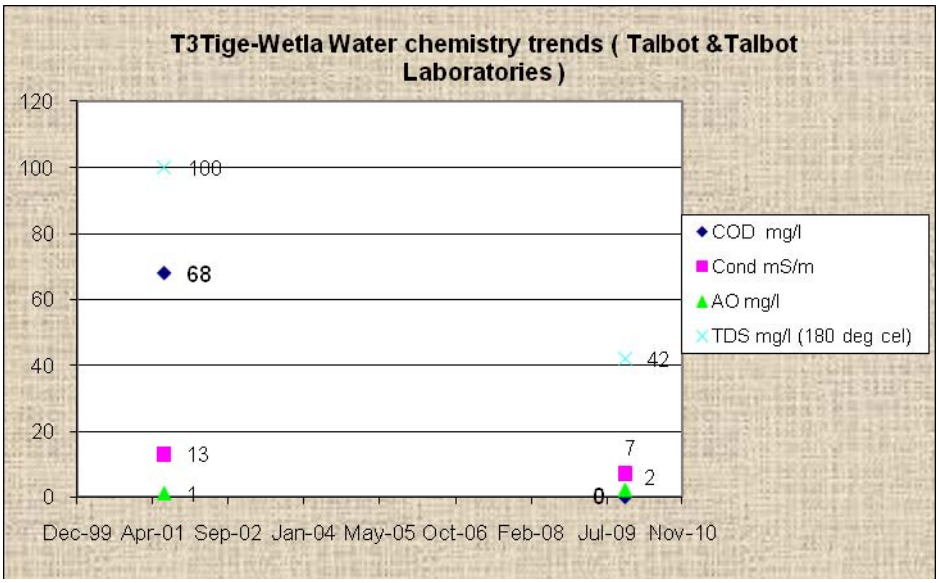


Figure 1. COD, Conductivity, Oxygen absorbed and Total dissolved solids flacuations at Tiger Valley Spruit below the wetland (by Talbot & Talbot Laboratories). Water chemistry data indicate compliance with Target Water Quality Range (DWA 2008)

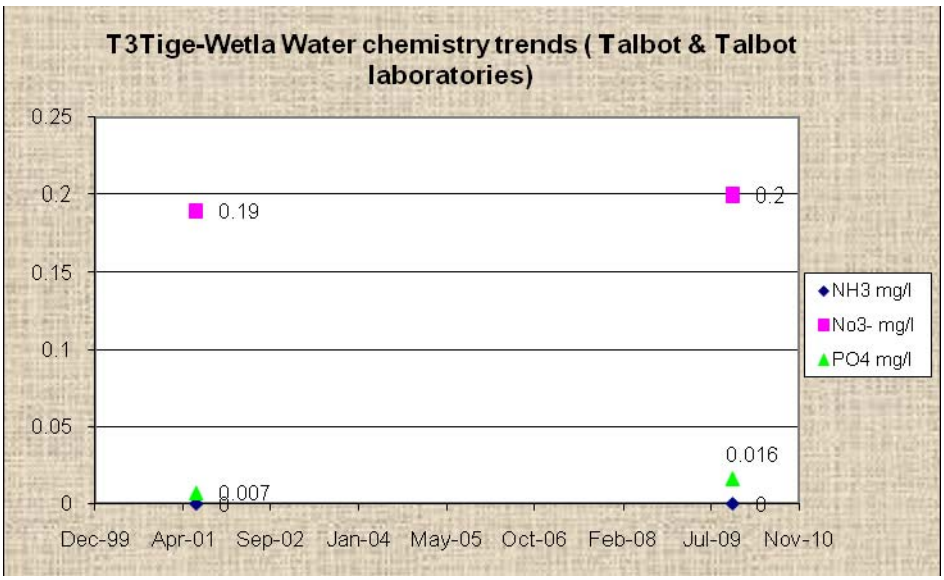


Figure 2. Ammonia, nitrates and phosphates flacuations at Tiger Valley Spruit below the wetland (by Talbot & Talbot Laboratories). Water chemistry data indicate compliance with Target Water Quality Range (DWA 2008)

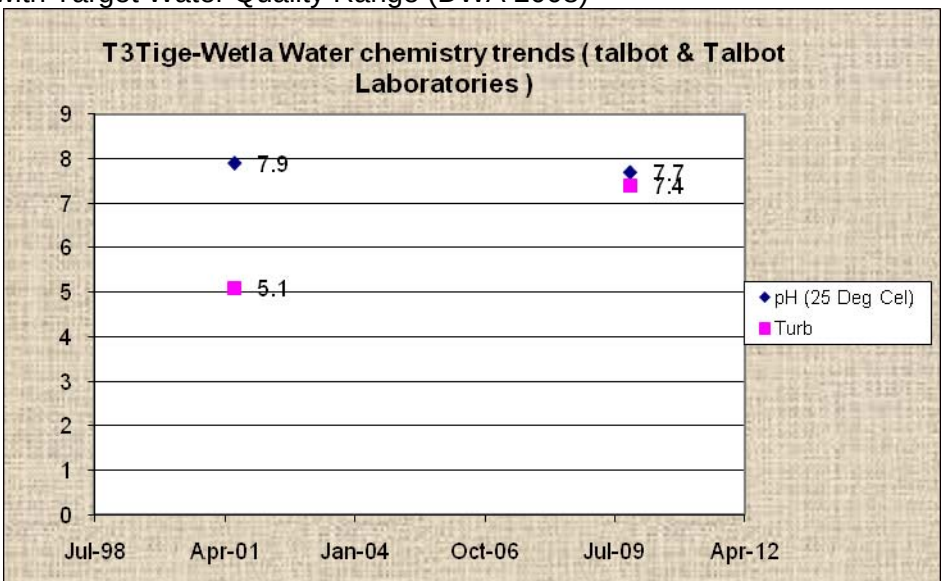


Figure 3: pH and turbidity flacuations at Tiger Valley Spruit below the wetland (by Talbot & Talbot Laboratories). pHtrends indicates compliance with Target Water Quality Range while turbidity has exceeded the the target range for domestic use(DWA 2008)

Invertebrates (Responses)

SASS 5 not done due to absence of sampling biotopes.

Fish Assessment (Responses)

Fish assessment not done due to absence of sampling biotopes (**no pools**).

Site Two:

Geomorphology: Driver component (Site one, upper reaches)

Site name: Tina Head waters (T3TinaR316R)

Plate 2: Tina Head waters (T3TinaR316R)
Altitude: 1679 masl.

The site is located at an incised channel with flood benches. No significant changes identified during the survey except the slight increase in morphological units (62.5% as compared to 50% of the spring survey). Such increases could be due to flow changes, as the recent survey was done during periods of base flows, and therefore exposure of other biotopes that were submerged by the water during 2009 spring survey. It could be observed that minor erosion occurred at a local scale. The Geomorphological Assessment Index (GAI) model shows that the site is at **A/B** class in terms of its present ecological state.

<u>Water Quality Trends on a river reach scale</u> (2nd driver)

Site two, T3TinaR316R

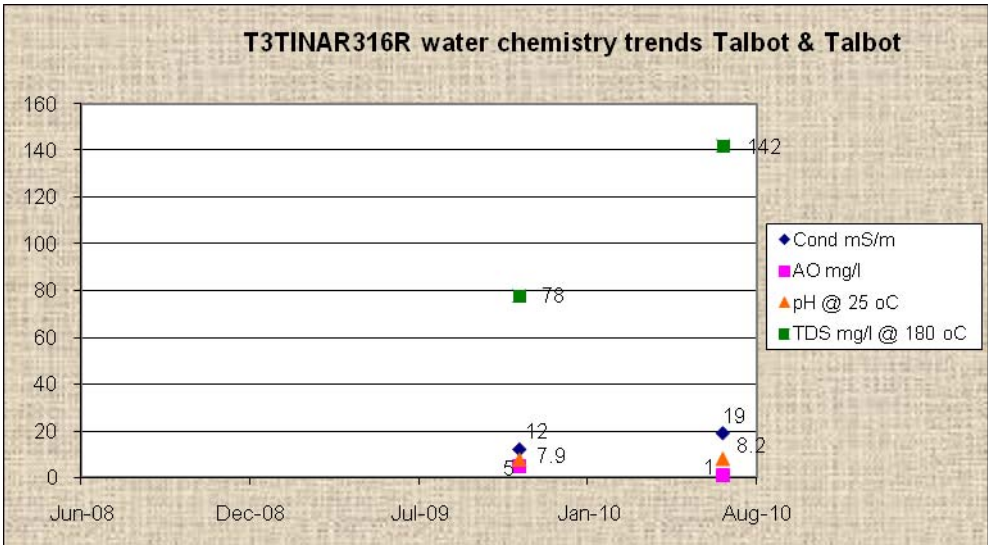


Figure 4: COD, Conductivity, Oxygen absorbed and Total dissolved solids flacuations at Tinar head waters (by Talbot & Talbot Laboratories). Water chemistry data indicate compliance with Target Water Quality Range (DWA 2008)

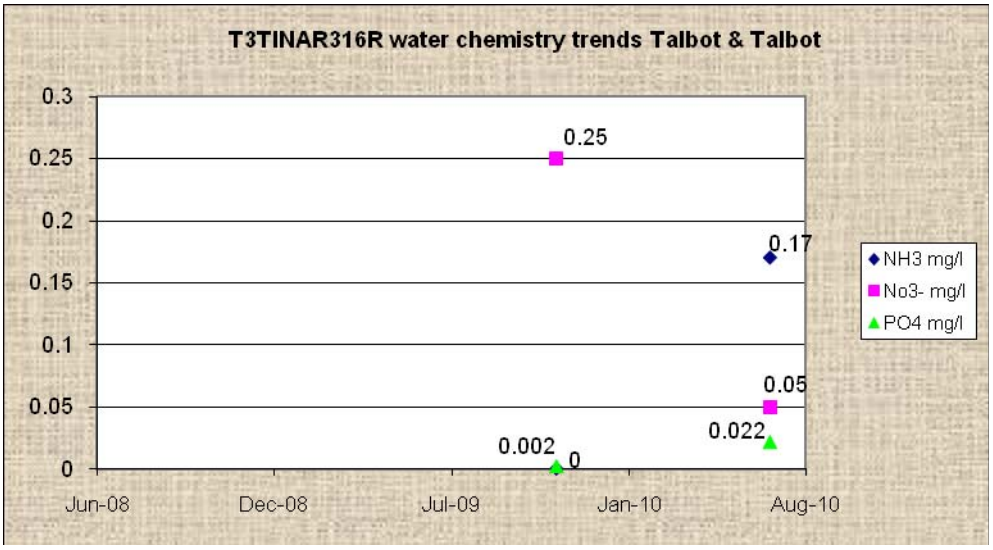


Figure 5:. Ammonia, nitrates and phosphates flacuations at Tina head waters (by Talbot & Talbot Laboratories). Water chemistry data indicate compliance with Target Water Quality Range (DWA 2008).

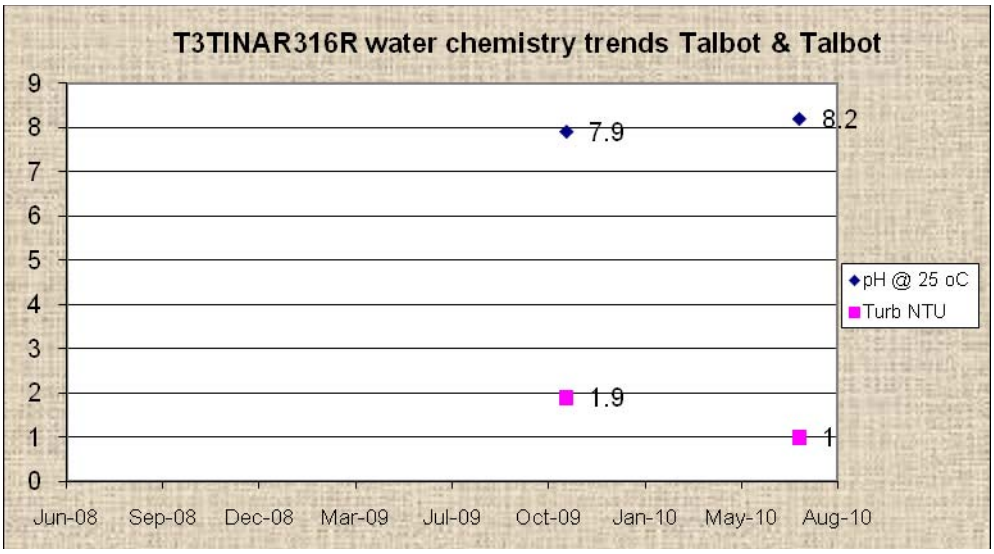


Figure 6: pH and turbidity flacuations at Tina head waters (by Talbot & Talbot Laboratories). pH trends indicates compliance with Target Water Quality Range while turbidity has exceeded the the target range for domestic use (DWA 2008), but the sicuation improved during base flow conditions.

<u>Invertebrates</u> (Responses)

Site two: T3TinaR316R (Tina Head waters):

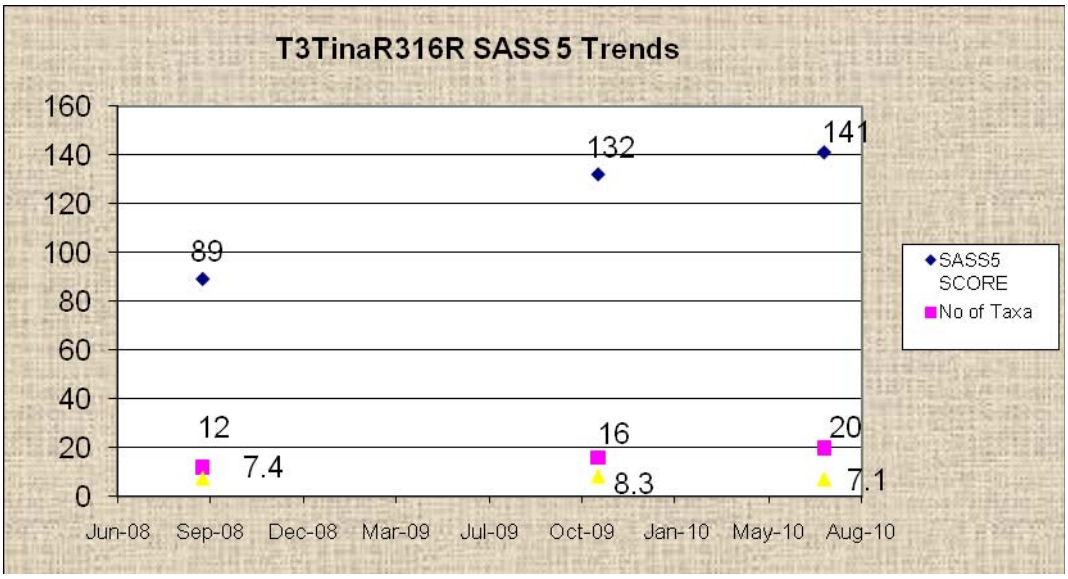


Figure 7: SASS 5 trends, start period march 2008 to July 2010. ASPT remains stable at natural conditions over the period of two years at an average ASPT of 7.6. Trends also indicate a steady increase of species population and diversity. These findings are consistent with water quality conditions of unimpacted rivers in the upper reaches.

Fish Assessment (Responses)

Although no fish was caught in this site, SASS 5 results suggest that these waters can support fish life.

Site three:

Geomorphology: Driver component (Site one, upper reaches)

Site name: Tentkop Spruit River Pass

Plate 3: Tentkop Spruit River Pass

Altitude: 1583 masl.

The site is located at a confined channel between two steep valleys. As a result, course sediments on the river bed are irregular in shape as they are directly from the Hillslope. It is a mixed channel where both the bedrock and alluvium are present but it is mainly dominated by bedrock. The channel is a pool-riffle. It has about 67% of morphological units where the living biota can survive. There is a localized erosion and sedimentation. Vegetation removal and subsistence farming are major disturbances. No sediment sampling could be done at a site as sediments were fixed on the river bed due to low flows and hardened finer material that hold the courser ones (compare with the spring survey, 2009 survey)

The Geomorphological Assessment Index (GAI) model shows that the site is at **B** class in terms of its present ecological state.

Water Quality Trends on a river reach scale (2nd driver)

Site three: Tentkop Spruit River Pass

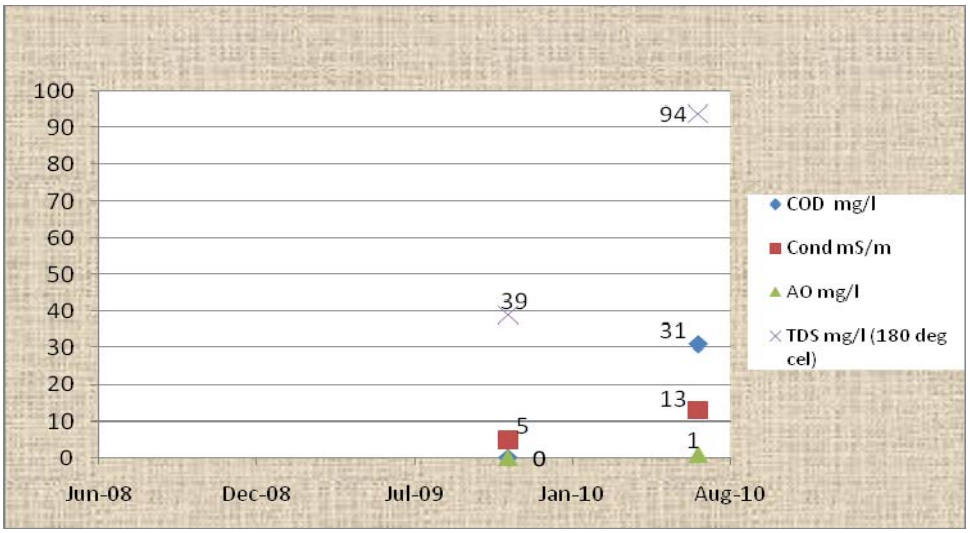


Figure 8: COD, Conductivity, Oxygen absorbed and Total dissolved solids flacuations at Tentkop Spruit River Pass (by Talbot & Talbot Laboratories). Water chemistry data indicate compliance with Target Water Quality Range (DWA 2008).

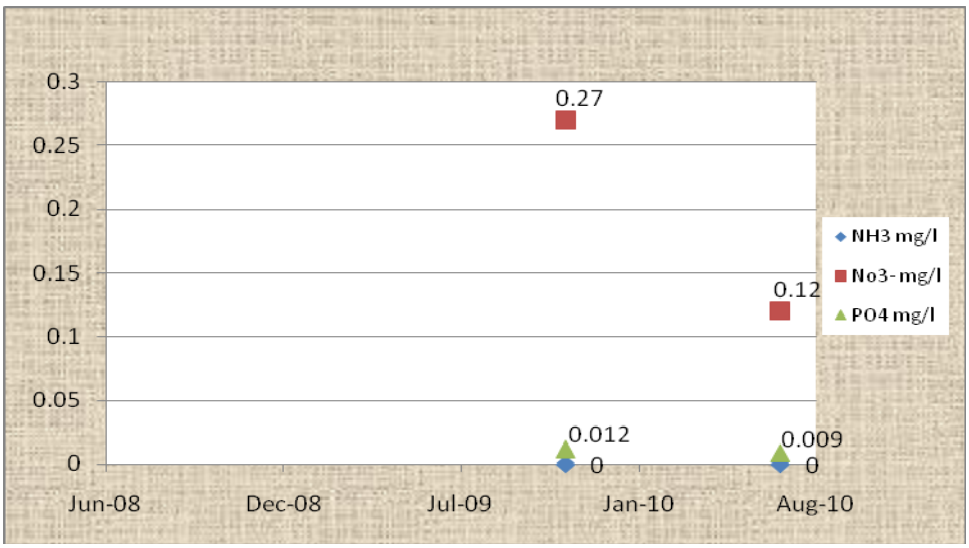


Figure 9: Ammonia, nitrates and phosphates flacuations at Tentkop Spruit River Pass (by Talbot & Talbot Laboratories). Water chemistry data indicate compliance with Target Water Quality Range (DWA 2008)

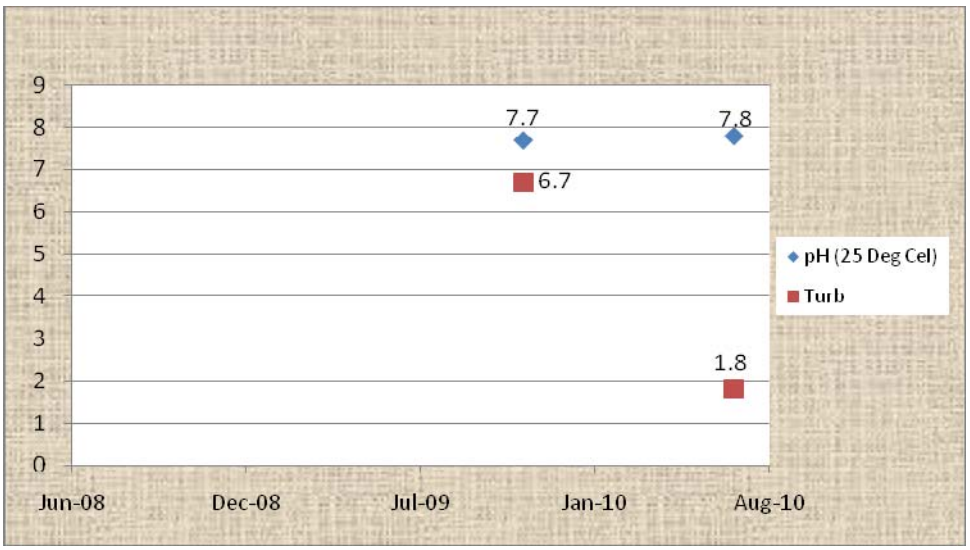


Figure 10: pH and turbidity flacuations at Tentkop Spruit River Pass (by Talbot & Talbot Laboratories). pHtrends indicates compliance with Target Water Quality Range while turbidity has exceeded the the target range for domestic use (DWA 2008)

Macro-Invertebrates (Responses)

Site three: Tentkop Spruit River Pass

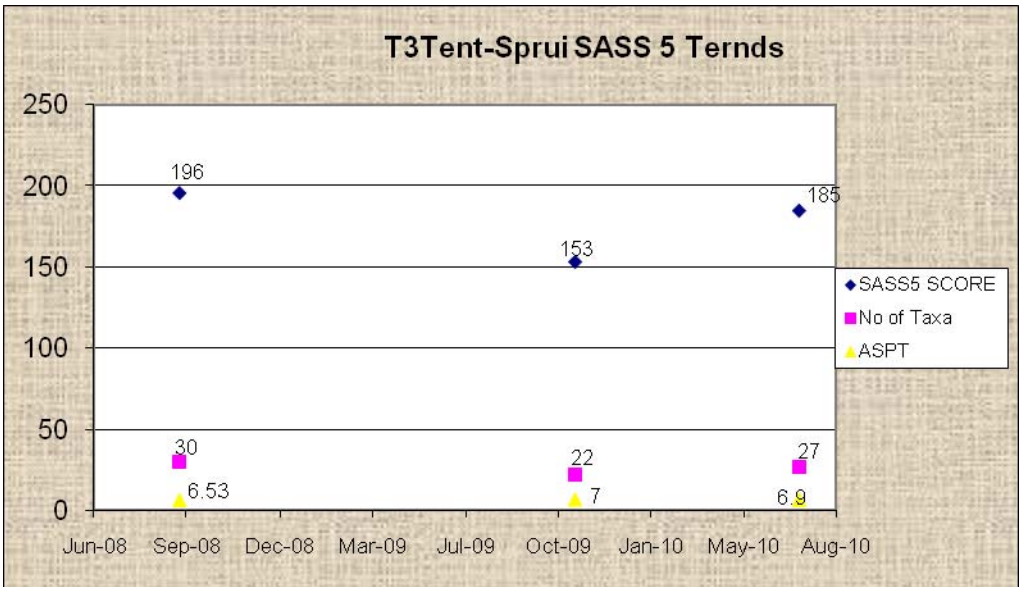


Figure 11: SASS 5 trends, start period September 2008 to July 2010. ASPT fluctuations remains between good and natural conditions with an average ASPT of 6.81. Trends also indicate a steady increase of species population and diversity. Landuse coverage consists of commercial forestation (BG Bison) and commercial farming activities. Therefore human impacts are identified at catchment scale but with little negative effect to water quality conditions.

Fish Assessment (Responses)

Site three: Tentkop Spruit River Pass

Nine alien fish species (*Oncorhychus mykiss*) were caught in this site. The present Ecological status (FAI) is **E.** Poor class relates more to biological pollution, lack of species diversity and not water quality.

Site four:

Geomorphology: Driver component (Site one, upper reaches)

Site name: Mzimvubu at Joan's bridge

Plate 4: Mzimvubu River at Joan's bridge

Altitude: masl.

The site is located at a reach confined on one side. It is a single thread, mixed with both the bedrock and alluvium and a pool-riffle system. The channel is rich in morphological units (about 67% present), both for the bedrock and alluvium. Recent sedimentation has taken place immediately below the bridge, probably due to impacts of invasive alien black wattle and a deep gully formed upstream as a result of developed headcuts created by animal trampling. Sediment sampling was done at a site (never done during spring survey). The GAI model reveals that the river at a site is at A/B in terms of geomorphology.

Water Quality Trends on a river reach scale (2nd driver)

Site four: Mzimvubu at Joan's bridge

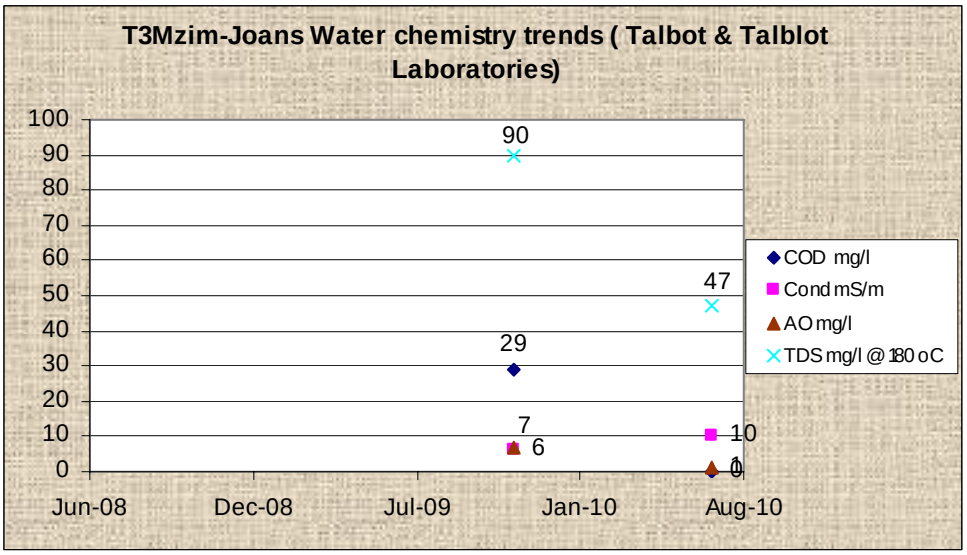


Figure 12: COD, Conductivity, Oxygen absorbed and Total dissolved solids flacuations at Mzimvubu River Joan's Bridge (by Talbot & Talbot Laboratories). Water chemistry data indicate compliance with Target Water Quality Range (DWA 2008)

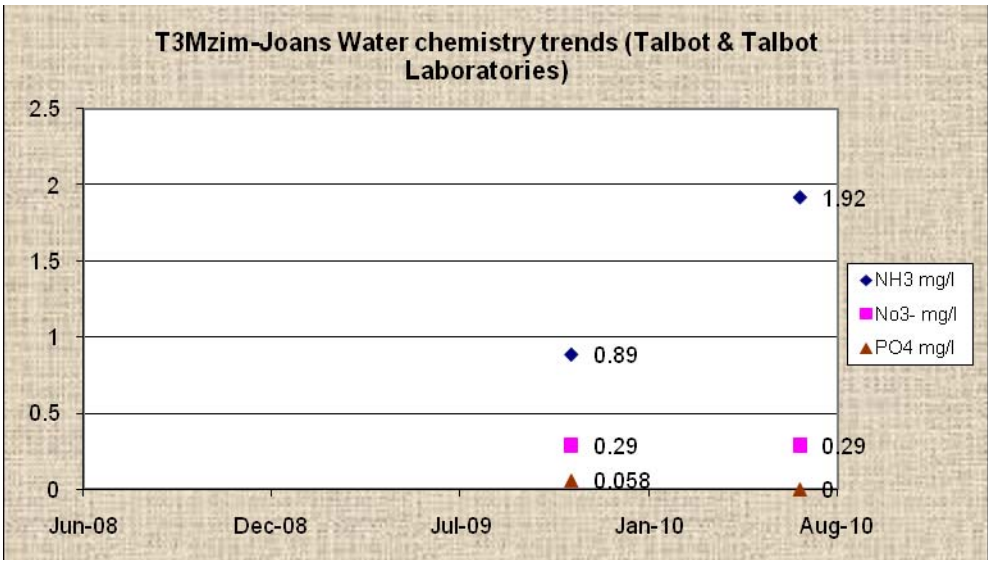


Figure 13: Ammonia, nitrates and phosphates flacuations at Mzimvubu Joan's Bridge (by Talbot & Talbot Laboratories). In terms of domestic water use, water chemistry data indicate compliance with Target Water Quality Range (DWA 2008), but for aquatic ecosysyem ammonia exceeded the Target Water Qaulity Range. Sheet flows during rainy season could lead to leaching of nitrogen base organic/inorganic matter (from live stock feases and fertilizers). Inspite of the surrounding landuse activity, this river reach demonstrates strong buffering and dilution capacity.

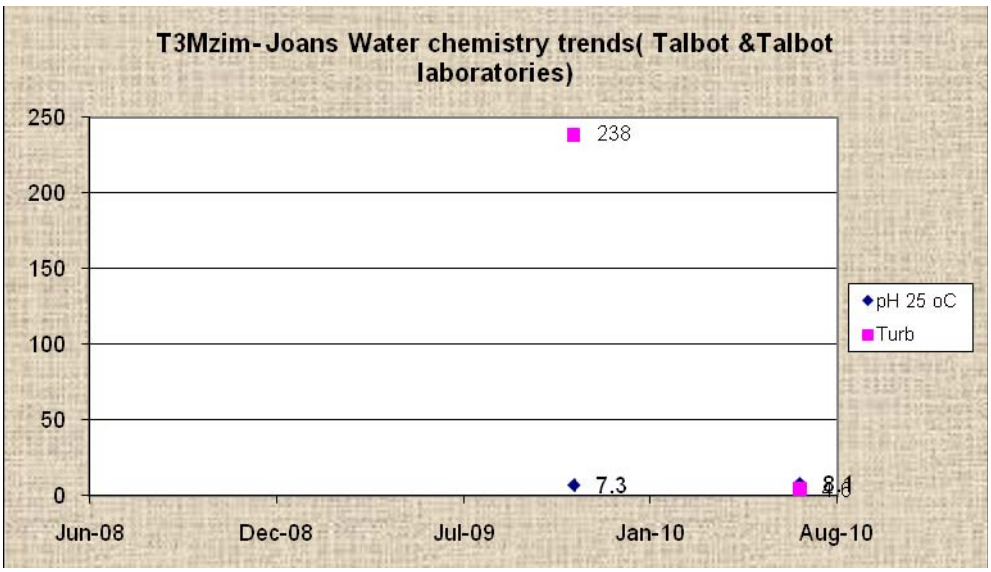


Figure 14: pH and turbidity flacuations at Tina head waters (by Talbot & Talbot Laboratories). pH trends indicates compliance with Target Water Quality Range while turbidity has exceeded the the target range for domestic use (DWA 2008). Excessive siltation during rainy season could due to unfavourable geology/ soils, poor land use practicses.

<u>Macro-Invertebrates</u> (Responses)

Site four: Mzimvubu at Joan's bridge

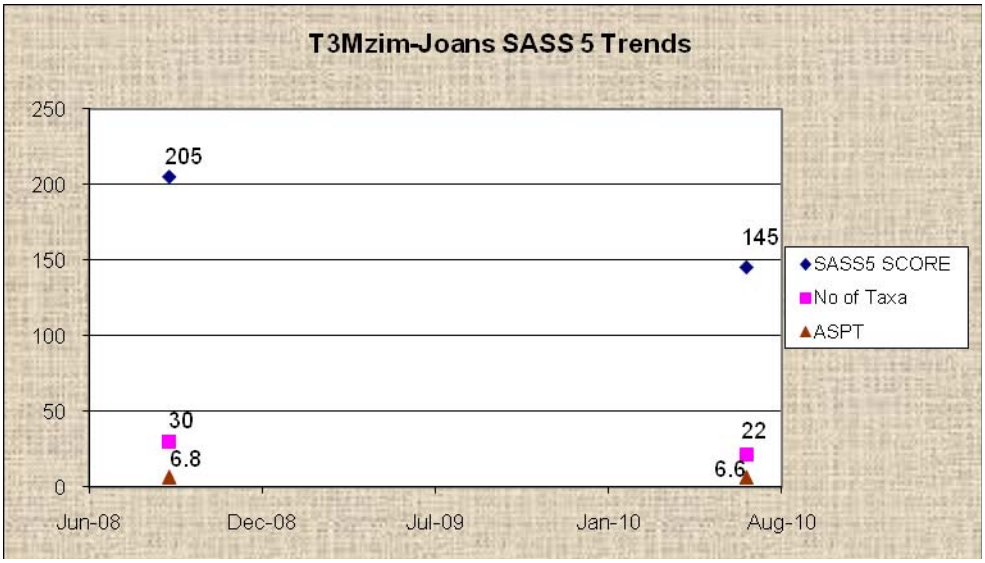


Figure 15: SASS 5 trends, start period September 2008 to July 2010. ASPT remains almost constant at good to near natural water quality conditions with an average ASPT of 6.7. Trends also indicate a decrease species population and diversity. Landuse predominantly consists of commercial farming activities. Therefore human impacts are identified at catchment scale but with little negative effect to water quality conditions.

Also note that SASS 5 sampling was not done in November 2009 due to high water flows.

Fish Assessment (Responses)

Site four: Mzimvubu at Joan's bridge

Seven alien fish species (*Oncorhychus mykiss*) were caught in this site. The present Ecological status (FAI) is **E.** Low ecological class is mainly due to biological pollution, high silt in water, high concentration of ammonia.

Site Five:

Geomorphology: Driver component (middle reaches)

Site name: Kinira River at Mabua

Plate 4: Kinira River at Mabua

Altitude: **1492 masl.**

The site is also located at a reach confined on one side. It is a single thread pool-riffle system in an active meandering state. Overflow channel was observed, suggesting increased flooding combined with vegetation removal. The sources of sediment at a reach scale are gullies and sheet erosion on the hillslope, accompanied by presence of alien *Acacia meansii* species. Comparing with previous survey (2009), a lot of boulders had been exposed, suggesting recent removal of fines (mainly sand). Figure 2 below shows the comparison between the variability of sediments found in the channel during 2009 spring survey and recent 2010 winter survey.

The Geomorphological Assessment Index (GAI) model shows that the site is at **B/C** class in terms of its present ecological state, and therefore negative impacts of catchment processes on the river ecosystem.

<u>Water Quality Trends on a river reach scale</u> (2nd driver)

Site Five, Kinira River at Mabua

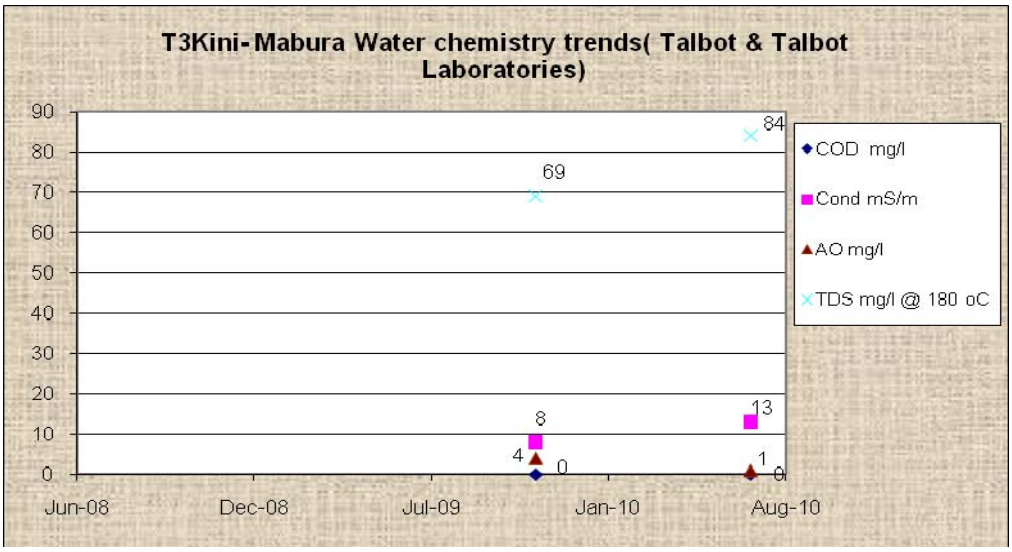


Figure 16: COD, Conductivity, Oxygen absorbed and Total dissolved solids flacuations at Kinira River at Mabua (by Talbot & Talbot Laboratories). Water chemistry data indicate compliance with Target Water Quality Range (DWA 2008)

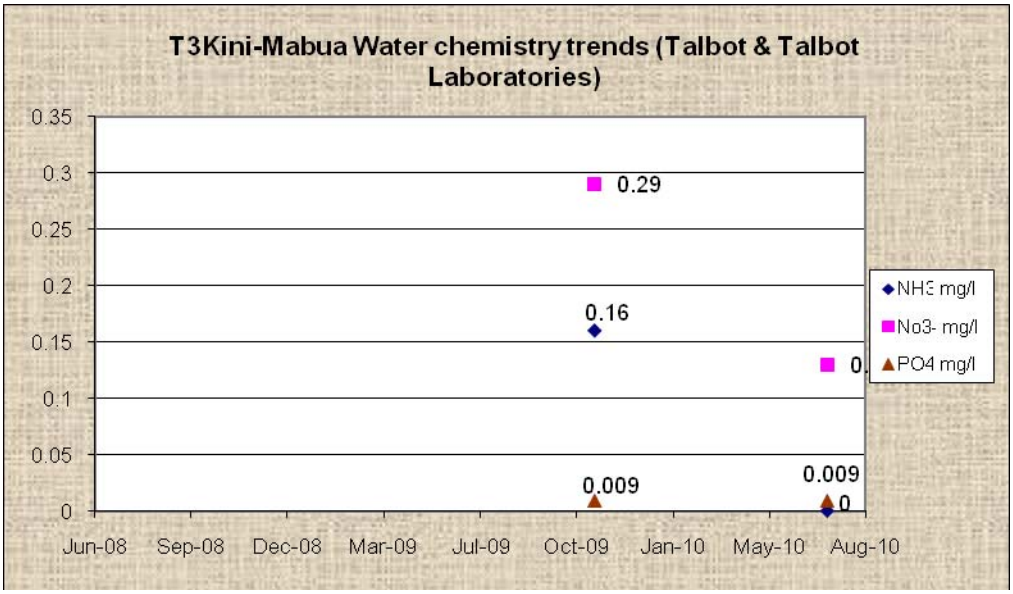


Figure 17: Ammonia, nitrates and phosphates flacuations at Kinira River at Mabua (by Talbot & Talbot Laboratories). In terms of domestic water use, water chemistry data indicate compliance with Target Water Quality Range (DWA 2008)

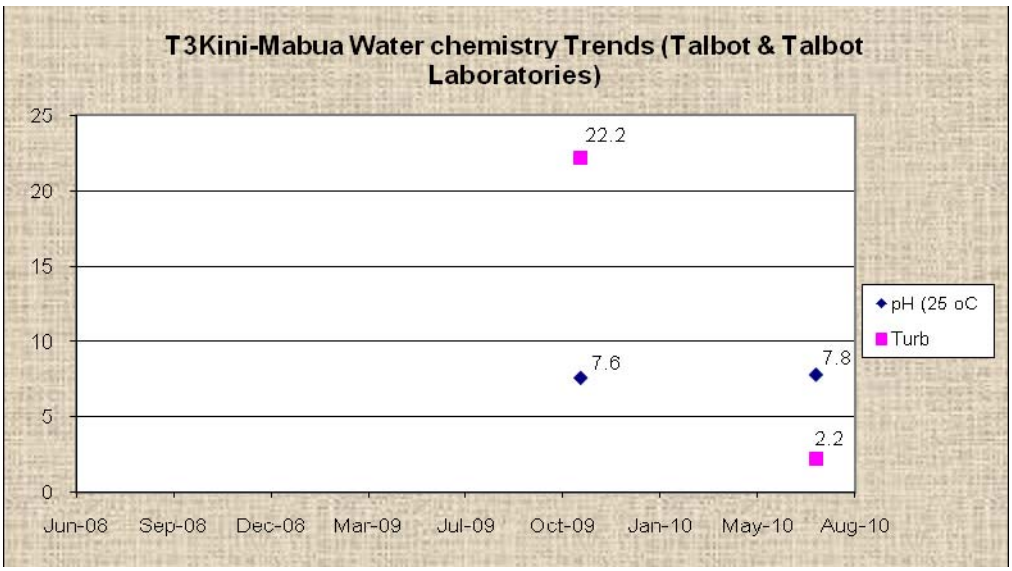


Figure 18: pH and turbidity flacuations at Kinira River at Mabua (by Talbot & Talbot Laboratories). pH trends indicates compliance with Target Water Quality Range while turbidity has exceeded the the target range for domestic use (DWA 2008). Turbidty increase was due to recent high rain fall that lead increased sediment input to the river channel..

<u>Macro-Invertebrates</u> (Responses)

Site Five: Kinira River at Mabua

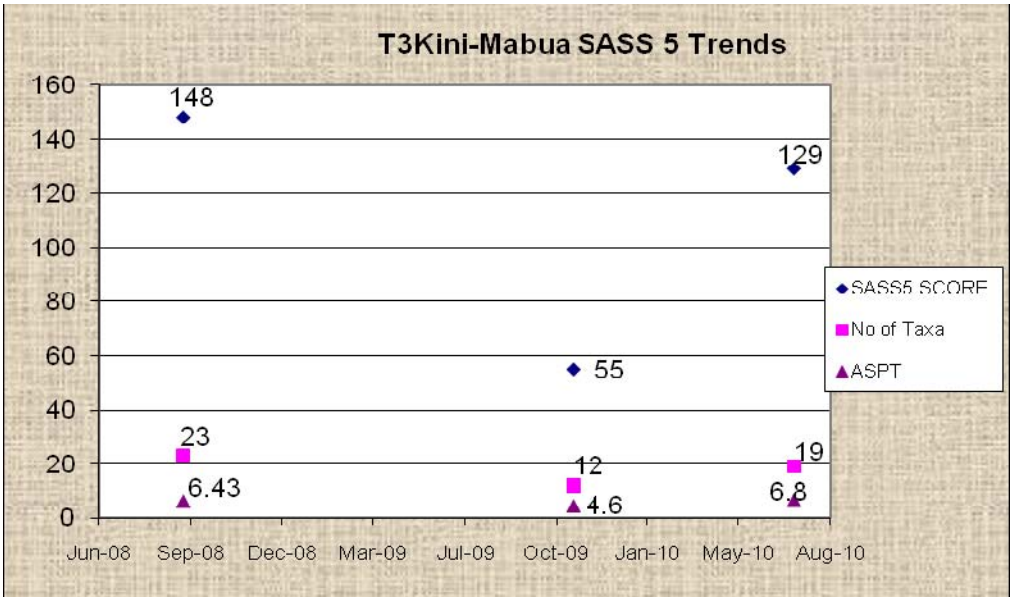


Figure 18: SASS 5 trends, start period September 2008 to July 2010.ASPT Trends or fluctuations indicates the river reach is predominantly in a good water quality condition, with one exception during November 2009, when the ASPT dropped to 4.6 (Poor conditions). SASS 5 sampling was done immediately after a fairly good rainfall, therefore

low ASPT does not necessarily reflects deteriorating water quality. High flows with high energy would dislodge some macro invertebrates and this forms part of a normal breeding circle, therefore sensitive species might be transported further down catchment. Average ASPT is 5.94 (Fair towards Good).

Fish assessment (Responses)

Site Five: Kinira River at Mabua

Twenty four fish species (*Oncorhychus mykiss*) were caught during w spring 2008 and one *(Micropterus salmoides)* in winter 2008 this site, all species were alien. The present Ecological status (FAI) is **E.**

Site Six:

Geomorphology (GAI): Co-driver component

Site name: Mzintlava River at Franklin Vlei

Plate 6: Mzintlava at Franklin Vlei

Altitude: **1481 masl.**

The site is located where alternating bedrock cliffs are opposite moderate slopes hence irregular shapes on alluvium found on the river bed and river banks. The river bed material is boulder-dominated. No significant changes were observed at a site. The site has about 39% of the morphological units. The GAI model suggests that the river at a site is at **B**, which has few modifications in terms of its fluvial geomorphology.

Water Quality trends: (Co-driver component)

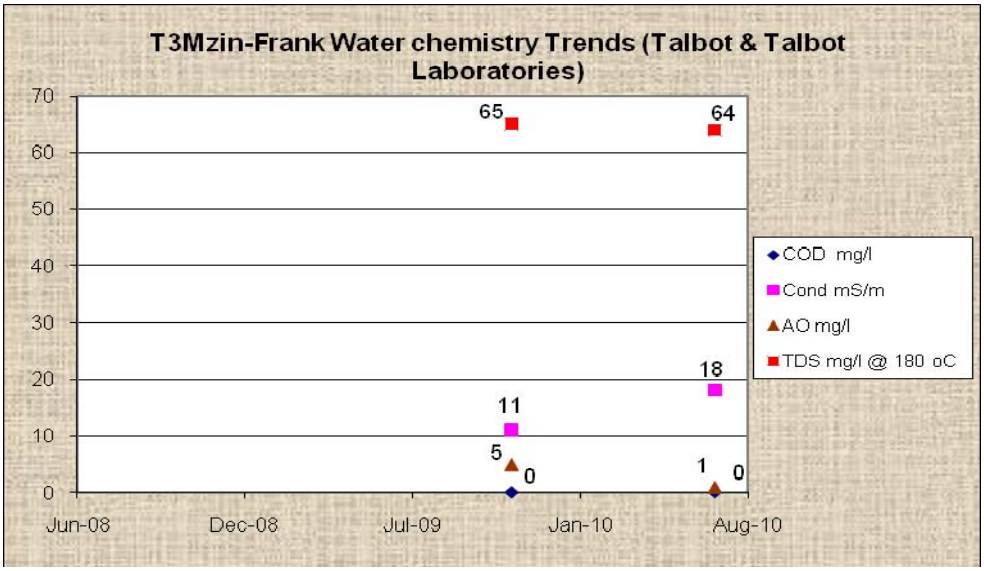


Figure 20: COD, Conductivity, Oxygen absorbed and Total dissolved solids flacuations at Mzintlava River at Franklin Vlei (by Talbot & Talbot Laboratories). Water chemistry data indicate compliance with Target Water Quality Range (DWA 2008).

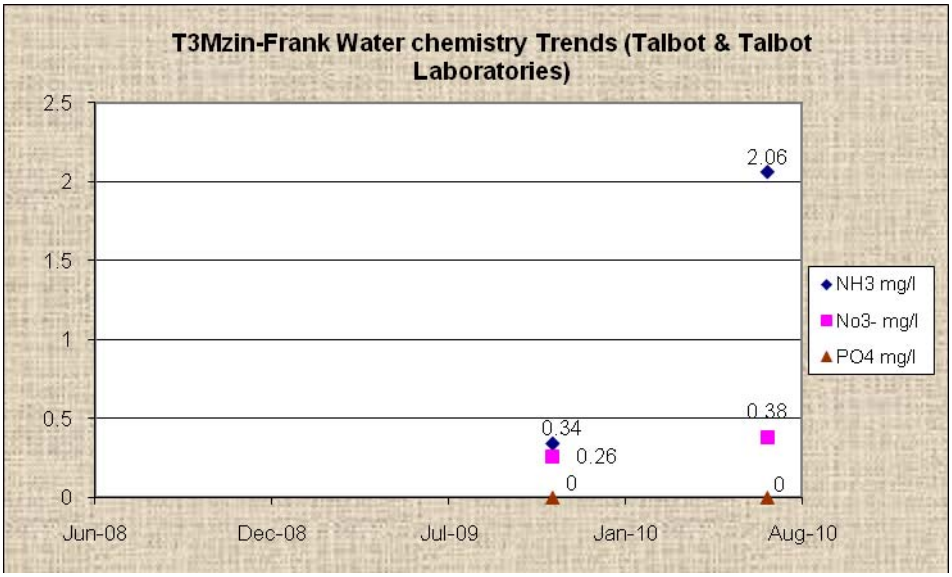


Figure 21: Ammonia, nitrates and phosphates flacuations at Mzintlava River at Franklin Vlei (by Talbot & Talbot Laboratories). In terms of domestic water use, water chemistry data indicate mostly compliance with Target Water Quality Range (DWA 2008) except for Ammonia that has doubled in concentration is caused by loss of dilution capacity as a result reduced water flows (base flows) in winter. This could also be atributed by extensive upstream industrial activities at the Ramsar wetland (Franklin Vlei). Commercial agricultural activities (cattle and crop plaughing) also dominates this catchment, hence anthrogenic impacts are both point source and diffused pollution related. The Ramsar wetland assimilate most of the impact though.

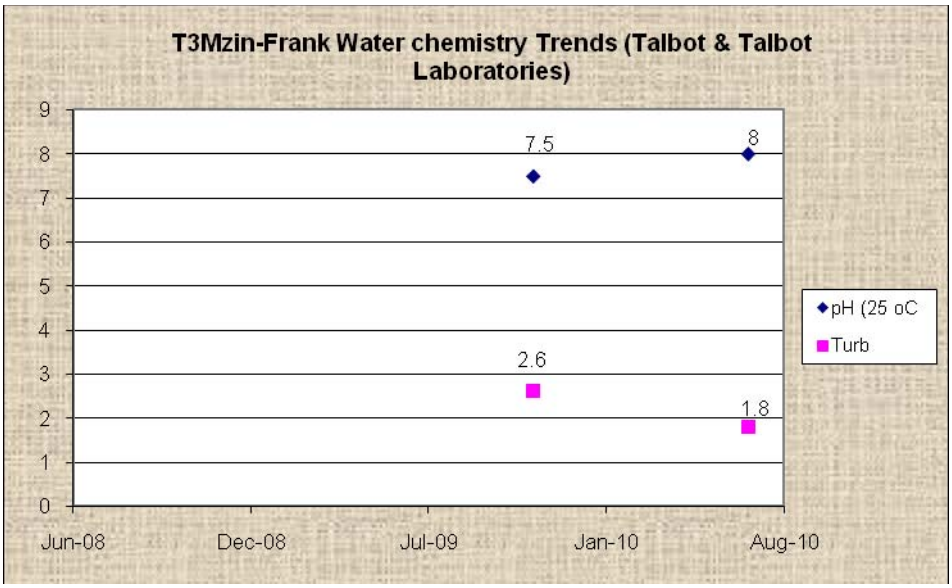


Figure 22: pH and turbidity flacuations at Mzintlava River at Franklin Vlei (by Talbot & Talbot Laboratories). pH trends indicates compliance with Target Water Quality Range while turbidity has slightlyexceeded the the target range for domestic use (DWA 2008). Observed turbidty was very minimal in this river reach, this could be due to favourable geological formation and the presence of a huge wetland (Ramsar) upstream.

<u>Macro-Invertebrates trends (SASS 5):</u> (Response component)

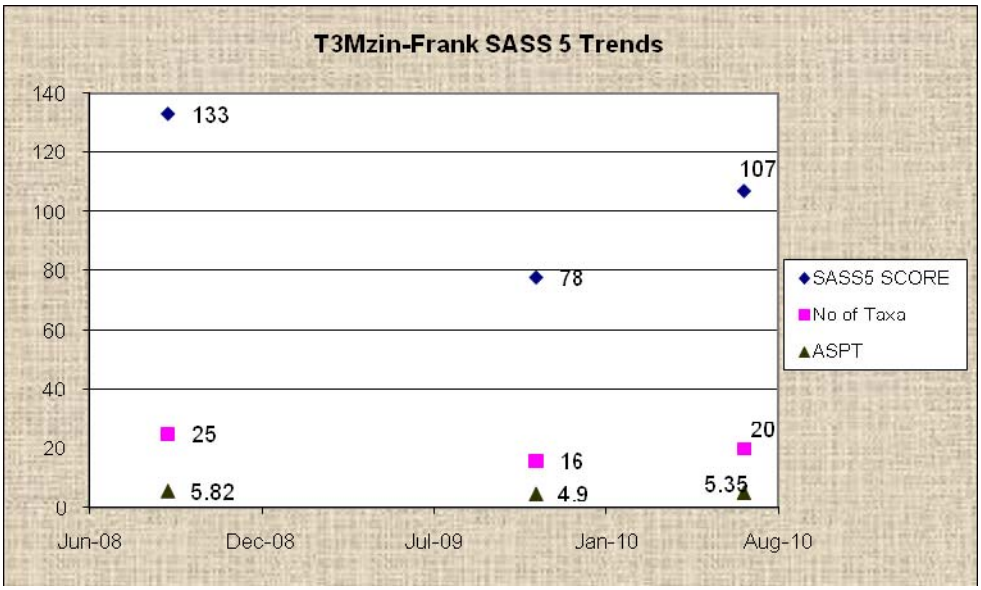


Figure 23: SASS 5 trends, start period September 2008 to July 2010.ASPT Trends or fluctuations indicates the river reach is predominantly in a fair water quality condition, with one exception during November 2009, when the ASPT dropped to 4.9 (Poor/fair conditions). SASS 5 sampling was done immediately after a fairly good rainfall; therefore low ASPT does not necessarily reflect deteriorating water quality. High flows with high energy would dislodge some macro invertebrates, therefore sensitive species might be

transported further down catchment. Average ASPT is 5.4 (Fair water quality conditions). So far Mzintlava at Franklin Vlei is the most negatively impacted Biomonitoring site in the Mzimvubu River catchment. Although there is a huge wetland (Ramsar status) in the upper reaches of Mzintlava, there is also a huge Saw Mill, commercial agricultural activities and there is little or no rural development in this sub catchment.

Fish assessment: (Response component)

Four *Micropterus Salmoides* fish species were caught, all alien. Present Ecological Status is **E**.

Site seven:

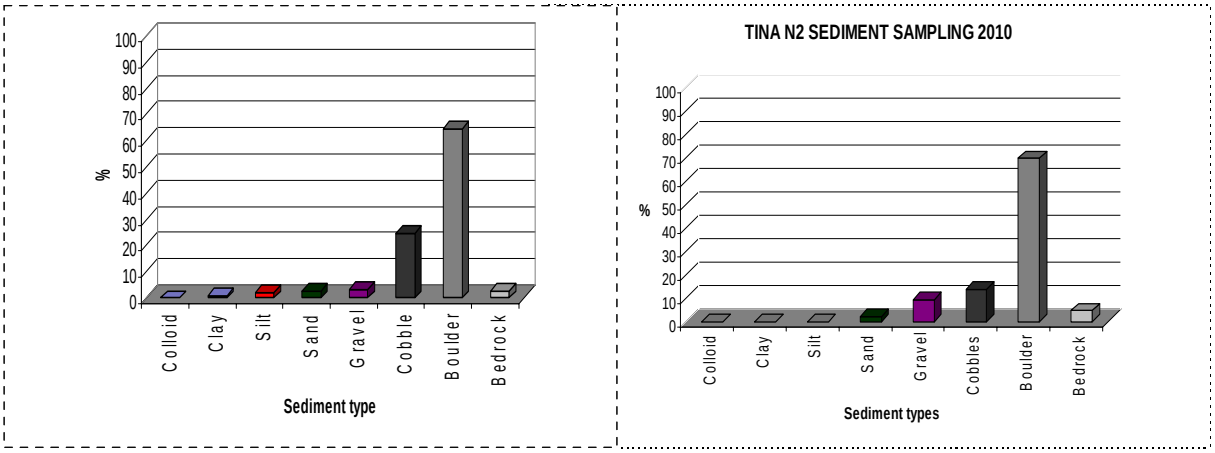
Geomorphology: Driver component (middle reaches)

Site name: Mzimvubu River at Springfontein Farm

Plate 7: Mzimvubu River at Springfontein Farm

Altitude: 1423 masl.

The site is also located at a reach where the floodplain is confined on one side. This means that the eroded sediment from the hillslope can either be trapped alternatively at a floodplain either at the right or the left side of the river, but never both. It is a single thread, alluvial and a pool-riffle system. This is where the river is experiencing a sinuous situation, with erosion of the river bank alternating with deposition of sediment on either left or right bank. Comparing with the previous survey, cobbles have become dominant over boulders, as well as additional proportions of fines. Therefore in the mean time there has been minimal increased sedimentation along the segment, probably due to plowing of fields on the hillslope, together with decreased flows. The morphological units on a river constitute about 33.5%. The figure below shows sediment proportions of a site.



A: Spring survey 2009 **B: Winter survey 2010**

Figure . Comparing percentage distribution of sediment types of Tina River at N2 site (some removal of silt occurred).

The GAI model demonstrates that the Present Geomorphological State of the river at a site is at B class.

Water Quality trends: (Co-driver component)

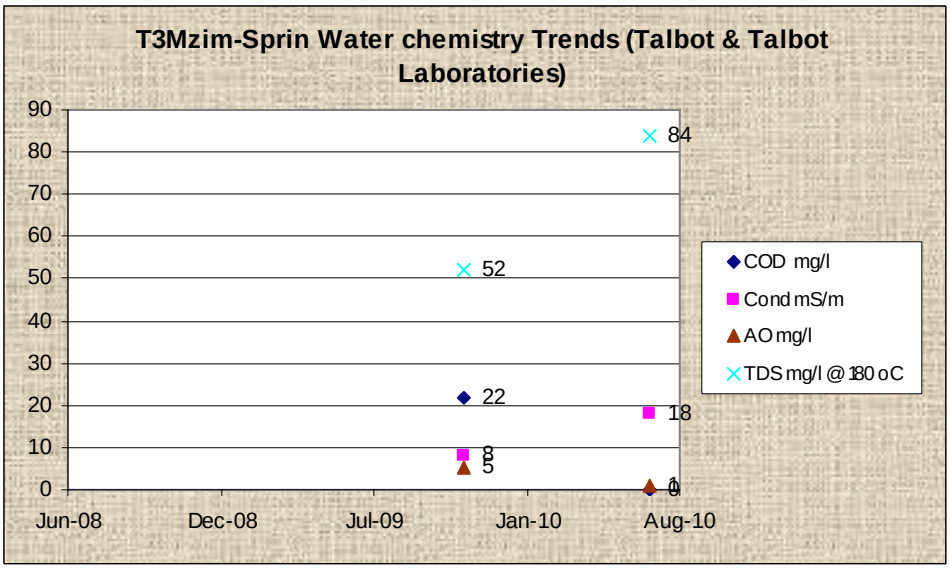


Figure 24: COD, Conductivity, Oxygen absorbed and Total dissolved solids flacuations at Mzimvubu River at Springfontein Farm (by Talbot & Talbot Laboratories). Water chemistry data indicate compliance with Target Water Quality Range (DWA 2008).

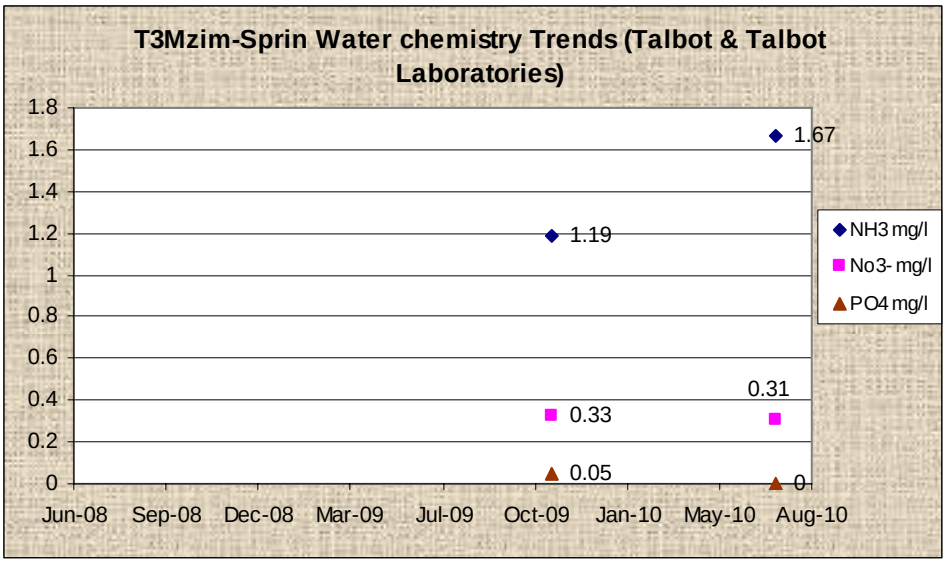


Figure 25: Ammonia, nitrates and phosphates flacuations at Mzimvubu River at Springfontein Farm (by Talbot & Talbot Laboratories). In terms of domestic water use, nitrates and phoshates indicate compliance with Target Water Quality Range (DWA 2008), but ammonia is beginning to shows signs of stress (non compliance). Immediate landuse include commercial agricultural activities (mixed livestock breeding and irrigated pastures). The site is also a cattle drinking point. Algae and Daphea (signs of water pollution was observed in this site. The water is still fit for agricultural activities, but a consideration for the rest of the downstream users needs to taken into consideration.

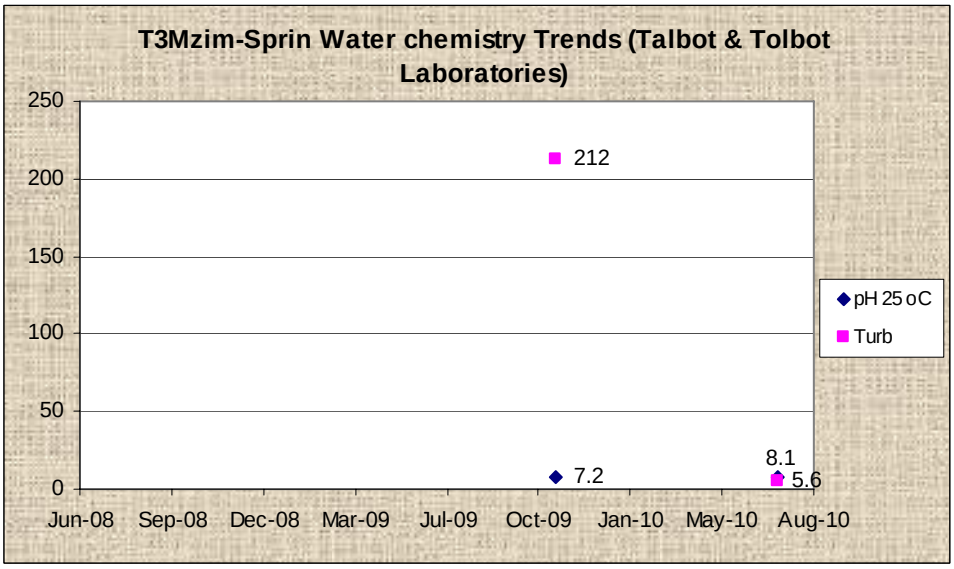


Figure 26: pH and turbidity flacuations at Mzimvubu River at Springfontein farm (by Talbot & Talbot Laboratories). pH trends indicates compliance with Target Water Quality Range while turbidity has greatly exceeded the the target range for domestic use (DWA 2008). Sampling was done immediately after heavy rains and because of geology and soils here, Mzimvubu River is naturally silted and does not respond well to rainfall and

high water flows. The siltation problem is greatly reduced during low (base) flows in winter as the energy and scouring potential of the river water is greatly reduced.

<u>Macro-Invertebrates trends (SASS 5):</u> (Response component)

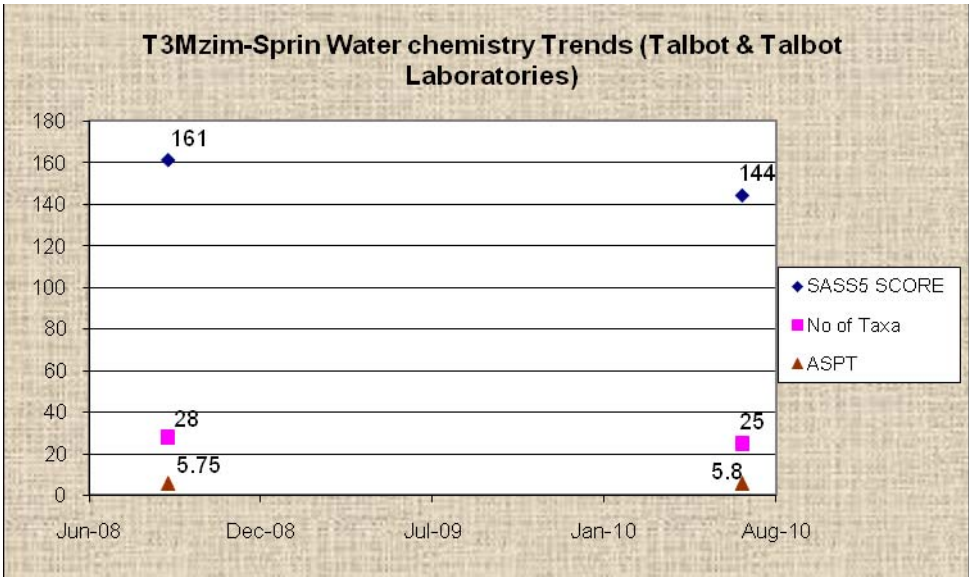


Figure 27: SASS 5 trends, start period September 2008 to July 2010.Trends indicates fluctuations between fair conditions, good and lately slightly poor. But on average ASPT is 5.8 (Fair/Good). Anthropogenic impacts in the form of commercial agricultural activities can be observed as most sensitive species are generally absent throughout the seasons. Unfavorable geology and soils (high siltation) at a catchment scale could also not be ruled out.

Fish assessment: (Response component)

No fish was caught here.

Site Eight:

Geomorphology: Driver component (middle reaches)

Site name: Tina River at Tsolobeng

Plate 8: Tina River at Tsolobeng

Altitude: 1364 masl.

This site is situated at a confined valley flood plain. The site is in a single thread, pool-rapid and mixed with bedrock and cobbles; the latter being dominant. A lot of sheet erosion and deep gullies as well as grazing are major catchment processes occurring on the adjacent hillslopes. No embeddings could be noticed during the survey, as compared to that of 2009 spring assessment and therefore most of the fine material has been removed. About 71% of morphological units were observed at a site of which these comprise diversity of habitat for aquatic flora and fauna.

The GAI model shows that the river at a site is at **B/C** class; a situation whereby the geomorphic changes have been largely modified.

Water Quality trends: (Co-driver component)

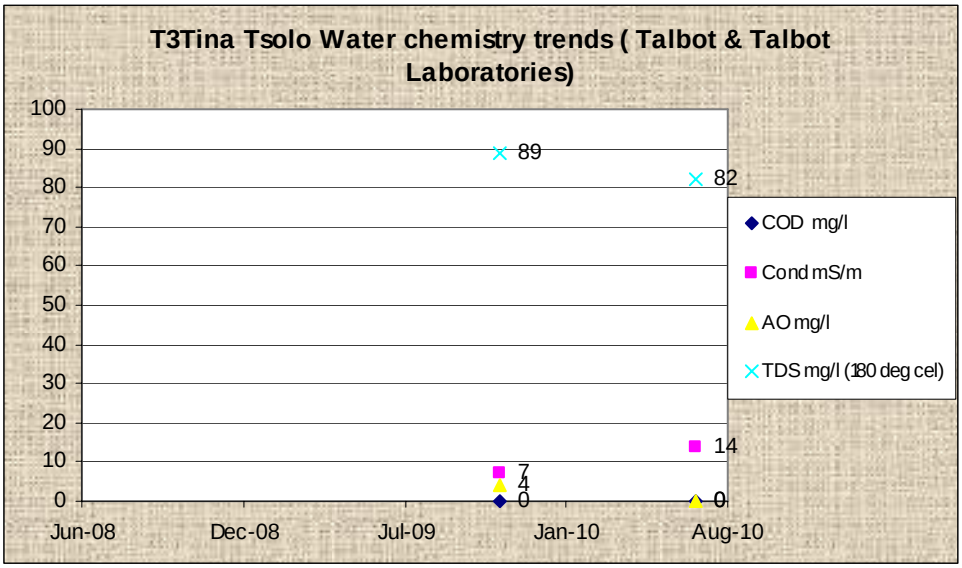


Figure 28: COD, Conductivity, Oxygen absorbed and Total dissolved solids flacuations at Tina River Tsolobeng (by Talbot & Talbot Laboratories). Water chemistry data indicate compliance with Target Water Quality Range (DWA 2008).

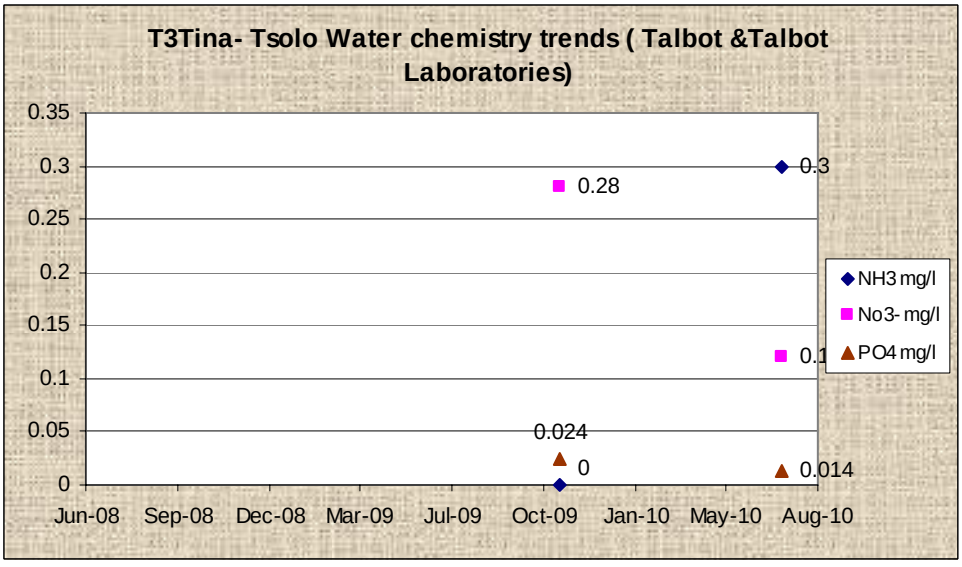


Figure 29: Ammonia, nitrates and phosphates flacuations at Tina River at Tsolobeng (by Talbot & Talbot Laboratories). In terms of domestic water use, water chemistry data indicate compliance with Target Water Quality Range (DWA 2008). A slimy substance floating in the water (also trapped between rocks in the river bed) was observed in this site. A new water treatment works about 700 metres upstream is in its final stages of construction (not yet operational). The rest of the surrounding and upstream catchment is predominantly rural, therefore the slimy substance could only be associated with the water treatment works.

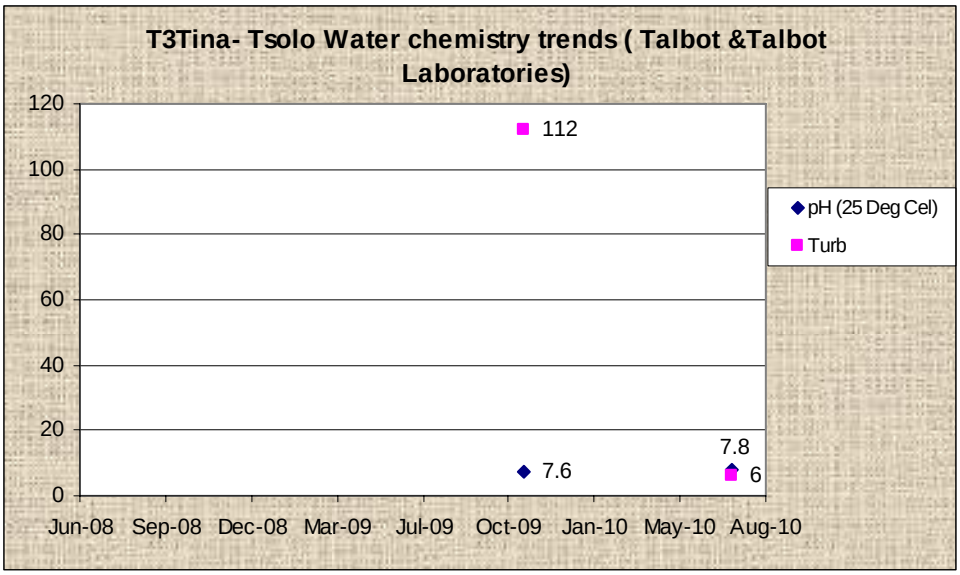


Figure 30: pH and turbidity flacuations at Tina River at Tsolobeng (by Talbot & Talbot Laboratories). pH trends indicates compliance with Target Water Quality Range while turbidity has greatly exceeded the the target range for domestic use (DWA 2008). Sampling was done immediately after heavy rains and because of geology and soils might have excasabated the situation, sitation is greatly reduced during low (base) flows.

<u>Macro-Invertebrates trends (SASS 5):</u> (Response component)

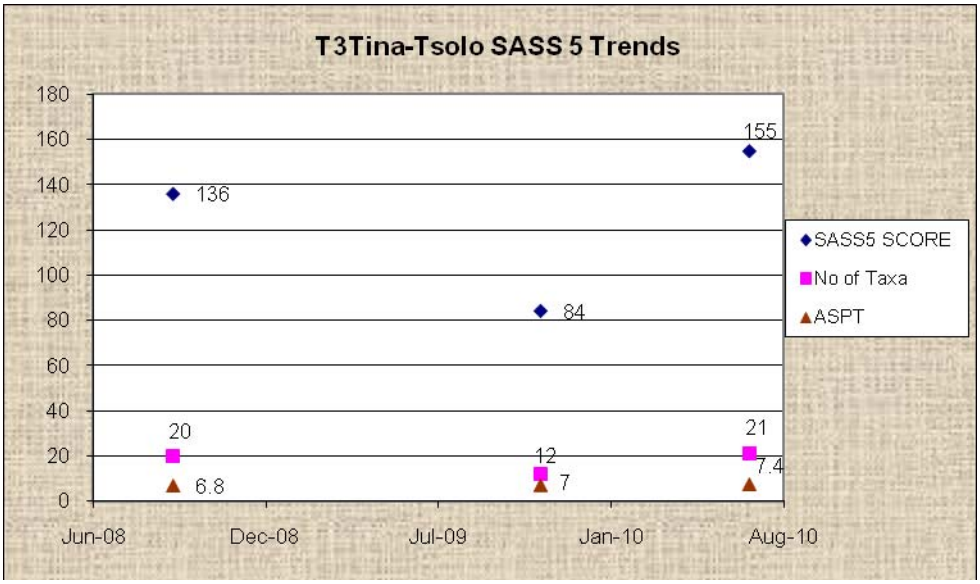


Figure 31: SASS 5 trends, start period September 2008 to July 2010.Trends indicates fluctuations water quality conditions are improving from good to mostly natural conditions ASPT is 7.07 (**Natural**).

Fish assessment: (Response component):

One alien fish specie (*Oncorhychus mykiss*) was caught here. Present Ecological Status is **E**

Site Nine:

Geomorphology: Driver component (middle reaches)

Site name: Gatberg River at Forestation

Plate 9: Gatberg River at Forestation

Altitude: **1356** masl.

The site is located in a confined valley floodplain. It is a single thread, sinuous, pool-riffle, flat bed system dominated by cobbles as a substrate. Two road culverts have inhibitory effect on upstream-downstream connectivity of the river system at a site. Due to this, the GAI index reveals that the site is at **B/C** class in terms of its PES.

<u>Water Quality trends:</u> (Co-driver component)

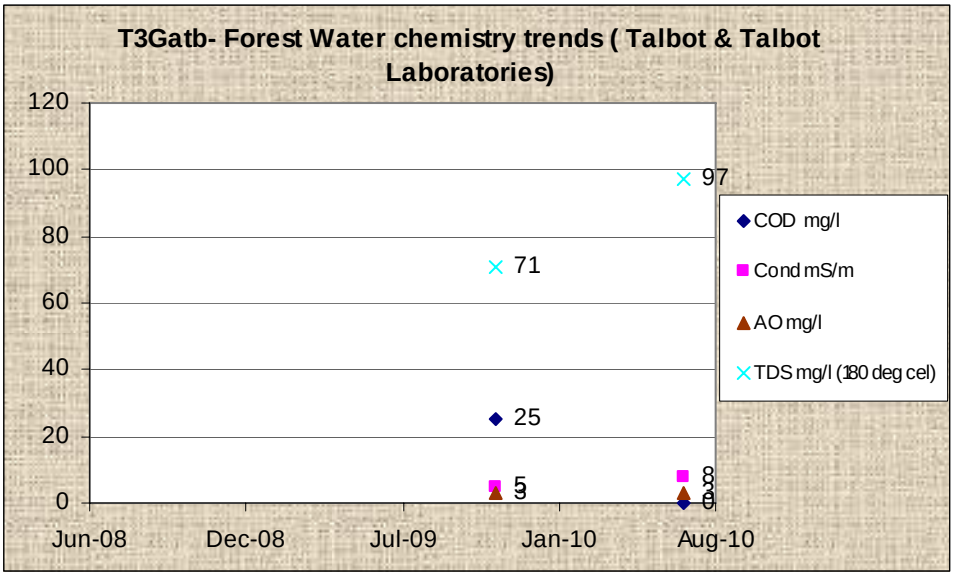


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Figure 32: COD, Conductivity, Oxygen absorbed and Total dissolved solids flacuations at Gatberg River Forest (by Talbot & Talbot Laboratories). Water chemistry data indicate compliance with Target Water Quality Range (DWA 2008).

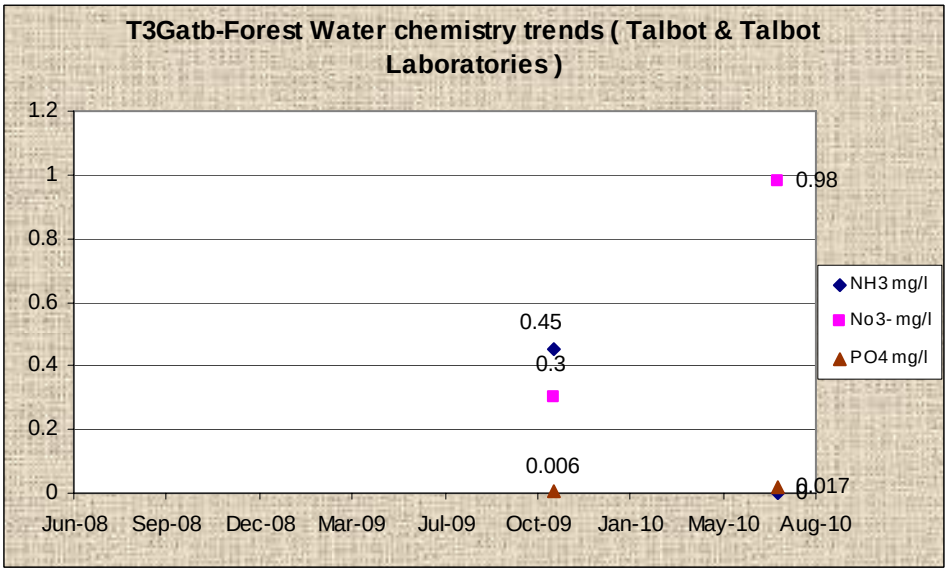


Figure 33: Ammonia, nitrates and phosphates flacuations at Gatberg River Forest (by Talbot & Talbot Laboratories). In terms of domestic water use, water chemistry data indicate compliance with Target Water Quality Range (DWA 2008). Ammona concentrations are almost problamatic during base flows.

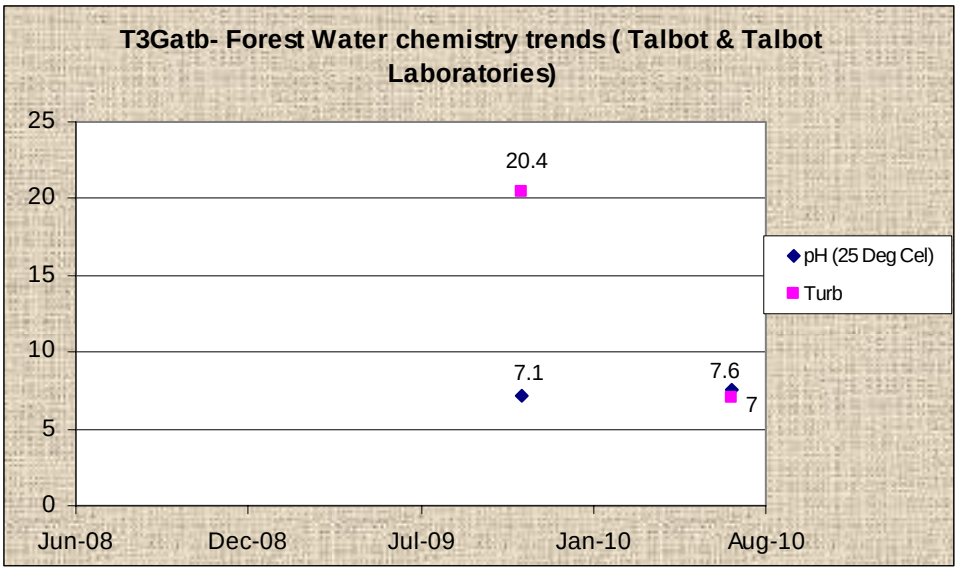


Figure 34: pH and turbidity flacuations at Gatberg River Forest (by Talbot & Talbot Laboratories). pH trends indicates compliance with Target Water Quality Range while turbidity has exceeded the the target range for domestic use (DWA 2008). This increase is fairly normal after heavy rains. However turbidity levels drop substantially during base flow conditions. Compared to the rest of the Mzimvubu River catchment, siltation is occuring far less.

<u>Macro-Invertebrates trends (SASS 5):</u> (Response component)

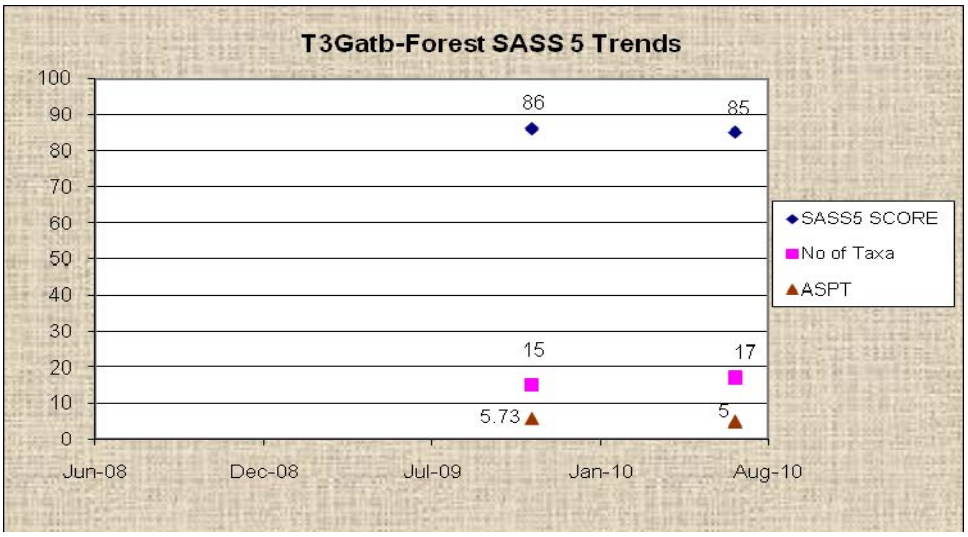


Figure 35: SASS 5 trends, start period September 2008 to July 2010.ASPT Trends indicates a slight drop in water quality from fair/good down to fair. The average ASPT remains at fair conditions (5.4). Species population remains almost the same while species diversity shows a slight increase. More of tolerant species have been recorded. This river reach runs through heavy commercial forestation and agricultural activities.

Fish assessment: (Response component):

This is a new site, therefore no fish sampling took place here so far.

Site Ten:

Geomorphology: Driver component (middle reaches)

Site name: Kinira River at Drift

Plate 10: Kinira River at Drift

Altitude: **1350** masl.

This site is situated at a confined valley flood plain. The site is at a single thread, sinuous, pool-riffle system dominated by sand. It is rich in morphological units about 83%, which means that it is naturally a 'home' for diversity of species. The channel is almost braided upstream of the bridge due to a lot of sedimentation. Scouring is also evident immediately below the bridge that is blocked by debris. Active erosion on the hillslope could be observed, and this erosion is accelerated by *Acacia meansii* invasion. Because the site is dominated by bedrock and sand deposits only, no sediment samples taken. The GAI model puts the site at a **B/C** category, with moderate modifications.

Water Quality trends: **(Co-driver component)**

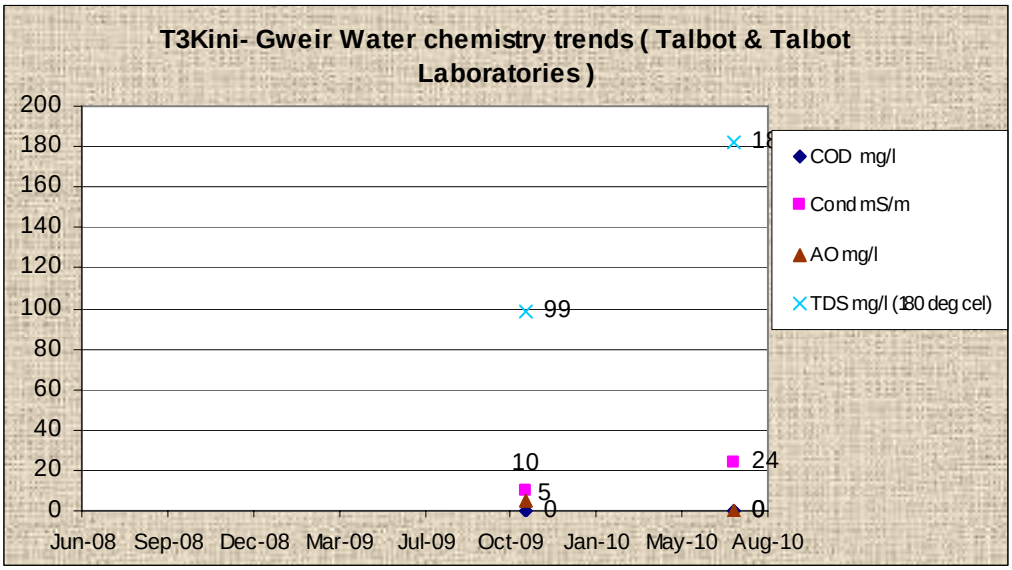


Figure 36: COD, Conductivity, Oxygen absorbed and Total dissolved solids flacuations at Kinira River at Drift (by Talbot & Talbot Laboratories). Water chemistry data indicate compliance with Target Water Quality Range (DWA 2008).

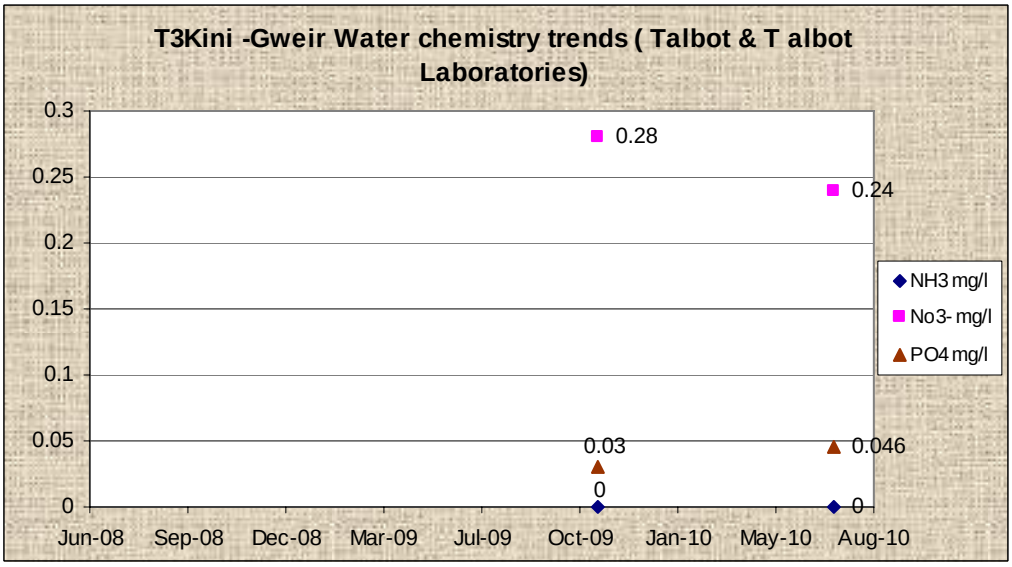


Figure 37: Ammonia, nitrates and phosphates flacuations at Kinira River at Drift (by Talbot & Talbot Laboratories). In terms of domestic water use, water chemistry data indicate compliance with Target Water Quality Range (DWA 2008)

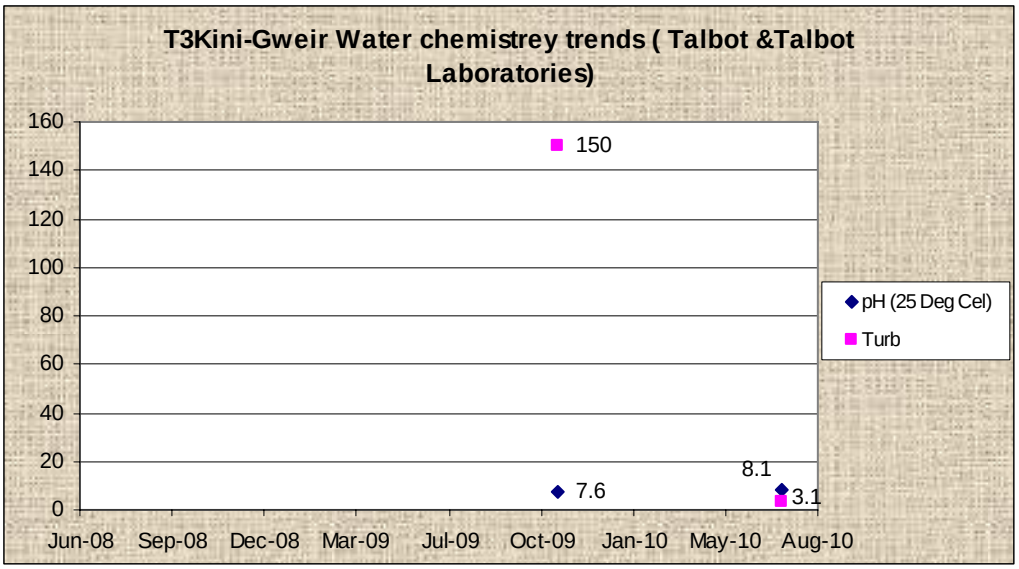


Figure 38: pH and turbidity flacuations at Gatberg River Forest (by Talbot & Talbot Laboratories). pH trends indicates compliance with Target Water Quality Range while turbidity has exceeded the the target range for domestic use (DWA 2008). Turbidity increase was also due to the sandy soils of Kinira River at a catchment scale.

<u>Macro-Invertebrates trends (SASS 5):</u> (Response component)

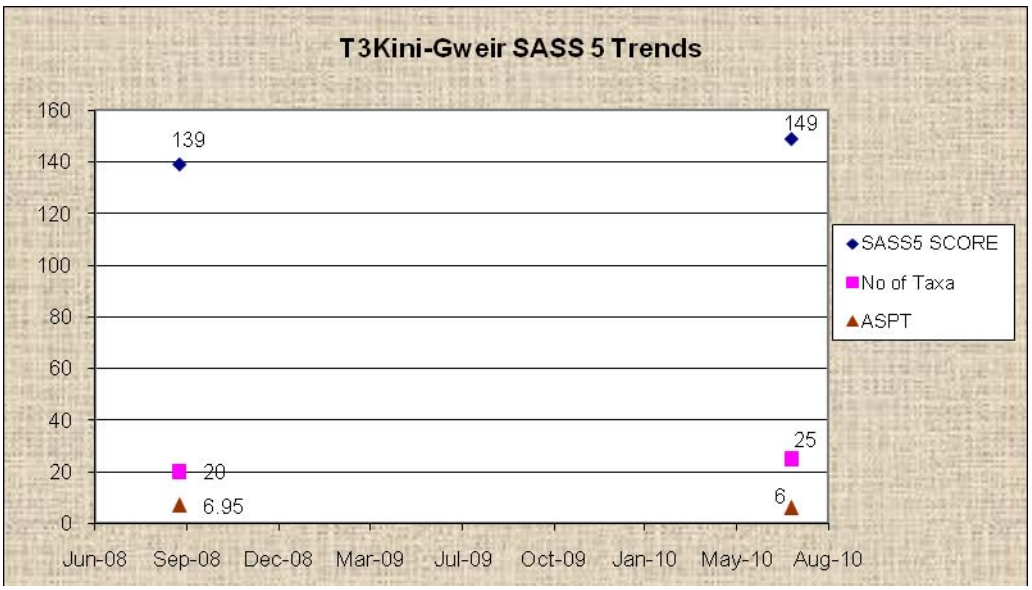


Figure 39: SASS 5 trends, start period march 2008 to July 2010.Trends indicates fluctuations from near natural to down to good conditions and an average ASPT of 6.5 (Good condition).

Fish Assessment:

No fish caught here.

Site Eleven:

Geomorphology: Driver component (middle reaches)

Site name: Mzintlava River at Ntshakeni

Plate 11: Mzintlava River at Ntshakeni

Altitude: **863** masl.

This is also a confined valley floodplain. It a pool-riffle river system with a straight and a single thread channel. Newly formed mid channel bars could be observed, associated with fine sediment from sources like gullies and collapsed river banks. In fact active hillslope erosion, vegetation removal and overgrazing are abundant. The river at a site is dominated by boulders; a character of a transitional zone. It has about 80% of morphological units suggesting diversity of habitat for aquatic biota. This is a characteristic of poor pasture management which can affect adjacent water resources. No sediment sampling could be done at a site due to fixed boulders in a river system (refer also to 2009 survey). It could be observed that at a site, sand, silt and clay deposits that were observed previously have been removed. When running the GAI model, the site can be classified as in a B class on its Present Geomorphological State.

<u>Water Quality trends:</u> (Co-driver component)

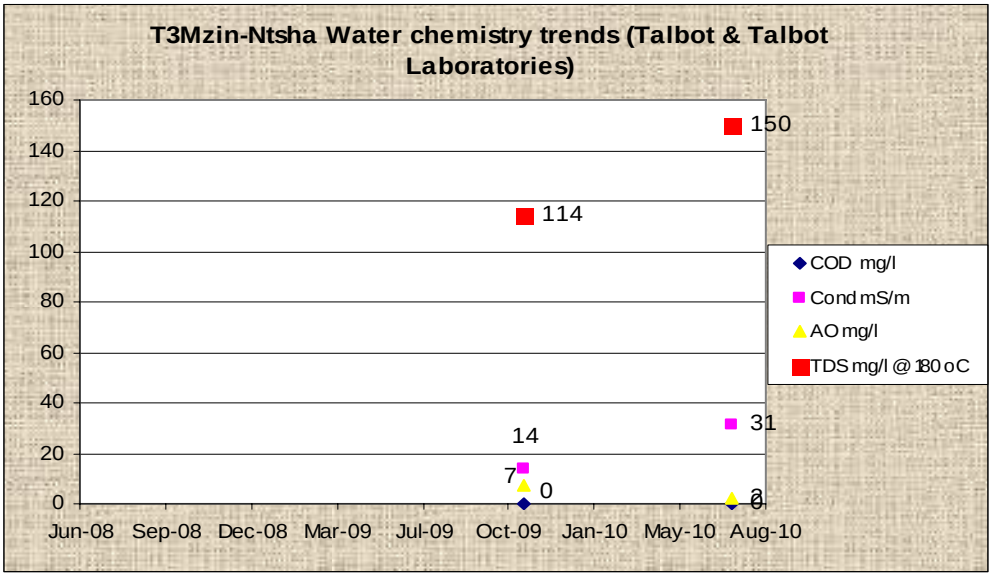


Figure 40: COD, Conductivity, Oxygen absorbed and Total dissolved solids flacuations at Mzintlava River at Ntshakeni (by Talbot & Talbot Laboratories). Water chemistry data indicate compliance with Target Water Quality Range (DWA 2008).

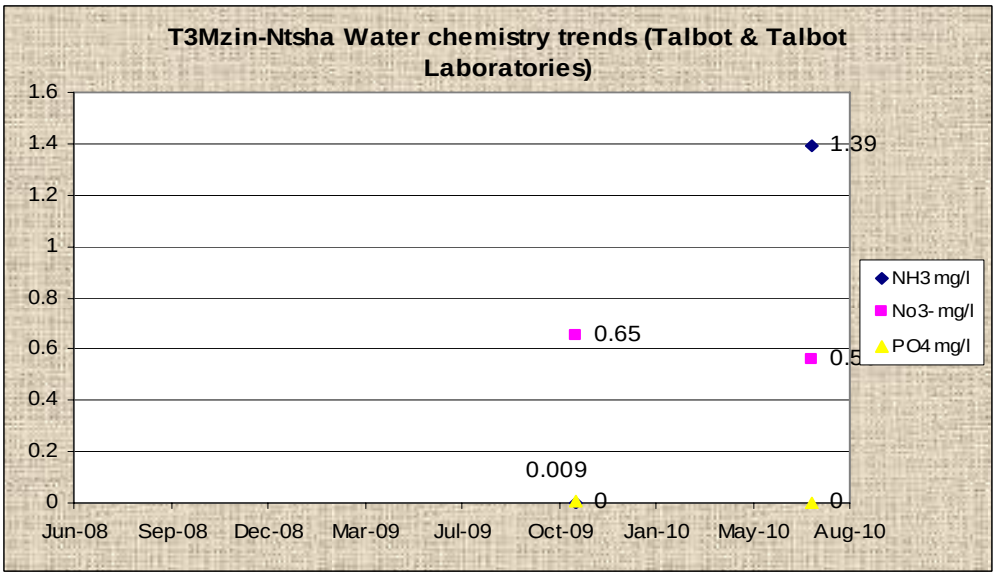


Figure 41: Ammonia, nitrates and phosphates flacuations at Kinira River at Drift (by Talbot & Talbot Laboratories). In terms of domestic water use, water chemistry data indicate compliance with Target Water Quality Range (DWA 2008) except for ammonia. Mount Aliff is +/- three kilometrs upstream of this site, also local community uses this river for washing clothes, etc. Mount Aliff has a sewage treatment plant that discharges to this river, live stock breedng at a subsistance scale are part of land use in this sub catchment.

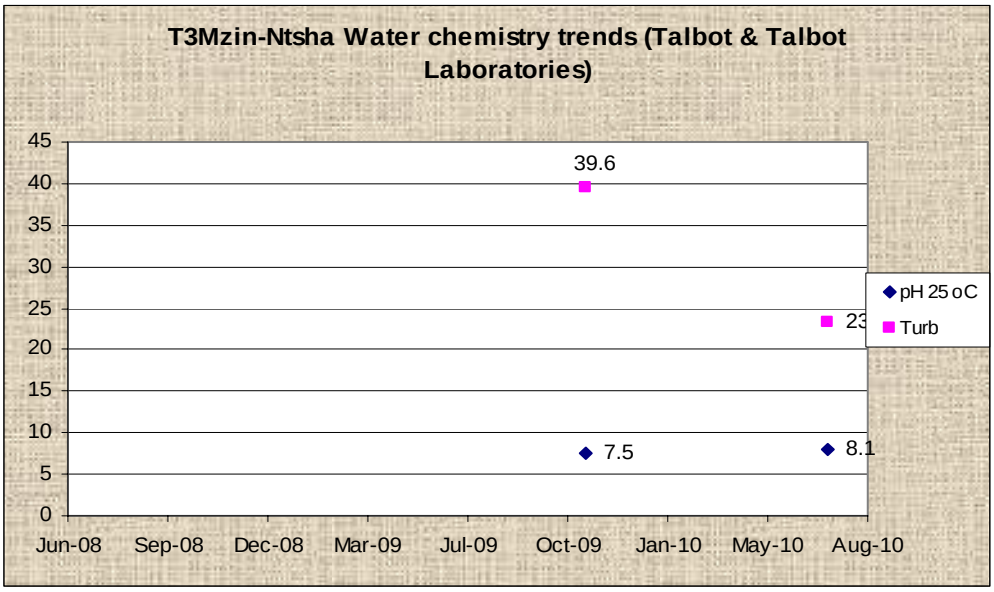


Figure 42: pH and turbidity flacuations at Mzintlava River at Ntshakeni (by Talbot & Talbot Laboratories). pH trends indicates compliance with Target Water Quality Range while turbidity has exceeded the the target range for domestic use (DWA 2008). This increase is fairly normal after heavy rains. During base flow conditions turbidity decreases substantially but still very high as compared to the rest of Mzimvubu River catchment and this could be linked to the surrounding land use activity and geology (see figure 41 and comments from geomorphological observation above.

<u>Macro-Invertebrates trends (SASS 5):</u> (Response component)

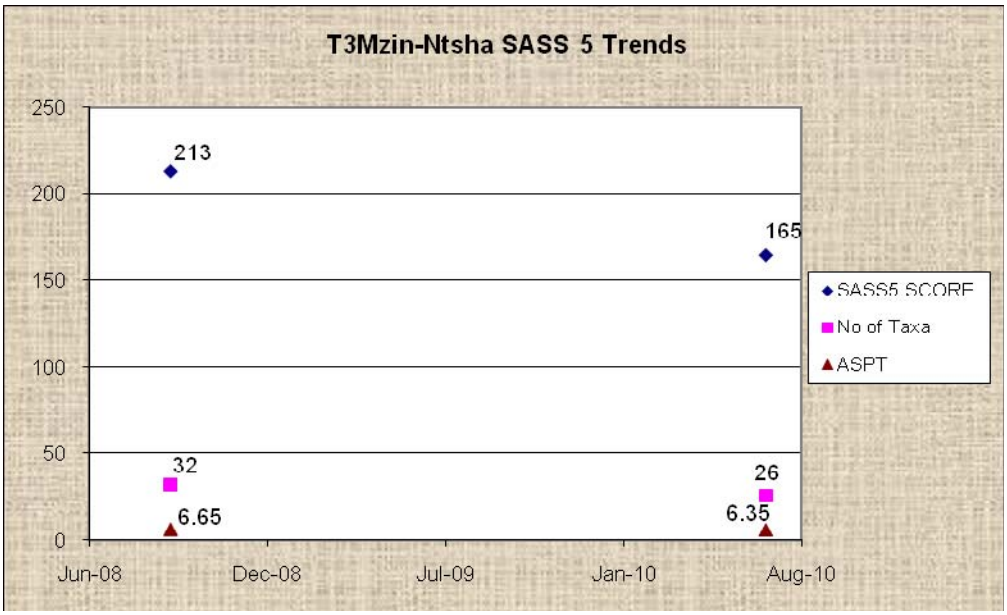


Figure 43: SASS 5 trends, start period September 2008 to July 2010.Trends indicates fluctuations between good conditions, with an average ASPT is 6.5 (Fair condition). November 2009 survey was not done due to dangerously high flows.

Fish assessment: (Response component)

Four alien fish species (*Cyprinus Caprio*) was caught here. Present Ecological Status is **E.**

Site Twelve:

Geomorphology: Driver component (middle reaches)

Site name: Mzimvubu River at N2 Road

Plate 12: Mzimvubu River at N2 Road

Altitude: **825** masl.

The site is geographically located on a confined valley floodplain. It is an anatomizing channel with numerous bars and sub-channels. The river at a site is at a dynamic sinuous condition. It is a mixed alluvial, pool-riffle system where both the bedrock and alluvium are dominant features. Moderate erosion occurs at a reach scale. Extensive sediment mining (cobbles, boulders and cobbles) had been taking place directly in a river channel. In addition, concrete material was deposited in the river channel and thus no sediment sampling whatsoever would be taken. Morphological units constituted about 42.5%. The GAI model demonstrates that the river at a site is at **C** class.

<u>Water Quality trends:</u> (Co-driver component)

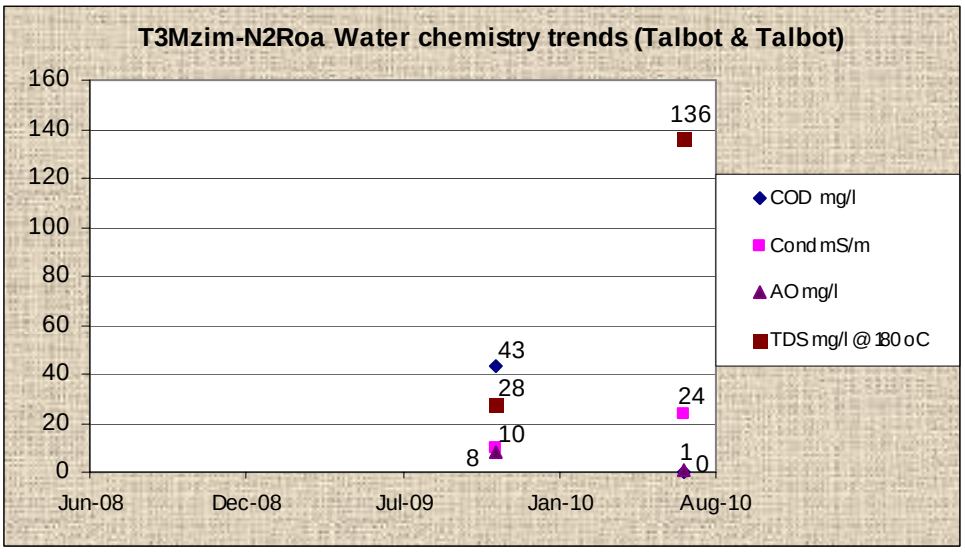


Figure 44: COD, Conductivity, Oxygen absorbed and Total dissolved solids flacuations at Mzimvubu River at N2 Road (by Talbot & Talbot Laboratories). Water chemistry data indicate compliance with Target Water Quality Range (DWA 2008). Total dissolve solids have increased during base flow conditions but the system still suggest good dilution capacity Accumulative and uptsream anthropogenic and natural impacts at a catchment scale can still be diluted and transported further downstream.

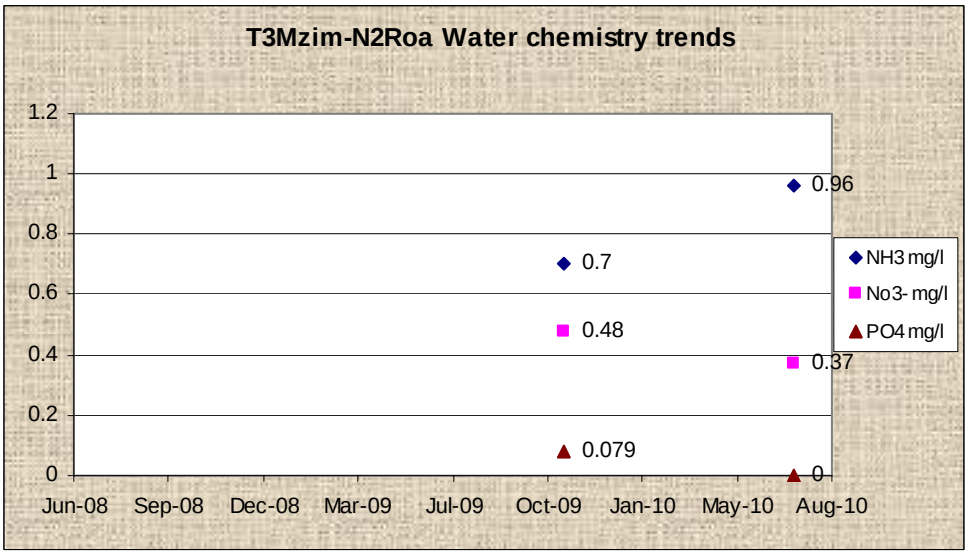


Figure 45: Ammonia, nitrates and phosphates flacuations at Mzimvubu River at N2 Road (by Talbot & Talbot Laboratories). In terms of domestic water use, water chemistry data indicate compliance with Target Water Quality Range (DWA 2008). Emerging

negative signs of ammonia are on a slight increase particularly during base flows, but good dilution capacity is very strong in this river system as a result of surplus water flows even during base flow conditions.

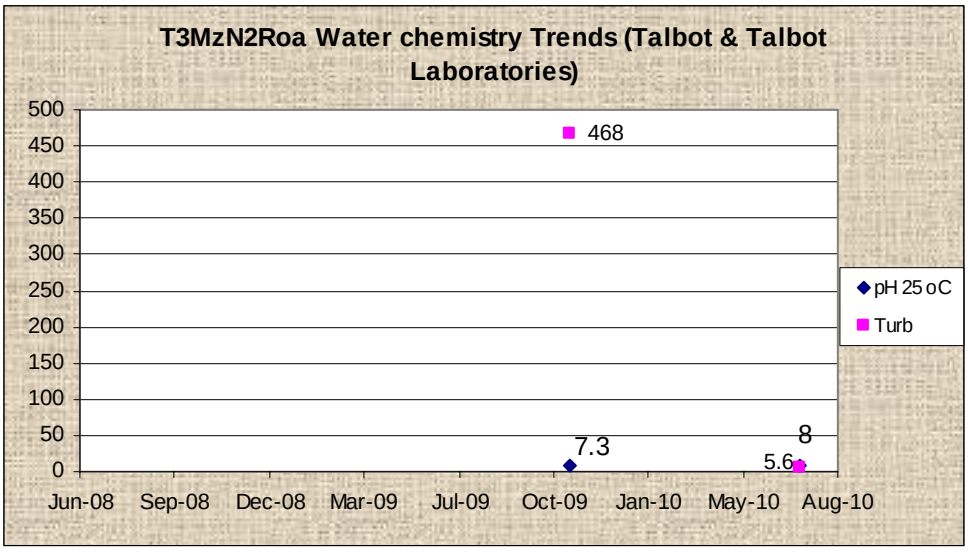


Figure 46: pH and turbidity flacuations at Mzimvubu River at N2 Road (by Talbot & Talbot Laboratories). pH trends indicates compliance with Target Water Quality Range while turbidity has increased over two folds from the first surveyed point in the upper reaches (at Joans Bridge). Non compliance is almost 467% over the target range for domestic use (DWA 2008).This increase is greatly excasabated by geology and soils and accumulate impacts anthropogenic impacts. Turbidity conditions improves greatly during base flows. Mzimvubu River (main stem) cannot handle high flows and this is mainly due to geology and soil formations at a catchment scale.

Macro-Invertebrates trends (SASS 5): **(Response component)**

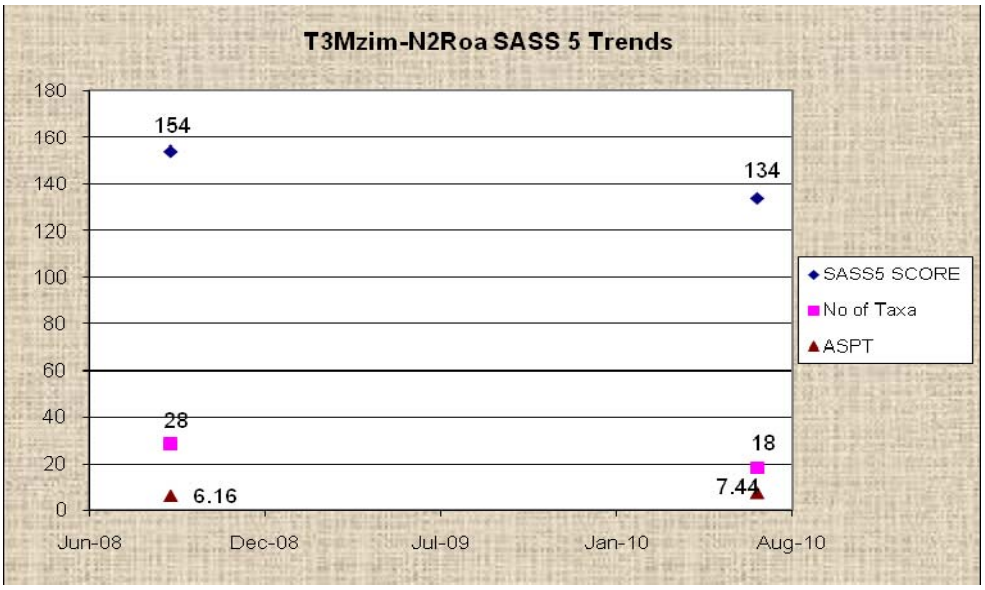


Figure 47: SASS 5 trends, start period September 2008 to July 2010.Trends indicates improved water quality from good to natural and with an average ASPT of 6.8 (good/natural condition). November 2009 survey was not done due to dangerously high flows.

Fish assessment: (Response component):

No fish was caught here.

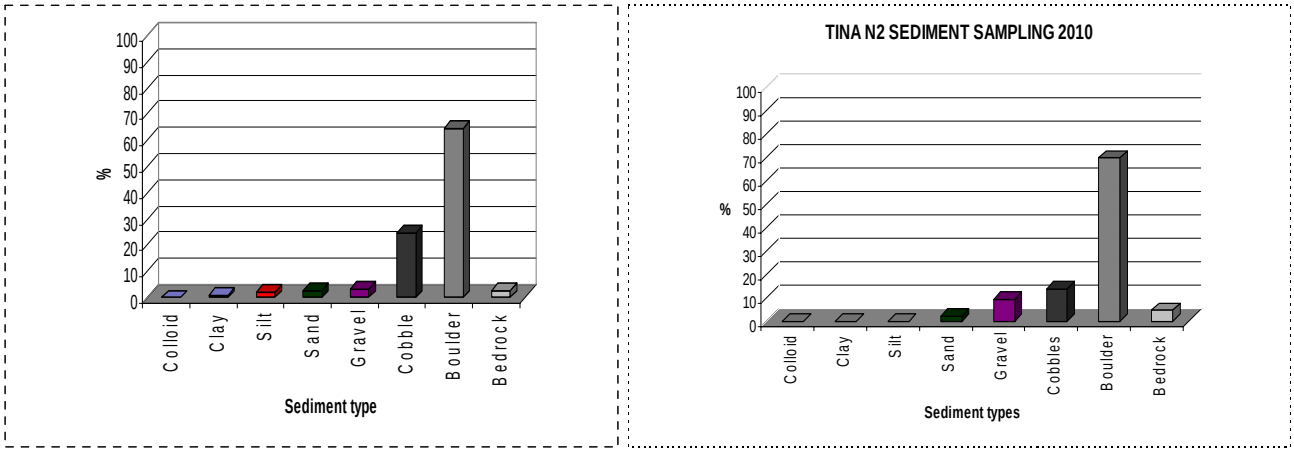
Site Thirteen:

Geomorphology: Driver component (middle reaches)

Site name: Tina River at N2 Road

Plate 13: Tina River at N2 Road
Altitude: **782** masl.

The site is in a confined valley floodplain. It is a multi-thread, mixed, pool-riffle system dominated by boulders. Erosion at catchment scale very minimal and there is less vegetation removal. About 83% of morphological units were present. As it can be illustrated in the figure below, very little fine material is found in the river at that site.



A: Spring survey 2009 B: Winter survey 2010

Figure 4. Comparing percentage distribution of sediment types of Tina River at N2 site (some removal of silt occurred).

The GAI model demonstrates that the Present Geomorphological State of the river at a site is at **B** class.

<u>Water Quality trends:</u> (Co-driver component)

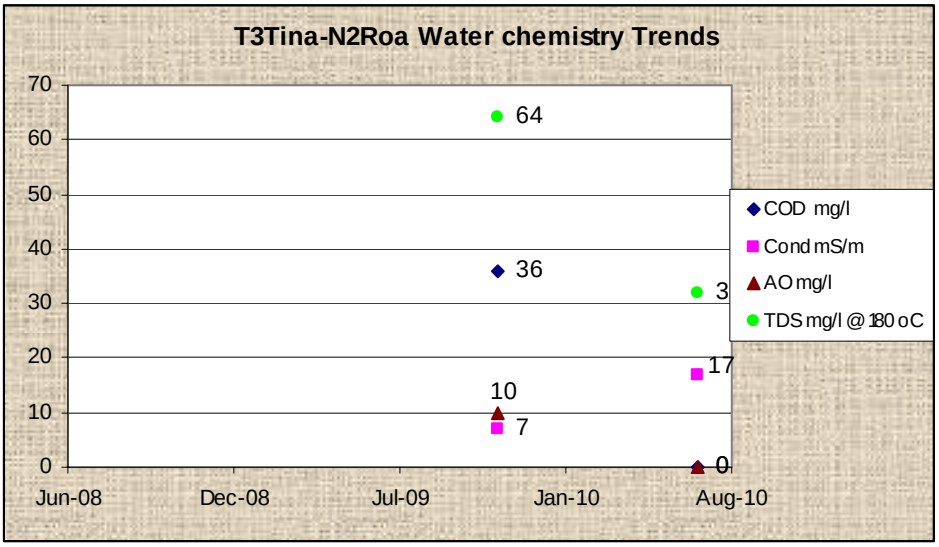


Figure 44: COD, Conductivity, Oxygen absorbed and Total dissolved solids flacuations at Mzimvubu River at N2 Road (by Talbot & Talbot Laboratories). Water chemistry data indicate compliance with Target Water Quality Range (DWA 2008).

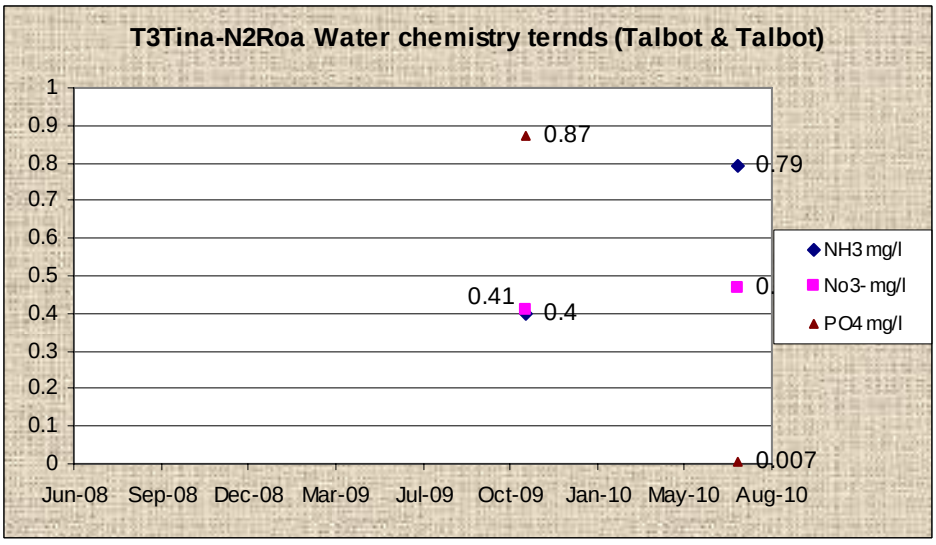


Figure 45: Ammonia, nitrates and phosphates flacuations at Mzimvubu River at N2 Road (by Talbot & Talbot Laboratories). In terms of domestic water use, water chemistry data indicate compliance with Target Water Quality Range (DWA 2008)

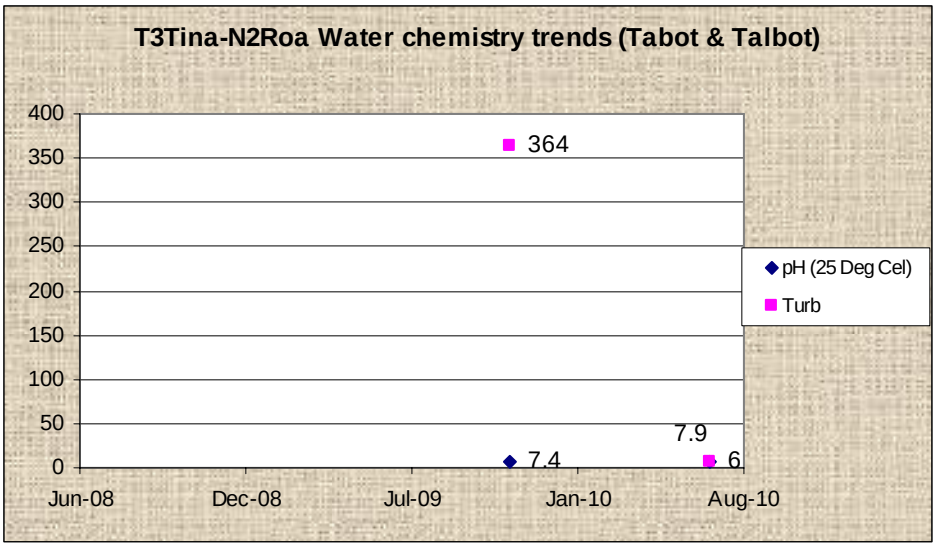


Figure 46: pH and turbidity flacuations at Mzintlava River at Ntshakeni (by Talbot & Talbot Laboratories). pH trends indicates compliance with Target Water Quality Range while turbidity has increased over two folds from the first surveyed point in the upper reaches (at Joans Bridge). Non compliance is almost 363% over the target range for domestic use (DWA 2008). This increase is greatly excasabated by geology and soils, accumulate impacts from downstream man made impacts.

<u>Macro-Invertebrates trends (SASS 5):</u> (Response component)

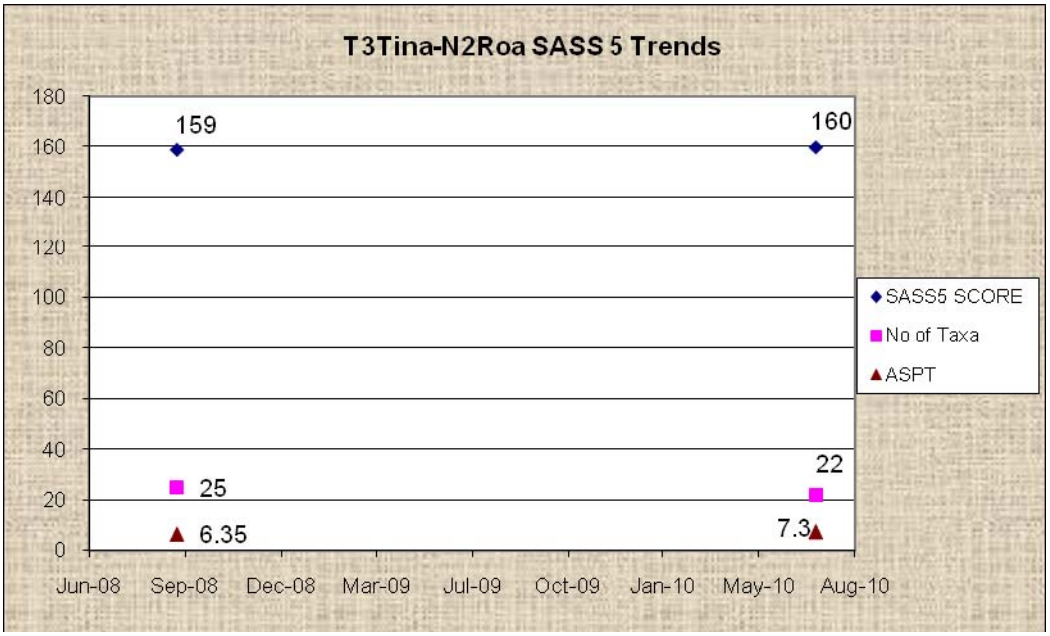


Figure 47: SASS 5 trends, start period September 2008 to July 2010.Trends indicates improved water quality from good to natural and with an average ASPT of 6.83 (good/natural condition). November 2009 survey was not done due to dangerously high flows.

Fish assessment: (Response component):

A total of 30 indigenous fish species (Barbus Anoplus) were caught at Tina River at N2 Bridge. Present Ecological Status is **C**

Site Fourteen:

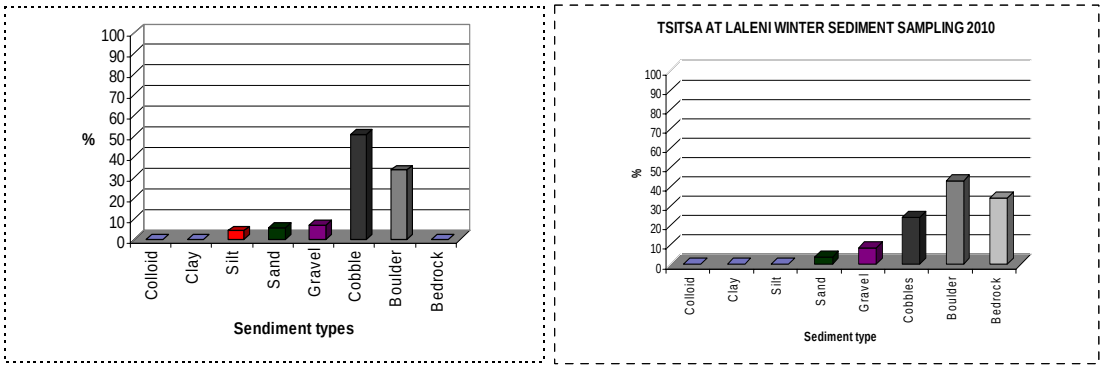
Geomorphology: Driver component (middle reaches)

Site name: Tsitsa River at Laleni

Plate 14: Tsitsa River at Laleni

Altitude: **742** masl.

The site is also at a confined valley floodplain. It is a single thread, sinuous, pool-riffle and a mixed channel although it is composed of the cobbles and boulders as a dominant substrates. No significant changes have occurred at a catchment level as compared to the previous survey though boulders have become more dominant than cobbles, with some removal of fines. This has resulted in the exposure of bedrock (refer to figure 11 below).



A: Spring survey 2009 B: Winter survey 2010

Figure 5. Comparing percentage distribution of sediments in Tsitsa at Laleni site (fine material removed and some cobbles moved away from the transet).

The GAI model illustrates that the river at a site is at **B/C** Present Geomorphological State and therefore no significant changes at a catchment level thereof.

<u>Water Quality trends:</u> (Co-driver component)

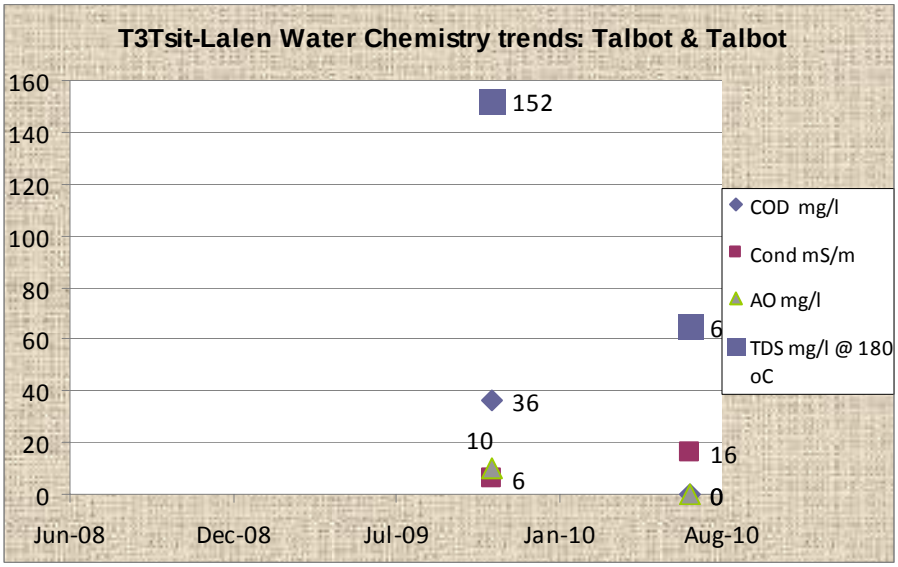


Figure 44: COD, Conductivity, Oxygen absorbed and Total dissolved solids flacuations at Tsitsa River at Laleni (by Talbot & Talbot Laboratories). Water chemistry data indicate compliance with Target Water Quality Range (DWA 2008). TDS drops significantly during base flows.

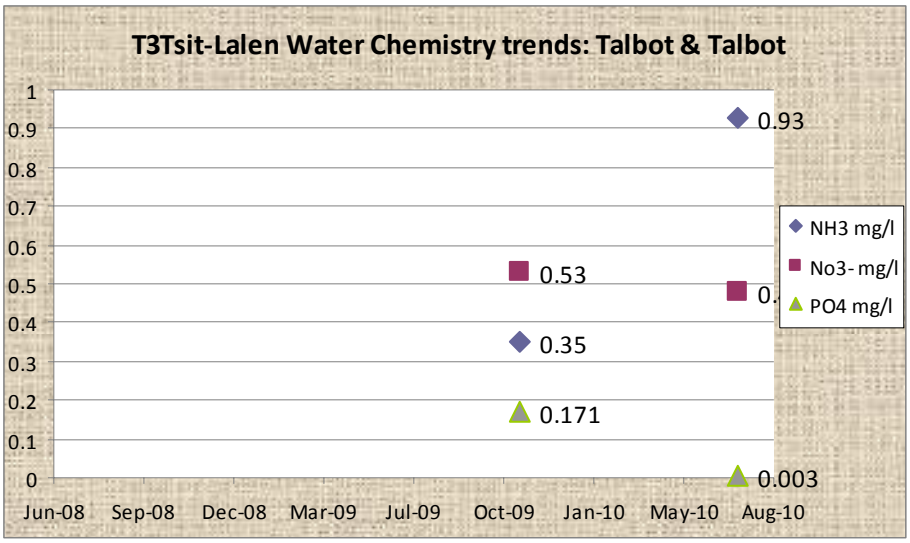


Figure 45: Ammonia, nitrates and phosphates flacuations at Tsitsa River at Laleni (by Talbot & Talbot Laboratories). In terms of domestic water use, water chemistry data indicate compliance with Target Water Quality Range (DWA 2008). Emerging problems with ammonia can be observed during base flow conditions.

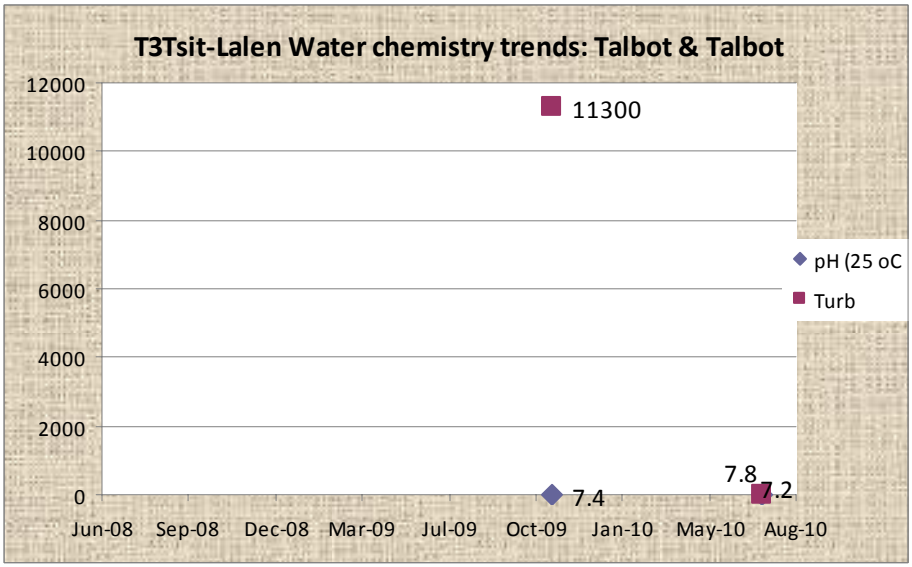


Figure 46: pH and turbidity flacuations at Tsitsa River at Laleni (by Talbot & Talbot Laboratories). pH trends indicates compliance with Target Water Quality Range while turbidity has increased over two folds from the first surveyed point in the upper reaches (at Joans Bridge). Non compliance is almost 11300% over the target range for domestic use (DWA 2008). This increase is by far the highest recorded non compliance in this catchmne. Interesting enough Tsitsa River is a tributary of Mzimvubu River these conditions might be greatly excasabated by geology and soils, accumulate impacts from downstream man made impacts. Turbidity problems here needs further verification.

Macro-Invertebrates trends (SASS 5): **(Response component)**

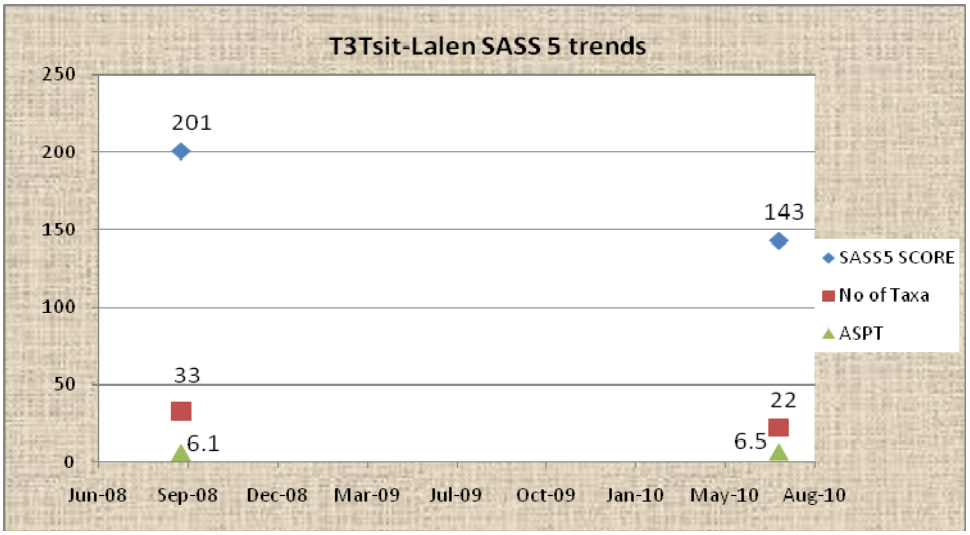


Figure 47: SASS 5 trends, start period September 2008 to July 2010.Trends indicates steady water quality at good conditions and with an average ASPT of 6.3 (good condition). November 2009 survey was not done due to dangerously high flows.

Fish assessment: (Response component)

Two fish species of *Anguilla mossambica* (indigenous) were caught in Tsitsa River at Laleni. Present Ecological Status is **C**

Site Fifteen:

Geomorphology: Driver component (middle reaches)

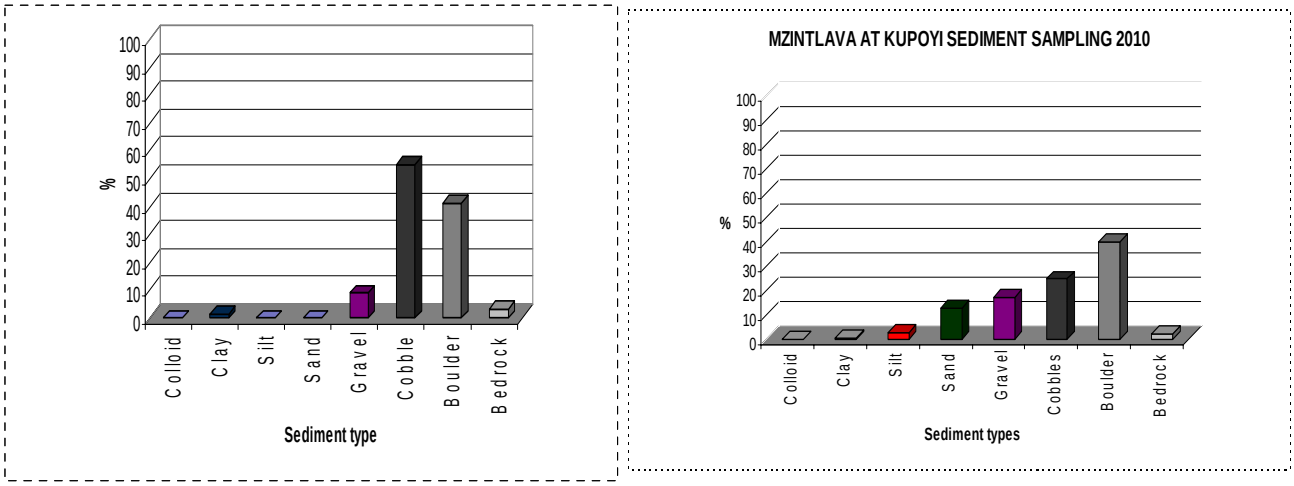
Site name: Mzintlava River at Kupoyi

Plate 15: Mzintlava River at Kupoyi

Altitude: **374** masl.

This site is an incised channel with flood benches. It is a single thread, straight, mixed alluvial channel. In addition, it is located at a pool-riffle segment dominated by cobbles and boulders where the living biota can survive. The site had about 42% morphological units during the survey. Deposition of fine material has occurred at a site due to erosion of the river bank and some gullies on the adjacent hillslope.

The figure below compares the sediment variability of 2009 and 2010 surveys. It can be noted that boulders had become more dominant than cobbles, while at the same time there had been additional gravel, sand and silt. Thus a lot of cobbles had been covered by fine material deposited. Figure 12 below shows the results of sediment sampling of Mzintlava at Kupoyi.



A: Spring survey 2009 B: Winter survey 2010

Figure 6. Comparing percentage distribution of sediments in Mzintlava at KuPoyi site (a lot of sedimentation had occurred at this site).

The GAI index revealed that the site can be considered as at its natural or near natural condition in terms of its fluvial geomorphology: Class set at A (negligible or no change).

<u>Water Quality trends:</u> (Co-driver component)

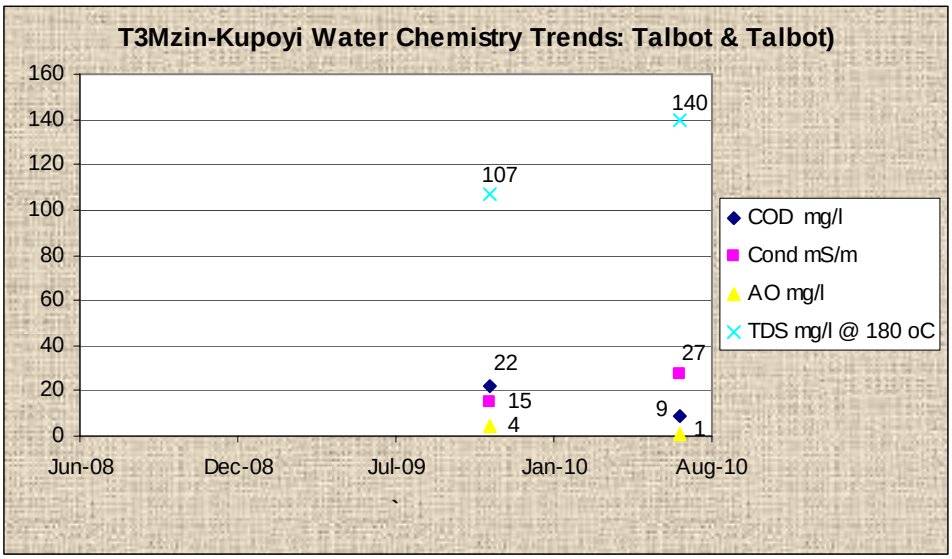


Figure 44: COD, Conductivity, Oxygen absorbed and Total dissolved solids flacuations at Mzintlava River at Kupoyi (by Talbot & Talbot Laboratories). Water chemistry data indicate compliance with Target Water Quality Range (DWA 2008).

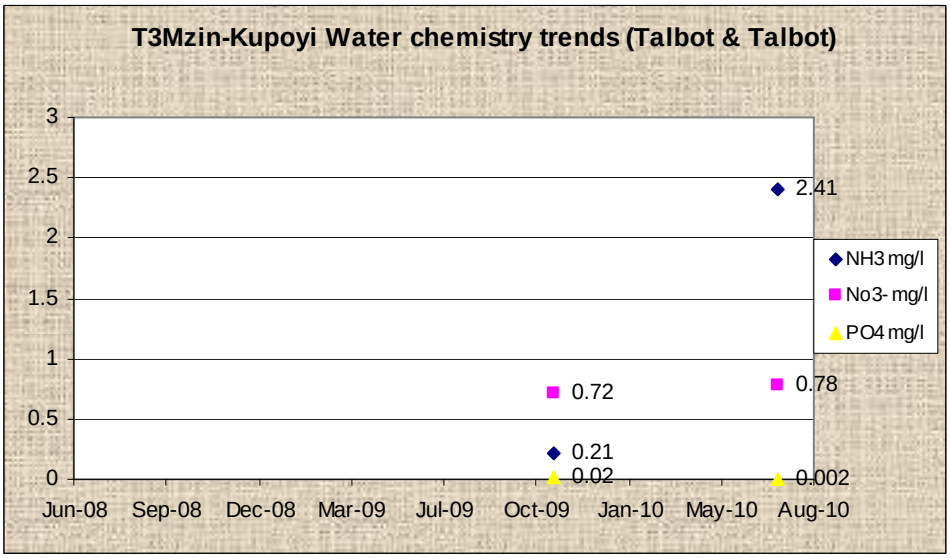


Figure 45: Ammonia, nitrates and phosphates flacuations at Mzintlava River at Kupoyi (by Talbot & Talbot Laboratories). In terms of domestic water use, water chemistry data indicate compliance with Target Water Quality Range (DWA 2008), except for ammonia which is nearl three times the recommended target for domestic. Upstream water users includes Flagstaff (a over populated rural town) and rural settlements.

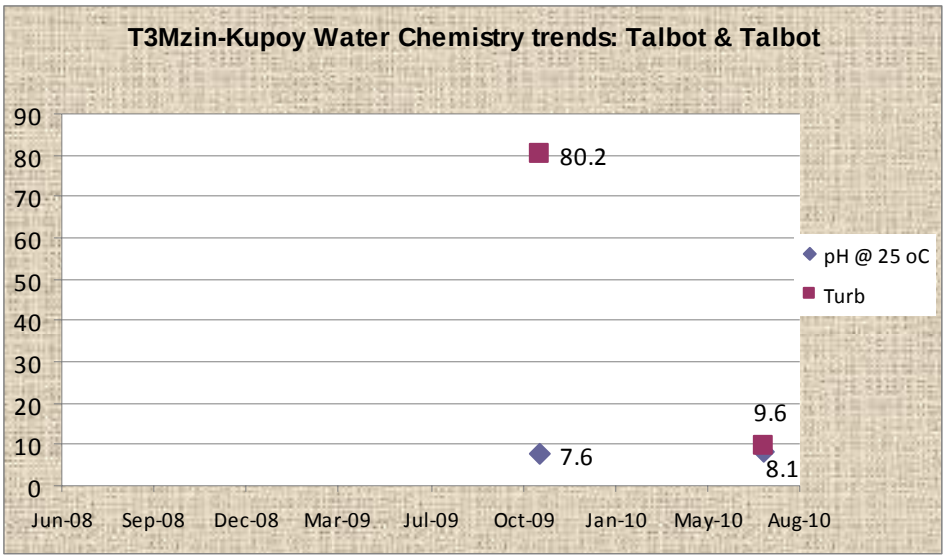


Figure 46: pH and turbidity flacuations at Mzintlava River at Kupoyi (by Talbot & Talbot Laboratories). pH trends indicates compliance with Target Water Quality Range while turbidity has exceeded the the target range for domestic use (DWA 2008).

<u>Macro-Invertebrates trends (SASS 5):</u> (Response component)

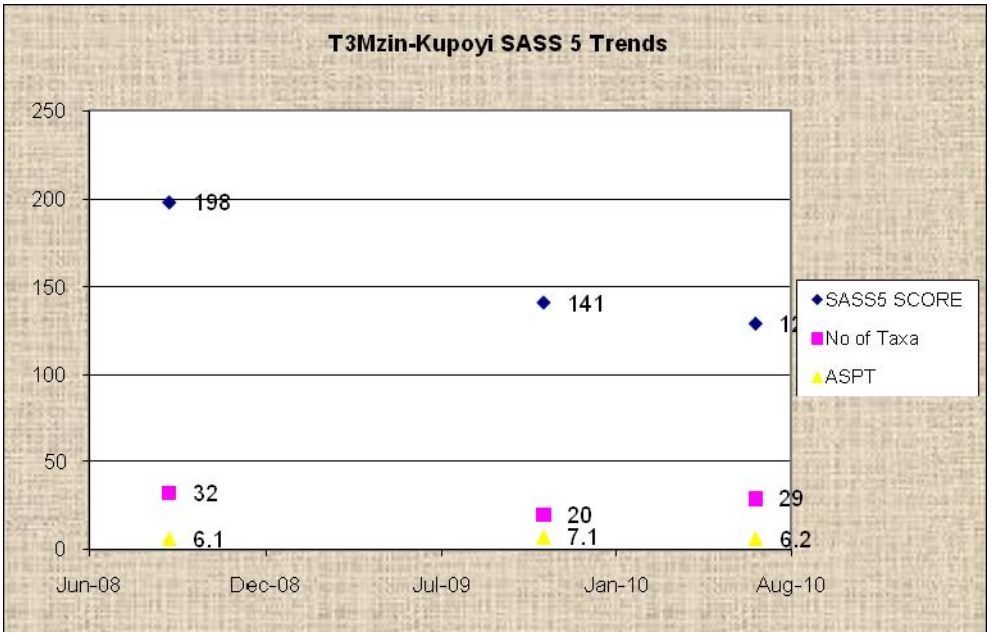


Figure 47: SASS 5 trends, start period September 2008 to July 2010.Trends indicates fluctuations between good to natural water quality then back to good conditions. An average ASPT of 6.5 (good condition) has been recorded so far. Population trends indicate a steady decline while species diversity shows some recovery.

Fish assessment: (Response component):

Four *Tilapia spirrmanii* (alien), one *Barbus Anoplus* (indigenous) and four *Cyniprus Caprio* (alien). Presesent Ecological Status is **D.**

Site Sixteen:

Geomorphology: Driver component (middle reaches)

Site name: Mzimvubu River at Bhuje

Plate 16: Mzimvubu River at Bhuje

Altitude**: 89** masl.

Located at a rejuvenated foothill and upstream of the estuary, the site is an incised channel, single thread and straight. Bedrock and fixed boulders are major physical condition in the channel and the river bank. It is a pool-riffle system, where the deep pools can act as refugia for aquatic biota during period of stress, for instance, during drought episodes. The site has about 70% morphological units. No significant changes have occurred at a catchment level, except newly formed mid channel bar and bank undercutting on the right bank. Sediment sampling could not be done at a site as it consists mainly of fixed boulders and bedrock. The GAI index shows that the site in A condition in its Present Ecological State, with minimal or negligible changes. No sediment sampling could be done at a site due to its nature of fixed boulder river bed.

<u>Water Quality trends:</u> (Co-driver component)

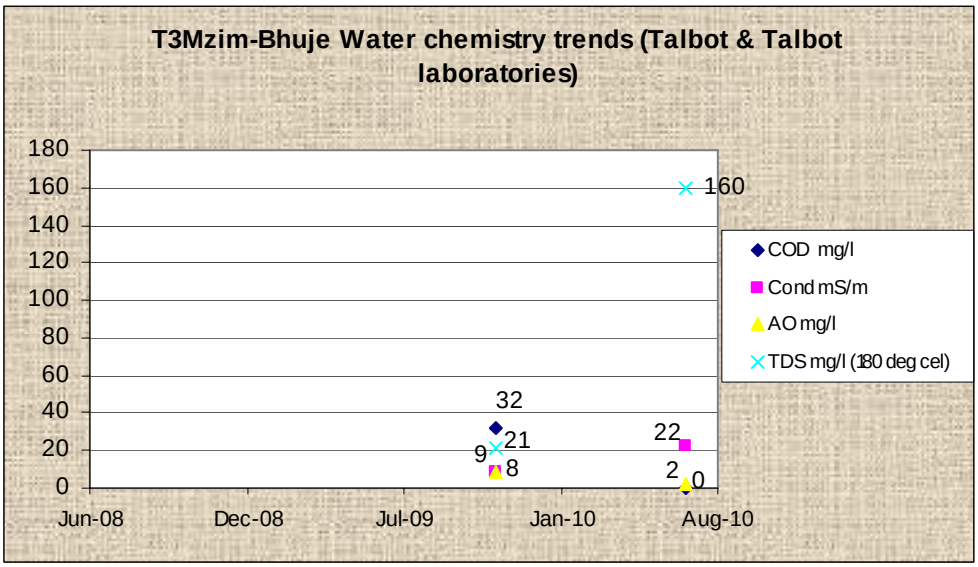


Figure 44: COD, Conductivity, Oxygen absorbed and Total dissolved solids flacuations at Mzimvubu River at Bhuje (by Talbot & Talbot Laboratories). Water chemistry data indicate compliance with Target Water Quality Range (DWA 2008).

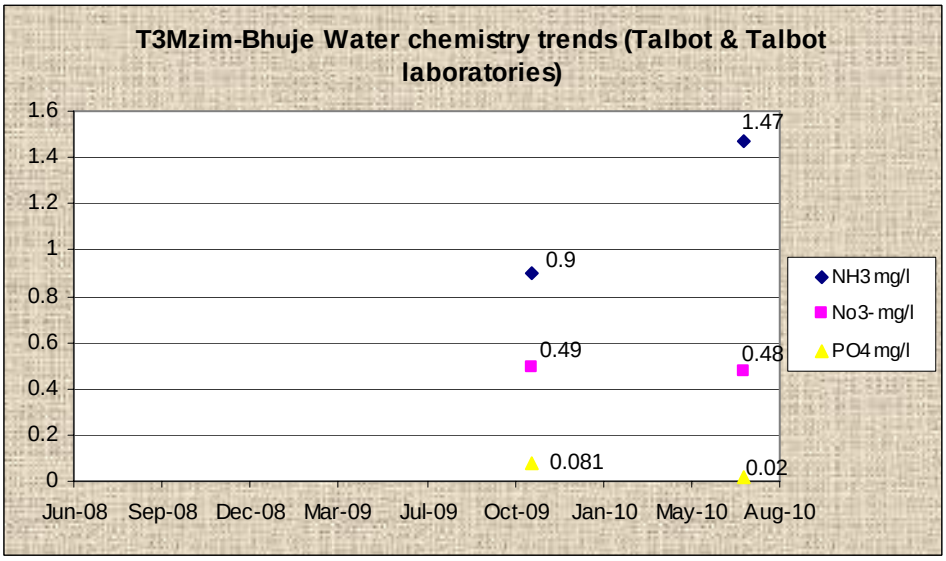


Figure 45: Ammonia, nitrates and phosphates flacuations at Mzintlava River at Kupoyi (by Talbot & Talbot Laboratories). In terms of domestic water use, water chemistry data indicate compliance with Target Water Quality Range (DWA 2008). Emerging problems with ammonia can be observed though as this value is above the target range for domestic use.

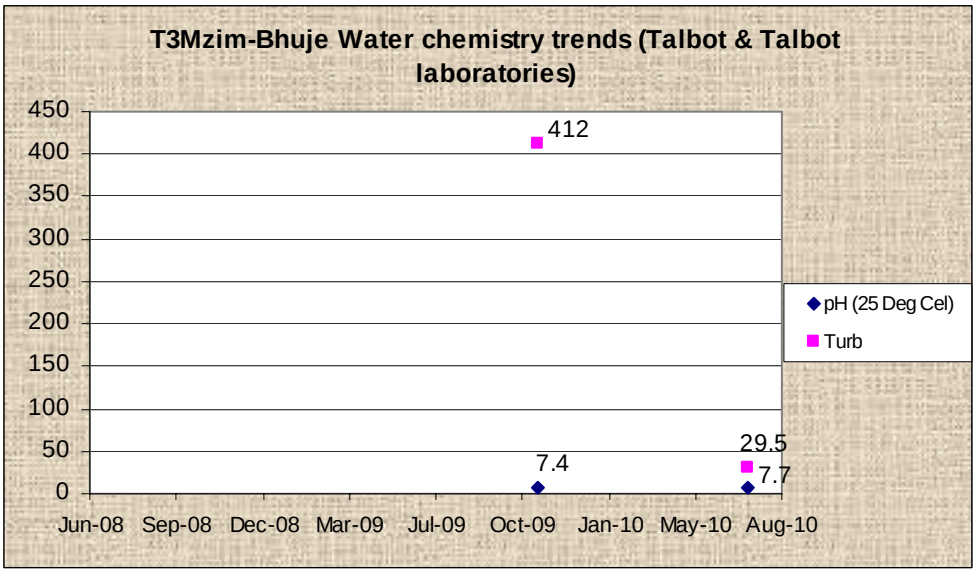


Figure 46: pH and turbidity flacuations at Mzintlava River at Ntshakeni (by Talbot & Talbot Laboratories). pH trends indicates compliance with Target Water Quality Range while turbidity has increased over two folds from the first surveyed point in the upper reaches (at Joans Bridge). Non compliance is almost 467% over the target range for domestic use (DWA 2008). This increase is greatly excasabated by geology and soils, accumulate impacts from downstream anthropogenic impacts.

<u>Macro-Invertebrates trends (SASS 5):</u> (Response component)

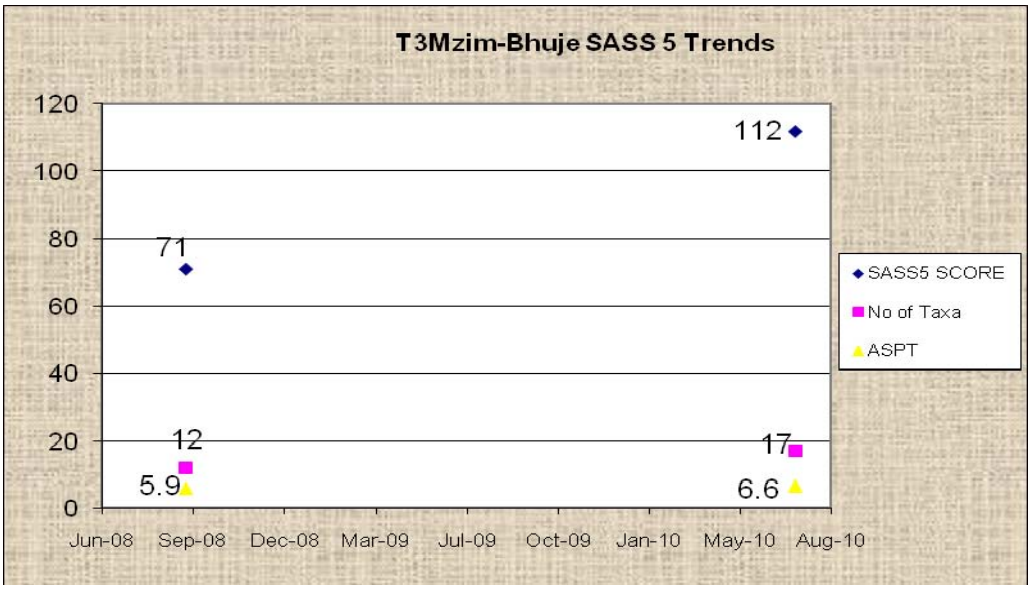


Figure 47: SASS 5 trends, start period September 2008 to July 2010.Trends indicates water quality recovery from fair/good to good conditions and with an average ASPT of 6.3 (good condition) Population and species diversity trends also indicates a steady

recovery. There is no vegetation at this site, even stones are mostly fixed to the river bed.

Fish assessment: (Response component):

No fish was caught at Mzimvubu River at Bhuje.

<u>Discussions and hot spots areas</u> (from source to mouth)

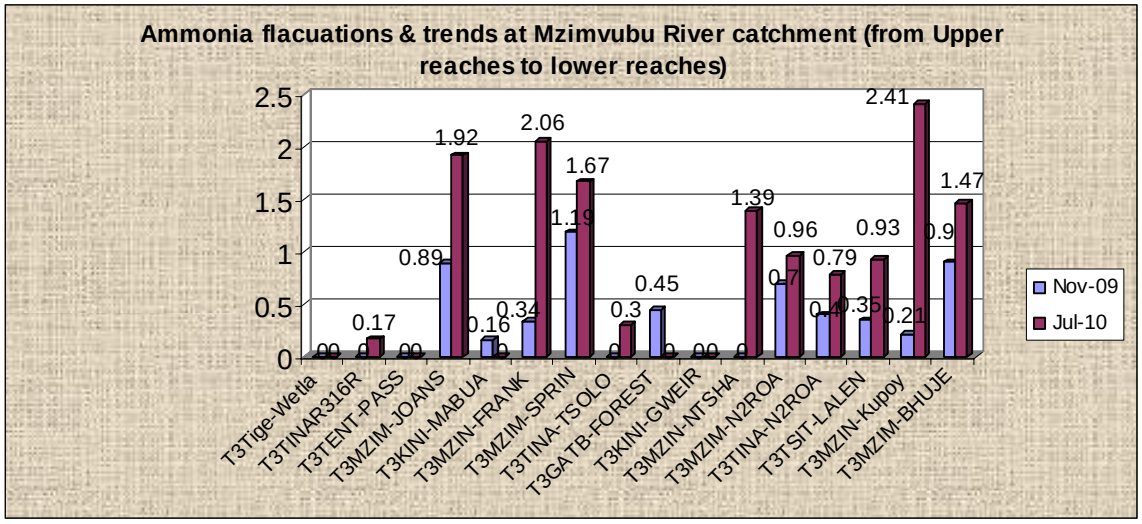


Figure 48: Graphic Summary of Ammonia fluctuations from source to mouth. Most upper reaches of Mzimvubu catchment are less impacted by ammonia or the system has good dilution capacity. Impacts from raw sewage, animal fesses and detritus matter is less visible. But Springfontein which is still in the upper reaches shows the highest levels of ammonia and the observed live stock commercial farming activities here are confirmed by high concentration ammonia. The water quality is still fit for agricultural use. Best farming practices could easy reverse these conditions as they are still reversible. Relatively high ammonium ion in river waters can have an adverse effect on fish natural spawning activities.

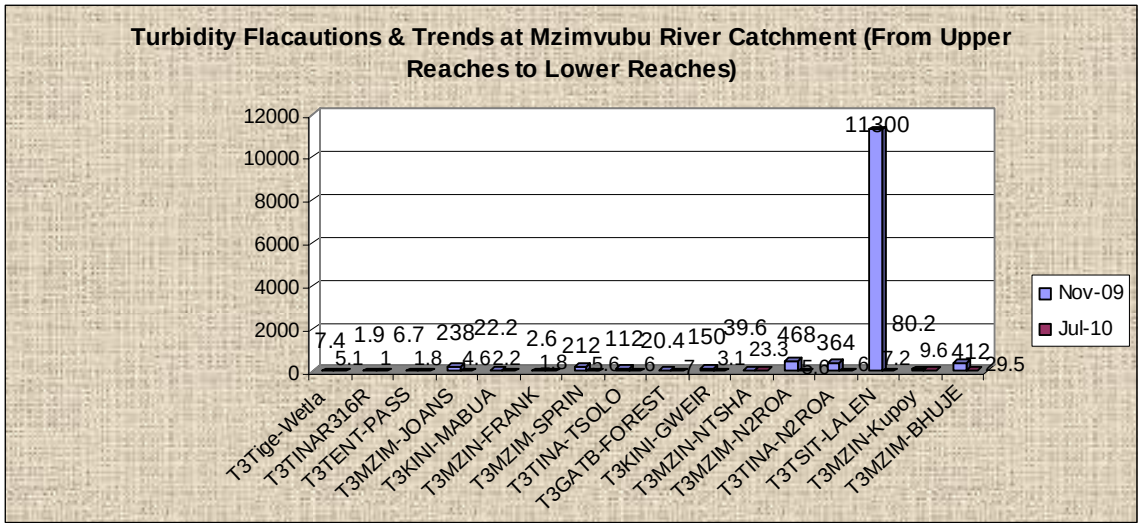


Figure 49: Graphic Summary of Ammonia fluctuations from source to mouth. Most tributaries of Mzimvubu River in the upper reaches show low sediment input. Mzimvubu River on the other hand shows increased sediment load right from the upper reaches. Sediment load almost doubles in the middle reaches and sustains constant levels until it discharges into the Port St Johns Estuary. Geological influence coupled with landuse activities are amongst the key factors for such high siltation in this main stem. However Tsitsa River at Laleni at the lower reaches shows the highest sediment load not observed anywhere in the Mzimvubu River system as a whole. Yet the upper reaches of Tsitsa River also show the lowest sediment load in the whole Mzimvubu River system.

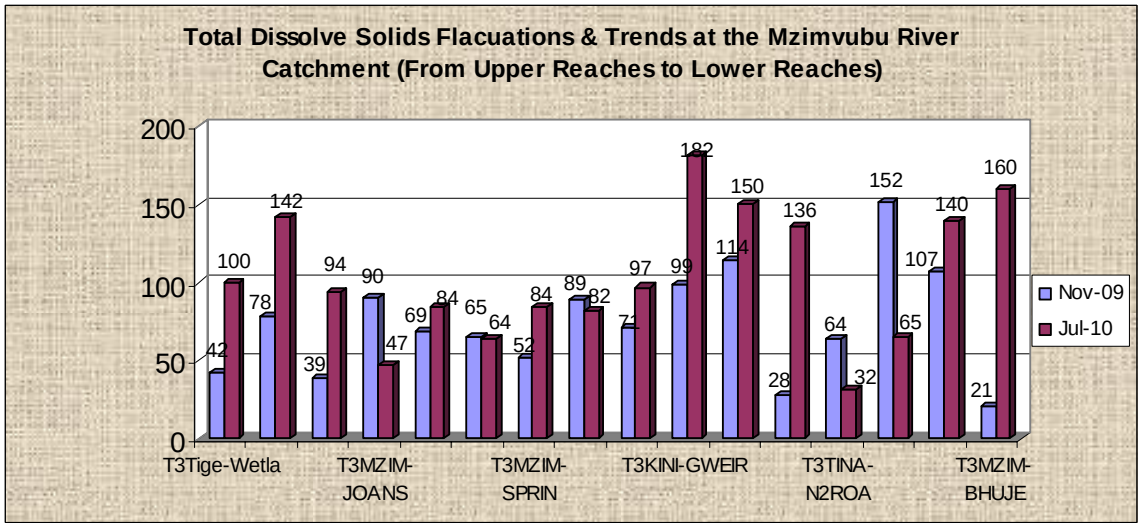


Figure 50: Graphic Summary of Total Dissolve solids fluctuations from source to mouth.

Total inorganic Salts accumulate as water moves downstream because total inorganic salts are continuously being added through natural and anthropogenic sources whilst very little is removed by precipitation or natural processes. Domestic and industrial effluent discharges and surface runoff from urban, industrial and cultivated areas are examples of the types of sources that may contribute to increased TDS concentrations. Evaporation also leads to an increase in the total salts. The fluctuation here also agrees with this general theory.

Heavy metals:

There are no observed heavy metals problems in all Biomonitoring sites in the Mzimvubu River system even during the dry season or base flow conditions of July 2010.

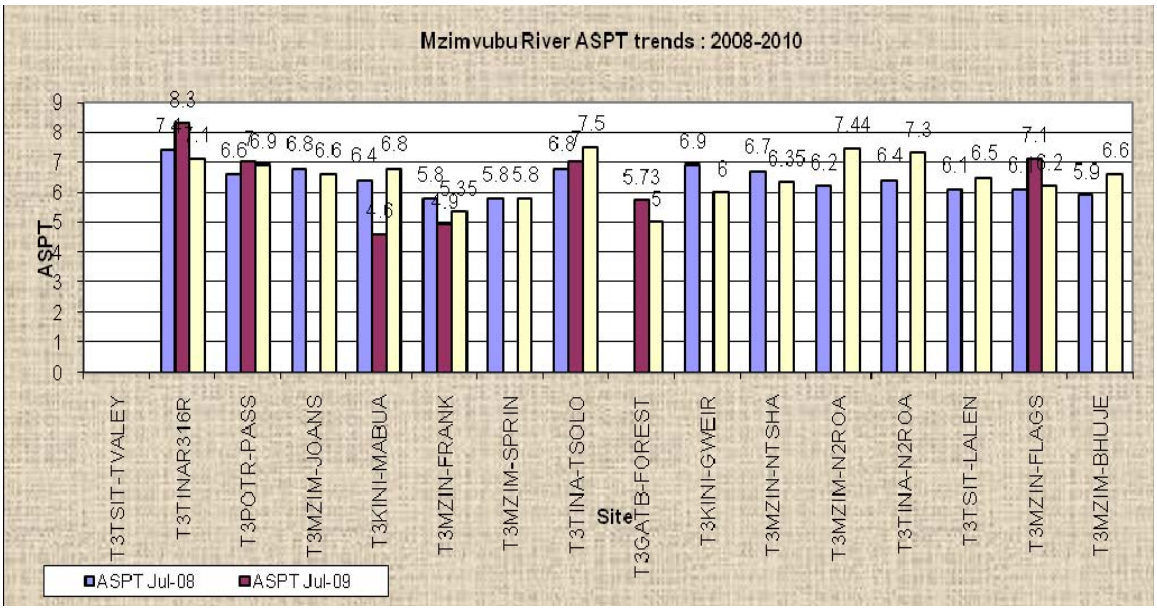


Figure 51: Graphic Summary of Macro Invertebrates ASPT fluctuations from source to mouth.

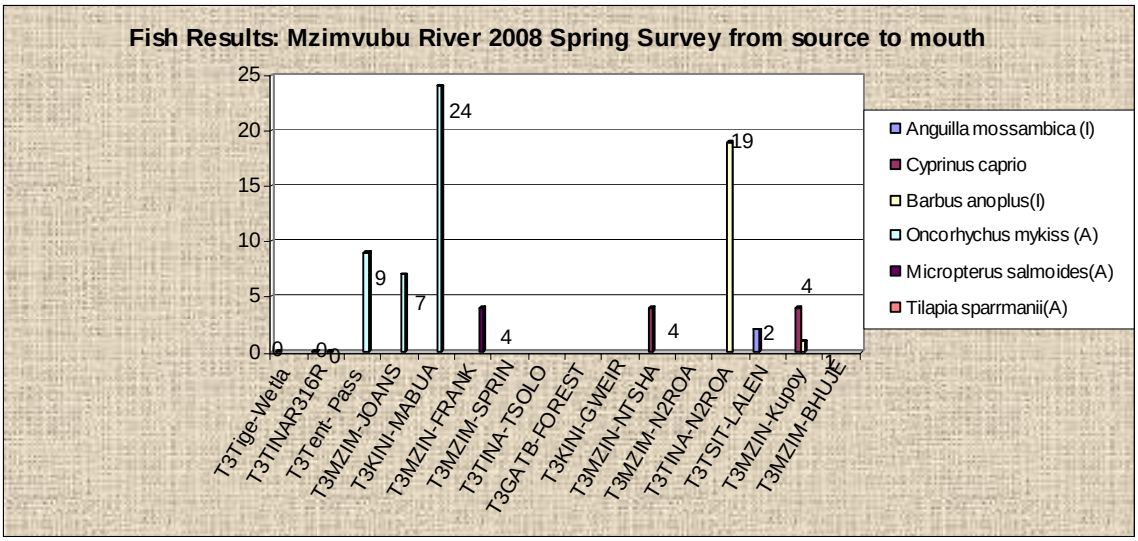


Figure 52: Graphic Summary of fish caught from source to mouth.

TABLE 7: A summary of the Mzimvubu River Basin survey (all assessed components assessed)

SITE	GEOMORHOLOGY: GAI	WATER QUALITY: TWQR	INVERTEBRATES (SASS5); Average	FISH :FAII	Topography
T3Tige-Wetla	A/B	C	Not assessed, no biotopes.	No biotope	Upper reaches
T3TINA-R316R	A/B	C	Natural	No fish caught	Upper reaches
T3Tent-Pass	B	C	Good/Natural	E	Upper reaches
T3Mzim-Jones	A/B	N/C (siltation/ammonia)	Good/Natural	E	Upper reaches
T3Kini-Mabua	B/C	C	Fair/Good	E	Upper reaches
T3Mzin-Frank	B	N/C (ammonia)	Fair	E	Upper reaches
T3Mzim-Sprin	A/B	N/C (Am/Silt)	Fair/Good	No fish caught	Upper reaches
T3tina-Tsolo	B/C	N/C (Siltation)	Natural	E	Upper reaches
T3Gatb-Forest	B/C	C	Fair	Not done	Middle reaches
T3Kini-Gweir	B/C	N/C (Siltation)	Fair/Good	No fish caught	Upper reaches
T3Mzin-Ntsha	B	N/C (Am/Silt)	Good	E	Middle reaches
T3Mzim N2Roa	C	N/C (Siltation)	Good/Natural	No fish caught	Middle reaches
T3Tina-N2Roa	B	N/C (Siltation)	Good/Natural	C	Middle reaches
T3Tsit-Lalen	B/C	N/C (Siltation)	Good	C	Lower reaches
T3Mzin-Kupoyi	A	N/C (Am/Silt)	Good	D	Lower reaches
T3Mzim-Bhuje	A	N/C (Am/Silt)	Good	No fish caught	Lower reaches

Upper reaches:

Hydrology: In the western side (Tsitsa River upper reaches) flow modifications are in the form of Stream Flow Reduction Activities (SFRA) caused by commercial forestation. The business owner of the plantation is PG Bison.
Water supply, most community in the western side is predominantly rural and the majority still has no access to portable drinking water, therefore still sources their schedule 1 water directly from the rivers. Those who have access to clean water mostly live within Maclear, Mt Fletcher and Matatiele towns, therefore it is not clear how many water supply scheme exist here. However in the eastern side (Mzimvubu and Mzintlava River upper reaches) flow modifications are in the form of farm dams.
In general the strong encroachment by alien vegetation such as Black Wattle would to some degree contribute to stream flow reduction activities throughout the upper reaches.

Geomorphology: Western side of Mzimvubu River catchment (Tsitsa, Tina and Kinira Rivers) is much more impacted than the eastern side (KZN side). Geology, alien invasive vegetation (Black Wattle), commercial forestation (Gatberg river and Tsitsa upper reaches in particular) and dense rural settlements coupled with poor land use practices (over grazing, vegetation clearing for fire wood etc) are amongst the key factors contributing to these findings on the western side. The eastern side (KZN area) is less densely populated but extensively developed in terms of commercial agricultural practices (Refer to Table 7 for summary of findings).

Water Quality: In the western side Tsitsa, Tina and Kinira upper reaches, physiochemical analysis report suggest compliance on most parameters except for turbidity at Kinira Drift. The causes are mainly due to unfavorable geology & soils, coupled with vegetation removal (active erosion) and presence of alien trees (Black Wattle). On a catchment scale cattle trampling and overgrazing cannot be ruled out.

On the eastern side however Mzimvubu River has problems with only ammonia and excessive siltation (turbidity) and this directly due to extensive commercial farming practices and geology/ soils sensitive to soil erosion. Mzintlava River just below Franklin Vlei has problems with ammonia and this could also be linked to extensive commercial farming practices. Impacts by the saw mill in Franklin still needs to be assessed and quantified, but it is assumed that most would be absorbed by the huge Ramsar wetland nearby.
Macro Invertebrates (SASS 5): In the eastern side water quality in terms of biological responses ranges on average from natural, mostly good to natural. Kinira Mabua and Drift (Weir) there was poor or no vegetation, hence this would contribute to low ASPT.

On the western side however, Mzintlava River at Franklin Vlei records fair conditions, the lowest in the KZN area, again this could be linked extensive land use activity (commercial farming). Mzimvubu River at Springfontein Farm records second lowest with fair to good water quality conditions, impacts are predominantly from extensive commercial farming practices and siltation problems cannot be ruled out.

Fish Assessment: In the western side some sites no fish activity was recorded, Kinira Mabua recorded the highest fish activity, but all alien with present ecological class of E (poor conditions in terms of biological pollution). On the eastern (KZN) side there was low fish count in Mzintlava River Franklin Vlei and Mzimvubu at Joans bridge, however

they were all alien with overall present ecological class of E (poor conditions in terms of biological pollution)

Middle reaches:

Hydrology (Drivers): Not much is known, but for huge water supply demand comes from Tsolo Town, Ugie, Qumbu, Mount Frere and Mount Ayliff. The majority of the local community depends on the untreated raw water from these rivers. And those that have access in the rural community the schemes don't operate continuously. Commercial forestation has a strong impact in terms of stream flow reduction activities. Small dams and abstraction weirs have been observed in these middle reaches.

Geomorphology (Drivers): Middle reaches shows a steady recovery in terms of present Geomorphological status (B) with the exception of Mzimvubu River at N2 Bridge with present Geomorphological status of (C). Reasons have already been discussed above.

Water Quality (Drivers): Gatberg has no water quality problems but middle reaches in general have problems with siltation (turbidity), and Mzintlava River at Ntshakeni has an additional problem of ammonia. This site is directly below a waste water treatment works in Mount Ayliff and the rural community uses this river for their basic domestic needs (washing, drinking cooking), the site is also a cattle drinking point.

Macro Invertebrates/ SASS 5 (Biological Responses): In general water quality conditions suggest mostly minimum impacts with ecosystem still intact, except for Gatberg River site assessment puts the reach at fair with multiple disturbances associated with the need for socio – economic development (commercial forestation, etc).

Fish Assessment (Biological responses): Indigenous fish was only found in Tina River at N2 bridge present ecological status is **C**, Mzintlava at Ntshakeni fish caught here was all alien with present ecological status of **E.** No fish was caught at Mzimvubu River at N2 Bridge and no fish assessment was done at Gatberg River (the site was newly added).

Lower reaches:

Hydrology (system driver): Major flow modification (reduction) would be in the form of water supply scheme and schedule 1 activity from the rural local communities. It is not clear where Flagstaff and Lusikisiki get their water for water supply. There is however a few dams on smaller tributaries. More studies are still outstanding on this subject.

Geomorphology (system driver): Class boundary indicates a general improvement with Mzimvubu River at Bhuje at A (natural and un-impacted) (refer to table 7 and table

Water Quality (system driver): Physiochemical lab report indicates that water quality problems are mainly associated with siltation (turbidity) and high occurrence of ammonia in Mzimvubu River at Bhuje and Mzintlava at Kupoyi. Tsitsa River at Laleni has serious problems with siltation (turbidity) and all other parameters are in compliance.

Macro Invertebrates (Biological responses): General water quality conditions in the lower reaches are rated as good, meaning largely natural with low human induced disturbances.

Fish assessment (Biological responses): Most indigenous fish species were found in the lower reaches (two in Tsitsa River at Laleni and one in Mzintlava River at Kupoyi. *Tilapia spirrmanii was* also caught in Mzintlava River at Kupoyi along with four other alien species. Although Tilapia spirrmanii is indigenous elsewhere in South Africa, it is alien in the Mzimvubu River catchment (it was introduced)..

Conclusion

In terms of water quality, Mzimvubu River system in general has a strong buffering capacity, through dilution and good transport capacity.

High sediment loads are a constant problem in the main stem, and Tsitsa River in the lower reaches being the most affected.

Invasive alien vegetation (Black Wattle) remains a major problem in the upper reaches of Mzimvubu River system.

Building of in channel dams could be a problem in the Mzimvubu River system, as dams would quickly lose storage capacity due to sediment build up (therefore would quickly be turned into wetlands.

While Mzimvubu River system has a high potential for hydro electricity production, it could prove to be very expensive to maintain.

Mzimvubu River system has a surplus of water, access to clean water for basic human needs remains a challenge for most black communities in this catchment and this is a schedule 1 water use activity (an entitlement long overdue).

Poor geology and soils in this catchment could make the land less fit for agricultural activities and most black communities rely on subsistence farming as their income bracket is below the poverty line in most part of the Mzimvubu River catchment.

Recommendations:

- Mzimvubu River system has been under studied and more data still needs to be collected.
- Hydrology data and assessment is required as one of the vital drivers of the ecosystem, mainly environmental flows.
- Requirements for the reference site for the reference sites for each Level I Ecoregion within the catchment.
- Mzimvubu River catchment has a potential for a variety of goods and services and DWA should try where possible to identify income boosting projects at local scale as most indigenous local community lives below the poverty line.
- One of the goods and services provided by Mzimvubu River is alluvial sand mining. Due to geology and soil formation here, alluvial sand is continuously being washed down and replenished in the system. Ntabankulu Local Municipality has already taken an initiative to legalize sand mining in an attempt to boost local income and achieve sustainable harvest of natural resource that appears to be in abundance in this catchment.

- At the very least, DWA should also play a supporting role to this initiative by providing best practice guidelines for sustainable alluvial sand mining in this catchment.

On training needs

Eastern Cape biomonitoring team has come a long way since the implementation of River Health Programme in this region and has a great potential as far as producing high quality mini technical report. DWA Eastern Cape region also has four accredited SASS 5 practitioners (two based in WMA 15 and the other two based in WMA 12).

Some of the gaps identified are as follows:

1. Index of Habitat Integrity and Eco Status modeling.
2. Need more Geomorphologists or increase internal capacity.
3. Hydrological modeling.
4. Riparian vegetation training.
5. Report writing skills, need a standard template seasonal biomonitoring reporting, trends or mini technical reporting.

RQS could come into assistance in two or three of the above training needs.

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