The state of the St Lucia estuarine system – February 2007.

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The purpose of this document is to record the state of St Lucia at the start of year 2007. The drought that started in January 2001 has been long and severe. This document reviews the recent history of the drought and how it has been affecting the ecosystem in the past few months; gives an assessment of the current conditions, and discusses possible scenarios for the near future.

Rainfall:
The graph below (fig 1) shows the deviation from average rainfall for each month. This is a way of illustrating the duration and severity of the drought. This shows that most months since January 2001 the rain has been below average.

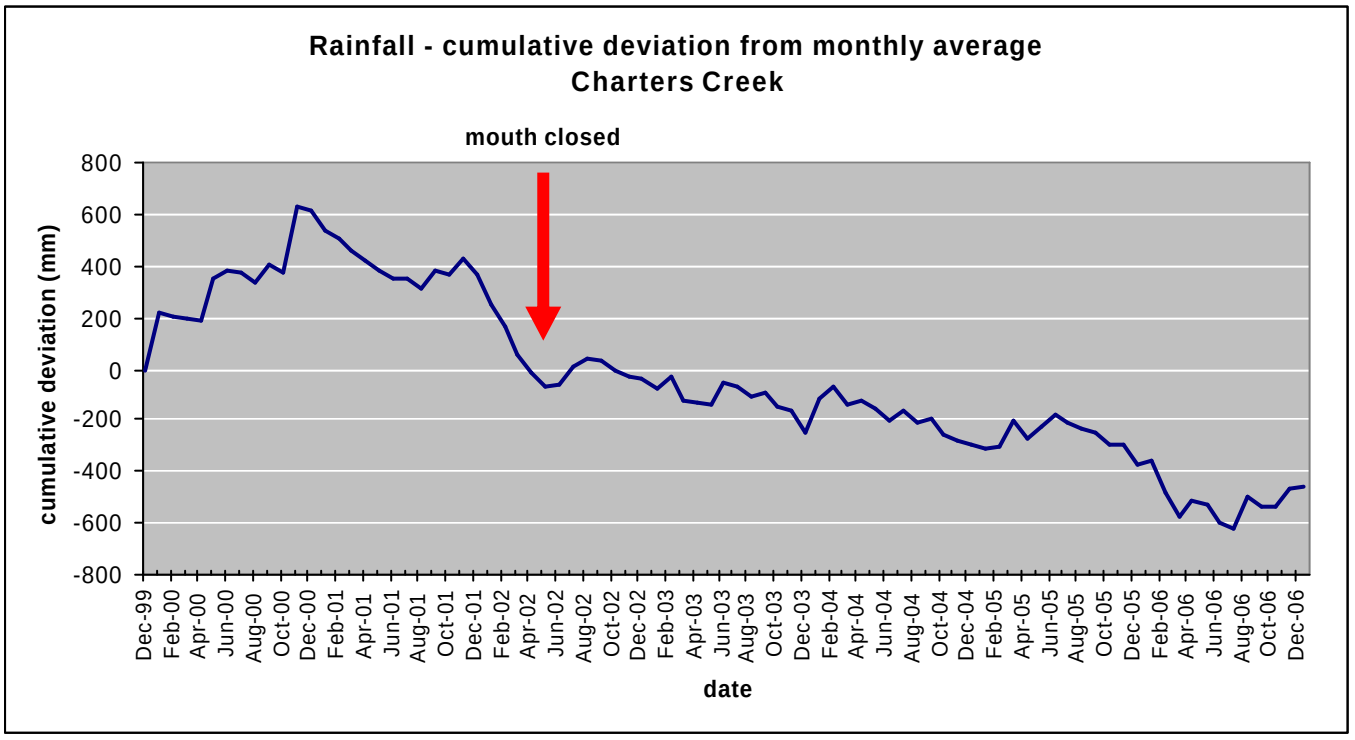

Figure 1. Rainfall. The graph shows the cumulative deviation from the long-term average rainfall for each month.

The below average rainfall trend changed in April 2006 and since then, although there have been months with below-average rainfall, there were above average rainfalls in August, October, November and December. However, the January rainfall was once again below average. We do not know if the overall upward trend will persist, but the predictions from the SA Weather Service indicate that it may. Their predictions for the February to April 2007 period are that there is a 55% chance of the rainfall being normal or above normal for the period (and hence 45% chance of it being below normal). Then for the period March to May 2007 they give a 65% chance of rainfall being normal or above normal (and hence a 35 % chance of it being below normal).

River flow:
As a result of these rainfalls the rivers have started to flow, and by the end of December the Nyalazi and Mzinene were flowing strongly into the Lake. The Hluhluwe River has been flowing into the Hluhluwe

Dam – which was 15 % full in November, and by the start of January had filled to 55 %. The Mkhuze had its first flows under the Lower Mkhuze Bridge in about 5 years in early December. Then with the December rains it overtopped the new Ophansi Bridge in Mkhuze Game Reserve on at least three occasions. It started flowing strongly under the Lower Mkhuze Bridge on 19 December. The Mkhuze Swamp basin is large and takes a lot of water to fill up. By the 3 January the Mkhuze water had not yet reached Lake St Lucia, but by 12 January a strong flow was entering the Lake. With the rising water level in the Mkhuze Swamp, a large number of fields – some of commercial sugarcane had been flooded. The concern is that this is being allowed by the Department of Agriculture. The law of the land forbids the planting of wetlands, and, should this escalate, the long-term consequences will be the destruction of Lake St Lucia. Exactly what has happened in the Umfolozi swampland will happen in the Mkhuze swamp.

In early February, good rains in the upper Mkhuze Catchment again filled the Mkhuze River, ensuring a continuous and strong flow into St Lucia.

Figure 2. Photograph taken on 12 January showing the fields that have been ploughed in the middle reaches of the Mkhuze Swamps. Although this is outside the boundary of the Greater St Lucia Wetland Park, ploughing in wetlands such as this is illegal. If this persists and expands, it will result in altered drainage through the swamp and an eventual loss of the sediment trapping ability of the swamp. The sediments in the Mkhuze River will then be deposited in Lake St Lucia.

The Mpate River continues to be a consistent source of water to the Narrows, and from here is flowing northwards, over a natural "spillway" between Makakatana and Mitchell Island – and then into Catalina Bay. It is likely that the devastating fires of September 2005 that burnt much of the pine and gum

plantation areas within the Mpate catchment area have reduced the transpiration losses in the area, and hence increased the stream flows.

The Umfolozi River has been flowing well most of the time since 5 December. On several occasions in late December and early January it has flooded, overtopping the weir at Riverview which diverts excess water into the Umsunduze River. Under these levels the water also overtops from the lower Umfolozi into the Link Canal downstream of the Intake Works. This has added a considerable amount of water into the Narrows, but comes with the cost of bringing in large quantities of very fine sediments.
The Umfolozi floodwaters have carried quantities of plant debris that have been deposited on the beaches from Maphelane to First Rocks. The Umfolozi sediments have turned the waves in the sea a chocolate colour (Figure 3). This is the catchment topsoil that has eroded, and been carried down the Umfolozi River. In the past these sediments would have been trapped in the Umfolozi Swamps, but nowadays are carried through the canals that drain the sugar fields, all the way to the sea. It is these sediments that prevent us from re-establishing the natural configuration of a combined St Lucia and Umfolozi mouth – where Umfolozi waters were diverted into St Lucia during periods of drought.

Figure 3. The sediment-laden waves off the Umfolozi Mouth, and the plant debris that has been deposited on the beaches. The plant debris will be left on the beach – not removed as it was done in the past – as it breaks down to form compost that enriches the beach and nearshore ecosystems

Water in Lake St Lucia.

The water now covers an estimated 70 % of the surface of the whole lake (Figure 4). The water-body is no longer separated into discrete compartments – except at the Makakatana "spillway" which separates the Narrows from the rest of the Lake. The water in the Narrows is higher than the water in the Lake. It flows over this natural "spillway" into Catalina Bay. The linkage is in one direction only.

Although the surface area of the water has increased by a lot in the past month, the water level is still very low. The water is still extremely shallow and the water volume is still very small relative to when the lake is at average water level. Water levels in the Narrows are higher than in the Lake. The plot of the water levels is shown in figure 5. Water levels in the Lake are monitored by the Department of Water Affairs and Forestry (DWAF). There are delays in obtaining these data.

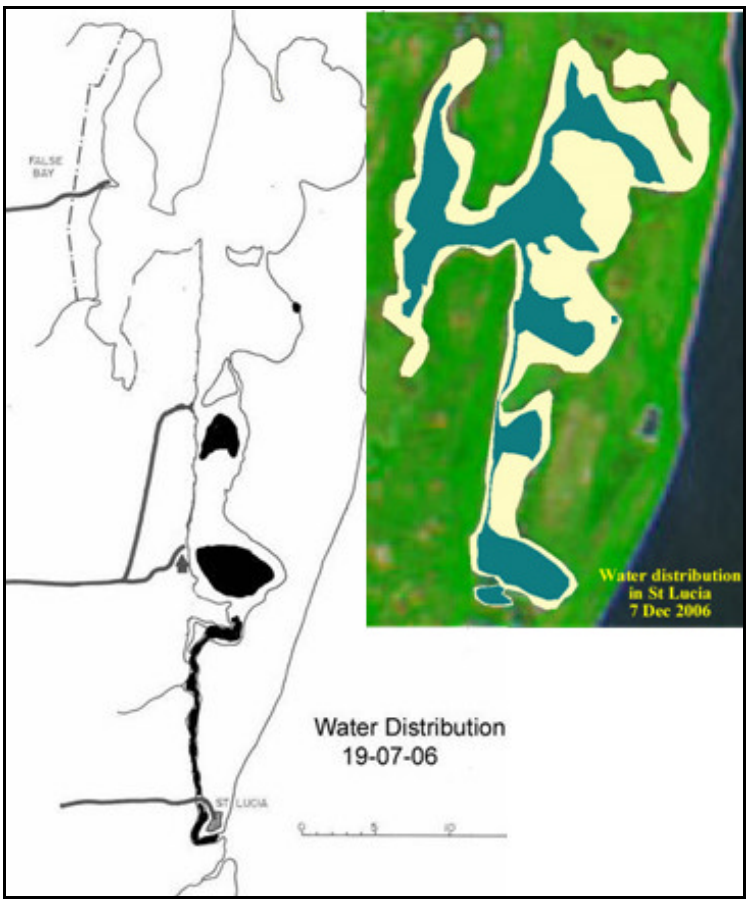

Figure 4: Water coverage of St Lucia in July and in December 2007. Map of 19 July 2006 drafted by Johan Gerber. Map of 7 December 2006 from Greg Nänni – then fitted on the MODIS satellite image taken on that day.

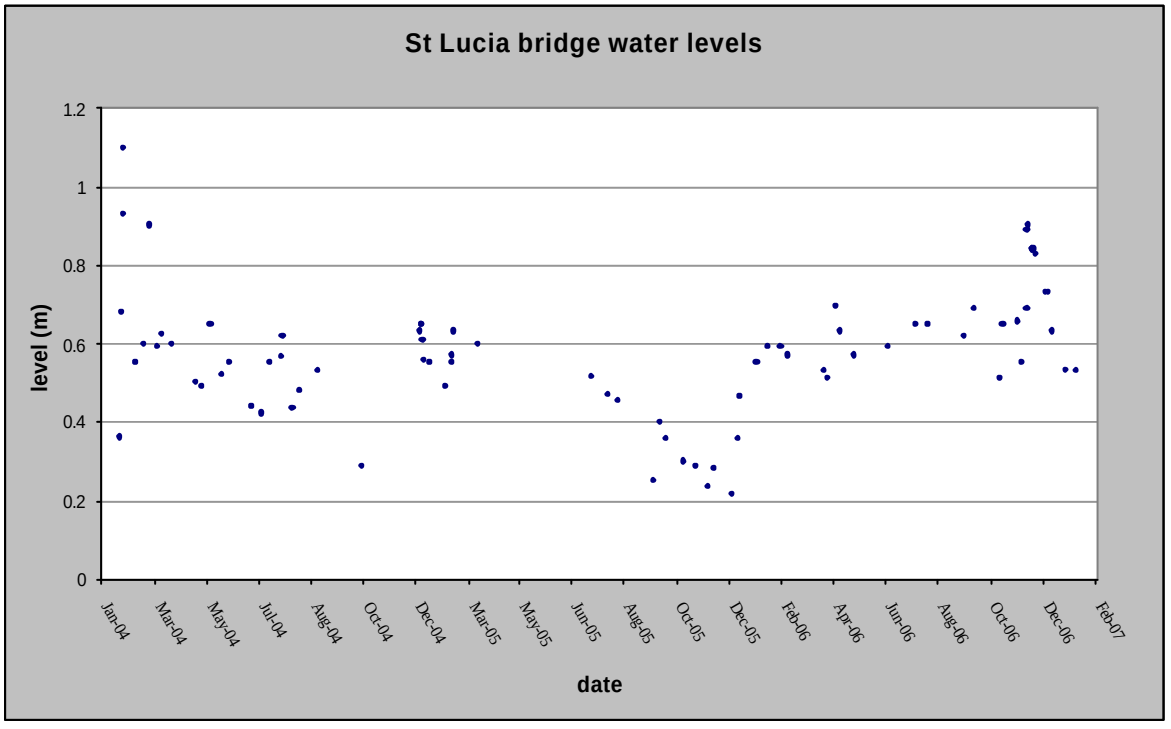

Figure 5. A plot of the water level in the Narrows – measured at the St Lucia Bridge.

Figure 5 shows that the highest water level in the Narrows since 24 Feb 2004 occurred in late December (when the Umfolozi flood overtopped into St Lucia). The 2004 level occurred when the Narrows was still connected to Lake St Lucia. Ever since then the Lake has been lower than the Narrows. The flood overtopping from the Umfolozi in December 2006 temporarily raised the water level in the Narrows, but this has since dropped as water has flowed northwards into the Lake. It reaches equilibrium at the level of about 0.6m on the bridge gauge-plate. The drought was at its most severe in the periods when the water level in the Narrows fell below the 0.4 level. During these periods, such as in September to December 2005 the evaporation in the Narrows exceeded water gains resulting in the severe drop in the water level.

The water level relative to mean sea level is not well understood. Generally DWAF sets their gauges to where the mean lake level is about '1' on the gauge-plate scale.

Figure 6: The Makakatana natural "spillway" between the northern Makakatana Peninsula and Mitchell Is. Water from the Narrows overtops this spillway to flow into the main body of the Lake (see arrow). It will continue to do so until the two water bodies have the same water level and are linked so that water can circulate in both directions

In the picture the Makakatana basin is in the foreground and water is flowing into the Catalina Bay basin in the distance.

As the water level in the Narrows has been rising faster than in the Lake, due to the good inflows from the Mpate River and also from Umfolozi flood waters overtopping into the Narrows, so there has been a net flow of water into the Lake

Salt concentrations:

The natural "spillway" at Makakatana has retained water at a fairly constant level in the Narrows for the duration of the drought. This is because more water is gained by the Narrows than is lost by evaporation. The surplus water flows into Catalina Bay. This net outflow has gradually caused a reduction in salinity in the Narrows (Figure 7).

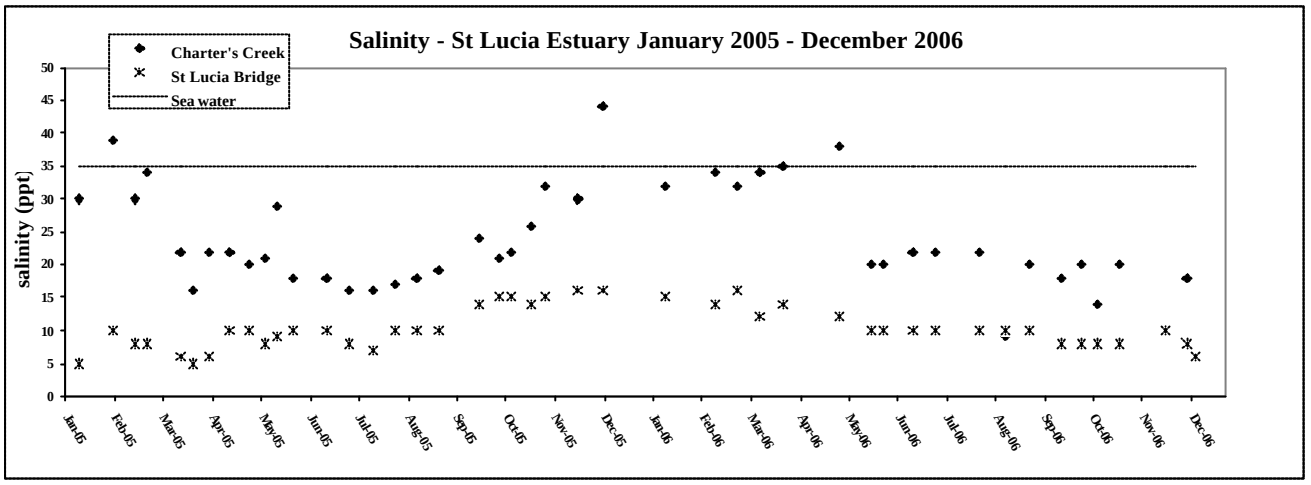

Figure 7. Plot of salinity measured at Charters Creek and at the St Lucia Bridge from January 2005 to December 2006. Sea water salinity (35 ppt) is shown as the horizontal line

The increase in water volume of the main Lake has reduced salinity in the water as shown in table 1.

Site	Salinity (ppt)
Hells Gates	20
Fanies Island	20
Charters Creek	12
Old Jetty	12
Makakatana	5
Narrows	Range 0 to 5

Table 1; Salinity at various places in St Lucia - measured on 9 January 2007.

The salinity figures throughout the system are much lower than expected. It is believed that a considerable amount of salt has blown out of the system, and also that salt has been trapped in the sediments of the lake bed. We do not know how much dust has blown out of the system? Residents in Hluhluwe town complain about the dust blowing into their houses and Figure 8 shows dust accumulated on the lake margins at False Bay.

Figure 8. Lake-bed dust that has accumulated on the periphery of False Bay. Under dry windy conditions dust storms have been observed. Photo by Jos Ackerman.

Vegetation

Normally no submerged water plants grow in the Narrows. But, with the Mouth closed there has been a lowering of salinity and the stopping of tidal or wind-induced currents. Beds of submerged water plants have been growing. In December 2007 these were mainly the plant *Potamogeton pectinatus* (Figure 9), but there is also *Ruppia cirrhosa* and *Najas marina.* In Makakatana there are *Potamogeton pectinatus*, *Ruppia cirrhosa* and *Lamprothamnion* sp. In Catalina Bay there is mainly *Potamogeton pectinatus* with traces of *Ruppia cirrhosa*. In Dead Tree Bay only *Ruppia cirrhosa* was recorded in December.

Figure 9. Aerial photo of the Narrows between Honeymoon Bend to the left and the Mullet Close jetty (bottom right). Note the circular patches of *Potamogeton pectinatus.* Also note the lush growth of *Phragmites* reeds fringing the Narrows and on the oyster-bed islands (mid-left). The water is discoloured by the sediment-laden Umfolozi water that flooded into the Link Canal (the outlet of this is top left). Photo: 12 January 2007.

On the mud flats and exposed shorelines, the rising water levels have now submerged some of the saltmarsh areas – covering the succulent *Salicornia* and *Sarcocornia* plants as well as the saline lawns of *Paspalum vaginatum, Sporobolus virginicus* and also the sedges associated with groundwater seepage (Figure 10). These flooded vegetation areas are attracting numbers of waders and ducks. The warm shallow water is rich in food and provides shelter for small fish (mainly *Oreochromis mossambicus*).

In the Narrows the mangroves are still about 50 cm above the water level. They are dry but healthy.

Figure 10. The shoreline of Dead Tree Bay with Fanies Island in the background. The lake water is starting to cover the sedge lawns which have formed where the plants are supported by groundwater seepage. Photo: 12 January 2007

Animals:

Fish populations continue to be severely affected by the closure of the mouth which prevents movement to and from the sea for spawning. Those fish that are able to breed are multiplying rapidly (e.g. tilapia) and small fish are very abundant in the shallows. The long-lived fish are still healthy. Kob and grunter are often seen and there are still some sharks and rays in Catalina Bay. The brak-water prawns (*Macrobrachium* spp) are abundant in places – especially where there is abundant shelter.

There are significant numbers of birds in the lake – a lot of waders, ducks and herons. There are however few pelicans and low numbers of flamingoes.

For the past couple of years about a third of the total hippo population (318 of about 900 hippo) has been in the Tewate Bay in a basin of about 3 ha in size that is fed by groundwater (Figure 11). Grazing has been good – especially in the rich pan-bottom grasslands, but there has been almost no freshwater north of Tewate. The recent rains have added water to some of the low-lying pans. The about half of the hippos in the Tewate Bay have recently dispersed into these small pans. Generally groundwater is slow to respond and it will take a lot more rain to raise the groundwater table to any degree. Until this happens, the larger pans on the Eastern Shores will remain dry.

The crocodiles in St Lucia are stressed – as there has been little water and little fish food for them. Many of them are in the Narrows. For the second year running the croc nest surveys have shown low nesting numbers – all in the southern parts of the Lake.

Figure 11: Part of the large group of hippos in the Tewate Bay

Umfolozi responses

The Umfolozi Mouth was relocated to close to Maphelane in April 2006. Since then it has again been slowly eroding northwards – and will continue to do so until it eats into the closed St Lucia Mouth. This is undesirable as it will result in a premature breaching of the St Lucia system, and will also then divert all the sediment-laden Umfolozi water into the lake. Monitoring is undertaken to show the rate at which the Umfolozi Mouth moves. (Figure 12)

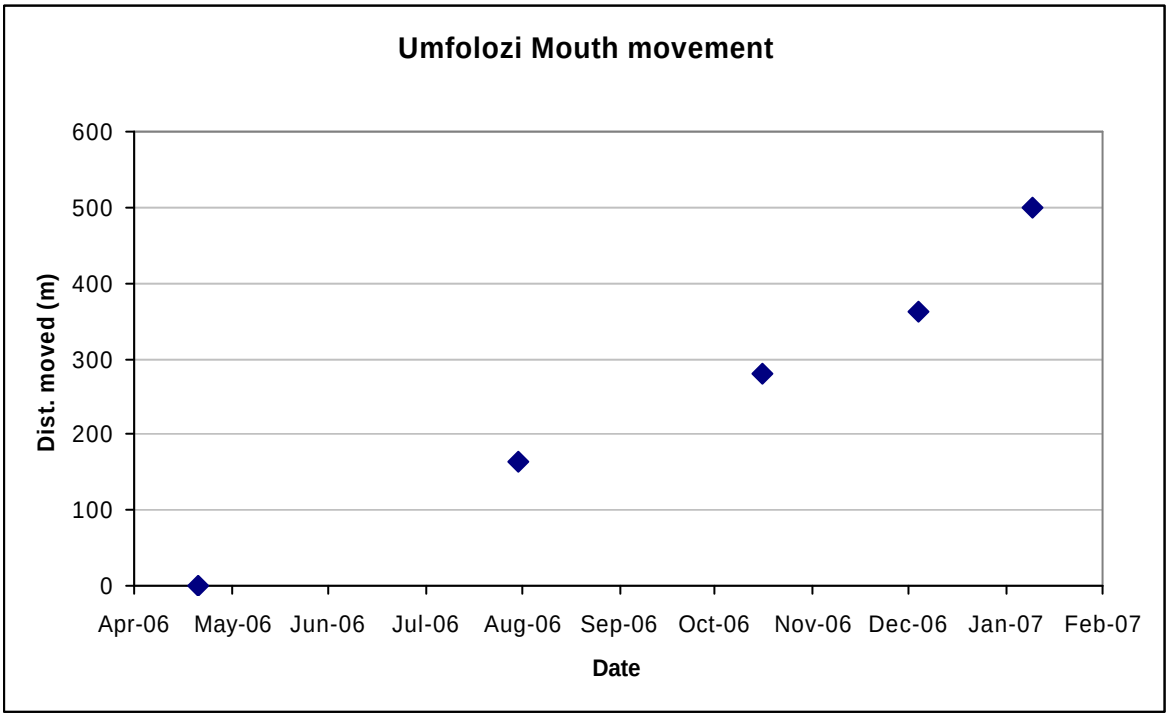

Figure 12: The Umfolozi Mouth was opened close to Maphelane on 21 April 2006. Periodically the position of the mouth is surveyed. This graph shows the movement of this mouth away from the April 21 position.

In the 264 days since opening, the Umfolozi mouth has migrated 500m. This is an average rate of 1.9 m per day. The Umfolozi Mouth is currently (10 January 2007) 850 m from the berm where we closed the Umfolozi the last time. At the current rate of movement, the Umfolozi will be at this berm by the end of March 2008. Note - this rate of movement is not constant so these figures are a guideline only.

Future scenarios

At this stage we do not know whether the drought has broken or whether the rains have provided a temporary respite only.

If the rains do not continue the rivers will once again dry up. Evaporation from the lake is very high and water levels could drop rapidly. If this persists, then we have to continue managing the system as we have been for the past few years by keeping the mouth closed.

However, the catchment areas have been recharged and it is likely that small rain events in the catchment will maintain river inflows. It is a good sign that the Mkhuze swamp has been filled and the river is flowing. This will buffer the system from short dry spells.

If the rains are average or above average the volume of the water in the lake will continue to increase. As this happens salinity will drop and the growth of submerged plants will be very rapid. In the Narrows this may hinder boating. These plants are an essential component of the ecosystem and will attract large numbers of ducks and wading birds. These plants are also important in providing shelter for fish and crustaceans. The system will become very productive. Fish numbers – mainly tilapia (*Oreochromis mossambicus*) – will increase rapidly. As they increase, so the numbers of fish-feeding birds will increase. However, without an estuary-sea link, numbers of the marine-dependent fish and crustaceans will continue to dwindle.

When to breach the mouth:

As water level rises, so at some stage the decision to breach the mouth will be taken. This cannot be left to occur naturally as it will preferentially breach into the Umfolozi Basin rather than directly to the sea. Under normal conditions the combined St Lucia and Umfolozi Mouth would have been closed. All the Umfolozi waters would be diverted into St Lucia, and would then back up into the Umfolozi and Mkhuze Swamps prior to breaching by overtopping the beach berm – which is normally about 3.5 m above mean sea level.

The decision to breach the mouth, and the timing for the breaching, will be informed by the following:

1 **The estuary water level**. This has to be high enough to prevent a strong flow of seawater into St Lucia at high spring tides. At present the water level in the Lake is below that of the Narrows; and, based on the levels relative to the mangrove roots, the Narrows water level is so low that there will be a large inflow of seawater. This will carry with it large quantities of marine sediments, as well as the sea salt (35 kg of salt for every m^3 of water that enters). So we will still have to wait for a significant rise in the lake water level before considering breaching the mouth.

2 **The season (and how much rainy season is still to come)**. January and February are the months when St Lucia and its catchment areas usually receive the highest rainfall – while July to September are the months with the highest evaporation. The seasonal trends do need to be taken into account as it is the most reliable indicator we have of what may occur in forthcoming months.

3 **How strongly the rivers are flowing**. This is an indication of whether these flows are likely to persist or not.

What do we expect when the mouth is eventually breached?

1 Once the water levels are high enough, the mouth will be artificially opened using heavy earth-moving machinery. It is very important that this is done at a time where there will be a net outflow – to widen the mouth and take the sediments seaward – and also so that inflows (at high tide) do not bring in sediments. It is best to open at the early stages of a neap tide when there is least tidal exchange.

2 Out-flowing water will move into the sea, providing the cues that will attract fish and crustaceans into St Lucia. Depending on the season, we expect a lot of animal movement. There will be adults of these, especially fish that want to move in to feed and adult female *Scylla* crabs that have spawned in the sea, but much of the influx will be of larvae of fish, prawns and crabs.

3 Salt water will enter the estuary. The amount will depend on the water level. There will be a "pumping" of sea water into the mouth area by marine tides – and further circulation by wind. It may take a few weeks for water levels to reach an equilibrium level.

4 As salinity rises near the mouth, it will soon exceed the level tolerated by the reeds and *Potamogeton*. These plants will slowly die-back – releasing organic matter which is the basis of the food chain. The remnants of the plants will provide a substratum on which microalgae and bacterial will grow.

5 Without a large salt load, salinity of the system will be low - at less than a quarter that of seawater throughout the system. In the main Lake there will be a massive growth of submerged water plants. These could be so abundant that they reduce wind-circulation effects (currents and seiche effects) and their stilling action will decrease water turbidity. This will allow greater light penetration which could increase the primary productivity of the system.

6 Incoming larvae will have an abundance of food as well as shelter (created by reeds and other water plants).

7 Fish and crustacean populations will build up – from immigrations as well as the rapid growth of small fish in the food-rich environment. It will take a few years for some of the marine fish to grow to full size, but as tilapia are so abundant at present, the overall biomass of fish is likely to be fairly high.

8 The plant growth will encourage the breeding of ducks – and we expect an increase in their populations

9 But – how much will the system revive before the next drought is experienced? This is dependent on the rainfall pattern and how many years before the next drought starts. We need to recognise that droughts are a natural phenomenon, but the lake is very stressed in drought periods because we cannot allow the silt-laden Umfolozi water to enter the system. We must not stop initiatives to look for ways to bring sediment-free water from the Umfolozi River into St Lucia.

Final comments:

In St Lucia, the effects of the drought are still severe.

Minor floods in the Umfolozi have reminded us just how much sediment is carried by the Umfolozi River, and how important it is to artificially keep this river separate from St Lucia while it carries such high quantities of sediment.

Considering everything, the responses of the system to the management strategy of keeping the mouth closed during this drought have been very positive. We are convinced that the St Lucia ecosystem would be in a dire condition had the mouth been artificially opened after its natural closure at the start of the drought..

See also the document "**St Lucia- the big picture**" at the internet site:
http://www.kznwildlife.com/PDF/stlucia_bigpicture.pdf

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