

SOME COMMENT ON THE DIVERSION OF THE MKUZE RIVER
INTO LAKE ST. LUCIA

1 Introduction

1.1 A $13\frac{1}{2}$ km long canal has been excavated from the Mkuze River near Mpempe Pan to a point in the swamp 1 km south of Demezane Pan. Over the last $4\frac{1}{2}$ km the canal follows the existing river channel through the swamp.

1.2 Concern has been expressed that the canal may introduce sediment into the lake and that it may drain part of the swamp. The purpose of this short report is to comment on the possible effects of the canal on the swamp, and to describe the observation network that has been installed by the Division of Hydrology of the Department of Water Affairs.

2 The hydrology of the Mkuze swamp

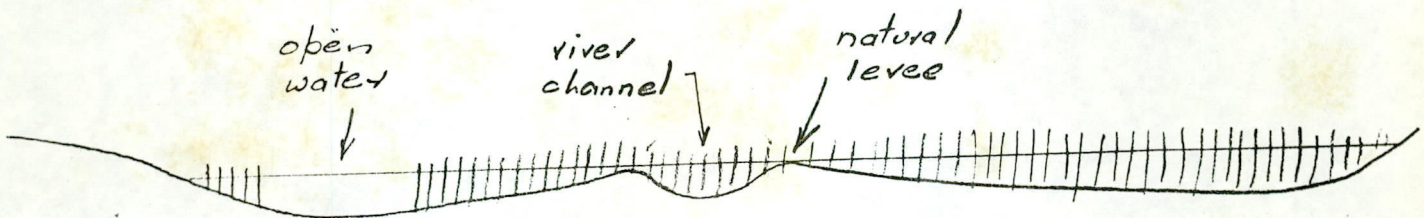
2.1 The gradient of the Mkuze River east of the Lebombo mountains is very flat with the result that the river banks are easily overtopped by flood water. The velocity of the water is reduced by the vegetation on the banks, and the coarser sediment is deposited on the banks forming natural levees. The river will continue elevating its banks and channel. The meander pattern is fairly stable but will move progressively downstream. Occasionally the river will abandon its channel and take a new course.

2.2 While sediment will be progressively deposited across the whole flood plain, the rate of deposition is generally highest close to the river. The areas closest to the valley sides are therefore usually lower than the river banks.

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2.3 The east flowing Mkuze River has also formed a delta where it enters the north-south oriented lake system. This is the main area of sediment deposition. Only the finer material has been transported through the swamp to the lake, and then only during high floods.

2.4 The river has rather unexpectedly maintained a clearly defined but reed-choked channel right through the swamp and into the lake. The river banks within the swamp are also higher than the adjacent ground which slopes away from the banks towards the sides of the valley.



Typical section through swamp (exaggerated vertical scale).

2.5 After a dry winter the general water level in the swamp will be well below the level of the river banks, and there will be little or no flow down the river channel towards the lake.

2.6 The first spring flows will flow down the top end of the channel, but due to the resistance offered by the reeds in the channel, the banks will be overtopped and water will flow into the adjacent low lying areas. Little of the incoming water will reach the lake.

2.7 This process will continue until the swamps become

progressively/.....

progressively "charged" from the upstream (northern) end.

- 2.8 Once the swamps are fully charged, most of the subsequent flows will pass through the swamps (via the channel as well as the adjacent areas) into the lake.
- 2.9 In a dry season the swamps may not become fully charged. On the other hand a single large flood could pass right through the swamps into the lake.
- 2.10 At the end of the season the water will continue to drain out of the swamps towards the lake until the water level drops below the level of the river banks. Thereafter flow from the swamps into the river channel will cease, but there will still be sufficient water available behind the levees to maintain the swamps until the following season.
- 2.11 There may be places where the levees have been breached allowing flow into and out of the river channel, but these would normally be healed by the natural geomorphological processes.
- 2.12 Under natural conditions, fresh water can be expected to reach the lake in late summer and to keep flowing for several months after the last flows have entered the top end of the swamp.
- 3 The effect of the canal on the flow into the lake
- 3.1 Minor spring flows will follow an unobstructed path down the canal. More fresh water will reach the lake than previously, but correspondingly less water will flow out of the canal into the adjacent swamp. The dumping of canal spoil along the banks will further inhibit flow out of the canal/.....

canal, particularly where the spoil is on one side of the canal only.

3.2 Floods will overtop the banks as before, but flood-water will drain more readily from the swamp until the water level drops to that of the levees.

3.3 The net effect of the canal will therefore be that a greater volume of water will reach the lake earlier and more frequently during the summer season than before, but the flow will subside more rapidly, leaving a significantly reduced fresh water flow during winter.

3.4 The adjacent swamp will be charged less frequently than before and may not be fully charged particularly in the lower reaches, by the end of summer. It will therefore be more vulnerable to prolonged droughts.

4 The effect of the canal on the drainage of the swamp

4.1 The natural levees are composed of fairly impervious material, so large scale seepage from the swamp into the dredged canal is unlikely to occur.

4.2 However, where the natural levees are breached by the canal there is a distinct possibility that the canal may drain these bodies of water. This has already occurred at Demezane. Temporary locks were subsequently placed to close off the main canal as well as the access canal, but there is a serious risk that the locks may be breached by leaks, hippo's or freshets in the river channel. If this occurs the water level in Demezane and ~~Nulaka~~ could be dropped by a metre in a matter of weeks.

4.3 Where the canal has been excavated through the low
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lying area between Mpempe and Ngwenya, the natural drainage is towards the canal, and only the material excavated from the canal prevents it from acting as a drain. Our flow gaugings have shown that there is an accretion of water in this reach indicating that some water from the adjacent ground is being drained into the canal.

4.4 Mpempe pan is connected directly to the canal, and water is presently flowing out of Mpempe into the canal. The flow is small and insignificant in its contribution to the lake, but highly significant as far as Mpempe's future is concerned.

4.5 The canal is presently diverting practically all of the low flow out of the Mkuze River.

5 The effect of the canal on sediment transport

5.1 The canal was not excavated to a predetermined size and gradient. In places it is too steep and is actively eroding its bed and banks (notably downstream of Mpempe), while in the vicinity of the second road bridge a lot of sediment has been deposited in the canal because the gradient is too flat. Much of this sediment has been derived from the scoured section upstream.

5.2 The velocities in the canal will generally be higher than those in the Mkuze River upstream of the intake, so the natural sediment in the water when it enters the canal is likely to be carried right through the system until the velocity is checked in the reeds of the swamp or when it enters the lake. The reeds effectively remove the sediment for low flows and must reduce the load considerably in times of flood. (The water in Demezane pan is still turbid, whereas it is much clearer in the nearby Ndlaka pan and crystal clear at the airboat section).

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5.3 Only a relatively small proportion of the sediment load of the Mkuze River could have reached the lake in normal times. The canal will increase this amount, but the total volume will probably be small. The actual rate of sediment movement will only be known after a full season of regular sampling.

5.4 The gradient along the canal route is steeper than the longer route followed by the river itself. This, together with the lack of vegetal obstruction along the first 5 km of the canal, will provide a preferential route for floodwater entering the swamp. There is therefore a serious risk that an abnormally large proportion of the water of a high flood may flow along this route and cause major scouring and re-deposition of sediment in the Ngwenya flats or further into the swamp. In my opinion it is essential that the volume of water entering the canal be controlled by headworks across the canal just south of Mpempe pan. The flow into the canal could then be limited to its safe non-scouring capacity.

6 Other effects of the canal

6.1 Bantu have free access to the canal. The possibility of bilharzia being propagated in this way should be investigated, and if necessary the canal should be fenced and drinking points provided.

7 Erection of observation network

7.1 The purpose of the recently erected observation network is to provide the necessary data for the evaluation of the rate and volume of water and sediment transport through the swamp, and the possible drainage of the swamp by the canal.

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7.2 During the period April to June, 1973, personnel of the Division of Hydrology of the Department of Water Affairs erected the following stations:

Water level recorders :

- (i) Mbazwan - open water
- (ii) Demezane - on the main canal downstream of Demezane pan
- (iii) Airboat section - on the river channel

(There are two NPA recorders at Mpempe and Demezane pans, and the Division of Hydrology has another two recorders on the Mkuze River upstream of the swamps)

Staff gauges :

- (i) "Butterfly" pan - free water surface
- (ii) Tshangwe pan - free water surface
- (iii) Ndlaka pan - free water surface
- (iv) Airboat section - ten points along section

Flow gauging stations :

- (i) Mkuze River at Thring's store
- (ii) Mkuze canal upstream of Mpempe pan
- (iii) Mkuze canal downstream of Mpempe pan
- (iv) Mkuze canal downstream of Ngwenya pan
- (v) Mkuze canal upstream of Demezane pan
- (vi) Mkuze canal downstream of Demezane pan
- (vii) Demezane access canal
- (viii) Mkuze River in airboat section.

8 Levelling traverses :

8.1 All of the above stations have been tied in to the Trig. Survey datum except the flow gauging station at Ngwenya.

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- 8.2 The Mpempe - Mbazwan - Butterfly - Tshangwe traverse was tied in to the Water Affairs beacon BM2 at Mpempe Pan. The ground control beacons at Mpempe and Ngwenya were included in the traverse, as well as the old Trig. Survey beacon at Ngwenya and the flow gauging stations near Mpempe.
- 8.3 The ground control beacons at the airboat section and Demezane were tied in to Trig. Survey beacon "Mission A" near Ezimbondweni. The staff gauges in the airboat section, Ndlaka pan and the Demezane access canal were included in the traverse. The most difficult traverse was that along the airboat section.
- 8.4 The levels of the flow gauging stations in the main and access canals and the recorder on the main canal at Demezane were related to the gauge plate at the recorder on the Demezane access canal by using the still water level as datum (there was no flow in the canals). This may be subject to a small error.
- 8.5 Except for the Thring's store-BM2 and "Mission A" - Demezane traverses all levelling was done by technicians of the Division of Hydrology. This was done to normal standards, no attempt being made to achieve precise levelling standards. The levels may have to be corrected after the establishment of the ground control network.
- 8.6 The reduced levels of the various observation points are as follows:-

9 Observed canal flows

9.1 The following schedule shows the measured canal flows on 3rd and 22nd May. By the middle of June there was still some flow in the canal, but this was too small to warrant gauging (all flows in cumecs).

<u>Station</u>	<u>3rd May</u>	<u>22nd May</u>
Thrings	0,15	0,007
u/s Mpempe	0,29	0,006
d/s Mpempe	0,30	0,012
Ngwenya	0,35	0,015
u/s Demezane	0,23	-
access Demezane	0,46	-
d/s Demezane	0,74	-

The drainage from Mpempe and Demezane pans, the accretion between Mpempe and Ngwenya, and the loss between Ngwenya and Demezane are clear from the table.

9.2 The flows in the airboat section could not be gauged. However, by using fluorescene dye, it was found that there was a southward movement of water at a velocity of about one metre per minute in the section to the west of the river channel, but no flow in the eastern section of the swamp. There was also no connection between the water in the river channel and the water on either side of it.

10 Water quality observations in the airboat section

10.1 The results of pH and conductivity analyses of water samples taken at the 10 stations in the airboat section are as follows:-

Station No./.....

WATER QUALITY OF SAMPLES IN AIRBOAT SECTION

STATION No.	CHAINAGE m	23/5/73		16/6/73		REMARKS
		pH	EC	pH	EC	
AB.1	0	7,0	1 010	-	-	West bank, papyrus
AB.2	500	7,3	870	7,5	1 000	Reeds
AB.3	1 000	7,7	2 200	7,7	2 950	Papyrus
AB.4	1 500	7,0	820	6,7	1 020	River channel
AB.5	2 500	6,9	930	6,7	3 100	River channel
AB.6	3 000	7,1	810	6,7	890	Old bed, papyrus
AB.7	3 500	6,9	640	6,7	740	Papyrus
AB.8	4 000	6,9	900	6,8	900	Papyrus
AB.9	4 500	6,7	1 050	6,6	1 070	Papyrus, reeds
AB.10	5 000	-	-	6,4	640	East bank, reeds

10.2 The differences in conductivity are larger than one would expect. Future sampling should throw more light on the possible causes.

10.3 Sediment analyses of samples taken at the beginning of May all showed values of less than 0,1%. Much of the solid constituent consisted of vegetal matter. Water in the airboat section was clear but noticeably clouded with flocculated sediment when disturbed. Water in the canal and Demezane pan still contained colloidal sediment in suspension.

11 Recommended additional works

11.1 Some of the views expressed in this report may have to be modified as more data become available. Urgent attention should nevertheless be given to the following:-

11.2 The construction of headworks across the canal near Mpempe to control the flow into the canal in times of flood.

11.3 Re-grading of the canal to prevent further erosion and deposition of sediment.

11.4 Trimming the canal banks to a stable slope and depositing the spoil in a bund to prevent flow into the canal from the surrounding ground (in the Ngwenya flats).

11.5 Fencing the canal and the provision of stock and household watering points.

11.6 Raising the outflow from Mpempe pan to prevent it from being drained by the canal, but still allowing flow into the pan at higher stages.

11.7 Replacing the two pipe bridges across the canal with

permanent/.....

permanent structures having unrestricted waterways.

11.8 The provision of permanent controls in the main and access canals at Demezane to prevent the canals from draining the water in the Demezane and Ndlaka pans, but at the same time allowing higher flows to enter the pans.

11.9 Water Affairs will build a Parshall Flume in the main canal downstream of Mpempe to measure the flow being diverted towards the lake.

12 Regular observations

12.1 Regular observations are vital for the prediction of the behaviour of the swamp/lake system. These should consist of the following:

12.2 Flow gauging. The Parshall Flume will provide a continuous record of the flow in the canal downstream of Mpempe. Hydro will assist in current gaugings at the remaining sites along the canal when time allows. Only sporadic gaugings will be possible.

12.3 Water level observations. All recorders will have to be serviced and charts changed at 28 day intervals. Gauge plate readings should be taken at the remaining sites at the same time.

12.4 Water samples should also be taken monthly at all observation sites. Hydro will provide the bottles and carry out the chemical and sediment analyses.

13 Ecological aspects

13.1 It is most important that the present ecological state of the system be determined in such a way that early detection of adverse changes can be made. These could then

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be correlated with the hydrological data.

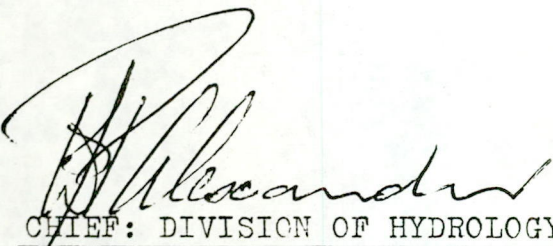
14 Extension of the canal

14.1 In my view, the present canal should not be extended until:-

- (i) Headworks have been constructed, the gradient in the Mpempe - Ngwenya reach has been rectified, and permanent water level controls have been installed in the main and access canals near Demezane.
- (ii) Observations have shown that there is no danger of parts of the swamp being permanently damaged or unacceptable volumes of sediment introduced into the lake, or that the benefits from the additional water introduced into the lake outweigh the disadvantages caused by the extension of the canal.

15 Acknowledgements

15.1 The investigations mentioned in this report could not have been carried out in the available time without the kindly assistance of Mr van Niekerk and his staff, and Mr Blok and his staff. My own staff worked with enthusiasm and ingenuity to overcome some rather unusual problems.


CHIEF: DIVISION OF HYDROLOGY

PRETORIA

20th June, 1973.