

A report to Nature Uganda on

WATER QUALITY ASSESSMENTS IN THE OPETA BISINA AND MBURO-
NAKIVALE WETLAND SYSTEMS

BY

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1.0 Introduction

Wetlands are among the most important ecosystems on earth. They have been described as the kidneys of the landscape because they function as the downstream receivers of water and waste from both natural and human sources (Mitsch & Gosselink, 2007). They stabilize water supplies, thus ameliorating both floods and drought. They serve as sources, sinks, and transformers of nutrients; and they are among the most productive ecosystems on the planet when compared to adjacent terrestrial and deep water aquatic systems. A detailed account of wetland functions is presented in Keddy (2000).

Factors such as temperature, electrical conductivity, dissolved oxygen; turbidity and pH interact to influence the abundance and distribution of biodiversity in wetland ecosystems. Variation in these parameters is influenced by the underlying geology, climatic factors, and land-use practices within the landscape. For example conductivity may increase in wetlands draining intensively cultivated watersheds and urban areas. An assessment was carried out on the above parameters in order to establish their baseline condition and explore possible human impacts on the wetlands.

2.0 Study sites and Methods

2.1 Study sites:

Opeta Bisina wetland system

It is located in eastern Uganda. The wetland system is characterized by open water that is clear with some emergent vegetation mainly of sedges and floating vegetation dominated by the day water lily *Nymphaea* sp and submerged water weeds. Some patches of *Cyperus papyrus* exist in areas with minimal agricultural encroachment. The main inflow into the Opeta system is through River Sironko.

Five sites were sampled on both Bisina (3) and Opeta (2). The Bisina sites were 1. Akidye landing site. It is located on the north-eastern end of Lake Bisina and was accessed from Kumi town. 2) Kakor village landing site. Most of the shore to this site is grazing land and it is located where water fowl counts are undertaken (starting point) and 3) Site is located towards the southern end of Lake Bisina but on the western shore of the Lake overlooking the rocks/hills on Soroti Kumi road. The point is located where the water fowl crew usually rests. The two points on Opeta were located, one on the northern end of the lake at Agule village landing site in Opeta Parish. The immediate environs of the site are characterized by overgrazing and bush burning seems prevalent in the area. The second site on Opeta was located on River Sironko to get an insight into the quality of water flowing into the wetland.

Nakivale-Mburo wetland complex

The wetland complex is located in western Uganda in the districts of Isingiro and Mbarara. The main inflow into the wetland system is via River Rwizi that divides up downstream supplying water to both Lakes Nakivale and Mburo. The Nakivale water is

mainly turbid with a greenish colour probably due to high concentrations of algae. Lake Mburo water is relatively less turbid compared to the Nakivale water. Shores of Lake Mburo and most of its catchment are relatively in pristine condition as opposed to those of Nakivale whose eastern end is mainly agricultural.

Ten sampling sites were located within the Nakivale-Mburo wetland system both on the open water of the lakes and in streams and rivers draining into the wetland system. The sites were 1) River Rwizi just above the bridge on Mbarara-Kabale road, characterized by fast flowing water. 2) Kahirimbi landing site on Lake Nakivale characterized highly turbid waters. The eastern side of the shore is mainly agricultural land settled by refugees while the western end of the site comprises of forested hills with a mixture of grazing fields, and a papyrus swamp close to the lake shore. 3) Rukinga landing site on Lake Nakivale is similar to Kahirimbi in catchment condition but with the eastern side highly impacted by agriculture. 4) Kashojwa landing site directly opposite River Rwizi inflow into Lake Nakivale. 5) Kagogo site, located on the arm of the Rwizi river that flows into Lake Nakivale. Slow flowing water in a mainly papyrus swamp. 6) River Rwizi arm flowing into Lake Mburo. This constitutes the main river Rwizi channel that is fast flowing; site is located approximately 3km from Lake Mburo. The site is located in a pure stand of *Cyperus papyrus*. 7) Kigaaga river- it appears to be the main inlet into Lake Nakivale and is characterized by slow flowing water in a savannah type of vegetation. Most of the watershed of this river is composed of pastureland. Emergent sedges and the water lily were some of the aquatic plants at the site. 8) A small stream flowing by the roadside approximately a km from Isingiro town on the Mbarara road. It is an inlet into Lake Nakivale. This was sampled to gauge the quality of water flowing into Lake Nakivale and to assess whether water quality in the catchment has an influence on the quality of water in the lake. 9) Lake Mburo at a point where river Rwizi enters the lake. The site is characterized by dark waters at the interface of open water and a papyrus swamp. 10) Lake Mburo in the middle/ open water site. This was located in the middle of lake in order to determine whether the Rwizi waters have an influence on the general water quality of the lake.

2.2 Field sampling

Various water quality parameters were measured at each site. They were; dissolved oxygen, surface water temperature, electrical conductivity, pH, total dissolved solids (TDS) and turbidity/water colour. Water depth was measure at sites where it was possible. All sites were georeferenced with a Global Positioning System (GPS, Model GPSmap 60Cx) and altitude was also read from the GPS.

2.2.1 Dissolved oxygen (mg/l)

Is a crucial requirement of all life in water. It is normally saturated in fast flowing rivers. It is however expected to drop with a reduction in river discharge and an increase in water temperature. Other human impacts such as pollution may alter the concentration of oxygen. Dissolved oxygen was measured using an oxygen meter (Model 76390 YSI 95). This was measured both at the surface and the bottom where site depth was greater than 50 cm.

2.2.2 Electrical conductivity ($\mu\text{S cm}^{-1}$)

This is a measure of the ability of water to conduct electricity. It varies with level of human activities in the watershed and the nature of the underlying geology. It also varies with season being lower in the wet season and higher during the dry seasons.

Conductivity and temperature were measured using a conductivity, salinity and temperature meter (Model 76244 YSI 30). Surface water temperature is influenced by other covariates such as the time of the day, the time of the year, and the air temperature at the time of measurement. Time of the day was therefore recorded wherever measurements were made.

2.2.3 pH

Is a standard measure of the hydrogen ion concentration of the water and is represented using a logarithmic scale. pH was measured using a digital pH meter (Model PHEP 5 TESTR)

2.2.4 Turbidity/water colour

This was assessed mainly based on the colour of the water and on whether it was possible to see the bottom of the lake or river. For example a river draining a wetland/papyrus swamp would have dark water that is not necessarily turbid whereas brown water would result in water bodies draining agricultural or urbanized watersheds.

2.2.5 Total dissolved solids (ppm)

Total dissolved solids a measure of suspended sediment was measured using a TDS Testr Low model, Oakton Instruments.

3.0 Results and discussion

There was variation in water quality parameters between the two wetland systems. The wetlands in the Bisina-Opeta complex were characterized by clearly shallow waters and high surface water temperature compared to the Nakivale Mburu system. Temperature ranged from 22.6 to 30.9 °C in the Bisina Opeta system while it ranged from 19 to 24.9 °C (see table 1). Temperature tended to be lower in sections of the wetlands with flowing water such as in the Sironko river (22.6 °C) draining into the Opeta wetland and in the Rwizi River (19 °C) draining into the Mburu-Nakivale system. Surface water temperature is influenced by other covariates such as the time of the day and the air temperature and accordingly water temperature tended to be lower in the morning than in the late afternoons at all sampled sites.

Electrical conductivity varied from 153.7 to 437.1 $\mu\text{S cm}^{-1}$ in the Bisina Opeta system, the lowest value being recorded in river Sironko that drains into Lake Opeta. Conductivity was much higher in the Opeta system compared to Lake Bisina. Conductivity varied highly in the Mburu-Nakivale system ranging from 117.1 $\mu\text{S cm}^{-1}$ in River Rwizi upstream to 1423.5 $\mu\text{S cm}^{-1}$ at Kigaaga, a major inflow into Lake Nakivale. The Lake Nakivale waters were the most saline of all sampled sites. According to Beadle

(1974), for most ecological purposes, except for very saline waters, conductivity reflects sufficiently closely the total concentration of the major ions and thus the salinity. Thus, it appears that Lakes Mbuoro and Nakivale drain catchments that differ in geology and therefore mineral composition with the result that Lake Mbuoro is less saline than Nakivale. Total dissolved solids (TDS) varied in a similar pattern as conductivity being highest in saline waters (900 ppm at Kigaaga) and lowest in freshwater/riverine sites (lowest, 70ppm in River Rwizi Wetland). The progressive drop in TDS from upstream sites as the water flows through papyrus swamps shows that the wetlands are performing an important ecological function of sequestering ions from the water. The differences in conductivity and TDS between Nakivale and Mbuoro systems probably shows little or no hydrological connection between the two lakes or the dilution effect of the Rwizi waters on Lake Nakivale is negligible.

Dissolved oxygen was much lower in the Bisina- Opeta compared to the Mbuoro-Nakivale system. It ranged from 3.03 to 7.23 mg/l in the Bisina-Opeta and 6.3 to 9.9 mg/l in the Nakivale Mbuoro system. The differences in dissolved oxygen might have important implications for the aquatic biota found in the two wetland systems. Thus productivity could be lower in the Bisina-Opeta system compared to the Nakivale-Mbuoro system. Casual observations on the fish catches on some landing sites of the two wetland systems showed that fish sizes were larger on the Mbuoro-Nakivale system than on the Bisina-Opeta.

Turbidity was estimated visually from the color of water. Generally waters of the Bisina-Opeta system were much clearer than that of Mbuoro-Nakivale which was mostly turbid ranging from dark to greenish colour. The dark colour of the Rwizi water may be attributed to the high concentrations of humic acids as a result of decomposition in the papyrus swamps and the fact that the river drains an agricultural watershed upstream. The greenish colour of Mbuoro-Nakivale waters is likely a result of high concentration of phytoplankton in the two lakes.

Cluster analysis (Fig 1) shows a clear separation of sites based on their physicochemical characteristics. Three major clusters were evident and they included the Bisina-Opeta complex, The Rwizi Mbuoro system that also clustered with the River Sironko site were characterized by low conductivity, low water temperatures and low TDS. The last cluster composed of Lake Nakivale sites and its tributary sites characterized by relatively high conductivity. The separation of sites/wetland types based the measured physicochemical parameters is proof that the variables can be used as indicators of wetland condition. That is, by measuring water quality, one is able to gauge the conservation status of a wetland as the variables are likely to change with wetland modification or degradation. Apart from anthropogenic impacts, the fundamental controls of background water quality are climate, geology, soils, topography and biota (Petts & Amoros 1996).

3.1 Conservation Implications

The water catchments of the two wetland systems are impacted to different levels by human activities. For example, River Sironko that drains into the Opeta system is highly turbid from agricultural activities implying that if conservation measures aimed at

maintaining or improving water quality in the wetlands are to be implemented, these efforts should not be restricted to wetlands systems only but should also take into consideration the upstream sources of the water. The Mbuoro-Nakivale system catchment appears to be better conserved than the Bisina-Opeta system as the most of the shoreline has been converted to pastureland in the latter. Several fishermen talked to on both wetland systems reported receding water levels in the lakes. Thus, a timely intervention to reverse or slow down this negative trend is recommended especially with the threat of global warming.

Wetland	Site name	DO(mg/l)	DO temp	TD S	Cond	cond temp	pH	Depth(cm)	Turbidity	Time	Northing	Easting	Altitude
Bisina	Akidye	3.84	26.9	175	285.5	26.9	7.1	130	Clear	morning	617420	180118	1043
Bisina	Kakor WFC	5.84	27.9	200	316	30	8.1	200	Clear	Noon	593886	184770	1041
Bisina	WFC end	7.17	30.7	205	321.1	30.9	-	167.5	Clear	afternoon	595908	187729	1040
Mburo	Rwizi-bridge	7.83	19	80	117.1	19	7.8	-	Dark	morning	237786	993164	1391
Mburo	Kagogo	6.25	19.6	75	149.4	19.5	7.3	78	Dark	morning	264621	992377	1263
Mburo	Rwizi-swamp	6.80	19.7	70	123.2	19.7	6.7	174	Darkbrown	morning	264739	992383	1261
Mburo	lake edge	6.79	22.5	90	140.9	22.9	8.3	-	Dark	Noon	269182	992352	1253
Mburo	mid-lake	8.19	22.8	90	144.6	23.05	7.8	-	Clear	afternoon	270304	992694	1253
Nakivale	Kahirimbi	7.59	24.4	430	727	23.8	12.2	99	Greenish	Noon	261362	990939	1249
Nakivale	Rukinga	9.9	23.7	420	678.5	24.9	12.5	190	Greenish	afternoon	266040	991294	1245
Nakivale	Kashojwa	9.85	23.7	390	642	23.8	12.6	63	Greenish	afternoon	268269	991590	1249
Nakivale	Kigaaga	9.63	20.8	900	1423.5	20.6	8.2	60	Clear	noon	260873	992280	1266
Nakivale	Stream	8.61	24	360	598	24	7.5	10	Milky	afternoon	256051	991366	1302
Opeta	Agule	3.03	27.02	285	437.1	27.3	-	67.5	Clear	morning	626815	184042	1046
Opeta	Sironko	7.23	22.6	90	153.7	22.6	-	60	Brown	noon	641104	152134	1063

Table 1 Mean water quality variables at the sampled sites. A – shows that variable was not measured at a site.

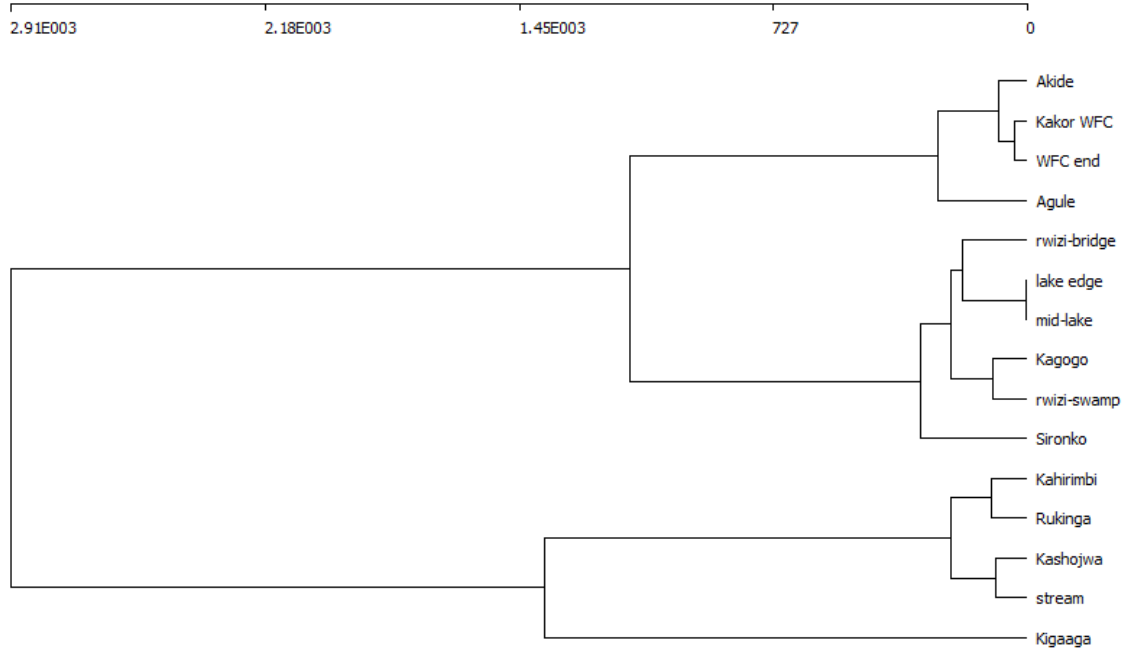


Figure 1 Dendrogram showing clustering of sites based on physicochemical variables. Sites that cluster together are similar in variables measured.

References

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