The Present Economic Value of Nakivubo Urban Wetland, Uganda

L. Emerton, L. Iyango, P. Luwum and A. Malinga

September 1999

NATIONAL WETLANDS CONSERVATION & MANAGEMENT PROGRAMME

IUCN
The World Conservation Union

BIODIVERSITY ECONOMICS FOR EASTERN AFRICA

CONTENTS

FIGURES AND TABLES

1. INTRODUCTION TO THE CASE STUDY

Throughout Eastern Africa wetlands are being modified – because their resources are being over-exploited and their lands converted to other uses, as well as through the implementation of upstream developments which alter the quality and flow of water which feeds them. A major reason for this is that the economic value of wetland goods and services is poorly understood. Wetlands, their resources and hydrological functions are modified, degraded and interfered with because they are seen to have little or no value as compared to other "developments" which yield more immediate and obvious profits.

The case of Nakivubo wetland in Kampala, Uganda, illustrates these issues. Nakivubo makes a number of contributions to economic activity. As well as treating and purifying domestic and industrial wastes and effluents, and thereby maintaining the quality of urban water supplies, wetland resources support a range of small-scale income-generating activities for adjacent slum dwellers. Nakivubo is also being reclaimed for industrial and residential expansion. Although financial and economic analysis have played a major role in encouraging and justifying the spread of industrial developments and urban settlement into the wetland, none has ever considered the economic costs associated with these developments. Decisions have been made on the basis of only partial information, because they have omitted any consideration of the value of the wetland itself. This study aims to investigate, and quantify, the economic values associated with Nakivubo wetland products and services.

The study was carried out over a 3 week period during March and April 1999 as a collaborative exercise between the National Wetlands Programme (NWP) and IUCN-EARO Biodiversity Economics Project. Study Team members included Lucy Emerton (IUCN-EARO), Lucy Iyango (NWP), Willy Kakuru (NWP), Phoebe Luwum (NWP) and Andrew Malinga (NWP). Data was collected through a series of interviews carried out with Uganda Government, community members living around Nakivubo, local councillors and from a review of relevant literature. In addition to this report, the findings of the study were presented at a half-day workshop to National Wetlands Programme staff.

The study forms a component of ***IUCN Eastern Africa Regional Programme's Biodiversity Economics Project***, and is one in a series of case studies being carried out on the economics of biodiversity conservation in different ecosystems and countries in Eastern Africa. These case studies aim to document existing conservation efforts from an economic viewpoint, contribute to available biodiversity economics information and methodologies, and provide recommendations for the formulation of conservation policy and practice in the Eastern Africa region.

The case study has been carried out in collaboration with the ***Uganda National Wetlands Programme***, ***implemented by the Government of Uganda Ministry of Water, Lands and Environment***, with financial support from the Government of the Netherlands and technical assistance from IUCN – The World Conservation Union.

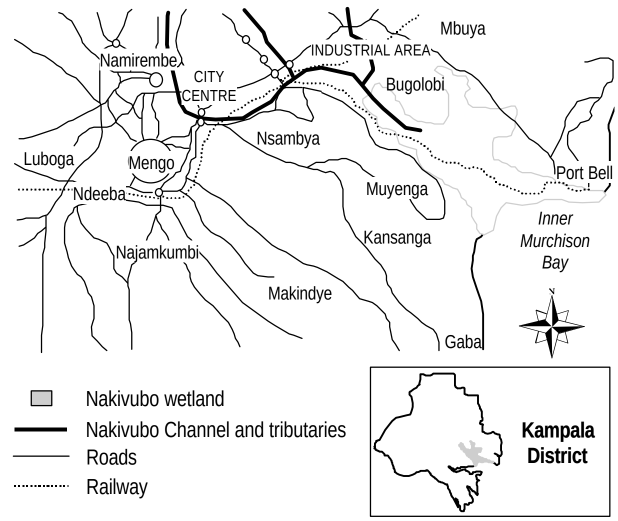
The National Wetlands Programme was established in 1989 to assist the Uganda Government to develop a national policy for the conservation and management of wetlands, and to seek alternatives to their on-going but unsustainable use and abuse. This policy was legally adopted in 1995. The National Wetlands Programme is now working towards policy implementation at national, district and community levels in Uganda.

2. BACKGROUND TO NAKIVUBO WETLAND

2.1 The wetland area

Just over one sixth of Kampala District, or 31 km^2, is covered by wetlands, most of which drain into Lake Victoria (NWCMP 1996). Of the twelve main wetland areas in the city, Nakivubo wetland is the largest. It covers approximately 5.29 km^2, and has a total catchment extending over 40 km^2 (COWI/VKI 1998). Lying to the south-east of Kampala District (Figure 1), Nakivubo forms a permanent swamp and is fed by the Nakivubo Rivers and its tributaries the Katunga, Kitante, Lugogo and Nakulabye Rivers. The wetland runs from the central industrial district of Kampala, entering Lake Victoria at Murchison Bay. En route it passes through dense residential settlements and commercial areas.

Figure 1: Location of Nakivubo wetland in Kampala



Nakivubo wetland is bisected by a railway line running through Central Kampala to Port Bell on Lake Victoria. While areas to the north of the railway have been substantially modified, to the south the wetland is relatively intact. Much of the shallow upper part of the wetland has been reclaimed for settlement and industrial development, or is under cultivation. Deeper parts of the wetland between the railway line and Murchison Bay comprise a floating papyrus swamp, and contain only small amounts of cultivation on their fringes. Unconverted parts of Nakivubo wetland are dominated by papyrus (*Cyperus papyrus*) grading to dry land through cat tails (*Typha sp.*) and common reeds (*Phragmites sp.*), with a large area on the north east side covered by *Miscanthidium* grass.

2.2 Human settlement and economic activity around Nakivubo

The land in and around Nakivubo falls under various tenurial regimes. Whereas the wetlands themselves are legally held in trust by the government, almost all of the land surrounding them is privately owned and used, with the exception of Luzira prison to the north east. Although most of the wetlands are in theory under public management, there is considerable confusion as to their boundaries, ownership and status. Parts of the wetland have been reclaimed by, or allocated to, private individuals, and some farmers on wetland fringes lay claim to cultivated plots.

Figure 2: Parishes adjacent to Nakivubo wetland

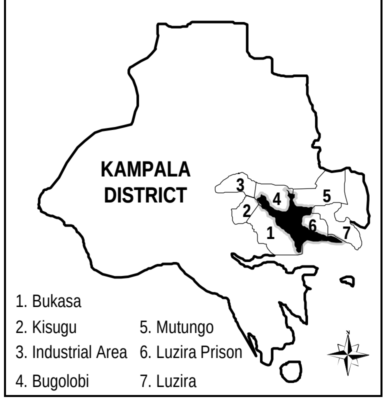


Table 1: Population of parishes surrounding Nakivubo wetland, 1999

Division	Parish	Area (km2)	No. persons	No. households	Density (persons/km^2)
Makindye	Bukasa	4.74	14,339	3,379	3,024
Makindye	Kisugu	1.15	17,017	4,010	14,797
Nakawa	Bugolobi	3.12	15,555	3,665	4,987
Nakawa	Luzira	2.50	20,090	4,734	8,049
Nakawa	Luzira Prison	2.14	8,123	1,914	3,792
Nakawa	Mutungo	4.16	24,275	5,720	5,830
Total surrounding population		**17.81**	**99,399**	**23,422**	**5,580**
Directly-bordering population		**-**	**33,133**	**7,807**	**-**

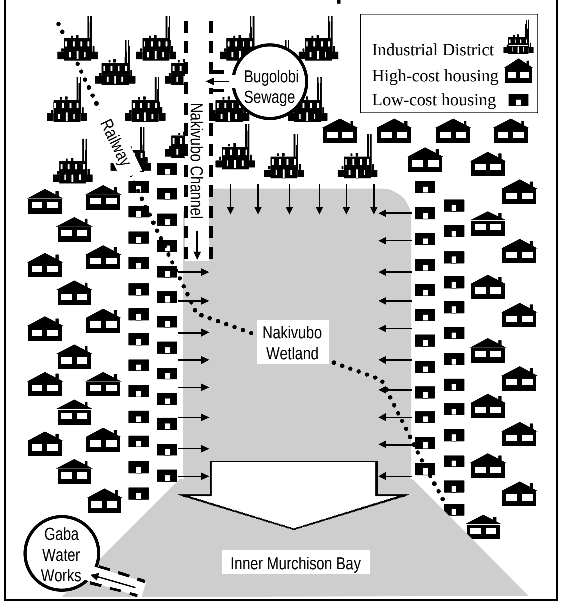
(Source: Number of persons and households from 1991 Population and Housing Census updated to 1999 figures using annual growth rates quoted in John van Nostrand Associates 1994, areas from John van Nostrand Associates 1994)

A total of just under 100,000 people or 25,000 households live in the 6 parishes which surround Nakivubo to the north-east and south-west (Table 1, Figure 2). Within surrounding Parishes 15 Zones, or villages, border the wetland. The upper slopes of these wetland-adjacent Zones are generally occupied by high-cost residential settlements of medium to low density, while the low-lying residential areas which directly abut Nakivubo are mainly comprised of low-cost, high-density settlements and slums. Based on estimates by local leaders, low-cost settlements which directly border the wetland may account for up to one third of the total population of surrounding Parishes, or 8,000 households (Table 1). The Industrial Area, to the north of the wetland, has a negligible residential population but contains approximately 15 medium to large-scale plants and factories (COWI/VKI 1998), as well as more than 190 smaller-scale enterprises (Techniplan 1997).

2.3 The role of the wetlands in Kampala water supply and wastewater disposal

Nakivubo wetland has particular significance because it acts as a sink for much of Kampala's domestic and industrial effluents. Nakivubo lies between the central business area, industrial district, residential settlements and sewage treatment plant, and the intake for all of the piped water supply to Kampala in Lake Victoria (Figure 3). Gaba water works are located approximately 3 km from the outflow of the wetland into Inner Murchison Bay.

Figure 3: Kampala water supply and wastewater disposal



Although Inner Murchison Bay is fed by 8 sub-catchments, by far the largest contribution to its nutrient load is made from the Nakivubo catchment. For example over 800 kg/day or 85% of the total load of nitrogen entering the swamps around Inner Murchison Bay passes through Nakivubo wetland, and just under 150 kg/day or 86% of total phosphorus loads (COWI/VKI 1998). The wetland provides a buffer between industrial and urban zones, the open waters of Inner Murchison Bay and Kampala's water supply. Three major sources of wastes and effluents discharge into Nakivubo wetland en route to Inner Murchison Bay, including those from:

- ***Nakivubo Channel:*** The Nakivubo River and its tributaries provide the main drainage channel for Kampala, carrying wastewater from the city centre, from the industrial area and from residential areas to the north-west of the city. In addition to effluents from industries which are not connected to the main sewage system, Nakivubo Channel transports domestic wastes corresponding to the raw sewage from an estimated 100,000 households (COWI/VKI 1998).

These domestic wastes contribute the bulk – approximately 75% – of nutrients entering the wetland from Nakivubo Channel.

- ***Bugolobi sewage treatment works:*** Just under a tenth of households (John van Nostrand Associates 1994) and approximately two thirds of medium and large industrial facilities in Kampala (COWI/VKI 1998) are connected to Kampala's waterborne sewage system. After passing through Bugolobi sewage works, partially treated sewage is then mixed with the untreated effluents already in Nakivubo Channel before entering the wetland, where it contributes about 7% of the total nutrient load, equivalent to the flow of sewage from about 7,000 persons (COWI/VKI 1998).
- ***Run-off, seepage and point sources from unsewered areas adjacent to the wetland:*** The majority of the low-cost residential settlements surrounding Nakivubo wetland are not connected to the municipal sewer system. Up to 8,000 households discharge domestic wastes into the wetland as runoff into the surface waters which enter it or through groundwater inflows from the infiltration of rainfall on hills beside the swamp, from pit latrines, septic tanks, soak pits and leaking waste pipes. At least three other point sources of wastes enter southern parts of the wetland directly, including effluents from Uganda Breweries and two sewage outflows from Luzira Prison.

2.4 Threats to Nakivubo wetland

Nakivubo wetland has become severely degraded over recent years, and is particularly threatened by the spread of industrial and residential developments. The areas surrounding Nakivubo, and the wetland itself, are regarded as prime sites for urban expansion due to their proximity to the city centre and industrial district, as a result of land shortage in higher areas of Kampala and because land prices are relatively cheap as compared to other parts of the municipality. The wetland has been encroached upon by settlement and industry, and small-scale cultivation on its fertile fringes has expanded. Much of the north-western part of Nakivubo wetland above the railway line, comprising up to half of its total area (COWI/VKI 1998, Tumusiime and Mijumbi 1999), has been modified or reclaimed for agriculture, industry and settlement.

There is a danger that Nakivubo may soon be modified and converted completely, resulting in the total loss of wetland resources and services and their associated economic benefits. Urban planners, decision-makers and developers have little understanding of the economic value of the wetland. While being well aware of the immediate gains in income and employment arising from wetland conversion, they have taken no account of possible economic costs associated with the loss of wetland resources and services. This study attempts to quantify present and potential economic benefits of wetland resources and services, so that they can be balanced with the potential gains from its conversion and modification for industrial and residential developments.

3. STUDY FINDINGS: THE ECONOMIC VALUE OF WETLAND GOODS AND SERVICES

3.1 The economic importance of Nakivubo wetland

The water, land, soils, plants, hydrological and ecological characteristics of Nakivubo wetland directly support economic activities. These economic activities can be grouped into two major categories – those which are based on wetland resources, and those which depend on wetland services:

- ***Wetland resources:*** include the water, land, soils, plants and animals contained within wetlands, all of which provide goods which can be used to generate subsistence, income and employment. In Nakivubo, the use of wetland resources for crop cultivation, papyrus harvesting, brick-making and fish farming are of particular economic importance to surrounding communities;
- ***Wetland services:*** include the hydrological and ecological functions of wetlands, which support and maintain economic activities and human settlement because they act as a sink for wastes and residues and protect human and natural production systems. In Nakivubo, the most important wetland service is the purification and treatment of wastewaters. This provides economic benefits which accrue throughout Kampala.

This chapter attempts to quantify the benefits associated with these economic activities, with the aim of providing information which can be compared with the profits and returns to the major alternative use of Nakivubo wetland – reclamation, and conversion to settlement and industrial developments.

3.2 Wetland goods

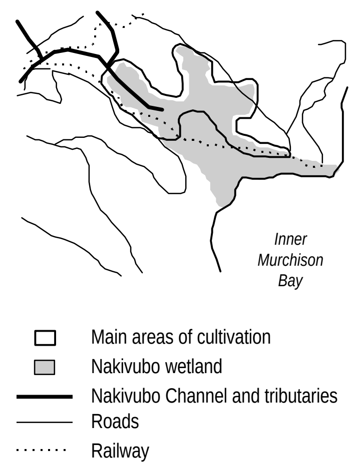
The resources contained in Nakivubo support various subsistence and income-generating activities. These activities are carried out mainly by the residents of the low-cost settlements which directly border the wetland. By far the most significant use of wetland resources in Nakivubo for surrounding populations is small-scale cultivation, which is considered in detail below. Other wetland utilisation activities, currently of less economic importance, include papyrus harvesting, brick-making and fish farming. This chapter also assesses the economic value of these activities.

3.2.1 Wetland cultivation

Nakivubo wetland supports farming because it provides the water required for irrigated crop cultivation, as well as depositing sediments and nutrients which maintain soil fertility. Of an original area of 5.29 km^2 (NWCMP 1996), it is estimated that 2.9 km^2 of Nakivubo remains unconverted (COWI/VKI 1998, Techniplan 1997), and thus that 2.39 km^2 or 45% has been modified or reclaimed. Assuming that three quarters of this modified area has been turned over to crops and the remaining quarter reclaimed for settlement and industrial development, this equates to a cropped area of some 1.8 km^2 or 180 ha in the wetland.

Cultivation takes place mainly in the northern parts and fringes of the wetland, in shallow waters and seasonally-flooded areas (Figure 4). There are between 450-500 farmers in Nakivubo wetland, most of whom are members of two informal associations of crop growers. The majority of farmers originate from the low-cost settlements which border the wetland, and live 3 km or less from its edge (Tumusiime and Mijumbi 1999). Individual plots are small, with a mean size of between 0.25-0.5 ha, typically composed of a number of small, scattered fields. Although a range of crops is grown, the vast majority of cultivated area is located in permanently waterlogged parts of the wetland and is occupied by cocoyams and sugarcane. Other crops such as sweet potatoes, matooke, mixed vegetables and cassava are farmed in only small quantities, in drier areas of the wetland.

Figure 4: Main areas of wetland cultivation



Although the exact area under different crops is not known in Nakivubo, information is available about major crops grown, the average size of wetland plots and the proportion of farmers growing different crops (Tumusiime and Mijumbi 1999). From these data and from field observations it is reasonable to assume that permanently waterlogged areas comprise three quarters and drier areas one quarter of an average sized plot of 0.38 ha, that cocoyam and sugarcane are grown in equal quantities in waterlogged areas and that drier areas are divided between cassava, sweet potatoes, mixed vegetables and matooke.

Under these assumptions crop production in Nakivubo wetland has a gross value close to USh 200 million a year (Table 2, Table 16 in Data Annex), including both the value of crops grown for home consumption and those sold. As there is virtually no use of artificial fertilisers or pesticides, and because the opportunity cost of farm labour is close to zero (almost all cultivators use only their own labour, the majority of farmers are otherwise unemployed or engage in cultivation as a secondary occupation when they are not working), inputs have not been costed or included in calculations.

Table 2: Gross value of all cultivation

			Average per farmer		Total all wetland	
	Yield (kg/ha/yr)	Price (USh/kg)	Area (ha)	Value (USh/year)	Area (ha)	Value (USh mill/year)
Cocoyam	2,625	300	0.14	112,219	68	53.16
Sugarcane	9,000	200	0.14	256,500	68	121.50
Sub-total waterlogged areas			**0.29**	**368,719**	**135**	**174.66**
Cassava	5,250	150	0.02	18,703	11	8.86
Sweet potatoes	3,750	150	0.02	13,359	11	6.33
Mixed vegetables	1,500	100	0.02	3,563	11	1.69
Matooke	6,938	100	0.02	16,477	11	7.80
Sub-total drier areas			**0.10**	**52,102**	**45**	**24.68**
Total all wetland			**0.38**	**420,820**	**180**	**199.34**

(Source: based on field observations, BoU 1993)

The economic value of Nakivubo's support to cultivation can be quantified by assessing the contribution of the wetland to agricultural output. In the absence of the wetland crop production would still be possible in the Nakivubo area if it remained as open land and was not completely converted, but arable potential would be far more limited than is currently the case. Without permanent standing water cultivation would be confined to rainfed crops, and yields would be lower in the absence of the nutrients and sediments, carried through wastewaters and deposited by the wetland, which maintain soil fertility. The major agricultural values associated with Nakivubo wetland are thus its contribution to crop productivity and support to the cultivation of irrigated crops.

The additional value generated by irrigated crops can be calculated by looking at the difference in the returns they generate for farmers as compared to crops grown in drier areas, which could be cultivated even in the absence of the wetland. The productivity added by wetland-borne nutrients and sediments can be calculated by looking at expenditures saved on alternative, purchased fertilisers which would be required to maintain yields in the absence of the wetland. Quantifying these incremental benefits suggests that in total the presence of Nakivubo wetland adds value worth some USh 110 million a year, or 55% of total value, to agricultural production (Table 2, Table 16 in Data Annex).

Table 3: Value added by wetland to cultivation

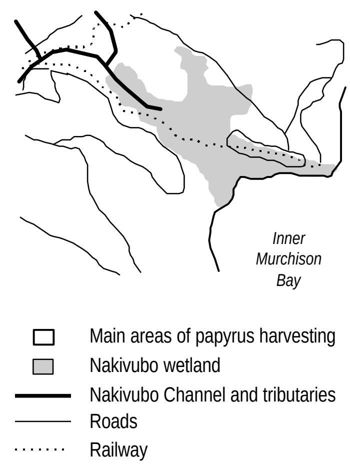
	Value (USh/ha/year)	Average value per farmer (USh/year)	Total wetland value (USh mill/year)
Returns to cocoyam and sugarcane	1,293,750	368,719	174.66
Returns to drier area crops*	495,624	141,253	66.91
Value-added by wetland to waterlogged areas	**798,126**	**227,466**	**107.75**
Gross returns no artificial fertilisers	548,438	52,102	24.68
Net returns using artificial fertilisers	495,624	47,084	22.30
Value-added by wetland to drier areas	**52,814**	**5,017**	**2.38**
Total value-added by wetland	**850,940**	**232,483**	**110.12**

*(Source: based on field observations, BoU 1993. Note: *Including the cost of artificial fertilisers)*

3.2.2 Papyrus harvesting

Up to 50 people are involved in harvesting papyrus from Nakivubo wetland, at least 30 of whom are organised into a loose association. The majority of papyrus is harvested from shallower parts of the wetland around the south-east of the railway line (Figure 5) – in upper parts of Nakivubo, relatively little papyrus remains. Papyrus generates income in three major ways – most commonly through the sale of raw materials to artisans such as thatchers or mat-makers, through the production of rough, low-cost mats, and through the production of fine, higher-cost mats. Based on field observations, this study assumes that half of harvesters sell dry bundles of papyrus, a quarter produces rough mats and a quarter produces fine mats.

Figure 5: Main areas of papyrus harvesting



Under this labour and production scenario just over 5,000 bundles, or approximately 180 tonnes, of dry papyrus may be harvested each year from the wetland (Table 4, Table 17 in Data Annex). With annual yields estimated at some 20 tonnes of dry papyrus per year nine month harvesting and regrowth cycle (Craddock-Williams 1996), this corresponds to the utilisation of just under 9 ha of the wetland.

Table 4: Demand for dry papyrus

	% harvesters	No harvesters	Papyrus use (dry bundles /harvester)	Papyrus use (dry tonnes/year)
Selling raw materials only	50	25	125	109
Harvesting papyrus to make rough mats	25	12.5	89	39
Harvesting papyrus to make fine mats	25	12.5	71	31
Total	**100**	**50**		**180**

(Source: based on field observations)

In the absence of the wetland there would be no papyrus – the full value of papyrus harvesting can therefore be attributed to Nakivubo. Papyrus harvesting can be valued in terms of the income it generates. With most papyrus harvesters working year round, earning a gross annual income of between USh 250,000-536,000, in total papyrus harvesting in Nakivubo wetland may be worth nearly USh 17.5 million a year (Table 5, Table 17 in Data Annex)

Table 5: Value of papyrus harvesting

	Gross returns to production (USh/harvester/year)	Gross returns to production (UShmill)
Selling raw materials only	250,000	6.25
Harvesting papyrus to make rough mats	357,143	4.46
Harvesting papyrus to make fine mats	535,714	6.70
Total		**17.41**

(Source: based on field observations. Note: labour costed zero)

3.2.3 Brick-making

Up to 50 people are involved in brick-making around Nakivubo wetland, mostly concentrated in southern parts of Bugolobi Parish (Figure 6). An average of 5 people work full-time on each kiln of bricks which, taking 5 weeks to excavate, mould and burn, yields up to 9,000 bricks.

Brick burning is primarily carried out during the eight drier months of the year. Based on available labour and time taken to prepare bricks, up to 64 kilns of bricks may be burned each year (Table 6). The value of these bricks can be calculated in terms of income generated (Table 18 in Data Annex) – some USh 32 million a year.

Figure 6: Main areas of brick-making

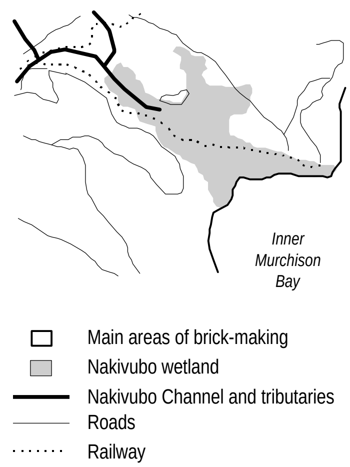


Table 6: Brick-making labour allocation and income

Total labour force	50 people
Labour per kiln	5 people
Time taken to prepare and burn kiln of bricks	1.25 months
Brick-burning season	8 months
Number of kilns per year	64
Average returns per kiln	500,000 USh
Total brick-making income	**32 million USh**

(Source: based on field observations. Note: income excludes costs of non-labour inputs, labour costed zero)

3.2.4 Fish farming

There are only two fish farming enterprises around Nakivubo wetland – including two fishponds in Bugolobi Parish and seven fish ponds in Luzira Prison. With the average annual returns to a 500 m^2 fish pond ranging between USh 155,000-905,000 (Table 19 in Data Annex), the total value of fish farming around Nakivubo may be worth some USh 6 million a year.

3.3 Wetlands services

Whereas wetland resource utilisation activities are carried out almost exclusively by the people who live in settlements which directly border Nakivubo, the benefits associated with water treatment and purification accrue over a much larger area, to urban residents and industries throughout Kampala. This chapter considers the indirect economic value of these services.

3.3.1 Water treatment and purification functions of the wetland

Section 2.3 above describes how Nakivubo wetland functions as a buffer through which much of Kampala's industrial and urban wastewater passes. The wetland plays an extremely important role in maintaining the quality of the city's water supply. It physically, chemically and biologically removes pollutants and sediments from the wastewater which passes through it, and reduces the pollution load entering Inner Murchison Bay through mineralisation and sedimentation processes. Of particular significance is the capacity of wetland plants to remove phosphorus and nitrogen, the accumulation of suspended solids, pollutants and pathogenic organisms in the wetland's bottom sediments and their decomposition, the conversion of heavy metals from soluble to insoluble forms and the dilution of effluents effected through density currents caused by the difference in temperature between wetland and bay water.

3.3.2 Wastewater loads entering Nakivubo wetland

Domestic wastes contribute by far the greatest quantity of wastewater and highest proportion of the total nutrient load entering Nakivubo wetland (COWI/VKI 1998), and originate from Nakivubo Channel, Bugolobi Sewage Treatment Works and from runoff and groundwater seepage from surrounding residential areas. These wastes are largely organic, and are together equivalent to the raw sewage produced by some 465,000 people or 40% of the total population of Kampala (Table 7).

Table 7: Wastewater loads entering Nakivubo wetland in person equivalents

Source	Person equivalents of raw sewage
Nakivubo Channel	425,000*
Bugolobi sewage treatment works	7,000*
Adjacent unsewered low-cost settlements	33,000+
Total	**465,000**

*(Note: *from COWI/VKI 1998, +from population and housing census/ John van Nostrand Associates 1994)*

Just over a third of the 15 medium and large industries to the north of the wetland and most of the nearly 200 smaller production facilities – which together include breweries, soft drink manufacturers, distillers, oil and soap factories, dairy producers, abattoirs and meat processors, fish processors, paint producers, tanneries, bakeries, metal works and garages, plastic and foam industries, saw mills, battery manufacturers, pharmaceutical industries, shoe makers and paper makers – discharge wastes directly into the surface water which flows into Nakivubo, often without primary treatment on-site. Effluents and pollutants contained in these untreated wastewaters, and in the industrial wastewaters which have passed through Bugolobi sewage treatment works, include detergents, lubricants, oils, acids, xenobiotics, nitrates, phosphates and heavy metals such as zinc and mercury (Table 8). Industrial wastes, although containing much higher concentrations of toxic substances than domestic sewage, currently contribute less than a quarter of nutrients to the wetland. Only four industries are considered to be major polluters –brewing, dairy, bottling and oil and soap producing facilities, although the total load of heavy metals, nitrogen, phosphorous, BOD and COD from these sources is currently described as "moderate to low" (COWI/VKI 1998).

Table 8: Characteristics of industrial wastewater discharge and treatment

Industry	Wastewater characteristics	On-site primary treatment
Discharge into surface water:		
Abattoir	BOD, nitrogen, phosphorus, suspended solids	None
Brewery	BOD, COD, detergents	None
Fish processing	BOD, COD, oil	Aeration pond
Meat processing	BOD, nitrogen, phosphorus, suspended solids	None
Oil and soap	BOD, COD	Oil separator, septic tank
Discharge through sewerage system:		
Battery producer	Heavy metals, oil, lubricants, acids	Neutralisation
Dairy	BOD, COD, detergents, oil	None
Galvansising	Heavy metals, oil, lubricants, acids	None
Paints	Xenobiotics, heavy metals	None
Pharmaceutical	BOD, COD, xenobiotics	None
Soft drinks	BOD, COD, detergents	Neutralisation

(Source: adapted from COWI/VKI 1998)

Nakivubo wetland plays a major role in treating domestic and industrial wastewaters, and makes a significant difference to water quality in Inner Murchison Bay. The economic value of Nakivubo's waste treatment and water purification services can be at least partially quantified by looking either at the costs of replacing them by artificial means, or the costs of setting in place measures to mitigate the effects of their loss. Either one of these costs represents the minimum economic benefit of the wetland in terms of alternative expenditures saved.

3.3.3 Replacement costs

Two major types of costs would be incurred to replace artificially the waste treatment and water purification services of Nakivubo wetland –the construction of proper sewerage and sanitation facilities in low-cost settlements around the wetland, and the connection of Nakivubo Channel to Bugolobi sewage treatment plant and its extension to cope with the resulting additional wastewater load.

3.3.3.1 Sanitation in low-cost settlements

Most residents of the low-cost settlements around Nakivubo wetland currently use either unimproved pit latrines or have no sanitation facilities at all. Almost all of their domestic wastes enter directly into the wetland, carried in surface water or as seepage from latrine pits. The high water table and recurrent waterlogging in these areas, and their close proximity to the wetland, would require the construction of elevated pit latrines to prevent sewage from entering directly into the wetland. At 1999 prices the costs of constructing an elevated pit latrine are some USh 625,000 per unit (updated from John van Nostrand Associates 1994). Assuming that each pit latrine is shared between five households, this translates into an average annual cost for the whole directly wetland-adjacent area of some USh 98 million a year (Table 9).

Table 9: Costs of improving sewerage and sanitation facilities in low-cost residential areas adjacent to Nakivubo wetland

	No low-cost households	Costs (USh mill/year)
Bukasa	1,126	14.08
Kisugu	1,337	16.71
Bugolobi	1,222	15.27
Luzira	1,578	19.72
Luzira Prison	638	7.98
Mutungo	1,907	23.83
Total	**7,807**	**97.59**

(Source: Number of persons and households in adjacent parishes from 1991 Population and Housing Census updated to 1999 figures using annual growth rates quoted in John van Nostrand Associates 1994, assumed that 1/3 reside in low-cost settlements. Investment cost of pit latrine USh 625,000, lifespan 10 years)

3.3.3.2 Extending the capacity of Bugolobi sewage treatment plant

Currently Bugolobi sewage treatment works serves some 10% of Kampala's population, or approximately 112,000 people, and are bypassed by the main Nakivubo Channel. The wastes in Nakivubo Channel, equivalent to raw sewage from an estimated 100,000 households or 425,000 people (COWI/VKI 1998), corresponds to a load of almost four times this amount. Estimates already exist for the additional capital and recurrent expenditures which would be required to extend the capacity of Bugolobi works to serve a population of more than 600,000 people, translating into an average annual cost of some USh 1.5 billion (Table 10).

Table 10: Investment and recurrent costs of sewage treatment plant

	Cost (USh mill)
Interest on loan	906.25
Depreciation of capital	519.07
Operation and maintenance costs @ 0.52%	74.98
Total annual cost	**1,500.29**

(Source: adapted from Gauff and Parkman Ltd 1990. Note: 1989 US$ prices converted to USh at prevailing exchange rate and updated to 1999 levels using composite CPI deflator in MFEP various)

3.3.4 Mitigative expenditures

The major mitigative expenditure required to offset the effects of impaired water quality resulting from the loss of wetland waste treatment and water purification services would be to move the inflow for Kampala's water supply to an alternative location sited away from the outlet of wastewaters into Inner Murchison Bay. Estimates already exist for the construction of a new water treatment plant for Kampala, translating into an average annual cost of some USh 2.7 billion (Table 11).

Table 11: Investment and recurrent costs of water treatment plant

	Cost (USh mill)
Interest on loan	1,585.94
Depreciation of capital	1,078.19
Total annual cost	**2,664.13**

(Source: Gauff and Parkman Ltd 1990. Note: 1989 US$ prices converted to USh at prevailing exchange rate and updated to 1999 levels using composite CPI deflator in MFEP various; operations and maintenance costs excluded as no different from existing facility)

3.3.5 Costs of maximising wetland water treatment and purification services

Although the presence of Nakivubo wetland improves significantly the quality of water entering Inner Murchison Bay, its waste treatment and water purification functions are currently not being utilised to maximum capacity. This is because the two outflows of Nakivubo Channel, through which the majority of wastewater and between 75-85% of nutrients enter the wetland (COWI/VKI 1998), do not spread wastes over the whole wetland area. Wastewater currently spends only 0.5-2 days in the wetland (COWI/VKI 1998), and mainly accumulates in lower parts to the south of the railway bridge.

While Nakivubo has a potentially high nutrient retention capacity and is effective in removing bacteria and microbes, under existing conditions the upper wetland area processes only a fifth of nitrogen and virtually no phosphorous. Overall the wetland removes about 43% of nitrogen and 22% of phosphorus (COWI/VKI 1998). To maximise water treatment and purification functions there is a need to spread wastes over a greater area, so as to utilise the upper wetland to its full capacity and to increase the time that wastewater is retained. The cost of undertaking these actions – which involve the construction of multiple outflows from Nakivubo Channel and their reticulation across the wetland – must be offset against the economic benefits of replacement or mitigative expenditures avoided when valuing Nakivubo's waste treatment and water purification functions.

Information is available about the costs of constructing and maintaining earth channels to carry and disperse wastewater. Although the exact length and area through which Nakivubo Channel must be reticulated is not known, it is reasonable to assume that its outflow could be taken into the upper wetland area through four additional channels of 0.5 km length, each with 4 branches of 100 m. The annual costs associated with constructing and maintaining these 3.86 km of channels are just over USh 350 million (Table 12).

Table 12: Costs of reticulating Nakivubo Channel outflow

	Costs of earth	Total costs of

	channels (USh mill/km)	reticulation (USh mill)
General requirements	159.66	574.77
Work on main channel	942.12	3,391.62
Day works	19.47	70.09
Supervision	77.65	279.53
Base Cost	1,086.92	3,912.90
Total capital cost (USh mill)	**2,285.81**	**8,228.92**
Annualised capital cost over 25 years	**91.43**	**329.16**
Operations (annual)	0.32	1.16
Routine maintenance (annual)	2.08	7.47
Periodic maintenance (averaged over 3 years)	2.21	7.95
Repair of parts (averaged over 10 years)	0.34	1.23
Emergency maintenance (averaged over 3 years)	0.45	1.62
Management (annual)	0.42	1.52
Total operations and maintenance (USh mill/year)	**5.82**	**20.94**
Total annual cost (USh mill/year)	**97.25**	**350.10**

(Source: KCC pers. comm.)

4. SUMMARY OF WETLAND ECONOMIC VALUES AND THEIR DISTRIBUTION

4.1 Summary of wetland economic values

The goods and services associated with Nakivubo wetland which have been valued in this report yield economic benefits worth approximately USh 2 billion a year (Table 13). While water treatment and purification services make up the bulk of this total value and are worth between USh 3 and 5 million/ha/year, crop cultivation contributes approximately two thirds of the value of resource utilisation activities. These figures represent a minimum estimate of Nakivubo's total economic value because they exclude consideration of other benefits yielded by the wetland, most importantly non-use values such as those attached to the conservation of biodiversity, cultural and aesthetic values and particular indirect values such as groundwater recharge services. They also deal only with existing wetland resource activities, which represent a small proportion of potential utilisation opportunities.

Table 13: Summary of the value of wetland economic benefits

Economic benefits	Current value (USh mill/year)	Value per unit area (USh mill/ha)
Wetland resources		
Crop cultivation	199.34	1.11
Less dryland cultivation value	*-89.21*	*-0.50*
Papyrus harvesting	17.41	1.14-4.29
Brick-making	32.00	2.50
Fish-farming	6.07	0.32-1.87
Total direct values	**165.61**	**-**
Wetland services		
Water treatment and purification	1,597.88 – 2,664.13	3.02 – 5.04
Less costs of reticulation	*-350.10*	*-0.66*
Total indirect values	**1,247.78 – 2,314.03**	**-**
Total wetland value	**1,763.49 – 2,479.64**	**-**

4.2 The distribution of wetland economic values

It is important to consider the distribution of wetland economic benefits between different groups. Four main groups benefit from the goods ands services associated with Nakivubo wetland (Table 14) – adjacent dwellers, other residents of Kampala who live outside the Nakivubo area, industries and the parastatal National Water and Sewerage Corporation (NWSC). The economic value of the wetland for these different groups is considered below.

Table 14: Summary of the distribution wetland economic values

Beneficiary groups	Nature of benefits	Value of benefits (USh mill/yr)
Adjacent dwellers	*Resource utilisation and waste treatment*	263
Domestic and industrial water consumers/NWSC	*Water purification expenditures saved*	2,664
Unsewered urban dwellers and industries/NWSC	*Wastewater treatment costs saved*	1,500

(Note: Sum of components does not equal total wetland value)

4.2.1 Adjacent dwellers

Up to 600 households, or 8% of the residents of low-cost settlements adjacent to Nakivubo, engage in wetland-based resource utilisation activities. For users the value of these wetland resources are high (Table 15, Tables 16-19 in Data Annex), in both cash and livelihood terms. Many adjacent residents lack access to other employment opportunities, or engage only in occasional and low-paid casual employment. Wetland utilisation activities often generate the only regular source of cash income for local households, or provide an significant supplement to other sources of earnings. Wetland crop cultivation also yields an important source of food for farming households, and other natural resources provide easily affordable products for household use. Residents of the low-cost settlements adjacent to Nakivubo are among the poorest households in Kampala, and wetland utilisation activities are particularly important for the most vulnerable and marginal groups among them, including the unemployed and women.

Table 15: Summary of net income and returns to labour from wetland resource utilisation

	Net income* (USh/year)	Returns to labour (USh/day)
Farming	420,820 per farm	5,515
Brick-making	3,200,000 per group of kiln workers	4,000
Papyrus harvesting	250,000 per harvester	1,000
Harvesting and making rough papyrus mats	357,143 per harvester/mat-maker	1,429
Harvesting and making fine papyrus mats	535,714 per harvester/mat-maker	2,143
Tilapia fish farming	154,508 per pond	1,236
Mirror carp fish farming	904,508 per pond	7,236
Casual wage rate	**-**	**3,000**

*(Note: *excludes labour costs)*

Two major issues are associated with wetland resource utilisation by adjacent dwellers – the environmental sustainability of activities, and the health implications of consuming food crops grown in the wetland. Information about both these issues is inconclusive. Although at current levels they appear to be broadly sustainable, it is not known whether crop cultivation, papyrus harvesting, brick-making or fish farming impact negatively on the biodiversity or ecosystem functions of Nakivubo wetland, either in terms of the techniques they employ or the areas they utilise. Studies have been carried out on the accumulation of heavy metals and other pollutants in crops (Tumusiime and Mijumbi 1999), especially yams, and it is known that the concentration of mercury, ethoxylates and hydrocarbons in sludges from Bugolobi sewage treatment plant exceed standards for application on agricultural land (COWI/VKI 1998). It is not however clear whether wetland crops are likely to have long-term health implications for consumers. Both these issues are important to wetland management, and should be the subject of further investigation.

4.2.2 Other urban residents and industries

Because of the location of Nakivubo's outflow into Murchison Bay only some 3 km from the intake for Kampala's water supply at Gaba, the major economic benefits of Nakivubo wetland for non-adjacent urban residents and industrial consumers are related to its function in treating wastes and maintaining the quality of piped water supplies. For unsewered households and industries, this represents a cost saved in terms of expenditures on private waste treatment, or costs of connection to the main waterborne sewerage system. For piped water consumers the wetland generates economic benefits which are mainly related to savings in expenditures on private water treatment and purification, and avoidance of the negative health implications of polluted water supplies.

4.2.3 Public sector

Nakivubo wetland represents major costs saved for the National Water and Sewerage Corporation, who are responsible for the provision of sewage treatment facilities and maintenance of water quality throughout Kampala. Most importantly these costs avoided include the processing of wastewaters which do not pass through the main sewage treatment plant and those that are only partially treated by Bugolobi sewage works, and the maintenance of the quality of water entering the city's piped water system.

5. ECONOMIC ASPECTS OF WETLAND MANAGEMENT

5.1 The economic implications of wetland degradation

The resources and services of Nakivubo wetland have a high economic value. These wetland values, and the economic costs associated with their degradation, must be offset against any gains arising from wetland modification for residential and industrial development. The figures cited in this case study represent minimum estimates of the present economic worth of Nakivubo wetland. They focus only on its most important goods and services – resource utilisation activities and water treatment and purification services. Consideration of other economic benefits associated with the wetland – for example those attached to groundwater recharge services, additional opportunities for resource utilisation, wetland biodiversity, aesthetic or cultural significance – would increase these figures still further, as would actions to maximise Nakivubo's waste treatment and water purification functions.

The degradation of Nakivubo wetland, as well as leading to economic costs in terms of goods and services foregone, would have distributional implications. The impacts of wetland degradation for different groups must also be taken into account when developments are planned and implemented in and around Nakivubo. Whereas the gains from industrial and residential development accrue largely to individual property owners and industrialists, the economic impacts associated with wetland degradation are felt as broader, social costs. They are reflected in subsistence, income and employment losses for some of the poorest sectors of Kampala's population, as costs to many other residents of the city, and as increased public sector expenditures on the infrastructure required to replicate wetland functions or offset the effects of their loss. Many of these groups already face pressing constraints in income and expenditure, and are not in a position to bear increased costs or additional expenditures.

This case study emphasises the importance of integrating wetland values into land use and development decisions, and provides estimates of the economic value of important wetland goods and services. The information it contains lends support to recommendations that Nakivubo should be fully recognised to be, and designated as, an economically important and environmentally sensitive area (for example in COWI/VKI 1998, John van Nostrand and Associates 1994, NWCMP 1996).

Contrary to the dominant development imperative of recent years, residential and industrial development in Nakivubo wetland does not necessarily make good economic sense, and cannot be based only on consideration of immediate profits. Development activities also have to consider the economic losses associated with wetland degradation. Integrating consideration of wetland values into decision-making gives a more complete picture of the economic desirability and long-term viability of converting and modifying Nakivubo.

It is clear that wetland reclamation and modification will incur high economic costs in terms of goods and services foregone, and that these costs will accrue to both the broader population of Kampala and to the public sector, as well as to some of the poorest and most vulnerable urban groups. It is however impossible to argue, on the basis of this study, that the conservation of Nakivubo makes more economic sense than wetland reclamation and modification. This is not necessarily the case, and will depend on the full value of the economic benefits associated with wetland goods and services, on the profits and income generated by residential and industrial development, and – perhaps most importantly – on decisions made by politicians, government policy-makers and urban planners.

5.2 Economic issues in wetland management

As mentioned above, whether Nakivubo wetland continues to be reclaimed for development or is managed sustainably depends ultimately on decisions made at policy and political levels. However, if recommendations to manage the wetland as an environmentally sensitive area are taken up, the findings of this study make it clear that management must be based on economic as well as ecological considerations. Of particular importance are issues relating to the financing of management activities, the provision of economic incentives for sustainable utilisation and the use of economic instruments to discourage wetland degradation. These issues are summarised below.

5.2.1 Financing wetland management

Wetland management requires a financing strategy. There is great potential for funding wetland management from existing water and sewerage fees. Mechanisms must be found to retain at least part of the revenues raised, and return them directly to the management of Nakivubo wetland.

Without intervention, Nakivubo's waste treatment and water purification functions will not be used to their maximum capacity. The wetland will also continue to be degraded and encroached upon. The maintenance of Nakivubo wetland implies some level of active management. This intervention will cost money – including expenditures on staff and equipment, on the further research required to develop management plans, on the enforcement of limitations on wetland degradation and on the investment and recurrent costs of improving wetland water treatment and purification services. The provision of local economic incentives for sustainable wetland management will also incur a range of direct and opportunity costs, as discussed below (Section 6.2.2).

Funds will need to be raised to cover all these expenditures. There is little – if any – possibility that they can be met from existing government expenditures. Uganda already faces a severe public sector deficit, and many other sectors of the economy compete with wetlands for scarce funds. It is likely that Nakivubo wetland will have to be financially self-sustaining, and raise its own funds to cover the management costs it incurs.

The main potential for raising funds for the management of Nakivubo comes from the goods and services it yields. Despite their high economic value, these goods and services are currently received free of charge by wetland beneficiaries, including both resource users and the households and industries who depend on waste treatment and water purification services. There is only limited potential for instituting charges for local resource utilisation activities – the groups who carry out these activities are already among the most economically marginalised sectors of Kampala's population, and the imposition of user fees is unlikely to be socially equitable, politically acceptable or practically implementable. There is however no reason why other recipients of wetland water treatment and purification services should not be charged for the benefits they receive.

Even including additional management-related expenditures, the use of Nakivubo wetland for waste treatment and water purification is likely to be far more cost effective than artificial treatment processes – for example the annual costs required to construct and maintain channels for wetland wastewater dispersal are less than a quarter of those associated with extending Bugolobi sewage treatment works. Both industrial and domestic consumers already pay for waste treatment and water consumption services in Kampala. Extending waste treatment charges to wetland users who currently pay no fee for mains coverage, or reallocating a portion of existing revenues raised from mains water and sewerage charges by NWSC, could raise significant finance for wetland management. Although no data are available about current levels of earnings from sewage and waste treatment fees, the full costs of improving Nakivubo's wastewater treatment services comprise less than 2% of existing water revenues earned in Kampala by NWSC. Wetland management could easily be funded from a combination of new charges and the reallocation of a portion of existing sewerage and water fees. Many of the economic instruments described below (Section 6.2.3) also have the potential to add to these funds for wetland management because they generate revenues.

A number of important conditions are attached to raising revenues for wetland management. Funding mechanisms should be cheap to implement and easy to enforce. Working through existing water and sewerage charge systems provide a way of raising finance without imposing an undue financial burden on either consumers or the NWSC. Effective funding also requires some level of financial retention or autonomy at the wetland level – the full amount of funds raised should be returned directly to the management of Nakivubo wetland. Currently NWSC has no ability to retain earnings – water and sewerage revenues flow into a central fund and are used to cross-subsidise operations in other parts of the country. The new Wetlands Division of the Ministry of Water, Lands and Environment as yet has no powers at all to raise or retain revenues. Effective financing of wetland management of Nakivubo wetland will necessitate either changes in existing revenue generation and budget allocation procedures, or the development of a new financing mechanism which is independent of both NWSC and the Wetlands Division.

5.2.2 Providing economic incentives for sustainable resource utilisation

Wetland management implies some restriction of resource utilisation activities. If wetland management is to have local support, and is to be equitable, viable alternative sources of income and employment must be set in place to compensate for these losses and cover opportunity costs.

At existing levels, many of the resource utilisation activities carried out in Nakivubo interfere neither with the integrity and status of the wetland nor with its waste treatment and water purification functions. Wetland management may however require that action be taken to prevent their further expansion, or to limit activities which are incompatible with the maintenance of wetland services.

Wetland crop cultivation activities, in particular, give rise to concern. Here the major issue is the health implications of consuming food crops grown in the wetland, rather than their interference with wetland ecosystem functions. Maximising and improving the waste treatment function of Nakivubo implies increasing the time that waste waters spend in the wetland, and spreading their flow over its area. This may preclude the cultivation of crops which accumulate pollutants. Although existing papyrus harvesting and brick-making activities currently appear to be broadly sustainable, the extent to which they can be increased or expanded before they start to threaten wetland status and integrity is not known.

Any interference with wetland cultivation, or future limitations on the exploitation of wetland plant resources, will lead to opportunity costs to adjacent populations in terms of income and subsistence generating activities foregone. Adjacent residents are unlikely to be willing – and may often be economically able – to bear these costs or to support wetland management if they incur an economic loss from it. Under current circumstances, local reliance on wetland resources is also unlikely to decrease without external intervention.

Improving the management of Nakivubo wetland will require that adequate economic incentives are provided to adjacent residents to cover these opportunity costs and to encourage sustainable utilisation. Because sanctions against unsustainable or undesirable wetland use are inequitable, and unlikely to be enforceable, the main potential for ensuring local support for wetland management lies in making available alternative, economically preferable, sources of income and subsistence products. Possibilities exist both for adding value to and improving existing sustainable wetland activities and for introducing new, profitable forms of resource utilisation – such as fish-farming, the production of high-value papyrus products and the development of wetland resource marketing. Ultimately it may however be preferable in both conservation and development terms to decrease, rather than increase, local reliance on the wetland. Higher levels of wetland exploitation run the risk of becoming unsustainable. Wetland resources are also often seen as inferior goods by users – they are not preferred activities, but rather provide low return, fallback sources of income and subsistence to groups who have no alternative employment or income opportunities. Efforts may be better directed to diverting local livelihoods away from wetland resources to more profitable and sustainable activities, rather than expanding and adding value to existing utilisation.

5.2.3 Internalising the economic costs of wetland degradation

Industrial activity and residential development can lead to wetland degradation. Various economic instruments can be used to discourage wetland degradation by passing on its costs to industrialists and developers. Some can also raise funds for wetland management.

Development pressures on Nakivubo wetland are likely to increase, rather than decrease, in the future. Of major concern are loads of toxic pollutants in industrial wastewaters, and residential and industrial expansion. Controls on wetland modification and pollution will undoubtedly form a component of sustainable management. A range of economic instruments can strengthen these restrictions by internalising the costs of wetland degradation, and making it relatively more expensive for developers to carry our activities which degrade wetlands. While the main aim of these economic instruments is to discourage wetland degradation by passing on its costs to private developers, some also have the potential to raise revenues for wetland management.

Although there is no immediate need to impose stricter conditions on industrial wastewater disposal because existing loads are within the treatment capacity of Nakivubo wetland (COWI/VKI 1998), should production levels increase significantly industrial discharges will have to be reduced. The volume and type of industrial effluents entering the wetland can be reduced by various means, including the implementation of clean technology programmes, connection to the existing treatment plant and the construction of on-site pre-treatment facilities. Various macreconomic and sectoral economic instruments which reduce the relative cost of these investments – for example through the reduction of taxes or duties on cleaner technologies and wastewater treatment facilities – can make them more attractive to industrialists. Simultaneously, economic instruments can also be used to discourage, or penalise for, increased wastewater discharges or to set limits on pollution loads, for example through the imposition of taxes, fines and charges for unacceptable levels or types of effluents or of bonds and deposits which are refundable against proper wastewater treatment and disposal.

Even if restrictions on wetland development are set in place, Nakivubo will still be under intense pressure from industrial and residential expansion. Economic instruments can be used as tools to support planning and development regulations by ensuring that, should wetland degradation occur, its full costs will accrue to developers. For example the imposition of bonds, deposits or levies on new developments, offset against proper planning procedures and wetland maintenance, can all discourage the construction of residential or industrial facilities from taking place in areas or ways which interfere with the status and integrity of Nakivubo.

The key aim of all these economic instruments is to encourage developers to take account of the full costs associated with wetland degradation. They internalise the costs of wetland degradation so that they appear as private expenditures and affect private profits, rather than accruing as broader social and economic losses. As well as providing incentives for wetland maintenance, or disincentives to wetland degradation, economic instruments have a secondary function of raising revenues. As long as fines, charges or levies are set at levels equivalent to the costs arising from wetland degradation, they also have the potential to make available funds to meet the costs of damage incurred should developments take place which harm or interfere with wetland goods and services.

6. REFERENCES

BoU, 1993, *Economics of Crop Production*, Bank of Uganda, Agricultural Secretariat, Kampala

COWI/VKI, 1998, *Kampala Water Quality Monitoring Programme: Murchison Bay Water Quality Project*, Report prepared for Ministry of Natural Resources National Water and Sewerage Corporation by COWI in association with VKI, Kampala

Craddock-Williams, V., 1996, *Suitability of Papyrus for Wood-Based Panels: the Economic Study*, Report prepared for National Wetlands Conservation and Management Programme, Kampala

Gauff and Parkman Ltd, 1990, *Seven Towns Water Supply and Sewerage Expansion Project, Final Design: Economic Analysis*, Report prepared for Ministry of Water and Mineral Development National Water and Sewerage Corporation by Gauff Engineering in Association with Parkman Ltd, Kampala

John van Nostrand Associates, 1994, *Kampala Urban Study*, Report prepared for Ministry of Lands, Housing and Urban Development by John van Nostrand Associates Ltd., Kampala

MFEP, various, *Key Economic Indicators*, Ministry of Finance and Economic Planning, Kampala

NWCMP, 1996, *Wetlands Status Report for Kampala District*, National Wetlands Conservation and Management Programme, Ministry of Lands Water and Environment, Kampala

Rogers, F., Rogers, K. and Buzer, J., 1985, *Wetlands for Wastewater Treatment, With Special Reference to Municipal Wastewaters*, Olifantsvlei Working Group, Department of Botany, University of Witwatersrand, Johannesburg

Techniplan, 1997, *Feasibility Study for the Rehabilitation of Nakivubo Channel Phase I*, Report Prepared for Kampala City Council by Techniplan SpA, Rome

Tumusiime, M. and Mijumbi, J., 1999, *Socio-Economic Survey of Nakivubo Wetland*, Report prepared for National Wetlands Conservation and Management Programme, Ministry of Lands Water and Environment, Kampala

7. DATA ANNEX

Table 16: Returns to crop farming

Cocoyams:

	Unit	No. units	Cost/unit (USh)	Total (USh)
Land	Ha	1		-
Yield	Kg/ha	2,625	300	787,500
Labour	Days	120		-
Fertiliser	USh/ha			
Net returns (excl. labour)	**USh/year**			**787,500**
Returns/ha	**USh/year**			**787,500**
Returns/day	**USh**			**6,563**

(Source: based on field observations, BoU 1993)

Sugarcane:

	Unit	No. units	Cost/unit (USh)	Total (USh)
Land	Ha	1		-
Yield	Kg/ha	9,000	200	1,800,000
Labour	Days	110		-
Fertiliser	USh/ha			
Net returns (excl. labour)	**USh/year**			**1,800,000**
Returns/ha	**USh/year**			**1,800,000**
Returns/day	**USh**			**16,364**

(Source: based on field observations,BoU 1993)

Sweet potatoes:

	Unit	No. units	Cost/unit (USh)	Total (USh)
Land	Ha	1		-
Yield	Kg/ha	3,750	150	562,500
Labour	Days	151		-
Fertiliser	USh/ha			28,508
Net returns (excl. labour)	**USh/year**			**562,500**
Returns/ha	**USh/year**			**562,500**
Returns/day	**USh**			**3,720**

(Source: based on field observations,BoU 1993)

Cassava:

	Unit	No. units	Cost/unit (USh)	Total (USh)
Land	Ha	1		-
Yield	Kg/ha	5,250	150	787,500
Labour	Days	202		-
Fertiliser	USh/ha			49,508
Net returns (excl. labour)	**USh/year**			**787,500**
Returns/ha	**USh/year**			**787,500**
Returns/day	**USh**			**3,906**

(Source: based on field observations,BoU 1993)

Vegetables:

	Unit	No. units	Cost/unit (USh)	Total (USh)
Land	Ha	1		-
Yield	Kg/ha	1,500	100	150,000
Labour	Days	150		-
Fertiliser	USh/ha			64,240
Net returns (excl. labour)	**USh/year**			**150,000**
Returns/ha	**USh/year**			**150,000**
Returns/day	**USh**			**1,000**

(Source: based on field observations,BoU 1993)

Matooke:

	Unit	No. units	Cost/unit (USh)	Total (USh)
Land	Ha	1		-
Yield	Kg/ha	6,938	100	693,750
Labour	Days	277		-
Fertiliser	USh/ha			69,000
Net returns (excl. labour)	**USh/year**			**693,750**
Returns/ha	**USh/year**			**693,750**
Returns/day	**USh**			**2,503**

(Source: based on field observations,BoU 1993)

Table 17: Returns to papyrus harvesting

Dry tonnes/ha/yr	20
Kg/ha/yr	20,000
Weight of dry bundle (kg)	35
Dry bundles/ha/yr	571
Days to collect and prepare bundle	2
Bundles/fine mat	0.67
Bundles/rough mat	0.25
Days to prepare fine mat	1
Days to prepare rough mat	0.20
Days to prepare fine mat inc. raw material	2.3
Days to prepare rough mat inc. raw material	0.7

(Source: based on field observations)

Selling raw materials:

	No. units	Cost/unit (USh)	Total (USh)
Labour(days)	250		
Bundles	125	2,000	250,000
Net returns (excl. labour)	**USh/year**		**250,000**
Returns/ha	**USh/year**		**1,142,857**
Returns/day	**USh**		**1,000**

(Source: based on field observations)

Harvesting and making rough mats:

	No. units	Cost/unit (USh)	Total (USh)
Labour(days)	250		
Mats	357	1,000	357,143
Net returns (excl. labour)	**USh/year**		**357,143**
Returns/ha	**USh/year**		**2,285,714**
Returns/day	**USh**		**1,429**

(Source: based on field observations)

Harvesting and making fine mats:

	No. units	Cost/unit (USh)	Total (USh)
Labour(days)	250		
Mats	107	5,000	535,714
Net returns (excl. labour)	**USh/year**		**535,714**
Returns/ha	**USh/year**		**4,285,714**
Returns/day	**USh**		**2,143**

(Source: based on field observations)

Table 18: Returns to brick-making

No kilns burned/year	64
Months to prepare and burn kiln	1.25
Months of brick-burning/year	8
Kilns/ha/yr	5

(Source: based on field observations)

Per kiln:

	No. units	Cost/unit (USh)	Total (USh)
Bricks	9,000	70	**630,000**
Labour (days)	125		
Firewood (lorry-loads)	1	130,000	**130,000**
Net returns (excl. labour)	**USh/year**		**500,000**
Returns/ha	**USh/year**		**2,500,000**
Returns/day	**USh**		**4,000**

(Source: based on field observations)

Table 19: Returns to fish farming

Average pond size	691 m^2
No. fish ponds	9
No. mirror carp ponds	4
No. tilapia ponds	5

(Source: based on field observations)

For 500 m^2 pond of Mirror Carp:

	Unit	No. units	Cost/unit (USh)	Total (USh)
Labour	Days	125		**-**
Equipment	Various	1	94,117	**94,117**
Fertiliser	Kg	520	600	**312,000**
Fry	No	1,000	100	**100,000**
Feed	Kg posho	163	550	**89,375**
Mature fish	Fish	750		
Mature fish weight	Kg	750	2,000	**1,500,000**
Net returns (excl. labour)	**USh/year**			**904,508**
Returns/ha	**USh/year**			**1,868,819**
Returns/day	**USh**			**7,236**

(Source: based on field observations)

For 500 m^2 pond of Tilapia:

	Unit	No. units	Cost/unit (USh)	Total (USh)
Labour	Days	125		**-**
Equipment	Various	1	94,117	**94,117**
Fertiliser	Kg	520	600	**312,000**
Fry	No	2,000	50	**100,000**
Feed	Kg posho	163	550	**89,375**
Mature fish	Fish	1,500		
Mature fish weight	Kg	750	1,000	**750,000**
Net returns (excl. labour)	**USh/year**			**154,508**
Returns/ha	**USh/year**			**319,232**
Returns/day	**USh**			**1,236**

(Source: based on field observations)