



ANALYSIS

# Economic consequences of wetland degradation for local populations in Africa

Kirsten D. Schuyt\*

*Erasmus Center for Sustainable Development and Management (ESM), Erasmus University Rotterdam, The Netherlands*

Received 16 September 2002; received in revised form 10 July 2004; accepted 10 August 2004

Available online 30 January 2005

## Abstract

Wetlands in Africa are an important source of water and nutrients necessary for biological productivity and often sheer survival of people. Sustainable management of wetlands is therefore critical to the long-term health, safety and welfare of many African communities. Despite their importance, wetlands are being modified or reclaimed, often driven by economic and financial motives. Wetlands, however, contain numerous goods and services that have an economic value not only to local populations but also to people living outside the periphery of the wetland. These values can be made more explicit through economic valuation studies. The goal of this paper is to highlight the importance of wetlands for local populations in Africa and the economic consequences for these people if wetlands are degraded. After explaining the characteristics, distribution and status of wetlands in Africa, the economic values of African wetlands will be highlighted through a discussion of several economic valuation studies carried out for different African wetlands. Recommendations are made as to how economic values may be used in decision-making on wetlands to allow more sustainable management of African wetlands.

© 2004 Elsevier B.V. All rights reserved.

*Keywords:* Wetlands; Africa; Economic value

## 1. Introduction

Much of Africa lies within arid and semiarid climates, where freshwater is scarce and many

regions face serious water shortages. Although Africa has abundant freshwater resources in rivers and lakes, they are unevenly distributed both within and between African countries. Currently, 14 countries in Africa are subject to water stress (1700 m<sup>3</sup> or less per person per year) or water scarcity (1000 m<sup>3</sup> or less per person per year), and another 11 countries are expected to join this list in the next 25 years (Johns Hopkins, 1999). In these contexts, wetlands

\* Present address: WWF-International, Gland, Switzerland. Tel.: +41 223649001; fax: +41 223640640.

E-mail address: [KSchuyt@wwfint.org](mailto:KSchuyt@wwfint.org).

are an important source of water and nutrients necessary for biological productivity and often sheer survival of people (Thompson, 1996). In some cases, wetlands are almost the exclusive source of natural resources upon which rural economies depend. In the Yala Swamp wetland in Western Kenya, for example, it was found that communities rely 100% on water extracted from the wetland for drinking, cooking and washing, while 86% of the population relies on building materials gathered in the wetland, such as clay, sand, wood and papyrus (Jansen and Schuyt, 1998). Sustainable management of wetlands is therefore critical to the livelihoods of many African communities.

Despite their importance, African wetlands are being modified or reclaimed—either their resources are overexploited and converted to other uses or upstream developments alter the magnitude, timing and quality of river water feeding the wetlands. A major factor contributing to these activities is that decision-makers often have insufficient understanding of the economic values of wetlands, in which case the protection of wetlands may not be a serious alternative. Wetlands are often perceived to have little or no value compared to other uses of their lands and water that may yield more visible and immediate economic benefits. These other uses, such as the draining of wetlands for agricultural activities and using the wetlands' waters for electricity generation, constitute the opportunity cost of wetland protection. Decision-makers often perceive these opportunity costs to exceed the benefits of sustainable wetland management.

The protection of wetlands, however, reflects the protection of numerous goods and services that have an economic value not only to the local population living in their periphery but also to communities outside these wetland areas. For instance, people depend on wetlands for water, medicine, food and building materials. The economic value of these goods and services can be made more explicit through economic valuation studies. The results of these studies can be weighed against other land and water uses, including the reclamation of wetlands or the diversion of water from wetlands for the purpose of agriculture.

Numerous economic valuation studies of wetlands around the world have been carried out; however,

most of these studies have focused on wetlands in developed countries. In those studies carried out for developing countries<sup>1</sup>, African wetlands are clearly underrepresented. At the same time, African wetlands are facing serious threats, and the importance of their protection for the survival of local people is increasingly recognized.

The goal of this paper is to explain the importance of wetlands for local populations in Africa and the economic consequences for these people if wetlands are degraded. In the next section, the types and distribution of wetlands in Africa will be discussed followed by an explanation of the status of African wetlands in Section 3. Section 4 then explains the economic importance of wetlands for local populations, illustrated by four case studies, while Section 5 discusses the economic consequences for local people when wetlands in Africa are further degraded. The paper will end with a discussion in Section 6 and conclusions in Section 7, in which recommendations are given as to how economic values may be used in decision-making on wetlands to allow more sustainable management of African wetlands.

## 2. Types and distribution of African wetlands

Wetlands are found throughout the African continent. The largest wetlands include the Okavango Delta, the Sudd in the Upper Nile, the wetlands of Lake Victoria and Lake Chad and the floodplains and deltas of the Congo, Niger and Zambezi rivers (UNEP, 2000). The greatest concentration of wetlands is roughly between 15°N and 20°S. Here, one can find the wetlands of the four major African river ecosystems (Nile, Niger, Zaire and Zambezi), Lake Chad, the wetlands of the Inner Niger Delta in Mali, the Rift Valley Lakes (Victoria, Tanganyika, Malawi, Turkana, Mweru and Albert), the Sudd in Southern Sudan and Ethiopia and the Okavango Delta in Botswana (Hails, 1996). Furthermore, along the African coast, saline and brackish coastal and marine wetlands are located,

<sup>1</sup> See for examples of wetland valuation studies in Asia: Jansen and Padilla (1997) (Philippines); Ruitenbeek, (1992) (Irian Jaya); and Christensen, (1982) (Thailand), and for wetland valuation studies in South America: Aylward et al., (1995) (Costa Rica); and Gammage, (1997) (El Salvador).

such as the mangrove forests in Eastern Africa (stretching from Kisimayu in Somalia to Maputo in Mozambique) and along the West African coastline from Northern Angola to Tidra Island in Mauritania (Hails, 1996). Outside the 15°N to 20°S belt, significant wetlands include inland oases, wadis and chotts in North–West Africa, the Oualidia and Sidi Moussa lagoons in Morocco, the Limpopo river floodplain in Southern Africa, the Banc d'Arguin of Mauritania and the St. Lucia wetlands in South Africa (Hails, 1996).

The percentage of wetland area in Africa has been estimated at lying in a range of approximately 1% to 16% of the total area of the continent (Koohafkan, 1998), covering an area of 220,000 to 1,250,000 km<sup>2</sup> (Bullock et al., 1998). However, due to a lack of scientific investigation and inconsistent mapping policies in Africa, an exact estimate of the total extent of wetlands in Africa is still unknown.

No universally agreed classification of wetland types exists in the literature. For example, wetlands have been classified on their sources of water and nutrients, according to their hydrological regime, soil type and vegetation structure. Differences between these classifications stem from reasons and regions for which the classifications have been developed (Roggeri, 1995). An important wetland classification is presented by Roggeri (1995), who characterizes wetlands according to geomorphological units (the main sources of water and nutrients) and ecological units, in particular vegetation. The first characterization distinguishes (1) alluvial lowlands, which are fringing floodplains, inner deltas and coastal delta floodplains; (2) small valleys, including headwater lowlands and small overflow valleys; (3) lakeshore wetlands on the shores of a deep lake (draw-down area) or in its shallows; and (4) depressions—wetlands in river and lake systems and isolated depressions. In addition to this, Roggeri (1995) specifies three ecological units of wetlands. The first unit encompasses periodically flooded ecosystems, such as flooded forests, flooded grasslands and seasonal shallow lakes and water bodies. Secondly, swamps and marshes may be distinguished, which include herbaceous swamps, swamp forests and peat swamps. The third unit comprises permanent shallow lakes and water bodies, such as natural ponds, oxbow lakes and lagoons. These

ecological units are often interlinked in a complex way, and several ecological units may make up one geomorphological unit. For example, floodplains can include flooded forests and grasslands as well as marshes and swamps. The most extensive wetlands found in the African continent according to this classification are the periodically flooded ecosystems of rivers and lakes.

Another classification system of wetlands is soil and terrain characterization (Koohafkan et al., 1998). In this respect, four wetland classifications can be distinguished. The first group is the Histosols, which are peats and swamps formed of incompletely decomposed plant remains. Secondly, Gleysols may be distinguished, which are the most typical mineral wetland soils, conditioned by water logging at shallow depth for part of or the entire year. A third group is the Fluvisols. These soils are developed particularly in periodically flooded places, such as floodplains. The last group concerns soils that are seasonally flooded. This group includes Vertisols (or dambos) with a high content of clay which shrink and swell according to soil moisture conditions; Planosols, which have a coarse textured layer overlying a deeper dense horizon with more clay; and Plinthic and Gleyic soils, where the former are tropical soils containing a mixture of iron and clay that hardens into ironstone when dried, and the latter are similar to Gleysols, but the water table remains deeper. All types of wetland soils exist in Africa, where the temporarily flooded soils are in the majority.

### 3. The status of African wetlands

Since 1900, more than half of the world's wetlands have disappeared (Barbier, 1993). The land and water of wetlands have been converted to other uses such as agriculture and infrastructure. While some wetland conversions no doubt have been in the best interest of society, wetlands have too often been lost for very limited benefits and even costs to society. Reasons for wetland loss are many (Turner et al., 2000). A major cause is the public nature of many wetlands products and services. Often, much of the land and water of wetlands do not have clear property rights, which means it is unclear who actually owns the wetlands and their products. This causes market failures

because markets are unable to regulate demand and supply for wetland goods and services. Market failure also causes negative externalities—costs associated with consumption of wetland goods by one group of stakeholders are imposed on another group of stakeholders. For example, in the case of dam construction for hydropower in upstream rivers, dam companies and those who consume the electricity will benefit, but those living in the periphery of the downstream wetlands and beyond will bear the costs of decreased functioning of these wetlands, such as decreased availability of water for consumption and increased sedimentation. Other reasons for wetland loss are associated with policy intervention failures due to a lack of consistency among government policies in different areas, including economics, environment, nature protection and physical planning. Such failures arise due to the insufficient understanding of the functions and values of wetlands and thus the consequences when wetlands are lost.

At the root of wetland conversion is the fact that numerous stakeholders of wetlands with different interests lay claims on the wetlands' water and lands that do not always coincide. For example, stakeholders include direct extensive users, which directly harvest wetland goods in a sustainable way; agricultural producers that drain and convert wetlands to agricultural land; indirect users that benefit from indirect wetland services, such as storm abatement and flood mitigation; nature conservation and amenity groups, whose objective is to conserve nature and enjoy the presence of plant and animal species; and even nonusers that may attribute an intrinsic value to wetlands (Turner et al., 2000). In many cases, it is likely that the different interests of these stakeholders conflict so that policy-makers are faced with complex trade-offs.<sup>2</sup>

In Africa, common factors that put increasing pressures on wetlands are demographic growth, rising poverty and severe economic stress (Dugan, 1992). This is often compounded by drought. Wetland loss in Africa is furthermore enhanced because the benefits of wetlands are often not shared by those who own the property (Dugan, 1992). Private landowners can often

derive higher profits from wetland conversion, while the public benefits of wetlands themselves and thus the costs of wetland conversion are shared by local populations.

A further underlying cause of much wetland degradation is information failures. Information failures relate to the "...complexity and 'invisibility' of spatial relationships among groundwater, surface water and wetland vegetation" (Turner et al., 2000, p. 1), the failure to understand the consequences of land use, water management, pollution and infrastructure on wetlands and the fact that many wetland functions do not have a market price and as such are not recognized as having an economic value by decision-makers. As a result, benefits of extensive crop production, improved water supply and power generation that are the results of different water management techniques are often perceived to have more economic benefits than the wetlands themselves.

An important activity that has often been viewed as being economically more profitable than ecosystem protection is dam construction. It is estimated that Africa has more than 1200 dams, of which more than 60% are located in South Africa and Zimbabwe (World Commission on Dams, 2000). In the first decades after colonial independence, many African countries dammed major rivers for hydropower and irrigation, aided and funded by First and Second World donors. It is now known, however, that the economic and social impacts of large dams on African communities living on the floodplains have often been adverse (Adams, 1996).

Perspectives on the relationship between humans and the environment, however, are slowly changing in many countries. An important event for sustainable management of wetlands was when the 'Convention on Wetlands of International Importance Especially as Waterfowl Habitat' entered into force in 1975, whereby wetlands became the only single group of ecosystems to have their own international convention (Turner et al., 2000). This convention (also known as the Ramsar Convention after the Iranian city in which the treaty was signed) is an intergovernmental treaty at first aimed at the conservation of wetlands as a habitat for water birds. Since then, however, the Convention has developed to cover all aspects of wetland conservation for biodiversity and well-being of human communities. There are presently 138 Contracting

<sup>2</sup> See Adams (1992) for an extensive discussion on regulation of river flow regimes in Africa and the conflicts this generates.

Parties with 1368 wetland sites listed as internationally important (Ramsar, 2004).

Although this convention in particular has significantly improved the status of wetlands around the world, including African wetlands, the present set of regulations does not seem to be sufficient (Turner et al., 2000). Wetlands are still being degraded in many parts of the world. Although Africa still has a significant number of pristine wetlands left when compared to Europe or parts of North America, many wetland areas are still experiencing immense pressures (Kabii, 1996). Current major threats are drainage for agriculture and settlement, excessive exploitation by local populations and improperly planned development activities. For example, Djoudj National Bird Park in Senegal is being threatened due to the construction of dikes and dams for the promotion of rice agriculture in the Senegal River valley. The quantity and quality of freshwater in the area has changed due to these activities, compounded by the use of fertilizers and pesticides to improve yields and control pests in rice fields (Seydina Issa Sylla and Balde, 1996). In Lake George, Uganda, threats to the wetland come from pollution from copper and cobalt mines and uncontrolled charcoal burning, which deplete tree resources (Mafabi, 1996). In the ephemeral wetlands of central north Namibia, the major threat is rapid population growth that puts increasing pressure on the wetland resources (Kolberg et al., 1996).

As populations in Africa are expected to grow into the future, pressures on wetlands are likely to increase. According to the Ramsar Bureau, “the future of African wetlands lies in a stronger political will to protect them, based on sound wetland policies and encouragement for community participation in their management.” (Kabii, 1996). The next section will explore why it is necessary to protect wetlands in light of their economic importance for local populations.

#### 4. The importance of African wetlands for local populations

##### 4.1. Values of wetlands

In the literature, several approaches towards wetland values exist, and one useful approach is given by

Turner et al. (2000), who provide a framework for an ecological–economic analysis of wetlands by distinguishing between characteristics, structure, processes and functions. Characteristics describe a wetland area in the simplest terms and include biological, chemical and physical features. The wetland structure consists of the biotic and abiotic webs of which characteristics are elements, such as vegetation and soil type, and wetland processes refer to the dynamics of transforming energy into matter. These processes enable the development and maintenance of the wetland structure. Lastly, wetland functions are the result of interactions between characteristics, structure and processes. There exists a wide body of literature on wetland functions, and one approach is provided by de Groot (1992), who classifies functions into four categories (de Groot, 1992): (1) regulation functions as ecosystems regulate ecological processes that contribute to a healthy environment; (2) carrier functions, where ecosystems provide space for activities, like human settlement, cultivation and energy conversion; (3) production functions—ecosystems provide resources for humans, like food, water, raw materials for building and clothing; and (4) information functions, where ecosystems contribute to mental health by providing scientific, aesthetic and spiritual information.

Wetland benefits are the capability of wetlands to provide humans with goods and services. Wetland services, such as cleansing and recycling capacity, are conditions and processes through which natural ecosystems sustain and fulfill human life. They maintain biodiversity and the production of wetland goods, like wood, water and medicine (de Groot, 1992). These goods and services constitute a value to humans. This total value consists of an ecological value, such as the maintenance of ecosystem stability and climatic stabilization; a socioaesthetical value, such as the role of ecosystems in cultural heritage; an intrinsic value, which is the value that resides in the environmental asset itself<sup>3</sup> and an economic value. Economic values are monetary measures for benefits or costs of environmental change. They are based on

<sup>3</sup> Intrinsic value is unlike the economic value type ‘existence value,’ which is a value humans attach to ecosystems—intrinsic value is the value intrinsically residing in ecosystems themselves, unrelated to man.

estimates of people's willingness to pay for that environmental change or willingness to accept compensation for that change. Economic values will, however, always depend on the type of functions that are perceived as valuable to society—what people perceive as being of value to them (Turner et al., 2000). Hence, not all functions have an economic value. Only functions that provide goods and services that satisfy human wants directly or indirectly have an economic value.

The economic value of wetland goods and services reflect the economic importance of wetlands for the people that depend on these goods and services. For example, wetlands provide people with fertile soils for agriculture, with fish to eat, with wood for fuel and with reeds for mats and roofs. Wetlands also store water temporarily and recycle nutrients and human waste to improve water quality. Famous wetland areas, like the Okavango Delta in Botswana, attract large numbers of tourists each year for recreational activities, like bird watching or safaris as well as for scientific study. In the next section, one tropical wetland in Africa is highlighted to indicate the dependence of local people on such wetland goods and services.

#### *4.2. Dependence of local populations on African wetlands: the case of the Yala Swamp wetland in Kenya*

The Yala Swamp wetland is a large area of swampland located in Western Kenya and is bordered by Lake Victoria in the west and the Yala River in the south. The wetland has three lakes: Lake Kanyaboli, Lake Sare and Lake Naboyo. The approximate area of the wetland is 17,500 ha, thereby making it Kenya's largest freshwater wetland. The Yala Swamp also has a high biodiversity. The swamp is home to several endemic species, including the Sitatunga antelope, and many fish species, such as Tilapia. The fish in Lake Kanyaboli are particularly unique as they are "...living museums of those fish which populated Lake Victoria before the 1960s" (Mavuti, 1989), when the introduction of the Nile Perch in Lake Victoria caused a rapid decline in fish species and resulted in one of the worst ecological disasters. Furthermore, the wetland is home to several bird species, such as the squacco and purple heron, the necked cormorant, fish

eagle, hamerkop, grey-headed kingfisher, guinea fowl, crested crane and the egret. Other common animals in the periphery of the swamp are the waterbuck, bushbuck, reedbuck, warthog and vervet monkey. The vegetation along the Lake Victoria lakeshore is dominated by rooted papyrus. Reeds grow on drier and higher grounds, and, further inland, the swamp is a mixture of different reed species and papyrus.

The Yala Swamp is part of the most densely populated areas in Kenya—the Nyanza and Western provinces. Both the periphery and the neighboring districts are densely populated, and, as a result, a great number of people live in the wetland area that are dependent on the functions the Yala Swamp fulfills. There has been a rapid rise in human population that has resulted in land scarcity, forcing land users to clear wetland vegetation for crop farming.

Unlike other wetlands in Kenya, the Yala Swamp does not have a protected status. This means that uncontrolled exploitation of the wetland and its resources can take place. As a result, it has been subject to reclamation since the 1960s mostly for agricultural purposes, such as the growing of rice, groundnuts, cassava, yams and sugarcane.

Research (Jansen and Schuyt, 1998) was initiated by the Royal Netherlands Embassy to study the economic values in the Yala Swamp wetland and analyse the population trends and the effects it would have on the wetland's sustainability. In terms of the latter, it was found that, although population pressures resulted in unsustainable use of many of the wetland's resources, it was the Kenyan government and not the local people who initiated wetland reclamation for agricultural purposes. It was found that this reclamation in general did not benefit the local people as most of the crops grown in the area were for the purpose of export. On the other hand, the costs of reclamation of the wetland were borne by the local people—the goods and services they depend on diminished as a result of reclamation activities.

In terms of the economic values of the Yala Swamp wetland, it was clear that the wetland provided numerous goods and services to the local population that represent economic values. For example, the quality of the water that is discharged into Lake Victoria from the swamp is exceptionally clear due to the filtering effect of the swamp into which most of the sediments are deposited. An investigation into the

importance of wetland resources to the livelihoods of local people showed dependence on fish, vegetation, building materials, birds and wild animals, agricultural products, livestock farming and water. The three most important products of the wetland for local people were water, fish and agricultural crops grown on the wetland's fertile grounds. Water, which is used for drinking, cooking, washing and irrigation, has a dependence ratio of 100% among the local people. In one part of the wetland, water is for free through boreholes, while, in other parts of the wetland, water needs to be obtained directly from the lake or bought from water sellers (who transport water around the wetland on donkeys); others can afford their own water pump. Local water transport is also a substantial use of water in the wetland: approximately 66% of local people use water transport. Fish, mostly Tilapia and Nile Perch, is caught for both commercial purposes (34% of the population) and noncommercial purposes (66% of the population). Indirect commercial activities related to fishing also take place: about 10% of the local people is engaged in activities such as net and boat repairing. Agricultural grounds of the wetland provide fertile soil for growing agricultural crops. The main crops grown are kales, tomatoes, maize, millet, sorghum, beans, peas, cassava, potatoes and onions. These crops are grown both for subsistence (38% of the population) and for commercial purposes (62% of the population). Wood is harvested by people to make charcoal as electricity is still very uncommon. Approximately 81% of the population gathers wood for subsistence, while 28% gathers fuel wood for income. Most people in the wetland (86%) live in traditionally built houses made of building materials gathered in the wetland, such as clay, sand, wood and papyrus. The framework of these houses is made of wood gathered in the wetland, while clay, also found in the wetland, is used for the walls. Papyrus is gathered to make the roofs of the houses. Hunting of birds and wild animals is also an important activity in the wetland that is carried out by approximately 46% of the local population despite a ban on hunting. Animals, including the Sitatunga antelope, Duiker, hares, Guinea fowl and Harlequin quail, are sold at markets. Lastly, livestock grazing is also an important activity in the Yala Swamp wetland, where 74% of the people graze animals mostly for subsistence. Cattle are often bought for food but

sometimes also as a form of banking. This process is as follows: the first animal bought is usually a chicken as it is the cheapest animal, and money is saved from selling eggs and chicks. When enough money is saved, a goat is bought and eventually a cow from which people may send their children to school.

The high dependence ratios show that people in the Yala Swamp wetland are sometimes entirely dependent on the wetland's resources. Reclamation and unsustainable use of wetland products would therefore seriously injure the local people especially since substitution of wetland products is often only possible at a high price. For example, the substitute price of papyrus with iron sheets for roofs is six times higher, and the substitute price of wood and clay with bricks for walls is 14 times higher.

The next question is what the consequences of the degradation and unsustainable management of wetlands will be for the local population. The next section will illustrate this by discussing the economic values of four African wetlands to local populations.

## 5. Consequences of wetland degradation to local populations: four case studies

### 5.1. Nakivubo urban wetland, Uganda

The Nakivubo urban wetland is located in Uganda, close to the capital city of Kampala. It is part of a system containing 12 main wetland areas that cover about one-sixth of the Kampala District (31 km<sup>2</sup>). All wetlands drain into Lake Victoria. The Nakivubo wetland is a permanent swamp and is the largest of these wetlands at 5.29 km<sup>2</sup>. It is fed by the Nakivubo River and runs from the Kampala central industrial district to enter Lake Victoria at Murchison Bay, thereby passing through dense residential settlements and commercial areas. Approximately 100,000 people reside in the wetland or 25,000 households in 15 villages. Due to the wetland's geographic position close to Kampala, it acts as an important sink for domestic and industrial wastes of the city.

The major threat in the Nakivubo urban wetland is reclamation for agriculture, industry and residential expansion. In fact, half of the total area has been modified or reclaimed for agriculture, industry and settlement; of an area of 5.29 km<sup>2</sup>, 2.9 km<sup>2</sup> is

unconverted. As a result, shallow wetland areas to the north are modified, while deeper wetlands in the south are relatively intact. The danger, however, exists that the entire wetland will be modified and converted for urban expansion purposes.

Emerton et al. (1998) carried out an economic valuation study of the Nakivubo urban wetland. In this study, four wetland resources were valued and one wetland service. The economic values are presented in Table 1.

The first wetland resource valued was crop cultivation, which is an important wetland resource as the wetland provides water required for irrigated crop cultivation and deposits sediments and nutrients that maintain soil fertility. Approximately 1.8 km<sup>2</sup> in the wetland is crop area in which about 450 to 500 farmers grow crops. In permanently water logged areas, mainly cocoyams and sugarcane are grown, and, in drier areas, crops grown include sweet potato, matooke, mixed vegetables and cassava. The economic value of crop cultivation in the wetland is estimated by looking at the total value-added generated by irrigated crops over dry-land cultivation. The second wetland resource valued was papyrus harvesting, valued in terms of the total income it generates. Approximately 50 people in the wetland harvest papyrus, which generates income in three ways: (1) half of the harvesters sell raw materials to artisans such as thatchers and mat-makers; (2) a quarter of the harvesters produce rough low-cost mats; and (3) a quarter of the harvesters produce fine higher-cost mats. A third resource valued was the economic value of brick making, also estimated based on the income it can generate. About 50 people make bricks for building during the 8 dry months of the year. The last resource valued was fish farming. The economic value was calculated based on the average annual returns to fish farming in the wetland.

Table 1  
Economic benefits of the Nakivubo urban wetland, Uganda

Wetland benefit	Economic value (US\$/year, 2002)
Crop cultivation	60,000
Papyrus harvesting	10,000
Brick making	17,000
Fish farming	3,000
Water treatment and purification	700,000–1.3 million

In addition to these wetland goods, one wetland service was valued, namely, water treatment and purification, which plays an important role in the wetland area. The largest amount of waste that enters the wetland is domestic waste, which is organic. Furthermore, one-third of the 15 industries plus 200 smaller production facilities discharge waste directly into surface water. These wastes include detergents, lubricants, oils, acids, xenobiotics, nitrates, phosphates and heavy metals. The wetland's role is to treat and purify this water. Two valuation methods were applied: (1) the replacement cost method—the costs of artificially replacing this service by investing in extending water treatment plants and increasing sanitation in low-cost settlements; and (2) mitigative expenditures—the costs required to offset the effects of impaired water quality.

### 5.2. *The Hadejia-Nguru wetlands, Nigeria*

The Hadejia-Nguru wetlands lie within the floodplains of the Hadejia-Jama'are river basin in Northeast Nigeria near Lake Chad. The wetlands have two rivers, the Hadejia and Jama'are, which converge into the Komadugu-Yobe River that drains into Lake Chad. Approximately one million inhabitants live in the wetland, many of whom have immigrated to the area since 1963, particularly in years of severe drought outside the wetland. Since 1987, the area has been the focus of the Hadejia-Nguru Wetlands Conservation Project, concerned with the conservation and sustainable management of the entire floodplain. The National Parks Commission of Nigeria has already designated some areas of the wetland as part of the Lake Chad Basin National Park, while the Nguru Lake complex, which is part of the Hadejia-Nguru Wetlands, has been designated a Ramsar site in 2000.<sup>4</sup>

It has been estimated that the maximum extent of flooding has declined from 250,000–300,000 ha in the 1960s and 1970s to 70,000–100,000 ha in recent years (Barbier and Thompson, 1998). The pressures that threaten the existence of the wetland consist of both

<sup>4</sup> See Hollis et al. (1993) for a detailed overview of the Hadejia-Nguru wetlands environment, economy and conservation development activities.



natural and human-induced pressures (FAO, 1997). In terms of natural pressures, drought has had serious implications on the sustainability of the wetland. Water developments projects in other places of the river basin, predominantly upstream, have also had serious effects on the wetland. The Tiga Dam, constructed in a tributary of the Hadejia River in the early 1970s has, in combination with the droughts, led to a serious decline in flooding of the wetland. Another dam on the Hadejia River, called the Challawa Gorge Dam, was completed in 1992, and the Hadejia Valley Project has been constructed immediately upstream of the wetland. Both are expected to have major effects on the timing and extent of flooding in the wetlands.

In the Hadejia-Nguru Wetlands area, several economic valuation studies have been carried out to value a number of wetland goods and services. All of the economic benefits that were valued are presented in Table 2.

One important economic valuation study was carried out by Acharya (1998), who estimated the economic value of groundwater recharge to be \$17,391 per year<sup>5</sup>. Two other important economic studies in the Hadejia-Nguru wetlands are Barbier et al. (1991) and Eaton and Sarch (1997). These two studies together valued agriculture, fishing and the collection of fuel wood and wild resources. Agriculture involves mostly dry-land farming of sorghum and millet, seasonally flooded rice farming, flood recession farming (mainly cowpeas) and irrigated farming. Rice is the most important crop grown in seasonally flooded areas. The second resource valued was fishing, which is done at various times of the year with different gears. The poor flooding of the wetland due to dams, diversions and climatic changes, however, seriously injures this estimate. Fuel wood is collected mostly for subsistence by both men and women but is also a very active trade. Lastly, wild resources were valued. These resources provide materials for utensils and construction and contribute to improved diets and health, food security, income generation and genetic experimentation. Two wild resources were quantified: doum palm and potash. Doum palm is a source of food, materials and income.

Table 2

Economic values of the Hadejia-Nguru wetlands, Nigeria

Wetland benefit	Economic value (US\$/year, 2002)
Groundwater recharge	17,391
Agricultural activities	11 million
Fishing	3.5 million
Fuel wood	1.6 million
Wild resources: doum palm	130,000
Wild resources: potash	900

Potash is sold as an industrial raw material first to wholesalers and then to traders from other parts of the country. Households use potash as a food ingredient, a stomach medicine and an appetite stimulant for livestock.

For an African wetland, the Hadejia-Nguru wetlands have received considerable attention in terms of economic valuation studies. Many studies have demonstrated the economic benefits of sustainable management and conservation of the wetland as opposed to the allocation of its land and waters for alternative uses. For example, by comparing agricultural, fishing and fuel wood benefits of the Hadejia-Nguru wetlands that would be lost through reduced downstream flooding caused by upstream irrigation projects with the value of irrigation production, Barbier and Thompson (1998) have demonstrated that the economic value of the wetlands is far greater than the expected present value of upstream irrigation projects. Furthermore, Barbier et al. (1993) show that the economic returns to the floodplain are more favorable than the net economic benefits of upstream water development projects, like the Kano River Project Phase I. Lastly, Acharya (1998) has demonstrated that changes in the groundwater recharge function would result in welfare losses for the population.

### 5.3. Lake Chilwa wetland, Malawi

The Lake Chilwa wetland has been designated as Malawi's first Ramsar site as a wetland of international importance in 1996. The wetland has an area of 2,400 km<sup>2</sup> and is situated in the south of Malawi, on the border with Mozambique. It is one of the most productive lakes in Africa, and it produces more than 20% of all fish caught in Malawi. It is also a very important area for agricultural activities and breeding waterfowl.

<sup>5</sup> See also Acharya (2000), Acharya and Barbier (2000, 2002).

The two major immediate threats facing the Lake Chilwa wetland are a reduction in lake level due to abstraction within the catchment and a degradation of the catchment by the local population due to poverty and high population growth rates. As a result, there is a shortage of wood for fuel, the construction of fishing crafts as well as building materials. Overtrapping and shooting resident and migratory birds in the wetland for food is also a major problem. Potential threats for the future of the wetland include further increases in poverty and population that result in overexploitation of the wetland's resources; soil erosion and siltation, mainly due to uncontrolled fishing and cultivation activities in the wetland; increased use of agrochemicals affecting the aquatic environment that kill fish and make the surviving fish stock unsuitable for human consumption; and invasion of the wetland by exotic plant species such as the mesquite and water hyacinth that spread over the water surface, blocking sunlight and air.

Designation of a wetland as a Ramsar site also means a management plan needs to be developed for the area. As part of the studies that were required to inform the development of the management plan, an economic valuation study was carried out (Schuyt, 1999). In this study, five wetland resources were valued (see Table 3).

The first resource was agricultural grounds, which includes crop-growing activities and small-scale organized rice schemes in existing wetland areas. The main crops grown in the wetland are maize and rice, depending on the location, and approximately 92% of the people in the wetland grow crops. The second resource valued was fish, which includes both the values accruing to fishermen and the values accruing to fishmongers. The average annual catch is 16,600 tons per year, making Lake Chilwa an extremely productive lake. A third group of resources valued was vegetation and clay, including reeds in the

wetland that are used for mats, brooms and baskets; bamboo that is used for fish traps; grass called Njeza that is used as a building material for roofs, walls and fences; wood that is mainly used for firewood; and clay, used for making bricks. Use of the wetland's water for transport was the fourth resource valued. Water transport does not take place in all areas of the wetland, a main reason being that many people are afraid of water as they cannot swim and believe that spirits exist in open water. Transport takes place on small boats for trips to islands and other places within the wetland and larger ferries that go to the north of Malawi and into Mozambique. Lastly, grasslands in the wetland were valued, mostly used for grazing cattle, goats, sheep and pig.

#### 5.4. Zambezi Basin wetlands, Southern Africa

The Zambezi basin is located in Southern Africa in the countries Angola, Zambia, Zimbabwe, Malawi, Botswana, Namibia and Mozambique. In the basin, several wetland types exist, where the largest by area is the freshwater floodplain wetland. Ten major freshwater wetlands may be distinguished (Hughes and Hughes, 1992; Davies, 1986): Kafue Flats (650,000 ha), Lukanga (250,000 ha), Barotse Plain (900,000 ha), Liuwa Plain (350,000 ha), Linyanti-Chobe (20,000 ha), Cuando (200,000 ha), Elephant Marsh (52,000 ha), Luangwa (250,000 ha), Busanga (200,000 ha) and Luena (110,000 ha) wetlands. Busanga and Linyanti-Chobe are protected, while the other wetlands are partly protected; only Elephant Marsh and Lukanga have an unprotected status.

Threats to the Zambezi basin wetlands include reduced flows caused by droughts and water abstractions; aquatic weed infestation; pesticides (especially DDT); infrastructure development, like dams; overuse of resources due to human pressures; uncontrolled fires; pollution; and deforestation (SARDC, 2000). More generally, the Zambezi basin wetlands have been viewed as wastelands, one of the reasons being a lack of incentives for preservation. At national level, for example, policies of wetland conservation are often counteracted by measures like the provision of soft loans for major wetland development projects or maintaining high crop prices by means of subsidy.

Two economic valuation studies on the Zambezi basin wetlands have been carried out: a large

Table 3  
Economic values of the Lake Chilwa wetland, Malawi

Wetland benefits	Economic values (US\$/year, 2002)
Agricultural grounds	1.2 million
Fish	18.7 million
Vegetation and clay	14,000
Water transport	436,000
Grasslands	638,000

valuation study by Turpie et al. (1998) and a smaller one by Seyam et al. (2001). The former study was initiated by IUCN as part of the Zambezi Basin Wetlands Resource Conservation and Utilization Project (ZBWCRUP). Four study areas were selected, namely, the Barotse Floodplain in Western Zambia, the Chobe-Caprivi wetlands in Namibia and Zambia, the Lower Shire wetlands in Malawi and Mozambique and the Zambezi Delta in Mozambique. In each of these wetlands, ranges for both wetland goods and services were valued. These are presented in Table 4. In addition to these, the economic value of tourism was considered quantitatively only in Chobe-Caprivi and was quantified at \$3.6/ha. Lastly, the nonuse or existence value of the Barotse wetland biodiversity in Zambia was measured using the Contingent Valuation Method (CVM). The economic value was estimated at \$4,229,309.

The aim of the second paper by Seyam et al. (2001) was to apply a simple and rapid approach for valuing wetlands under limited availability of data. By using a rapid valuation approach, the study summarizes the most frequently reported products and services of the

Table 4  
Economic values of the Zambezi basin wetlands, Southern Africa (1)

Wetland benefit	Minimum economic value (US\$/year)	Maximum economic value (US\$/year)
Livestock grazing	1.8 million (Caprivi-Chobe)	3.9 million (Barotse)
Agriculture	4.8 million (Zambezi)	13 million (Lower Shire)
Fishing	0.7 million (Caprivi-Chobe)	6.5 million (Zambezi Delta)
Wild animals	5,000 (Zambezi Delta)	219,000 (Caprivi Chobe)
Reeds and papyrus	163,000 (Zambezi Delta)	378,000 (Caprivi-Chobe)
Palms	2000 (Lower Shire)	621,000 (Zambezi Delta)
Grass	130,000 (Caprivi-Chobe)	2.2 million (Lower Shire)
Flood attenuation	400,000 (Barotse)	2.7 million (Lower Shire)
Groundwater recharge	500,000 (Chobe-Caprivi)	7.5 million (Lower Shire)
Water purification	1.6 million (Chobe-Caprivi)	18.4 million (Zambezi Delta)
Carbon sequestration	8 million (Lower Shire)	64 million (Zambezi Delta)

Table 5

Economic values of the Zambezi basin wetlands (2)

Wetland benefit	Economic value (US\$ per year)
Flood plain recession agriculture	50 million
Fish production	78.6 million
Wildlife services and goods	–1 million
Livestock grazing	70.6 million
Ecotourism	814,000
Biodiversity	68,000
Natural products and medicine	2.6 million

Zambezi basin wetlands for the local population. These are presented in Table 5.

An interesting figure is presented for wildlife services and goods, which resulted in a negative value for the Zambezi basin wetlands. The reason is that the costs of managing wildlife in the wetlands exceed the income derived from tourism.

## 6. Discussion

The economic values estimated for the different wetland resources in the case studies of the previous section constitute losses to local people if wetlands are converted or degraded. Such losses must be incorporated in decision-making processes and weighed against the benefits of wetland conversion. In all four cases studied, a total of 16 different goods and services that these wetlands supply to people have been valued. Although generalization from these studies to the entire continent is impossible, it is interesting to know how representative these wetlands are for the African continent. In this respect, two of these wetlands actually represent the most common wetland types in Africa, namely, the floodplain wetlands of the Zambezi basin and the Hadejia-Jama're basin. The other two wetlands (Nakivubo urban wetland and Lake Chilwa wetland) represent wetlands associated with lakes, which are also very common in Africa. Therefore, although each and every wetland must be approached separately due to the often very different local economic, social and ecological circumstances, the case studies are representative of other wetlands in Africa.

Valuable wetland goods and services to local populations that were conveyed in the case studies are fish, agriculture, livestock farming, natural products and medicine, and water treatment and purifica-

tion. In terms of the types of resources derived, valuation of wetland goods was dominant, where agriculture, fish and livestock grazing were most commonly valued. Only two wetland services were quantified, namely, water treatment and purification in the Nakivubo wetland and groundwater recharge in the Hadejia-Nguru wetland. This indicates that it is still relatively difficult and time-consuming to value wetland services.

A further observation with respect to the valuations is that, in all four case studies, the focus was on the so-called use values. Use values are economic values associated with the direct and indirect use of a wetland good or service, such as agriculture, fishing and water treatment and purification. Nonuse values, on the other hand, refer to noninstrumental values of a wetland, not associated with use. Only two nonuse values were quantified in the case studies, namely, biodiversity and existence value in the Zambezi basin wetlands. Use values were derived mostly from production functions and carrier functions; only two regulation functions were valued and no information functions. An important reason why use values are dominant in valuation studies is that they are relatively straightforward when it comes to valuation—most use values can be approached through market pricing techniques, which apply market prices to estimate the economic value.<sup>6</sup> Nonuse values can only be estimated through shadow pricing techniques, like the Contingent Valuation method, which directly obtains people's willingness to pay (or willingness to accept compensation) for a change in the level of an environmental resource through interviews and questionnaires. Shadow pricing methods, however, often require a relatively long time and involve high costs—this was the key motivation not to apply it in the economic valuation study of the Lake Chilwa wetland and may also have been important motivations in the other case studies in Section 5.

The types of threats facing the wetlands in the case studies all have one aspect in common: principally, the wetlands are all being threatened by human

activities. The major factors threatening the Nakivubo urban wetland in Uganda and the Hadejia-Jama'are wetland in Nigeria are reclamations and developments, such as dams, water diversions and industrial expansions, performed by people outside the wetland. On the other hand, the Lake Chilwa wetland is mostly threatened by government-driven reclamation activities as well as the overuse of its resources by local people, driven by poverty and overpopulation. Lastly, the Zambezi basin wetlands are faced with a combination of overuse of wetland resources by local populations and outside influences such as infrastructural developments.

## 7. Conclusions and recommendations

This paper highlights the economic importance of wetlands for local people in Africa and the economic consequences for these people if wetlands are further degraded. Case studies on four African wetlands enumerate the importance of wetlands for local people in Africa and the costs they must bear if their wetlands are lost or degraded. It is therefore important that decision-makers take these costs into account in plans to convert wetlands' lands and waters for other purposes, including agriculture and urban or industrial expansions.

The case studies show that the greatest threats and causes of wetland loss are associated with human activities. However, when approaching stakeholders with evaluations of costs and benefits of ecosystems, a distinction must be made between (1) decision-makers outside the wetland area, who perceive wetland economic benefits as less than the benefits of wetland conversions and (2) actors within the wetland area who, driven by poverty and population increases, do not use the wetlands' resources in a sustainable way. The first group of stakeholders, when faced with information shortages on the economic benefits of wetland conservation, may be approached with economic valuation studies that highlight these benefits. However, the second group of stakeholders, who overuse wetland resources, must principally be approached by fighting the root causes of this unsustainable use of wetland resources, namely, poverty and overpopulation in the African continent. Nevertheless, in management plans of wetlands where

<sup>6</sup> See for example Emerton (1998) in which wetland crops such as cocoyam, sugarcane and cassava were valued using market pricing in addition to papyrus harvesting and fish.

local people overuse wetland resources, economic valuation may be an important tool in providing information on different economic activities in the wetland and, perhaps more importantly, the relative importance of these activities for the local people.

The types of economic values obtained in the case studies presented in this paper must be integrated in decision-making processes. If, on the other hand, these values are ignored, the result will be economically inefficient decisions at a very high cost for low-income rural communities. One approach towards such integration is integrated ecological–economic modeling. Turner et al. (2000) suggest an integrated wetland research framework, which combines economic valuation, integrated modeling, stakeholder analysis and multicriteria evaluation. It is the combination of social and natural sciences that “. . . can help in part to solve the information failure to achieve the required consistency across various government policies” (Turner et al., 2000: 7). Integrated ecological–economic models are analytical, numerical or statistical and describe either steady-state or dynamic change. Aerial photography and satellite imaging can be integrated through GIS systems to add spatial dimensions—such tools can be very useful in land-use planning processes and in negotiation processes of land-use trade-offs. As a result, integrated models may provide important information about eco–hydrological consequences and the associated costs and benefits of land-use policies (Turner et al., 2000). Economic valuation plays an important role in these models by providing data on the economic costs and benefits related to environmental change resulting from these policies. A good example of a case study where such an integrated approach has been applied is provided by Barbier and Thompson (1998), in which the economic losses of floodplain benefits were compared with the value of upstream irrigation production.

Although this paper explains why understanding and recognizing the economic values of wetlands in Africa is important, it also suggests that few economic valuation studies of wetlands in the African continent exist relative to other continents. It is therefore important that resources for economic valuation studies are allocated in a more balanced way across continents such that more economic valuation studies are carried out that highlight the significance of African wetlands. Furthermore, all of the case studies

found were carried out by European organizations and scientists albeit often with the help of local organizations and people. However, since local people often have a clearer understanding of local economies, it is very important to stimulate further integration of local expertise in these valuation studies and aim towards strengthening local skills in resource valuation studies.

### Acknowledgements

This article is based on a Working Paper (IR-02-063, 2002) that was written during the Young Scientists Summer Program at the International Institute for Applied Systems Analysis (IIASA) in Laxenburg, Austria. The funding for this research was obtained from The Netherlands Institute for Scientific Research (NWO). The author is grateful to Harrij van Velthuisen and Jan Sendzimir of IIASA, who provided useful comments to the initial working paper. The author also thanks Jack Ruitenbeek and one anonymous reviewer for his/her very useful and constructive comments. Both significantly improved this article.

### References

- Acharya, G., 1998. Hydrological–Economic Linkages in Water Resource Management. Unpublished PhD thesis, University of York.
- Acharya, G., 2000. Approaches to valuing the hidden hydrological services of wetland ecosystems. *Ecol. Econ.* 35 (1), 63–74.
- Acharya, G., Barbier, E.B., 2000. Valuing groundwater recharge through agricultural production in the Hadejia–Nguru wetlands in Northern Nigeria. *Agric. Econ.* 22, 247–259.
- Acharya, G., Barbier, E.B., 2002. Using domestic water analysis to value groundwater recharge in the Hadejia–Jama’re floodplain, Northern Nigeria. *Am. J. Agric. Econ.* 84 (2), 415–426.
- Adams, W.M., 1992. *Wasting the Rain: Rivers, People and Planning in Africa*. Earthscan, London.
- Adams, W.M., 1996. Economics and hydrological management of African floodplains. In: Acreman, M.C., Hollis, G.E. (Eds.), *Water Management and Wetlands in Sub-Saharan Africa*. IUCN, Gland, pp. 21–33.
- Aylward, B., Echeverria, J., Barbier, E.B., 1995. Economic Incentives for Watershed Protection: A Report on an Ongoing Study of the Arenal, Costa Rica, CREED Working Paper Series No. 3, IIED, London.
- Barbier, E.B., 1993. Sustainable use of wetlands—valuing tropical wetland benefits: economic methodologies and applications. *Geogr. J.* 159 (1), 22–35.

- Barbier, E.B., Thompson, J.R., 1998. The value of water: floodplain versus large-scale irrigation benefits in Northern Nigeria. *Ambio* 27 (6), 434–440.
- Barbier, E.B., Adams, W.M., Kimmage, K., 1991. Economic Valuation of Wetland Benefits—The Hadejia-Jama'ra Floodplain, Nigeria, LEEC Discussion Paper, DP 91-02, IIED, London.
- Barbier, E.B., Adams, W.M., Kimmage, K., 1993. An economic valuation of wetland benefits. In: Hollis, G.E., Adama, W.M., Amino-Kano, M. (Eds.), *The Hadejia-Nguru Wetlands: Environment, Economy and Sustainable Development of a Sahelian Floodplain Wetland*. IUCN, Gland, pp. 191–209.
- Bullock, A., Gilman, K., McCartney, M., Waughray, D., Blyth, K., Andrews, A., 1998. Hydrological strategy to develop and manage African wetland resources for sustainable agricultural use. *Wetland Characterization and Classification for Sustainable Agricultural Development*. FAO/SAFR, Rome. [www.fao.org](http://www.fao.org), Part III.
- Christensen, 1982. *Management and Utilization of Mangroves in Asia and the Pacific*, FAO Environment Paper. FAO, Rome.
- Dugan, P.J., 1992. Wetland management: a critical issue for conservation in Africa. In: Matiza, T., Chabwela, H.N. (Eds.), *Wetlands Management: A Critical Issue for Conservation in Africa*, Wetlands Conservation Conference for Southern Africa. IUCN, Gland, pp. 1–8.
- Eaton, D., Sarch, M.-T., 1997. *The Economic Importance of Wild Resources in the Hadejia-Nguru Wetlands, Nigeria*, CREED Working Paper, no. 13, London.
- Gammage, S., 1997. Estimating the Returns to Mangrove Conversion: Sustainable Management or Short-Term Gain? IIED Discussion paper 97-02, IIED, London.
- de Groot, R.S., 1992. *Functions of Nature: Evaluation of Nature in Environmental Planning, Management and Decision Making*. Wolters-Noordhoff, Groningen.
- Hails, A.J., 1996. *Wetlands, Biodiversity and the Ramsar Convention*. Ramsar Convention Bureau, Gland.
- Hollis, G.E., Adams, W.M., Amino-Kano, M. (Eds.), *The Hadejia-Nguru Wetlands: Environment, Economy and Sustainable development of a Sahelian Floodplain Wetland*. IUCN, Gland.
- Jansen, R., Padilla, J.E., 1997. Preservation or conservation?—valuation and evaluation of a mangrove forest in the Philippines. *Environ. Resour. Econ.* 14, 297–331.
- Jansen, R., Schuyt, K.D., 1998. *Demographic Effects and Economic Values of an Ecologically Vulnerable Environment—The Case of a Tropical Wetland in Kenya*. Master Thesis University of Maastricht, August, Maastricht.
- Kabii, T., 1996. An overview of African wetlands. In: Hails, A.J. (Ed.), *Wetlands, Biodiversity and the Ramsar Convention*. Ramsar Convention Bureau, Gland, pp. 1–4. [www.ramsar.org](http://www.ramsar.org), Ch. 3.
- Kolberg, H., Griffin, M., Simmons, R., 1996. The ephemeral wetlands of central Northern Namibia. In: Hails, A.J. (Ed.), *Wetlands, Biodiversity and the Ramsar Convention*. Ramsar Convention Bureau, Gland, pp. 4–6. [www.ramsar.org](http://www.ramsar.org), Ch. 3.
- Koohafkan, P., Nachtergaele, F., Antoine, J., 1998. Use of agro-ecological zones and resource management domains for sustainable management of African wetlands. *Wetland Characterization and Classification for Sustainable Agricultural Development*. FAO/SAFR, Rome. [www.fao.org](http://www.fao.org), Part III.
- Mafabi, P., 1996. Lake George. In: Hails, A.J. (Ed.), *Wetlands, Biodiversity and the Ramsar Convention*. Ramsar Convention Bureau, Gland, pp. 11–13. [www.ramsar.org](http://www.ramsar.org), Ch. 3.
- Mavuti, K., 1989. Ecology of the Yala Swamp. *Resources* 1 (1), 11–14.
- Ramsar, 2004. [www.ramsar.org](http://www.ramsar.org).
- Roggeri, H., 1995. *Tropical Freshwater Wetlands—A Guide to Current Knowledge and Sustainable Management*. Kluwer Academic Publishers, Dordrecht.
- Ruitenbeek, H.J., 1992. *Mangrove Management: An Economic Analysis of Management Options with a Focus on Bituni Bay, Irian Jaya*, Environmental Management Development in Indonesia (EMDI). Dalhousie University Printing Center, Canada.
- SARDC, State of the Environment, SARDC, 2000. at: [www.sardc.net](http://www.sardc.net).
- Schuyt, K.D., 1999. *Economic Valuation of the Lake Chilwa Wetland—Report for the Lake Chilwa Wetland and Catchment Management Project*, May, Zomba.
- Seyam, I.M., Hoekstra, A.Y., Ngabirano, G.S., Savenije, H.H.G., 1992. The Value of Freshwater Wetlands in the Zambezi Basin, AWRA/IWLRI—University of Dundee International Specialty Conference, August 6–8, Dundee.
- Sylla, S.I., Balde, D., 1996. Djoudj National Bird Park. In: Hails, A.J. (Ed.), *Wetlands, Biodiversity and the Ramsar Convention*. Ramsar Convention Bureau, Gland, pp. 6–7. [www.ramsar.org](http://www.ramsar.org), Ch. 3.
- Thompson, J.R., 1996. Africa's floodplains: a hydrological overview. In: Acreman, M.C., Hollis, G.E. (Eds.), *Water Management and Wetlands in Sub-Saharan Africa*. IUCN, Gland, pp. 5–20.
- Turner, R.K., van den Bergh, J.C.M., Soderqvist, T., Barendregt, A., van der Straaten, J., Maltby, E., van Ierland, E.C., 2000. *Ecological-economic analysis of wetlands: scientific integration for management and policy*. *Ecol. Econ.* 35, 7–23.
- Turpie, J., Smith, B., Emerton, L., Barnes, J., 1998. *The Present Economic Value of Nakivubo Urban Wetland, Uganda*. IUCN, Eastern Africa Office, Nairobi.
- UNEP, 2000. *Global Environmental Outlook 2000*. UNEP, Nairobi.
- World Commission on Dams, 2000. *Dams and development—A New Framework for Decision-making*. Earthscan Publications, London.