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# Land and Water Use of Wetlands in Africa: Economic Values of African Wetlands

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**Approved by**

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# Summary

African wetlands are a very important source of natural resources upon which many rural economies depend. Despite their importance, wetlands throughout Africa are being modified and reclaimed. A major factor contributing to these activities is that decision-makers often have insufficient understanding of the economic values of wetlands, so the protection of wetlands is not a serious alternative. Wetlands, however, have numerous goods and services that have an economic value, and economic valuation of wetlands can be applied to highlight this value to decision-makers. Although many economic valuation studies of wetlands around the world have been carried out, most of these studies have focused on wetlands in developed countries, while in those studies carried out for developing countries Africa is seriously underrepresented. This paper gives an overview of the current status of wetlands in Africa and an evaluation of several economic valuation studies that have been carried out for African wetlands. The conclusions drawn from this paper can be used for arguments favoring the protection of valuable wetland resources.

Most of the African wetlands are threatened by economic and financial pressures, fed by demographic growth, rising poverty and severe economic stress. This is furthermore compounded with drought and the contrast between private land ownership and public benefits. At the root of these problems is the fact that numerous stakeholders of wetlands with different interests lay claims on the wetlands functions that don't always coincide. In this conflict of interest, those stakeholders that are dependent on the protection of wetland functions have mostly been overshadowed by those that have a stake in the conversion of its lands and waters. This can be attributed mainly to information failures regarding both spatial relationships and the consequences of land use, water management, pollution and infrastructure.

Four cases on economic valuation of African wetlands were studied: the Nakivubo urban wetland in Uganda, the Hadejia Jama're wetlands in Nigeria, the Lake Chilwa wetland in Malawi and the Zambezi basin wetlands in Southern Africa. In each of these case studies, the wetland and the types of threats facing the wetland were first described, followed by an explanation of the economic values of wetland goods and services. The result is an overview of economic values of sixteen goods and services. The total economic values of the four wetlands per square kilometer, and thus the cost to the local population when these wetlands disappear, range from $6.7 thousand per year for the Zambezi basin wetlands to $189 thousand per year for the Nakivubo urban wetland.

The results show that in all four cases, the wetlands were threatened by human activities, including reclamations and developments and overuse of the wetlands resources by local populations. In this respect it is important to distinguish between (1) actors outside the wetland, and (2) actors residing inside the wetland. The first group is led by the perception that wetland economic benefits are less than the benefits of wetland conversions, while the second group is driven by poverty and population increases. While the first group can be approached with economic valuation studies, the second group must, however, principally be approached by the root causes of wetland degradation – poverty and overpopulation in the African continent. In the last case, however, economic valuation studies may be applied as a tool in the provision of information for decision-makers on different economic activities in the wetland and their relative importance to local people. It is furthermore important that more economic valuation studies are carried out on African wetlands that integrate local expertise on wetlands. Such studies could then serve as an important input for ecological-economic modeling processes on wetlands in the integration of wetlands value into decision-making processes.

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# LAND AND WATER USE OF WETLANDS IN AFRICA: ECONOMIC VALUES OF AFRICAN WETLANDS

*Kirsten Schuijt*

## 1 BACKGROUND AND OBJECTIVES

Wetlands are ecosystems that occupy about 6% of the world's land surface. The term 'wetland' was developed out of a need to manage these specific areas, for which several definitions exist. The difficulty in defining a wetland arises partly because of their highly dynamic character, and partly because of difficulties in defining their boundaries (Mitsch and Gosselink, 1993, in: Turner et. al., 2000). The official definition proposed by the Ramsar Convention (1971) reads as follows: "areas of marsh, fen, peat land or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters". Wetlands are therefore both land ecosystems that are strongly influenced by water, and aquatic ecosystems with special characteristics due to shallowness and proximity to land (Roggeri, 1995).

Much of Africa lies within arid and semi-arid climates, where fresh water is scarce. In fact, Africa is one of the two regions in the world facing serious water shortages (Johns Hopkins, 1998, in UNEP, 2000). Although Africa has abundant freshwater resources in rivers and lakes, they are unevenly distributed both within and between African countries[1]. Currently, 14 countries in Africa are subject to water stress (1700 $m^3$ or less per person per year) or water scarcity (1000 $m^3$ or less per person per year), and another 11 countries are expected to join in the next 25 years (Johns Hopkins, 1999, in: UNEP, 2000). In these contexts, wetlands are an important source of water and nutrients necessary for biological productivity and often sheer survival of the people (Thompson, 1996). In some cases, wetlands are the exclusive source of natural resources upon which rural economies depend. Sustainable management of wetlands is therefore critical to the long-term health, safety and welfare of many African communities.

Wetlands are complex ecosystems with multiple values, including ecological value, socio-esthetical value, intrinsic value and economic value. An example of ecological value is the fact that over 2,000 known species of indigenous freshwater fish live in African wetlands (Hails, 1996). Socio-esthetical value is reflected, for example, in the tradition of some tribes to have initiation rites in wetland areas, while intrinsic value is the value residing in the wetlands themselves. Each of these values is known as a secondary value: the primary value of an ecosystem is its value as a life-supporting function (Turner et. al., 1994). This paper focuses on one aspect of these secondary values, namely economic value, which reflects a significant part of the importance of wetlands for human populations. This value is very clearly demonstrated in Sub-Saharan Africa, where many people survive by exploiting natural resources of wetlands (Acreman & Hollis, 1996). Within the African continent, wetlands play a vital role in sustaining a significant portion of the population.

[1] For example, the Congo river basin has 10% of Africa's population but receives 30% of Africa's annual run-off (Johns Hopkins, 1998, in UNEP, 2000).

Despite their importance, African wetlands are being modified or reclaimed – either their resources are over-exploited, their lands are converted to other uses, or upstream developments alter the quality and flow of 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 its 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, together with other costs of wetland protection including possible increases in diseases such as Malaria, as exceeding the benefits of wetlands.

African wetlands, however, have numerous goods and services that have an economic value to the local population living in its periphery but also to communities outside the wetland area. The economic value of these goods and services can be quantified through economic valuation studies. The economic value of those wetland goods that are traded on the market place, such as fish, can be valued through the market price of the resource. Many wetland resources and almost all wetland services, however, are not traded in the market place and economic theory provides shadow-pricing methods that allow for the economic valuation of such important services as retention capacity and water cleaning capacity of wetlands, and wetlands as nurseries. The results of economic valuation 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[2], 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. This paper presents an overview and evaluation of economic valuation studies that have been carried out for African wetlands.

This paper is the result of a three-month research carried out during the Young Scientists Summer Program of IIASA. After briefly discussing the importance of wetlands in Chapter 1, Chapter 2 provides a description of the status of African wetlands. Chapter 3 discusses the economic values of African wetlands and Chapter 4 presents case studies on economic valuations of four different wetlands in Africa. In these case studies the nature of threats facing these wetlands and the type and height of the economic values of the wetlands will be evaluated. The paper concludes with a discussion of the economic importance of African wetlands, which can be used for arguments favoring the protection of African wetlands as opposed to the allocation of its lands and waters for other purposes.

[2] See for wetland valuation studies in Asia: Janssen & Padilla, 1999 (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).

# 2 THE STATUS OF AFRICAN WETLANDS

## 2.1 Wetland Types

A number of wetland classifications exist in the literature, and just as some disagreements on definitions of wetlands exist, there is also no universally agreed classification of wetland types. Wetlands have been classified on their sources of water and nutrients, according to their hydrological regime, soil type, vegetation structure, and so on. Differences between these classifications stem from reasons and regions for which the classifications have been developed (Roggeri, 1995). In this section, three types of classification are presented.

Roggeri (1995) characterizes wetlands according to geomorphological units (the main sources of water and nutrients) and ecological units, in particular vegetation. The first characterization distinguishes four units:

1. **Alluvial lowlands**: fringing floodplains, inner deltas and coastal delta floodplains.
2. **Small valleys**: headwater lowlands and small overflow valleys.
3. **Lakeshores**: either on the shores of a deep lake (draw-down area) or in its shallows.
4. **Depressions**: in river and lake systems and isolated depressions.

In addition to this, three ecological units may be specified:

1. **Periodically flooded ecosystems**: flooded forests, flooded grasslands and seasonal shallow lakes and water bodies.
2. **Swamps and marshes**: marshes, herbaceous swamps, swamp forests and peat swamps.
3. **Permanent shallow lakes and water bodies**: shallow lakes, natural ponds, oxbow lakes and lagoons.

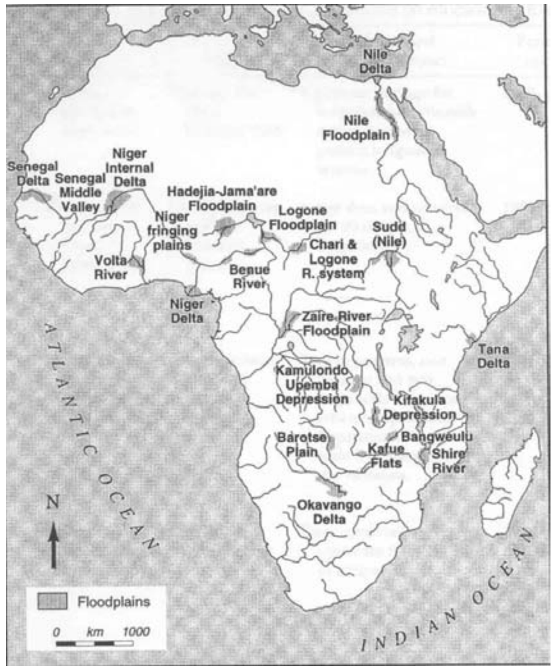
A geomorphological unit can include several ecological units, where these ecological units are often interlinked in a complex way. For example, floodplains can include flooded forests and grasslands as well as marshes and swamps. The most extensive wetlands are the seasonally inundated floodplains (see Figure 1).

Another classification of wetlands is through soil and terrain characterization (Koohafkan et. al., 1998). In this respect, the following four wetland classifications can be distinguished:

1. **Histosols**: peats and swamps, formed of incompletely decomposed plant remains.
2. **Gleysols**: the most typical mineral wetland soils, conditioned by water logging at shallow depth for some or all of the year.
3. **Fluvisols**: developed particularly in periodically flooded places, such as flood plains.
4. **Soils that are seasonally flooded**: vertisoils (dambos) with a high content of clay which shrink and swell according to soil moisture conditions; Planosoils, which have a coarse textured layer overlying a deeper dense horizon with more clay; and Plinthic and Gleyic soils, where the first are tropical soils containing a mixture of iron and clay that hardens into ironstone when dried, and the latter are like Gleysols where the water table remains deeper.

These types of wetland soils all appear in Africa - the temporarily flooded soils are in the majority (7.63%), followed by Gleysols (5.97%), Fluvisols (4.6%), and a very small percentage of Histosols (0.69%).

*Figure 1: Major African Floodplain Wetlands*




*Source: Lemly, et. al., 2000*

The Ramsar Convention adopted the Ramsar Classification of Wetland Type at the Conference of the Parties in 1990 (Kabii, 1998). It divides wetlands into three main categories as a broad framework to aid rapid identification of wetland habitats:

1. Marine/Coastal Wetlands
2. Inland Wetlands
3. Man-Made Wetlands

The marine and coastal wetlands include estuaries, inter-tidal marshes, brackish, saline and freshwater lagoons, mangrove swamps, as well as coral reefs and rocky marine shores such as sea cliffs. Inland wetlands refer to such areas as lakes, rivers, streams and creeks, waterfalls, marshes, peat lands and flooded meadows. Lastly, man-made wetlands include canals, aquaculture ponds, water storage areas and even wastewater treatment areas.

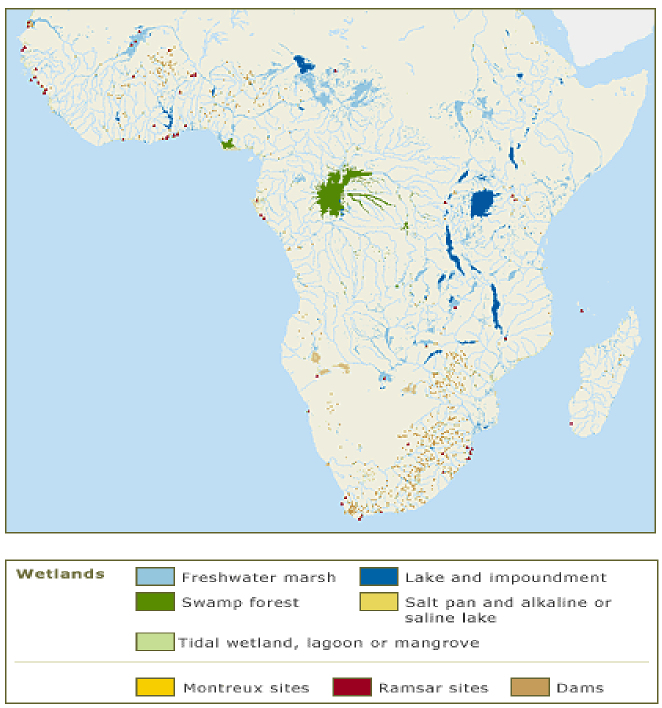
The three classifications of wetlands presented in the previous paragraphs show the immense diversity of wetlands. At the same time, wetlands contain an enormous diversity of functions. The combination of this diversity in wetlands and within wetlands makes them such valuable ecosystems.

## 2.2 Distribution

The percentage of wetland area in Africa has been estimated at lying in a range of approximately 1% (WCMC, 1992) to 16% of the total area of the continent (Koohafkan, 1998)[3]. 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. Different estimates exist, ranging from 220,000 km² to 1,250,000 km² (Bullock et. al., 1998). These wetlands vary in type from saline coastal lagoons in West Africa to fresh and brackish water lakes in East Africa.

At present, the most accurate approximation of wetlands in Africa was carried out by the World Conservation Monitoring Center (WCMC) and IUCN. This is presented in Figure 2. It shows the main wetlands in the continent as well as Ramsar sites and the location of dams. It also shows Ramsar sites that have been listed in the Montreux Record, which registers wetlands that are on the List of wetlands of International Importance where changes in ecological character have occurred, are occurring, or are likely to occur as a result of technological developments, pollution, or other human interference (Ramsar Convention Bureau, 2002).

*Figure 2: Wetland Distribution in Africa*




*Source: World Resources Institute, 2002*

Wetlands are found in most African countries. The largest wetlands in the continent include the Okavango Delta, the Sudd in the Upper Nile, Lake Victoria basin and Lake Chad basin, and the floodplains and deltas of the Congo, Niger and Zambezi rivers (UNEP, 2000). The greatest concentration of wetlands is roughly between 15ºN and 20ºS. Here one can find the wetlands of the four major African river ecosystems (Nile, Niger, Zaire, Zambezi); Lake Chad; the wetlands

[3] Most of this divergence is due to problems of wetland definition, wetland borders and lack of scientific investigation.

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 areas are situated, such as 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 15ºN to 20ºS area, significant wetlands are inland oasis, 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).

## 2.3 Major Threats

Since 1900, more than half of the world's wetlands have disappeared (Barbier, 1993). These losses are generally caused by: (1) the public nature of many wetlands products and services; (2) user externalities imposed on other stakeholders; and (3) policy intervention failures due to a lack of consistency among government policies in different areas, including economics, environment, nature protection and physical planning (Turner et. al., 2000). In the United States, it is estimated that 54% of its original wetlands has been lost, of which 87% to agricultural development and 8% to urban development (Maltby, 1986, in: Barbier, 1993). In France, 67% of its wetlands have been lost in the period 1900 to 1993, while the Netherlands has lost 55% of its wetlands in only 35 years between 1950 and 1985. With respect to the status of tropical wetlands, such data is lacking, but it is expected that the pattern of wetland conversion is similar to that of the United States (54%). In Africa, the Niger for example has lost more than 80 % of its freshwater wetlands over the past two decades (Niger Ministry of Environment and Hydraulics, 1997, in UNEP, 2000). Although some past conversions might have been in society's best interests, wetlands have frequently been lost to activities resulting in limited benefits or costs to society (Turner et. al., 2000).

At the root of the wetland conversions is the facts that numerous stakeholders of wetlands with different interests lay claims on the wetlands' functions that don't always coincide. Turner et. al. (2000), identify nine groups of stakeholders:

1. **Direct extensive users**: directly harvest wetland goods in a sustainable way.
2. **Direct intensive users**: have access to new technologies that allows to harvest more intensively.
3. **Direct exploiters**: dredge sediments in the wetland, or exploit mineral resources, clay, peat and sand without a direct concern for the health of the environment.
4. **Agricultural producers**: drain and convert wetlands to agricultural land.
5. **Water abstractors**: use wetlands as sources of drinking water, agricultural irrigation, flow augmentation, and so on.
6. **Human settlements close to wetlands**: wetlands as sites for human settlement expansions.
7. **Indirect users**: benefit from indirect wetland services, such as storm abatement and flood mitigation.
8. **Nature conservation and amenity groups**: groups whose objective is to conserve nature and groups who enjoy the presence of plant and animal species.
9. **Non-users**: users that may attribute an intrinsic value to wetlands.

In many cases, it is likely that the different interests of these stakeholders result in conflicts, so that policy-makers are faced with complex trade-offs.

Water management in wetlands has often been oriented solely towards the needs of humans, such as transportation, agriculture, flood control and settlement. Instead of an integrated approach towards water management issues, in which the ecosystem and its different stakeholders play a key role, wetlands have been transformed to a wide variety of human uses. In this respect, several engineering techniques have been applied (Roggeri, 1995). First of all, for the purpose of embankment and water retention, man may construct dikes, dams and reservoirs in rivers that feed wetlands. These may prevent flooding, promote water storage for drinking water or irrigation, or produce electricity. Secondly, lakes, rivers or canals in wetlands may be subject to dredging, excavation and deepening, to prevent flooding or, for example, to eliminate shallow water bodies favorable for water-related diseases. Third, canalization of waters in wetlands is aimed at the improvement of flows within a river basin or to transfer water to an area where water demand is high. A fourth activity that affects wetlands is drainage. Drainage of polders or fields is carried out through, for example, pumping or gravity drainage. The activity may also be carried out to create new land for agricultural, industrial or urban purposes. Fifth, in the field of water supply, activities such as exploitation of surface water and groundwater through for example pumping or excavation may be distinguished. Lastly, different types of irrigation schemes and techniques require total water control and therefore may have serious adverse effects on wetlands. The results of human interventions can alter the functioning and natural evolution of a wetland, thereby eliminating its potential benefits.

It is estimated that Africa has more than 1200 dams, of which more than 60 per cent are located in South Africa and Zimbabwe (World Commission on Dams, 2001). 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 (Acreman & Hollis, 1996). For example, in a 1968 report of the Food and Agricultural Organization of the United Nations and the United Nations Development Program, it is described how Zambia "…needs additional electric power for mining and other developing industries, which could be obtained economically at the Kafue Gorge by utilizing the natural head and ample water resources available at the site." (FAO, 1968: 8). It is now known, however, that the economic and social impacts of large dams on African communities living on the floodplains have been mostly adverse (Adams, 1996).

In Africa, common factors that put increasing pressures on wetlands are demographic growth, rising poverty and severe economic stress (Matiza & Chabwela, 1992). This is often compounded by drought, which, as a recent study has pointed out, may be caused by industry and power-generation in Europe and North-America (Nowak, 2002). Wetland loss in Africa is furthermore enhanced because the benefits of wetlands are often not shared by those who own the property (Matiza & Chabwela, 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.

The underlying cause of much wetland degradation is information failures. These failures relate to the "…complexity and 'invisibility' of spatial relationships among groundwater, surface water and wetland vegetation" (Turner et. al., 2000: 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. One approach to increase the awareness of (economic) values of wetlands, and thereby allow for the integration of wetland functions in decision-making processes, is through economic valuation, which will be further explained in Chapter 3.

## 2.4 Current Situation and Future Prospects

In the previous section, it was explained how pressures on wetlands in Africa have principally been economic or financial. Apparent benefits received from activities that alter or injure the status of wetlands seemed to have overshadowed the economic benefits of the protection of wetlands. A major factor contributing to these activities is that the perspective towards the environment in this time period was still one of unlimited exploitation for human needs. Since then, our knowledge and information about the environment, about the effects of human actions on the environment and about ecological relationships have improved. This has led to changing perspectives on the relationship between humans and the environment in many countries. As a result, it is increasingly being recognized that humans depend on ecosystems for their survival.

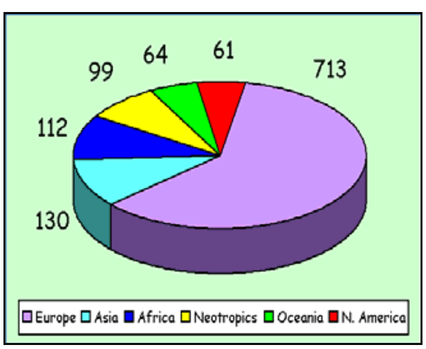
In 1975, the Convention on Wetlands of International Importance entered into force. Interestingly, wetlands are the only single group of ecosystems to have their own international convention (Turner et. al., 2000). This convention (also known as the Ramsar Convention after the Iranian city in which the treaty was signed) is an intergovernmental treaty at first aimed at the conservation and wise use 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. Countries that sign the treaty agree to four commitments:

1. To designate at least one wetland for inclusion in the 'List of Wetlands of International Importance' and to promote its conservation, including its wise use.
2. To include wetland conservation considerations in their national land use planning.
3. To establish nature reserves in wetlands, whether or not included in the Ramsar list, and to promote training in the fields of wetland research, management and warding.
4. To consult with other Contracting Parties about implementation of the Convention.

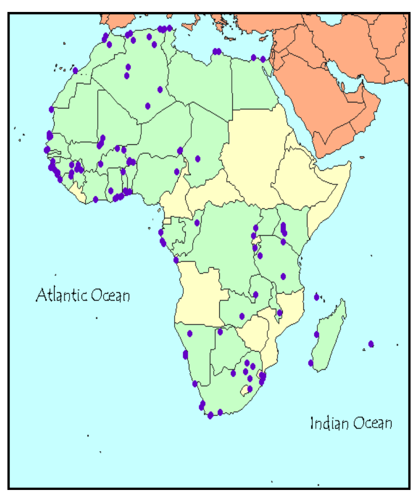
In June 2001, the Convention had 124 contracting parties with more than 1070 wetlands. The distribution of Ramsar sites around the world in Africa is presented in Figure 3.

*Figure 3: Distribution of Ramsar Sites*

a) Ramsar Sites in the World




b) Ramsar Sites in Africa




*Source: The Ramsar Convention Bureau, 2002*

Although this and other conventions have 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 quality of the fresh water 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 et. al., 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 et. al., 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 will 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). Increasingly more African countries are signing the Ramsar Convention, indicating a growing commitment to sustainable wetland management in Africa. Execution of more economic valuation studies of African wetlands can aid in the pursuit of sustainable wetland management by increasing awareness of wetland benefits.

# 3 ECONOMIC VALUES OF AFRICAN WETLANDS

## 3.1 Values of Wetlands

In the introduction of this paper, it was explained how many rural populations in Africa are dependent on wetlands often as an exclusive source for survival. This section will explain what functions wetlands fulfill that makes them so valuable for populations.

Several approaches towards wetland values exist; in this paper the functions approach of de Groot (1992) is taken. Turner et. al. (2000) provide a framework for an ecological-economic analysis of wetlands, thereby 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. 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. These functions can be classified into four categories (de Groot, 1992):

1. **Regulation Functions**: ecosystems regulate ecological processes that contribute to a healthy environment – examples are recycling of nutrients and human waste, and watershed protection;
2. **Carrier Functions**: 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;
4. **Information Functions**: ecosystems contribute to mental health by providing scientific, aesthetic and spiritual information.

A list of key wetland functions is presented in Table 1.

The functions in Table 1 constitute value to humans. This total value consists of an ecological value, such as the maintenance of ecosystem stability and climatic stabilization; a socio-esthetical value, such as the role of ecosystems in cultural heritage; an intrinsic value, which is the value that resides in the environmental asset itself[4]; and an economic value. *Economic values* are monetary measures for benefits or costs of environmental change (Wills, 1997). They are based on 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 having 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. 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 ecosystem goods, like wood, water, and medicine (de Groot, 1992).

Although there is still considerable disagreement regarding the classification of economic values, one approach is to distinguish between use values and non-use values (Turner et. al., 1994) (see

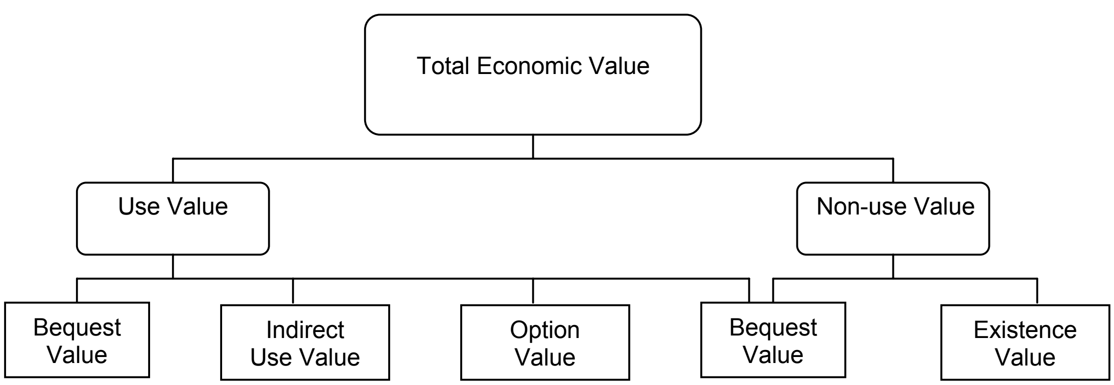
[4] Intrinsic value is unlike the economic value type 'existence value', which is a value humans attach to ecosystems – intrinsic value is the value intrinsically residing in ecosystems themselves, unrelated to humans.

*Table 1: Wetland Functions*

| Function Type | Wetland Good, Service or Attribute |
|---|---|
| Regulation Functions | Storage and recycling of nutrients<br>Storage and recycling of human waste<br>Storage and recycling of organic waste<br>Groundwater recharge<br>Groundwater discharge<br>Natural flood control and flow regulation<br>Erosion control<br>Salinity control<br>Water treatment<br>Climatic stabilization<br>Maintenance of migration and nursery habitats<br>Maintenance of ecosystem stability<br>Maintenance of integrity of other ecosystems<br>Maintenance of biological and genetic diversity |
| Carrier Functions | Agriculture<br>Stock farming (grazing)<br>Wildlife cropping/resources<br>Energy production<br>Transport<br>Tourism and recreation<br>Human habitation and settlements |
| Production Functions | Water<br>Food<br>Fuelwood<br>Medicinal resources<br>Raw materials for building, construction and industrial use<br>Genetic resources |
| Information Functions | Research, education and monitoring<br>Uniqueness, rarity or naturalness and role in cultural heritage |

*Source: Based on de Groot (1992) and Roggeri (1995).*

*Figure 4: Total Economic Value*




*Source: Turner et. al., 1994*

Figure 4). The *use value* of a wetland comprises both direct use of the wetland, such as the consumption of fish, trees and water, and indirect use of the environment, like retention capacity and nutrient recycling of wetlands. Furthermore, option value is distinguished as a use value. Option value is defined as the value to humans to preserve an environment as a potential benefit for themselves in the future. It arises from retaining an option to a good or service for which future demand or supply is uncertain: if people are uncertain about their future preferences or the future availability of the good, people might be willing to pay a price to keep the option for future use open (Perman et. al., 1996: 277)[5]. The *non-use value* of a wetland refers to the non-instrumental value, not associated with use. This includes existence value; a recognition of the value of the very existence of wetlands. It is based on a sympathy with or concern for the welfare of non-human beings – a desire that ecosystems or species should have a right to exist. Bequest value is both a use and a non-use value. It is related to option value, but it is the willingness to pay for the preservation of a wetland for the benefit of one's descendants. This benefit incorporates both use and non-use of the environment (Turner et. al., 1994).

People are thus highly dependent on wetlands for a large variety of goods and services. 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 and the Pantanal in Brazil 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 such tropical wetland in Kenya is highlighted to show the importance of wetlands for local people.

## 3.2 Dependence of Local Populations on African Wetlands: The Case of the Yala Swamp Wetland in Kenya[6]

### *3.2.a Background & Area Description*

The Yala Swamp wetland is a large area of swampland located in Western Kenya and is Kenya's largest freshwater wetland (see Figure 5). It 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 hectares.

The Yala Swamp wetland 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 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, greyheaded 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 lake shore is dominated by rooted

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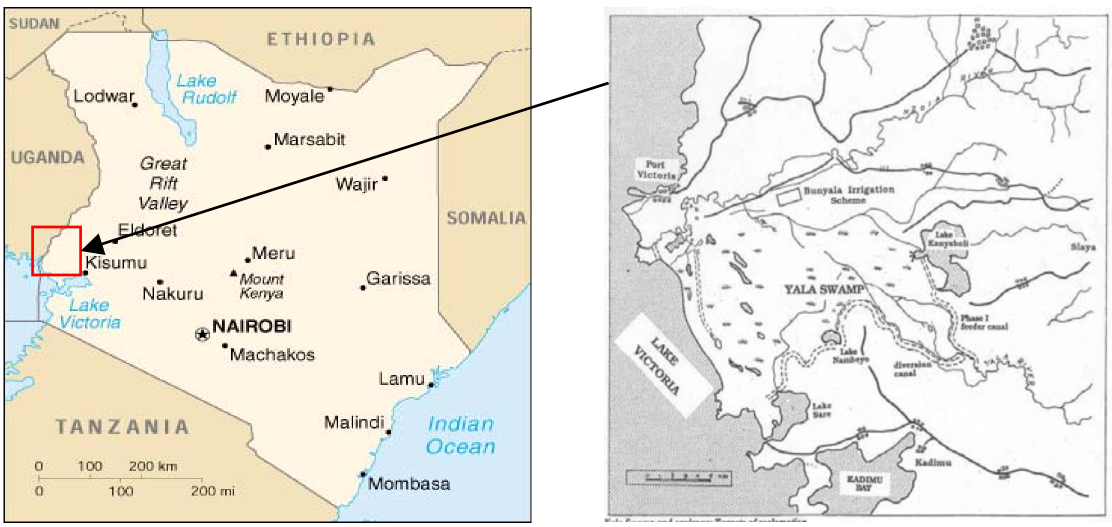
[5] Option value arises when people are risk averse: it is the amount an individual would be willing to pay today for the right to consume the good tomorrow. In the case of no risk aversion, however, people may still attach value to a resource in the case of uncertainty: an individual might be willing to pay for maintaining options for future use of some resource. This is called *quasi option value* and is based on expectations about future technological advances and development of knowledge. An example is the value individuals might attach to the protection of the rainforests as a potential source for medicinal remedies in the future. (Perman et. al., 1996: 277)

[6] Jansen & Schuijt, 1998

papyrus (Cyperus Papyrus). Reeds (Phragmites Mauritianus) grow on drier and higher grounds, and further inland the swamp is a mixture of different reed species and papyrus.

The Yala Swamp is also part of the most densely populated areas in Kenya - the Nyanza and Western provinces. The population is predominantly Luo and Bunyala. 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.

*Figure 5: The Yala Swamp Wetland in Kenya*




*Source: CIA World Fact Book, 2001 & Lake Basin Development Authority, 1989*

### *3.2.b Threats to the Wetland*

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. It has been subject to reclamation since the 1960s, mostly for agricultural purposes, such as the growing of rice, groundnuts, cassava, yams and sugarcane.

Much of the literature on this wetland assumes that "the rapid rise in human population has resulted in land scarcity, forcing land users to clear wetland vegetation for crop farming" (Kareri, 1992). However, as the research progressed, it was discovered that the reclamation of the wetland was not initiated by local people but by the Kenyan government. Although population pressures resulted in unsustainable use of the wetland's resources, the government initiated wetland reclamation for agricultural purposes. Furthermore, reclamation did not benefit the local people at all as most of the crops grown in the area were for the purpose of export and so the income derived from these activities flows right into the pockets of government officials. The costs of reclamation of the wetland are however borne by the local people – the goods and services they depend on are diminishing. The threats to the wetland are thus twofold:

1. Population growth drives the unsustainable use of the wetland's resources;
2. Government initiatives drive the reclamation of the wetland for agricultural purposes.

### *3.2.c Economic Dependence on Wetland Functions*

In addition to the wetland's function for biodiversity, it also has numerous goods and services. For example, the quality of the water that is discharged in Lake Victoria is exceptionally clear due to the filtering effect of the swamp into which most of the sediments are deposited. An investigation into direct use values of the wetland 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 are water, fish and agricultural grounds. *Water* is used for drinking, cooking, washing and irrigation. In one part of the wetland, water is for free through boreholes, while in other parts it is not. In this situation, people either obtain water directly from the lake or buy it from water sellers – some can afford their own water pump. The water sellers transport water on donkeys and derive an income from it. Local transport is also a substantial use of water in the wetland. *Fish* is caught for commercial and non-commercial purposes and is mostly Tilapia and Nile Perch. Furthermore, indirect commercial activities related to fishing also take place, such as net repairing 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 and for commercial purposes.

Other important use values (in order of importance) are building materials, wood, livestock grazing, and birds and wild animals. *Wood* is harvested by people to make charcoal as electricity is still very uncommon. Most people in the wetland 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 found in the wetland is used for the walls. Papyrus is used to make the roofs of the houses. Hunting of *birds and wild animals* is an important activity in the wetland, despite a ban on hunting. Animals are sold on markets, including the Sitatunga antelope, Duiker, hares, Guinea fowl and Harlequin quail. Lastly, *livestock grazing* is also an important activity in the Yala Swamp wetland. Cattle are mostly bought for food, but also as a form of banking – as an investment. The 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 they can send their children to school. The dependence ratios of people on these wetland uses are presented in Table 2.

It can be concluded from Table 2 that people in the Yala Swamp wetland are highly dependent on the wetland's resources, ranging from a 100% dependence ratio on water, fish and agricultural grounds to 46% of the population being dependent on birds and wild animals that live in the wetland. Reclamation and unsustainable use of wetland products that would result in the disappearance of these 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 fourteen times higher. Furthermore, it may result in problems at the macro level - as local areas become unsustainable, many people will tend to migrate to urban areas, contributing to overpopulation of cities, unemployment, crime, and so on.

*Table 2: Dependence Ratios on Wetland Values*

| Economic Value | Activity | Dependence Ratio |
|---|---|---|
| Fish | | 100% |
| | subsistence catching | 66% |
| | source of income | 34% |
| | net and boat repairing | 10% |
| Fuel Wood | | 83% |
| | subsistence | 81% |
| | source of income | 19% |
| Building Materials | | 86% |
| | subsistence | 72% |
| | source of income | 28% |
| Birds and Wild Animals | | 46% |
| | subsistence | 78% |
| | source of income | 22% |
| Agricultural Grounds | | 100% |
| | subsistence | 38% |
| | source of income | 62% |
| Livestock | | 74% |
| | subsistence | 91% |
| | source of income | 10% |
| Water | | 100% |
| | transport use | 66% |
| | source of income | 27% |

## 3.3 Economic Valuation of Ecosystems

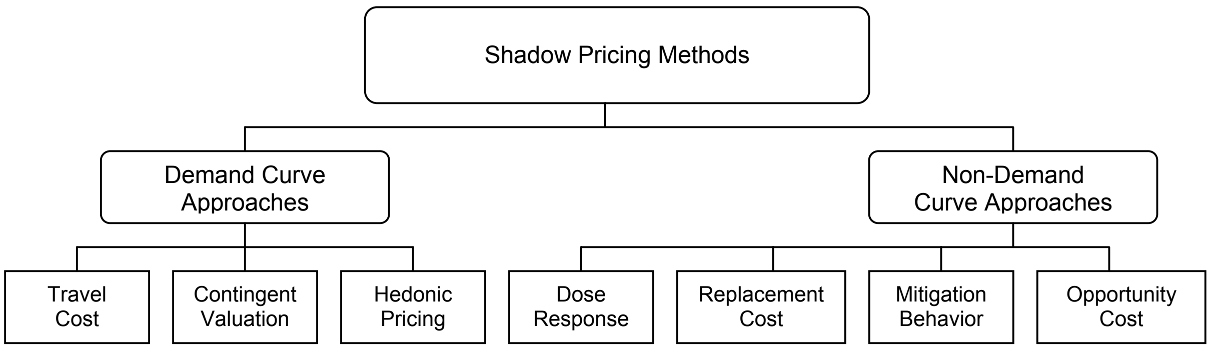
The economic values that were qualitatively investigated in the previous section can be given a price. This process is called economic valuation of ecosystems. For those wetland goods and services that are traded in the market place and whose prices are not distorted (this can be the case with, for example, fish), market prices can be used as indicators for economic values. Often, however, most goods and services do not have a market price and shadow pricing techniques can be applied to determine their economic values. Economic theory distinguishes several shadow valuation methods (Figure 6)[7].

Demand curve approaches use demand curves to obtain economic values. These approaches are Contingent Valuation, Travel Cost and Hedonic Pricing. The most well-known demand-curve method is called *Contingent Valuation (CV)*. This method directly obtains consumers' willingness to pay (or willingness to accept) for a change in the level of an environmental good, based on a hypothetical market (Hanley & Spash, 1993). It attempts to reveal individuals' stated preferences and is based on the Hicksian demand curve, in which real income is held constant. The most common method is to state a hypothetical market for an environmental good, and ask consumers (through surveys, questionnaires or experimental techniques) to state their maximum willingness to pay to realize an improvement in the quality of that environmental good, or their minimum willingness to accept compensation for deterioration in the quality of the environmental good

[7] This is just one typology that exists in the literature.

(Pearce and Turner, 1990). A major advantage of the CV method is its technical capacity to estimate non-use values, for which it is widely used (Pearce & Turner, 1990). Technically speaking, it is applicable to all circumstances and is therefore often the only technique to measure benefits.

*Figure 6: Shadow Pricing Methods for Economic Valuation*




*Source: Turner et. al., 1994*

The *Travel Cost (TC)* method is the oldest non-market valuation method that is widely used. Since it relies on individual valuations of environmental goods that are revealed in the travel costs made by consumers to obtain the environmental good, this method is known as a revealed preference technique (Turner et. al., 1994). Travel costs consist of distance costs per kilometer traveled, time costs of the individual, and the entrance fee of the particular environmental good (Hanley & Spash, 1993). These estimates are included in a trip generating function, which also includes factors like income, education and age, to estimate the amount consumers value the environmental good (Hanley & Spash, 1993).

The *Hedonic Pricing (HP)* method also measures consumer surplus from the demand curve, and is also known as a revealed preference technique. It relies on valuations of environmental goods that are revealed in their purchases of market priced goods (Turner et al., 1994). The method utilizes statistical techniques, such as multiple regression, to find a relationship between, for example, the level of pollution in a specific area and the prices of houses in the same area. The HP method attempts to (i) identify how much of a property differential is due to a particular environmental difference between two properties, and; (ii) infer how much people are willing to pay for an improvement in environmental quality that they face (Turner et. al., 1994).

The non-demand curve approaches are Dose-Response, Replacement Cost, Mitigation Behavior and Opportunity Cost, and do not measure economic value via a demand curve for the environmental good. These methods, therefore, do not provide 'true' measures of value, however, the information they provide is useful to policy makers (Turner, et. al., 1994). *Dose-Response* is based on the relationship between an environmental good and a marketed good. The costs of air pollution can be derived from, for example, the effects on agricultural crop production – an increase in pollution causes a decrease in crop quality and therefore constitutes a decrease in benefits for farmers. The *Replacement Cost* approach looks at the cost of replacing or restoring a damaged natural asset, which is used as a measure of the benefit of restoring that natural asset. For example, the replacement of wetlands (through wetland restoration elsewhere in a region, wetland relocation, or new wetland creation) can be used to value the economic benefits of wetland conservation (Turner et.al., 1994). The valuation method *Mitigation Behavior*, also known as 'averting expenditure', is based on the relationship between an environmental good and its perfect substitute. For example, the benefits of water cleaning capacity of wetlands can be estimated by the avoidance of expenditure on drinking water cleaning facilities. In the *Opportunity Cost* approach, environmental benefits are not directly valued; instead, the benefits of the activity that causes the environmental degradation are estimated to indicate what the benefits of the environment would have to be for the activity not to take place (Turner et. al., 1994). For example, the value of agricultural output after wetland reclamation is an estimation of the minimum value the wetland would have to represent for the reclamation not to take place.

## 3.4 Why Economic Valuation?

Economic valuation is a practice that is not undisputed. Many arguments are heard against the monetary valuation of nature. For example, it is argued that markets are not the appropriate basis for dealing with the allocation of scarce environmental resources. Markets do not automatically lead to sustainable outcomes because they cannot show whether a system is approaching its limits and fails to see the context of or the interconnections between species as well as resource quality (Gowdy, 1995). Instead, a system of democracy should be utilized to allocate natural resources, as part of the legislative process (Sagoff, 1988). Others argue that most people are not willing to pay for species as they believe they have an inherent right to life independent of their value to humans (Hanley and Spash, 1993). Some people are motivated by altruism and ethical considerations, which do not show up in a quantifiable pricing system (Stevens et. al., 1991). As Nijkamp (1977) argues: 'one may question whether ecological functions are evaluated or whether the output for man is evaluated'. Instead, monetary values should be replaced by multiple (qualitative and quantitative) values (Munda, 1993). Other arguments concern the issue of economic valuation and decision-making. When economic valuation is applied in such decision-making tools like cost-benefit analysis, it does not take account of sustainability and distributional aspects. Economic valuation only deals with economic efficiency and is therefore not sufficient in answering the question of which decision or policy is the preferred alternative. Furthermore, it is argued that many environmental effects are irreversible; a cost-benefit analysis incorporates benefits of nature that are lost for a certain period of time, while in reality these benefits are lost forever (Hanley and Spash, 1993). Economic valuation, therefore, cannot guide decision making in the appropriate directions.

A further problem with economic valuation studies is that little agreement exists on methodological aspects. Studies on the same subject often show the application of different valuation methodologies, different discount rates and different environmental functions included in the analysis. In this respect, the context in which the economic valuation studies are carried out must be taken into account (Schuijt, (forthcoming)). This context consists of the actors included in the analysis, their interests, goals and relationships, as well as the institutional context in which these actors reside, consisting of informal institutions (such as norms) and formal institutions (rules and regulations). The effects of such actors and their contexts on the valuation process may, however, be limited through the development of methodological agreements and increased stakeholder participation in valuation studies (Schuijt, (forthcoming)).

As a result, application of economic valuation must be done with care. Nevertheless, economic valuation does have an important added value. In general, one can say economic valuation of wetlands has two benefits. First, economic valuation is important to highlight the relative importance of different economic activities that depend on wetland functions. In this way, it can make important contributions to management plans of wetlands. Secondly, economic valuation may be useful in countering arguments on wetland conservation. Putting a monetary value on activities can highlight the significance of wetlands for people and thus provide strong arguments for the conservation of wetland lands and water as opposed to reclamation or diversion. In both cases, monetary valuation is an important complementary assessment to other, qualitative assessments on wetland functions that cannot be monetarized.

An important role for economic valuation lies in integrated ecological-economic modeling. Turner et. al. (2000) suggest an integrated wetland research framework, which combines economic valuation, integrated modeling, stakeholder analysis, and multi-criteria evaluation[8]. 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. 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.

[8] See also van den Bergh, 1996 for ecological-economic modeling applications.

# 4 CASE STUDIES

## 4.1 Nakivubo Urban Wetland, Uganda[9]

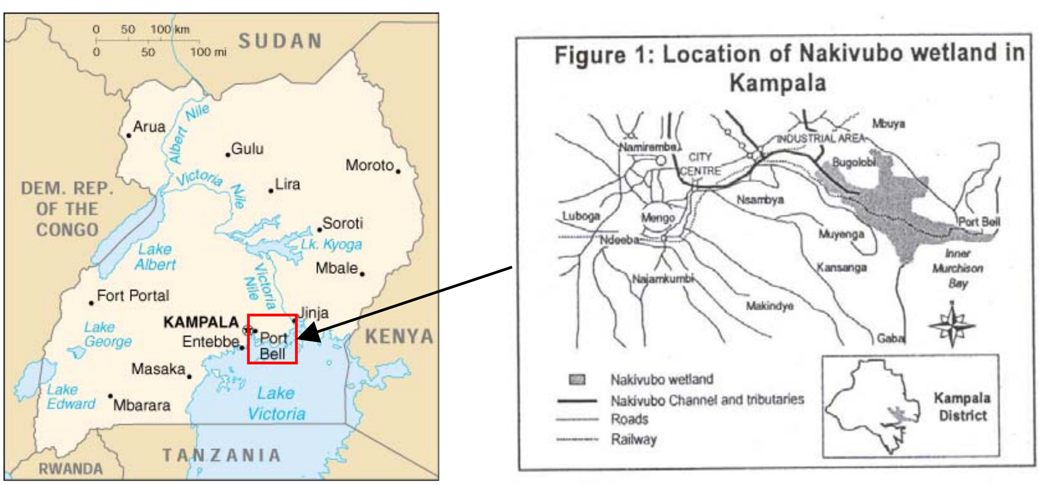
### *4.1.a Background & Area Description*

This study was carried out in 1998 by the IUCN-EARO Biodiversity Economics Project and Uganda National Wetlands Program of the government of Uganda Ministry of Water, Lands and Environment. The National Wetlands Program of Uganda was established in 1989 to assist the government to develop national policy for the conservation and management of wetlands and to seek alternatives to their unsustainable use and abuse. The goal of the economic valuation study was to quantify present and potential economic benefits of wetlands for the use of balancing them with potential gains form its conversion and modification for industrial and residential developments.

The Nakivubo Urban wetland (see Figure 7) is held in trust by the government, but the surrounding lands are privately owned. This has led to confusion as to the boundaries, ownership and status. 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, the capital of Uganda, it acts as an important sink for domestic and industrial wastes of the city. These wastes have three major sources:

1. **Nakivubo Channel**: waste water from the city center, industrial area and residential areas (transport domestic wastes from 100,000 households).
2. **Bugolobi sewage treatment works**: partially treated sewage is mixed with untreated effluents in the Channel before entering the wetland, where it contributes 7% of total nutrient load.
3. **Run-off, seepage and point sources from unsewered areas adjacent to the wetland**: 8,000 households discharge domestic wastes into the wetland from pit latrines, septic tanks, soak pits, leaking waste pipes and Uganda breweries and Luzira prison have outflows.

*Figure 7: Nakivubo Wetland in Uganda*




*Source: CIA World Fact Book, 2001 & Emerton et. al., 1998*

[9] Emerton, L. et. al., 1998

### *4.1.b Threats to the Wetland*

The major threat in the Nakivubo Urban wetland is reclamation for agricultural, industrial 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 km², 2.9 km² is unconverted. As a result, wetland areas to the north are modified and in the south they are relatively intact. The danger, however, exists that the entire wetland will be modified and converted for urban expansion purposes.

### *4.1.c Economic Values*

The goal of the economic valuation study was 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 development. Four wetland resources were valued (crop cultivation, papyrus harvesting, brick making and fish farming; and services) and one wetland service (purification and treatment of wastewaters):

1. **Crop cultivation**: the wetland provides water required for irrigated crop cultivation and deposits sediments and nutrients, which maintain soil fertility. Three quarters of the reclaimed area has been turned over to crops, and about one quarter for settlement. Approximately 1.8 km² of the wetland is crop area of which about 450 to 500 farmers grow crops. In permanently water logged areas, mainly cocoyams and sugarcane is grown; in drier areas, crops grown include sweet potato, matooke, mixed vegetables and cassava.
2. **Papyrus harvesting**: approximately 50 people in the wetland harvest papyrus, which generates income in 3 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.
3. **Brick making**: about 50 people make bricks for building during the 8 dry months of the year.
4. **Fish farming**: there are two fish farms in the wetland area.
5. **Water treatment and purification**: the largest waste that enters the wetland is domestic waste, which is organic. Furthermore, one-third of the fifteen industries plus 200 smaller production facilities discharge waste directly into surface water. Wastes include detergents, lubricants, oils, acids, xenobiotics, nitrates, phosphates and heavy metals. The wetlands treat and purify the water.

The economic values and valuation methods are given in Table 3.

*Table 3: Economic Values of the Nakivubo Urban Wetland*

| Wetland Good or Service | Valuation Method | Economic Value per Year (converted to 2002 US$) |
|---|---|---|
| Crop cultivation | (a) Market pricing: contribution to crop productivity (b) Averting expenditure/Mitigation behavior: support to the cultivation of irrigated crops. | 59,844 |
| Papyrus harvesting | Market pricing | 9,521 |
| Brick making | Market pricing | 17,409 |
| Fish farming | Market pricing | 3,264 |
| Water treatment & purification | (a) Replacement cost: Replacement of functions (b) Mitigative expenditure: mitigation of the effects of the loss of functions (c) subtraction of the costs of multiple outflows | 678,842 – 1,258,925 |
| TOTAL ECONOMIC VALUE | | 768,880 – 1,348,960 |

## 4.2 Hadejia-Jama're Floodplain / Hadejia-Nguru Wetlands, Nigeria[10]

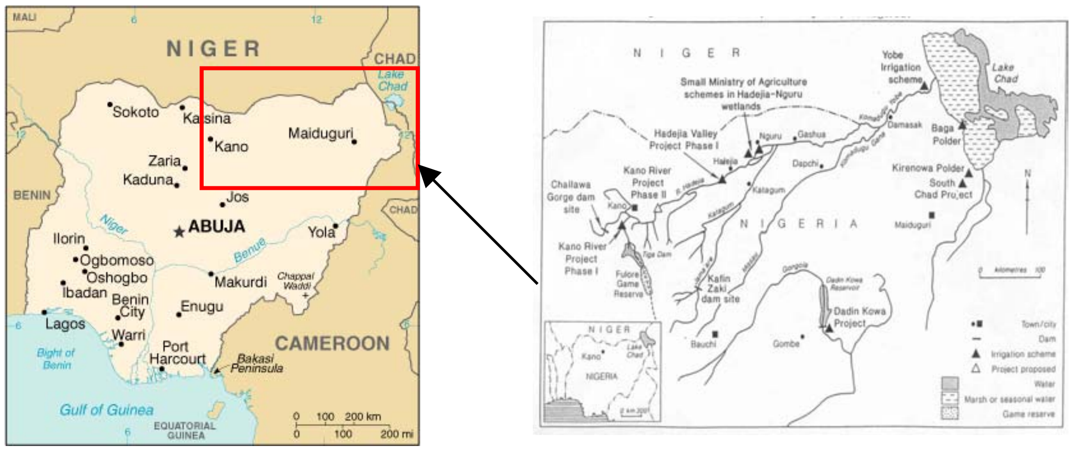
### *4.2.a Background & Area Description*

Both of the studies were carried out by the International Institute for Environment and Development (IIED) in the United Kingdom. The goal of the study by Barbier et. al. (1991) was to illustrate the economic importance of wetlands. The results of the study can be used to serve as a basis for comparing the benefits of wetlands with benefits of other water uses. The goal of the study by Eaton and Sarch (1997) was to present the research results and discuss participatory appraisal techniques with the aim to strengthen the capacity of local organizations working in the field to conduct resource valuation at community level.

The Hadejia-Jama're and Hadejia Nguru wetlands are located in Northeast Nigeria (see Figure 8). It has an area of 3,500 km² with two rivers – the Hadejia and Jama're. Approximately one million inhabitants live in the wetland, many of which had 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 project, concerned with the conservation and sustainable management of the entire floodplain. The National parks Commission of Nigeria has already designated some parts of the wetland as part of the Lake Chad Basin National Park.

[10] Barbier, 1991 & Eaton and Sarch, 1997

*Figure 8: Hadejia-Jama're Floodplain / Hadejia Nguru Wetland in Nigeria*




*Source: CIA World Fact Book, 2001 & Barbier, 1991*

In this area, several studies have been carried out, of which two are economic valuation studies. The first study was carried out by Barbier in 1991 on the economic values of the Hadejia-Jama're floodplain, and the second study was carried out in 1997 by Eaton and Sarch on the economic values of wild resources Hadejia-Nguru wetlands. Both studies cover the same wetland area in Nigeria and will therefore be used together in this section.

### *4.2.b Threats to the Wetland*

The pressures that threaten the existence of the wetland consist of drought and upstream and downstream water developments. Upstream, dams alter the timing and size of flood flows and divert surface or ground water for irrigation. Downstream, increasing demand for irrigated agriculture leads to diversion of water past wetlands through bypass channels. At the time of the study, the Tiga dam is the only dam in place in the area, which delays wet season flood peaks, However, the Challawa Gorge dam is being constructed and a third dam is planned - both are expected to have similar effects on the wetland. These developments take place without consideration of impacts on the floodplain or loss of economic benefits provided by the floodplain. Lastly, intensified human use within the wetland, especially wheat irrigation, is also putting pressure on the wetland. For example, Fuelwood has become a source of conflict – a number of forest reserves have been developed in the area that are being heavily exploited by commercial firewood harvesters for large urban centers.

### *4.2.c Economic Values*

The goals of the valuation studies were to illustrate the economic importance of wetlands. In the case of one of the valuation studies, an additional goal was being pursued to discuss the participatory research techniques applied in the valuation study.

Several economic activities take place in the wetland, the most important ones agriculture, fishing, dry season grazing and the collection of wild resources:

1. **Agriculture**: dry-land farming of sorghum and millet, seasonally flooded rice farming, flood-retreat farming (mainly cowpeas) and irrigated farming. Rice is the most important crop grown in seasonally flooded areas.
2. **Fishing**: this is done at various times of the year with different gear. The poor flooding of the wetland due to the dams, diversions and climatic changes causes poor fishing revenues.
3. **Dry season grazing**: grazing of sheep, goat, cattle and a few camels. Pastoralists often move into the area as the dry season develops.
4. **Wild resources**: provide materials for utensils and construction, and contribute to improved diets and health, food security, income generation and genetic experimentation. Three resources are particularly significant in monetary terms: doum palm, potash and firewood. Doum palm is a source of food, materials and income. Dried palm is harvested throughout the year to make a variety of products like mats, baskets and roofing materials. 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. Firewood is collected mostly for subsistence by both men and women, but is also a very active trade.

The economic values and valuation methods are presented in Table 4.

*Table 4: Economic Values of the Hadejia-Jama're Floodplain*

| Wetland Good or Service | Valuation Method | Economic Value per Year (converted to 2002 US$) |
|---|---|---|
| Agriculture | Market pricing | 10,652,616 |
| Fishing | Market pricing | 3,465,116 |
| Fuelwood | Market pricing | 1,601,744 |
| Doum Palm[11] | Market pricing | 130,178 |
| Potash[7] | Market pricing | 888 |
| TOTAL ECONOMIC VALUE | | 15,850,542 |

## 4.3 Lake Chilwa Wetland, Malawi[12]

### *4.3.a Background & Area Description*

The Lake Chilwa wetland has been designated as Malawi's first Ramsar site as a wetland of international importance in 1996. This requires the development of a management plan, carried out by the Lake Chilwa Wetland and Catchment Management Project of the Danish Ministry of Foreign Affairs (Danida). This economic valuation study is part of this project. The goal of the project was to enhance community-based natural resource management as part of the management plan. The goal of the economic valuation study was to value net annual benefits to suggest implications of these values for management of the wetland.

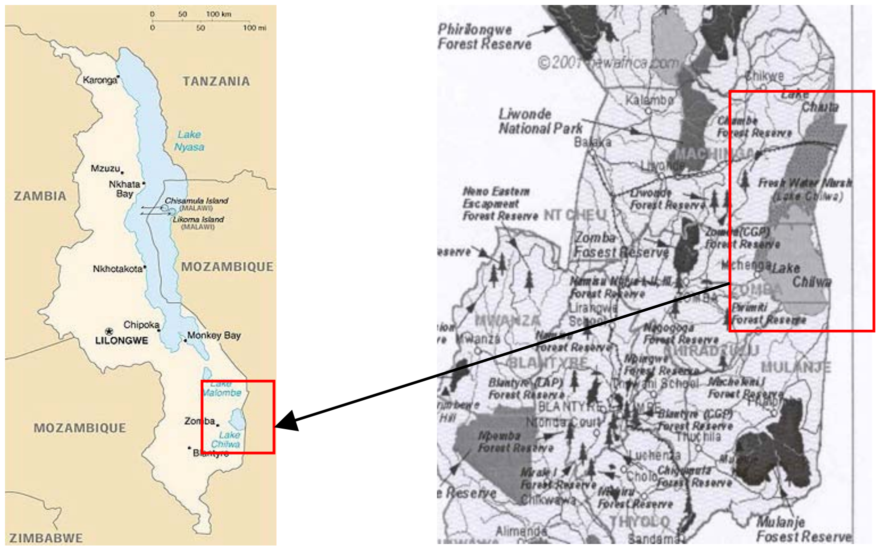
The Lake Chilwa wetland has an area of 2,400 km² and is situated in the south of Malawi, on the border with Mozambique (see Figure 9). It is one of the most productive lakes in Africa it

[11] For the wild resources Doum palm and Potash economic values were only calculated for Adiani village in the wetland.

[12] Schuijt, 1999.

produces more than 20% of all fish caught in Malawi. It is also a very important area for breeding waterfowls and agricultural activities.

*Figure 9: Lake Chilwa Wetland in Malawi*




*Source: CIA World Fact Book, 2001 & New Africa.com, 2001*

### *4.3.b Threats to the Wetland*

The two major threats facing the Lake Chilwa wetland are a reduction in lake level due to abstraction within the catchment and degradation of the catchment by the local population. There is a shortage of wood for fuel, which is used for fuel, the construction of fishing crafts and building materials. Over-trapping and shooting birds resident and migratory is also a major problem. Potential threats for the future include poverty, population increase, soil erosion and siltation, destruction of breeding grounds and sanctuaries for fish increased use of agro-chemicals affecting the aquatic environment and invasion by exotic plant species.

### *4.3.c Economic Values*

The goal of the project for which the valuation study was carried out was to sustain and enhance the benefits of the Lake Chilwa wetland to local communities (community-based natural resource management). The aim of the economic valuation study was to value the net annual benefits of the Lake Chilwa wetland and to suggest implications of these values for the management of the wetland.

Five wetland resources were valued:

1. **Agricultural grounds**: including crop-growing activities and organized rice schemes. The main crops grown in the wetland are maize and rice, depending on the location. Approximately 92% of the respondents in the wetland said to grow crops. The main costs of growing crops were fertilizer and employment costs, which were both subtracted from the benefits. Fertilizer is only used by a small group of people (28%) as it is often too expensive to afford. A hired hand or 'ganyu' is used by 14% of the people to work on their land.

2. **Fish**: both values accruing to fishermen and values accruing to fish mongers were calculated. The average annual catch is 16,600 tons per year, making Lake Chilwa an extremely productive lake. The major costs for fishermen were employment costs, depreciation costs of boats, rental costs of boats, reparation costs of boats and depreciation of equipment. For fish mongers, main costs were purchasing and processing fish, transport, living expenses and market fees.
3. **Vegetation**: reeds in the wetland are used for mats, brooms and baskets; bamboo is used for fish traps; grass called Njeza is used as a building material for roofs, walls and fences; wood is mainly used for firewood and clay is used for making bricks.
4. **Open water**: water is utilized by people for fishing, transport, irrigation, and for domestic use. 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 can't swim and a belief that spirits exist in open water. Transport is through 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.
5. **Grasslands**: grasslands in the wetland are mostly used for grazing cattle, goats, sheep and pig.

The total economic values for the Lake Chilwa wetland are given in Table 5.

*Table 5: Economic Values of the Lake Chilwa Wetland*

| Wetland Good or Service | Valuation Method | Economic Value per Year (converted to 2002 US$) |
|---|---|---|
| Agricultural grounds | Market pricing | 1,293,802 |
| Fish | Market pricing | 18,675,478 |
| Vegetation | Market pricing | 13,457 |
| Open water | Market pricing | 435,668 |
| Grasslands | Market pricing | 637,987 |
| TOTAL ECONOMIC VALUE | | 21,056,392 |

## 4.4 Zambezi Basin Wetlands, Southern Africa[13]

### *4.4.a Background & Area Description*

This study was carried out by the International Institute for Infrastructural, Hydraulic and Environmental Engineering (IHE) in the Netherlands. The goal of the study was to apply a simple and rapid approach for valuing wetlands under limited data availability.

The Zambezi basin is located in southern Africa in the countries Angola, Zambia, Zimbabwe, Malawi, Botswana, Namibia and Mozambique (see Figure 10). In the basin, several wetland types exist, where the largest by area is the freshwater floodplain wetland[14]. Ten major freshwater wetlands may be distinguished (Hughes & Hughes,1992 and Davies, 1986; in: Seyam et. al., 2001):

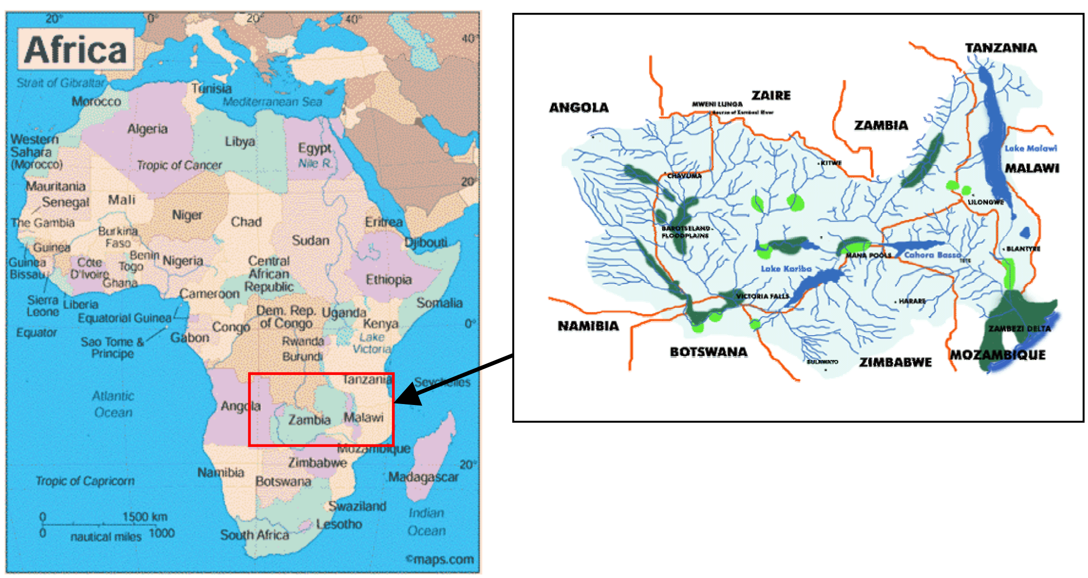
[13] Seyam et. al., (2001). Note: another study on the economic values of the Zambezi basin wetlands was carried out by Turpie et. al., 1998; however, this study is unpublished and unobtainable even at the organization who carried it out - the IUCN.

[14] Other types of wetlands are dambos and what the authors call "fringe wetlands".

- 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)
- Luena (110,000 ha)

Busanga and Linyanti-Chobe are protected, while the other wetlands are partly protected; only Elephant Marsh and Lukanga have an unprotected status.

*Figure 10: Zambezi Basin wetlands in Southern Africa*




*Source: Infoplease.com & The Zambezi Society*

## *4.4.b Threats to the Wetland*

Threats to the Zambezi basin wetland 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).

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 such as provision of soft loans for major wetland development projects of maintaining high crop prices by means of subsidy.

### *4.4.c Economic Values*

Wetland resources in the Zambezi basin wetlands provide numerous goods and services to surrounding communities. For example, the wetlands support a diversity of plant and animal species. Furthermore, fish is a major source of protein in the basin states – there are 85 fish species in the Upper Zambezi alone (SARDC, 2000).

The study by Seyam et. al. (2001) indicates the most frequently reported products and services of the wetlands. These were:

1. Flood plain recession agriculture
2. Fish production
3. Wildlife services and goods
4. Livestock grazing
5. Eco tourism
6. Biodiversity
7. Natural products and medicine

Each of these products was valued. The economic values and valuation methods are presented in Table 6.

*Table 6: Economic Values of the Zambezi Basin Wetlands*

| Wetland Good or Service | Valuation Method | Economic Value (2002 US$/y) |
|---|---|---|
| Flood plain recession agriculture | Market pricing | 49,655,172 |
| Fish production | Market pricing | 78,620,690 |
| Wildlife services and goods | Market pricing | -1,144,828 |
| Livestock grazing | Market pricing | 70,620,690 |
| Eco-tourism | Benefit transfer | 813,793 |
| Biodiversity | "debt-for-nature-swap"[15] | 67,586 |
| Natural products and medicine | Benefit transfer | 2,620,690 |
| TOTAL ECONOMIC VALUE | | 201,253,793 |

[15] The authors use the exchange of 1.17 million ha for US$2.27 and calculate it as an annuity as an indication of the value of biodiversity.

# 5 DISCUSSION

In the previous chapters, the economic importance of African wetlands has been explained and illustrated with case studies of economic valuations of four different African wetlands. Two of these wetlands represent the most common wetland types in Africa, namely the floodplain wetlands of the Zambezi basin and the Hadejia-Jama're basin, while the other two wetlands (Nakivubo urban wetland and Lake Chilwa wetland) represent wetlands of African lakes, which are also very common in Africa. Therefore, although each and every wetland must be approached separately to different local economic, social and ecological circumstances, the case studies are representative of other wetlands in Africa. Table 7 gives an overview of the sixteen goods and services these wetlands supply to people that have been valued in the four case studies.

*Table 7: Overview of Economic Values of African Wetlands*

| | Wetland Good or Service | Economic Values per Wetland (2002 US$/yr * 1,000) | Wetland |
|---|---|---|---|
| 1 | Crop cultivation / Agriculture | 59.8 | Nakivubo |
| | | 10,652.6 | Hadejia-Jama're |
| | | 1,293.8 | Lake Chilwa |
| | | 49,655.2 | Zambezi Basin |
| 2 | Papyrus harvesting | 9.5 | Nakivubo |
| 3 | Fuelwood | 1,601.7 | Hadejia-Jama're |
| 4 | Doum Palm | 130,.2 | Hadejia-Jama're |
| 5 | Potash | 0.89 | Hadejia-Jama're |
| 6 | Vegetation (reeds, bamboo, grass) | 13.5 | Lake Chilwa |
| 7 | Brick making | 17.4 | Nakivubo |
| 8 | Fishing | 3,465.1 | Hadejia-Jama're |
| | | 18,675.5 | Lake Chilwa |
| | | 78,620.7 | Zambezi Basin |
| 9 | Fish farming | 3.3 | Nakivubo |
| 10 | Grasslands / Livestock farming | 638 | Lake Chilwa |
| | | 70,620.7 | Zambezi Basin |
| 11 | Water treatment & purification | 968.9 | Nakivubo |
| 12 | Water transport | 435.7 | Lake Chilwa |
| 13 | Wildlife services and goods | -1,144.8 | Zambezi Basin |
| 14 | Eco-tourism | 813.8 | Zambezi Basin |
| 15 | Biodiversity | 67.6 | Zambezi Basin |
| 16 | Natural products and medicine | 2,620.7 | Zambezi Basin |

It can be deducted from Table 11 that the top five economic values accrue to the following goods and services:

1. **Fishing** ($3,465.1 thousand - $78,620.7 thousand per year)
2. **Crop cultivation / Agriculture** ($59.8 thousand - $49,655.2 thousand per year)
3. **Grasslands / Livestock farming** ($638 thousand - $70,620.7 thousand per year)
4. **Natural products and medicine** ($2,620.7 thousand per year)
5. **Water treatment and purification** ($968.9 thousand per year)

When all the economic values of each wetland are added together, the total economic value of the wetlands may be calculated, although one does need to take the danger of double counting into account[16]. Furthermore, when comparing the value of the wetland with values of alternative wetland uses, it is necessary to calculate economic values per wetland km². Both total economic value estimates and values per km² are presented in Table 8.

*Table 8 Total Economic Values of Wetlands*

| Wetland | Area (km²) | Total Economic Value (2002 US$/y*1000) | Economic Value per km² (2002 US$/y*1000) |
|---|---|---|---|
| Zambezi Basin wetlands | 29,829 | 201,253.8 | 6.7 |
| Lake Chilwa wetland | 2,400 | 21,056.4 | 8.8 |
| Hadejia-Jama're wetland | 3,500 | 15,850.5 | 4.6 |
| Nakivubo wetland | 5.29 | 1,058.9 | 189 |

It can be observed from Table 8 that the economic values per km² for the first three wetlands are in a similar range. However, the Nakivubo wetland in Uganda has an extremely high economic value per km². This can be assigned mostly to the value of the wetland service "water treatment and water purification". This service has been valued through application of two methods: replacement costs in case this wetland service disappears (investment in pit latrines in low-cost settlements and investments in extending the capacity of one of the sewage treatment plants), and mitigative expenditure required to offset the effects of a loss in water quality when the wetland service is lost (investment costs for moving Kampala's water supply to an alternative location – the construction of a new water treatment plant). This provides a range of $678,842 million - $1,258,952 million per year, which contributes 88% to 93% to the total economic value.

The Nakivubo wetland case study, however, was the only study in which wetland services were valued. In all the other studies, only wetland goods were quantified. Of these goods, the most commonly valued were agriculture (in four cases); fish (in three cases); and livestock grazing (in two cases). These were all valued using Market Pricing techniques, except for the Nakivubo wetland, where agriculture was calculated by a combination of Market Pricing techniques and Mitigating Expenditures saved on alternative, purchased fertilizer. All other wetland goods were valued only once over the four case studies. Again all were valued using Market Pricing except

[16] For example, Barbier (1994, in Turner et. al., 2000) noted that if the function of nutrient retention is integral to the maintenance of biodiversity, the aggregation of the economic values of both functions would double count the nutrient retention already captured by biodiversity value. Furthermore, Turner et. al. (2000) note that some functions may be incompatible, such as water extraction and groundwater recharge – combining these functions would also result in an overestimation of benefits.

for one – in the study on the Zambezi Basin wetlands, the value of "biodiversity" was calculated through willingness to pay estimates derived from debt-for nature swaps.

The emphasis on Market Pricing methods is related to the kind of values and functions that were valued. In all valuation studies, the focus was on use values. Only one non-use value was quantified, namely biodiversity in the Zambezi basin wetlands. The use values were derived mostly from production functions (nine) and carrier functions (five); only one regulation function was valued and no information functions. Use values are relatively straight forward when it comes to valuation as most can indeed be approached through Market Pricing. Common reasons for not applying shadow pricing methods to value non-use values of wetlands is the limited amount of time often available (in most studies the time was limited to a few weeks) and often high costs involved.

The goals for which the economic valuation studies were carried out were diverse. The two valuation studies Nakivubo wetland and the Hadejia-Jama're wetland of Barbier (1991) were carried out in order to balance the economic values with other potential gains and benefits derived from the conversion of the wetland for other purposes. The second valuation study in the Hadejia floodplain wetlands, the Hadejia Nguru wetland by Eaton and Sarch (1997), was carried out as a way to strengthen the capacity of local organizations to conduct resource valuation studies. The goal of the Lake Chilwa wetland study was to suggest implications of the different economic values for the management of the wetland. Lastly, in the Zambezi basin wetlands study, the goal was simply to apply simple and rapid valuation approaches under limited data availability. It shows the wide variety of roles economic valuation studies may play in wetlands management.

The types of threats facing the wetlands for which the economic valuation studies were carried out 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 the overuse of its resources by local people. These activities are 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.

# 6 CONCLUSIONS & RECOMMENDATIONS

This paper gives an overview and evaluation of economic valuation studies that have been carried out for four African wetlands. These evaluations enumerate the importance of wetlands for local people in Africa, and what the costs will be to society if these wetlands should disappear that surpasses common intuition. These costs range from $6.7 thousand per square kilometer annually in the Zambezi basin wetlands in Southern Africa to $189 thousand per square kilometer annually in the Nakivubo urban wetland in Uganda. Decision makers must take these costs into account in plans to convert wetlands' lands and waters for other purposes, including agriculture and urban or industrial expansions. One way to approach the integration of such environmental costs in decision-making is through ecological-economic modeling. Economic valuation could play an important role in these models by providing data on economic costs and benefits related to environmental change resulting from certain policies, in addition to other data about eco-hydrological consequences. If, on the other hand, these costs are ignored in decision-making contexts, the result will be economically inefficient decisions at a very high cost for low-income rural communities.

The results of the threats facing the wetlands in the case studies show that at the basis of the degradation of the wetlands are indeed human activities. However, when approaching stakeholders with evaluations of costs and benefits of ecosystems, a distinction must be made between (1) actors outside the wetland area who perceive wetland economic benefits as less than the benefits of wetland conversions; and (2) actors in the wetland area who, driven by poverty and population increases, do not use the wetlands' resources in a sustainable way. The first group of actors may be approached with economic valuation studies by highlighting the economic benefits of wetland conservation. However, the second group of actors, 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 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.

Although this paper explains why economic valuation of wetlands is important, it also observed that very few economic valuations 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 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, albeit often with the help of local organizations and people. Since local people often have a clearer understanding of local economies, however, 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.

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# APPENDIX: DATABASE AFRICAN WETLANDS

| | 1a. Nakivubo Urban Wetland | 2a. Hadejia Jama're Wetland |
|---|---|---|
| **Region** | Uganda | Nigeria (1) |
| **Area** | 5.29 sq. km. | 3,500 sq. km. |
| **Threats** | * reclamation for industrial and residential expansion.<br>* 45% modified or reclaimed and danger that the remainder will also be modified or converted. | * natural threats: drought.<br>* upstream developments: dams.<br>* downstream developments: diversion of water. |
| **Goal study** | * " 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 fro industrial and residential developments."<br>* expansion projects have been based on financial analyses, never including economic (social) costs. | * to illustrate economic importance of wetlands<br>* to serve as a basis for comparing with benefits of other water uses |
| **Resources valued** | 1. Crop Cultivation<br>2. Papyrus Harvesting<br>3. Brick-Making<br>4. Fish-Farming | 1. Agriculture<br>2. Fishing<br>3. Fuelwood |
| **Valuation method** | 1. (a) contribution to crop productivity: Market Pricing Method<br>(b) support to the cultivation of irrigated crops: Mitigation Behavior/ Averting Expenditure Method<br>2. Market Pricing Method<br>3. Market Pricing Method<br>4. Market Pricing Method | 1. Market Pricing Method<br>2. Market Pricing Method<br>3. Market Pricing Method |
| **Economic values resources p/y** | 1. 110,000,000<br>2. 17,500,000<br>3. 32,000,000<br>4. 6,000,000 | 1. 7,329,000<br>2. 2,384,000<br>3. 1,102,000 |
| **Economic values p/y, 2002** | 1. 59,844<br>2. 9,521<br>3. 17,409<br>4. 3,264 | 1. 10,652,616<br>2. 3,465,116<br>3. 1,601,744 |
| **Services valued** | Water treatment & Purification | None |
| **Valuation method** | a) replacement of functions: Replacement Cost Method<br>b) mitigation of effects of the loss of functions: Mitigative Expenditure Method<br>c) subtraction of costs of construction of multiple outflows: Market Pricing | None |

| | 1b. Nakivubo Urban Wetland | 2b. Hadejia Jama're Wetland |
|---|---|---|
| **Economic values services p/y** | 1,247,780,000 - 2,314,030,000 | None |
| **Economic values services p/y, 2002** | 678,842 - 1,258,926 | None |
| **Total economic value p/y** | 768,880 - 1,348,960 | Not calculated, only present values of 3 resources together. Own calculation: 10,715 |
| **Total economic value p/y, 2002** | 418 - 734 | 15,574 |

| | 3a. Hadejia Nguru Wetland | 4a. Lake Chilwa Wetland |
|---|---|---|
| **Region** | Nigeria (2) | Malawi |
| **Area** | 3,500 sq. km. | 2,400 sq. km. |
| **Threats** | * natural threats: drought.<br>* upstream developments: dams.<br>* downstream developments: diversion of water.<br>* fuelwood has become a source of conflict through exploitation by commercial harvesters. | * reduction lake level due to abstraction and degradation by local people.<br>* shortage of wood for fuel, fishing crafts and building materials.<br>* over-trapping and shooting of birds.<br>* potential threats of poverty, population increase, soil erosion, siltation, destruction breeding grounds and fish sanctuaries, increased use of chemicals, invasion exotic plant species. |
| **Goal study** | * presenting research results & discussion on participatory appraisal techniques.<br>* to strengthen the capacity of local organizations working in the field to conduct resource valuation at community level.<br>* conservation of ecological functions | * goal project: community-based natural resource management as part of a management plan due to Ramsar status.<br>* goal paper: to value net annual benefits to suggest implications of these values for management of the wetland. |
| **Resources valued** | 1. Doum Palm<br>2. Potash<br>3. Firewood | 1. Agricultural grounds<br>2. Fish<br>3. Vegetation<br>4. Open water<br>5. Grasslands |
| **Valuation method** | 1. Market Pricing Method<br>2. Market Pricing Method<br>3. Market Pricing Method | 1. Market pricing<br>2. Market pricing<br>3. Market pricing<br>4. Market pricing<br>5. Market pricing |
| **Economic values resources p/y** | 1. 110,000<br>2. 750<br>3. 11,000 | 1. 1,195,473<br>2. 17,256,142<br>3. 12,434<br>4. 402,557<br>5. 589,500 |

| | 3b. Hadejia Nguru Wetland | 4b. Lake Chilwa Wetland |
|---|---|---|
| **Economic values p/y, 2002** | 1. 130,178<br>2. 888<br>3. 13,018 | 1. 1,293,802<br>2. 18,675,478<br>3. 13,457<br>4. 435,668<br>5. 637,987 |
| **Services valued** | None | None |
| **Valuation method** | None | None |
| **Economic values services p/y** | None | None |
| **Economic values services p/y, 2002** | None | None |
| **Total economic value p/y** | Not calculated; own calculation: 121,750 | 18,645,845 |
| **Total economic value p/y, 2002** | 144,083 | 20,179,486 |

| | 5a. Zambezi Basin Wetland |
|---|---|
| **Region** | Southern Africa |
| **Area** | 29,829 sq. km. |
| **Threats** | * reduced flows caused by droughts and water abstractions, aquatic weed infestation, pesticides (DDT), infrastructure developments, overuse by local people, uncontrolled fires, pollution deforestation. |
| **Goal study** | * to apply a simple and rapid approach for valuing wetlands under limited data availability. |
| **Resources valued** | 1. Agriculture<br>2. Fish production<br>3. Wildlife services and goods<br>4. Livestock grazing<br>5. Eco-tourism<br>6. Biodiversity<br>7. Natural products and and medicine |
| **Valuation method** | 1. Market pricing<br>2. Market pricing<br>3. Market pricing<br>4. Market pricing<br>5. Market pricing<br>6. Willingness to pay (debt for nature swaps)<br>7. Market pricing |
| **Economic values resources p/y** | 1. 36,000,000<br>2. 57,000,000<br>3. -830,000<br>4. 51,200,000<br>5. 590,000<br>6. 49,000<br>7. 1,900,000 |
| **Economic values p/y, 2002** | 1. 49,655,172<br>2. 78,620,690<br>3. -1,144,828<br>4. 70,620,690<br>5. 813,793<br>6. 67,586<br>7. 2,620,690 |
| **Services valued** | None |
| **Valuation method** | None |

| | 5b. Zambezi Basin Wetland |
|---|---|
| **Economic values** | None |
| **Services p/y** | None |
| **Economic values services p/y, 2002** | None |
| **Total economic value p/y** | 145,000,000 |
| **Total economic value p/y, 2002** | 200,000,000 |