Values and Rewards:

Counting and Capturing Ecosystem Water Services for Sustainable Development

Edited by Lucy Emerton

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BACKGROUND

The project "Integrating Wetland Economic Values into River Basin Management" has the overall goal of more equitable, efficient and sustainable wetland and river basin management resulting from the practical application of environmental economics techniques and measures. To help to achieve this goal, its immediate objectives are:

- To increase awareness and capacity among planners, policy-makers and managers to identify and use economic measures for wetland conservation.
- To generate and disseminate practical and policy-relevant tools and examples of the use of economic measures for wetland conservation.
- To assess environmental economic aspects of wetland and river basin management at key sites, including the identification of wetland values, economic causes of wetland loss, incentives and financing mechanisms for wetland conservation.
- To work with local communities, government and non-government agencies and the private sector to integrate wetland economic values into development and conservation decision-making and to pilot concrete economic measures for wetland management.

National, regional and global case studies, policy briefs and technical working papers are being carried out as part of this project. These deal with the practical application of environmental economics techniques and measures to ecosystem and river basin management in different regions of the world, including Africa, Asia and Latin America.

The project has involved developing and applying economic assessment tools for assessing the value of water-related ecosystems in river basins, in order to provide practical and policy-relevant information to be used in the context of addressing real-world river basin management issues. This document summarises these valuation case studies, all of which were carried out by IUCN and its partners within the context of planning, managing and implementing an ecosystem approach to wetland and river basin management, including:

The Barotse Floodplain, Zambia (IUCN Regional Office for Southern Africa; study undertaken by J. Turpie, B. Smith, J. Barnes and L. Emerton).

Ream National Park, Cambodia (IUCN Asia Regional Environmental Economics Programme and ICEM, the International Centre for Environmental Management; study undertaken by L. Emerton, Seilava, R. and H. Pearith).

Kala Oya River Basin, Sri Lanka (IUCN Sri Lanka Country Office and the Mahaweli Authority of Sri Lanka; study undertaken by S. Vidanage, S. Perera and M. Kallesoe).

Stoeng Treng Ramsar Site, Cambodia (IUCN Asia Regional Environmental Economics Programme and the IUCN-UNDP-MRC Mekong Wetlands Biodiversity Project; study undertaken by J. Chong).

Waza Logone Floodplain, Cameroon (IUCN Regional Office for Central Africa; study undertaken by L. Emerton, R. Kouokam and I. Peghouma).

Indus Delta, Pakistan (IUCN Pakistan Country Office and the South Asia Network for Development and Environmental Economics; study undertaken by U. Iftikhar).

Tana River, Kenya (IUCN Eastern Africa Regional Office, Acropolis Kenya and NR International; study undertaken by L. Emerton).

Sekong Province, Lao PDR (IUCN Lao PDR Country Office and WWF Lao Office; study undertaken by R. Rosales, M. Kallesoe, P. Gerrard, P. Muangchanh, S. Phomtavong and S. Khamsomphou).

Pangani Basin, Tanzania (IUCN Eastern Africa Regional Office and the Pangani Basin Water Office; study undertaken by J. Turpie, Y. Ngaga and F. Karanja).

Nakivubo Swamp, Uganda (IUCN Eastern Africa Regional Office and the Uganda Wetlands Inspectorate Division; study undertaken by L. Emerton, L. Iyango, W. Kakuru, P. Luwum, and A. Malinga).

Muthurajawela Marsh, Sri Lanka (IUCN Sri Lanka Country Office; study undertaken by L. Emerton and B. Kekulandala).

That Luang Marsh, Lao PDR (IUCN Lao PDR Country Office and WWF Lao Office; study undertaken by P. Gerrard).

Valuing ecosystems in water decisions: where are we now?

Water ecosystem under-valuation: defining the problem

Natural ecosystems yield a wide range of goods and services, many of which are related to either their demand for water or their role in water supplies, and most of which have an extremely high economic value.

Yet, paradoxically, water ecosystems have long been perceived by decision-makers as having little value – there are seen to be few economic benefits associated with the conservation of habitats such as wetlands or catchment forests, and few economic costs attached to their degradation and loss. Given this tendency to under-valuation, it is hardly surprising that ecosystems are being rapidly modified, converted, over-exploited and degraded in the interests of other more 'productive' land and resource management options which appear to yield much higher and more immediate profits. For example dam construction, irrigation schemes, housing developments and industrial activities have all had devastating impacts on wetland integrity and status, and economic policies have often hastened these processes of ecosystem degradation and loss. At the same time conservation efforts have traditionally paid little attention to economic values – as a result it has often been hard to justify or sustain ecosystem management in economic terms, or for it to compete with other, often destructive, investments and land uses.

In fact, the problem is not that water ecosystems have no economic value, but rather that this value is poorly understood, rarely articulated, and as a result is frequently omitted from decision-making. Although conventional analysis decrees that the 'best' or most efficient allocation of resources is one that maximises economic returns, calculations of the returns to different land, resource and investment options have for the most part failed to deal adequately with ecosystem values.

Investment appraisals of dams do not usually consider either the economic costs attached to modifying downstream river flows and hydrology or the economic benefits associated with maintaining the integrity of upstream catchments, the economic impacts of loss of wetland resources tends not to be factored into calculations of the potential profitability of land reclamation or conversion schemes, cost-benefit analyses of infrastructure projects have rarely incorporated estimates of environmental benefits and costs. Decisions have tended to be made on the basis of only partial information and have thus favoured short-term (and often unsustainable) development imperatives, or led to conservation regimes that generate few financial or economic benefits. In the absence of information about ecosystem values, substantial misallocation of resources has occurred and gone unrecognised[1], and immense economic costs have often been incurred.

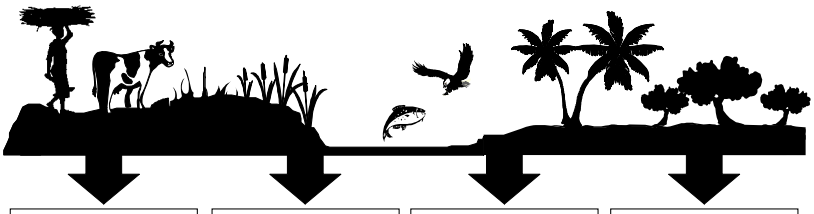
Economic valuation can provide a powerful tool for placing water ecosystems on the agenda of conservation and development decision-makers. Its basic aim is to determine people's preferences: how much they are willing to pay for ecosystem goods and services, and how much better or worse off they would consider themselves to be as a result of changes in their supply. By expressing these preferences, valuation aims to make ecosystem goods and services directly comparable with other sectors of the economy when investments are appraised, activities are planned, policies are formulated, or land and resource use decisions are made. When properly measured, the total economic value of ecosystem functions, services and resources frequently exceeds the economic gains from activities which are based on ecosystem conversion or degradation[2]. Although a better understanding of the economic value of ecosystems does not necessarily favour their conservation and sustainable use, it at least

permits them to be considered as economically productive systems, alongside other possible uses of land, resources and funds.

Total economic value: a framework for defining ecosystem economic benefits

One reason for the persistent under-valuation of ecosystems is that, traditionally, concepts of economic value have been based on a very narrow definition of benefits. Economists have seen the value of natural ecosystems only in terms of the raw materials and physical products that they generate for human production and consumption, especially focusing on commercial activities and profits. These direct uses however represent only a small proportion of the total value of ecosystems, which generate economic benefits far in excess of just physical or marketed products.

The total economic value of ecosystems



DIRECT VALUES	INDIRECT VALUES	OPTION VALUES	NON-USE VALUES
Production and consumption goods such as: Water, Fish, Firewood, Building poles, Thatch, Wild foods Medicines, Crops, Pasture, Transport, Recreation, **… *etc* ...**	**Ecosystem functions and services such as:** Water quality and flow, Water storage and recharge; Nutrient cycling; Flood attenuation, Micro-climate, **… *etc* ...**	**Premium placed on possible future uses or applications, such as:** Agricultural, Industrial, Leisure, Pharmaceutical, Water use, **… *etc* ...**	**Intrinsic significance of resources and ecosystems in terms of:** Cultural value, Aesthetic value, Heritage value, Bequest value, **… *etc* ...**

The concept of total economic value has now become one of the most widely used frameworks for identifying and categorising ecosystem benefits[3]. Instead of focusing only on direct commercial values, it also encompasses the subsistence and non-market values, ecological functions and non-use benefits. As well as presenting a more complete picture of the economic importance of ecosystems, it clearly demonstrates the high and wide-ranging economic costs associated with their degradation, which extends beyond the loss of direct use values.

Looking at the total economic value of a ecosystem essentially involves considering its full range of characteristics as an integrated system – its resource stocks or assets, flows of environmental services, and the attributes of the ecosystem as a whole[4]. Broadly defined, the total economic value of water ecosystems such as wetlands and catchment forests includes:

- **Direct values:** raw materials and physical products which are used directly for production, consumption and sale such as those providing energy, shelter, foods, agricultural production, water supply, transport and recreational facilities.
- **Indirect values:** the ecological functions which maintain and protect natural and human systems through services such as maintenance of water quality and flow, flood control and storm protection, nutrient retention and micro-climate stabilisation, and the production and consumption activities they support.
- **Option values:** the premium placed on maintaining a pool of species and genetic resources for future possible uses, some of which may not be known now, such as leisure, commercial, industrial, agricultural and pharmaceutical applications and water-based developments.
- **Existence values:** the intrinsic value of ecosystems and their component parts, regardless of their current or future use possibilities, such as cultural, aesthetic, heritage and bequest significance.

Commonly-used valuation tools

- **Replacement costs:** Even where wetland goods and services have no market themselves, they often have alternatives or substitutes that can be bought and sold. These replacement costs can be used as a proxy for wetland resource and ecosystem values, although usually represent only partial estimates, or under-estimates.
  In order to value non-marketed use of papyrus products by local households in Bushenyi District, Uganda, the price of substitute products was used. Annual household consumption of papyrus products was expressed in terms of equivalent market substitutes, including clay tiles instead of thatch, rubber floor coverings instead of mats, plastic bowls instead of baskets, and purchased firewood instead of papyrus[5]. Replacement costs were also used to value the benefit of Korea's coastal wetlands in treating wastewaters and pollutants. Here, the costs of building and operating a waste treatment facility were used as a proxy for the replacement cost of wetland services[6].
- **Effects on production:** Other economic processes often rely on wetland resources as inputs, or on the essential life support provided by wetland services. Where they have a market, it is possible to look at the contribution of wetland goods and services to the output or income of these wider production and consumption opportunities in order to assess their value.
  The benefit of the Hadejia-Nguru wetlands for groundwater recharge was valued a production function approach. Wetland value was assessed by modelling the demand for water for household consumption and dry season irrigated agricultural production, and relating welfare changes to changes in ground water levels[7]. The economic value of mangroves in Pagbilao, Philippines, was assessed by looking at their contribution to fisheries production. Sustainable harvests were calculated, and the impacts of mangrove nutrient production on productivity were isolated in order to determine the role of mangrove management in fisheries production[8].
- **Damage costs avoided:** The reduction or loss of wetland goods and services frequently incurs costs in terms of damage to, or reduction of, other economic activities. These damage costs avoided can be taken to represent the economic losses foregone by conserving wetlands.
  Wetlands around the Tana River and Delta, Kenya, provide important flood attenuation services for nearby infrastructure and surrounding human settlements. These services were partially valued by modelling the impact of wetland loss on the frequency and severity of flooding, and assessing the costs of damage avoided to roads, buildings and other infrastructure[9].
- **Mitigative or avertive expenditures:** It is almost always necessary to take action to mitigate or avert the negative effects of the loss of wetland goods and services, so as to avoid economic damage. These mitigative or avertive costs can be used as indicators of the value of conserving wetlands in terms of expenditures avoided.
  Coastal marshes and mangroves play an important role in shoreline stabilisation, erosion control, flood and storm protection on Mahé Island in the Seychelles. The value associated with these functions was calculated by applying a preventive expenditure approach. In the absence of wetlands services it would be necessary to construct groynes and flood barriers to offset or mitigate coastal erosion and damage to infrastructure, the cost of which was used as a proxy for the value of coastal marsh and mangrove services[10].
- **Hedonic pricing:** Hedonic methods look at the differentials in property prices and wages between locations, and isolate the proportion of this difference that can be ascribed to the existence or quality of wetland goods and services.
  The amenity and landscape benefits of Bhoj wetland in the city of Bhopal, India were valued using hedonic pricing methods. This compared house prices in different parts of the city, and isolated the premium on property prices for houses that were in close proximity to the Upper and Lower Lakes[11].
- **Travel costs:** wetlands typically hold a high value as a recreational resource or destination. Although in many cases no charge is made to view or enjoy natural ecosystems and species, people still spend time and money to reach wetlands. This spending — such as on transport, food, equipment, accommodation, time, etc. — can be calculated, and a demand function constructed relating visitation rates to expenditures made. These travel costs reflect the value that people place on leisure, recreational or tourism aspects of wetlands.
  The travel cost method was applied to value the recreational value of wildlife viewing in Lake Nakuru National Park, Kenya. This was done by administering a questionnaire to visitors which collected data on origin, distance travelled, income and expenses. Demand curves were constructed using regression analysis to describe the relationship between travel costs and number of visits, and individual and aggregate willingness to pay for wetland recreational services were estimated[12].
- **Contingent valuation:** Even where wetland goods and services have no market price, and no close replacements or substitutes, they frequently have a high value to people. Contingent valuation techniques infer the value that people place on wetland goods and services by asking them their willingness to pay for them (or willingness to accept compensation for their loss) under the hypothetical scenario that they would be available for purchase.
  Contingent valuation methods were used to assess the value of a maintaining the Chao Phraya River in Thailand as a clean and well-functioning environment. A survey was carried out to gauge Bangkok residents' willingness to pay for a clean environment through eliciting bids for various measures to improve river water quality and minimise pollution loads entering the river[13].

Methods for valuing ecosystem benefits

The simplest, most straightforward and commonly used method for valuing any economic good or service is to look at its market price – how much it costs to buy, or what it is worth to sell. In many cases market prices can provide an accurate indicator of the value of ecosystem goods, when they are freely bought or sold.

Yet market prices do not necessarily reflect the real economic value of ecosystem. Many wetland goods and services are never traded, are under-valued by market prices, are subject to prices which are highly distorted, or have characteristics of public goods which mean that they cannot be accurately allocated or priced by the free market. Especially, market prices may be inappropriate for valuing ecosystem services and functions (which tend to be under-priced, or not priced at all), and subsistence-level use of natural resources (which are consumed within the household, or are not traded through formal markets). Yet these categories of benefits typically contribute a large proportion of the total economic value of wetlands, and failing to consider them runs the risk of seriously under-valuing wetlands.

For these reasons, it is frequently necessary to find alternative or additional techniques for valuing ecosystem goods and services, if their total economic value is to be more comprehensively expressed. Parallel to the advances made in the definition and conceptualisation of total economic value, techniques for quantifying environmental values and expressing them in monetary terms have also moved forward over the last decade[14].

Today a wide range of methods which move beyond the use of direct market prices are available, and used, for valuing ecosystem benefits. These include approaches which elicit people's preferences directly (such as through contingent valuation methods) as well as those which use indirect methods to impute people's preferences through their purchase of related goods and services (for example through production functions, dose-response relationships, travel costs, replacement costs, or mitigative or avertive expenditures). These methods are summarised above and are described in detail elsewhere[15].

Expressing ecosystem values for decision-making

Calculating the economic value of ecosystem is not an end in itself. Rather, it is a means of providing information which can be used to make better and more informed choices about how resources are managed, used and allocated. Economic arguments and indicators exert a powerful influence over these choices, and decision-makers need to be able balance the relative gains from different activities and investments, including those that are concerned with conservation as well as those that lead to ecosystem modification, degradation or conversion. Valuation enables ecosystem to be factored into economic decisions.

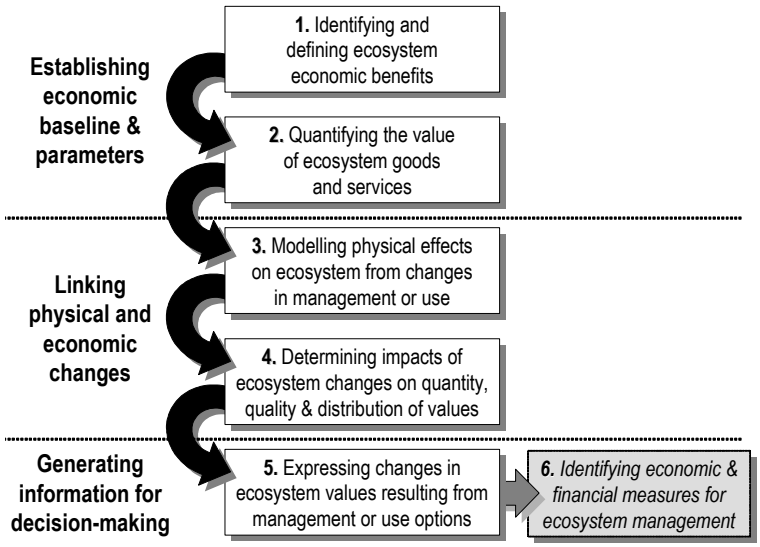
Decision-makers are primarily concerned with choosing between different uses of land, funds and other resources – for example whether to manage a wetland under strict protection or to allow for some form of sustainable use, whether or not to build a dam, irrigation scheme or housing estate, which infrastructure design option to invest in, or whether to zone a wetland for conservation or to convert it to settlement or agriculture. In order to integrate wetlands values into these decision-making processes, it is necessary to trace the economic implications of changes in the stock of ecosystem resources, flows of wetland services, or attributes of wetland systems that result from following a particular course of action, and factor them into measures of its economic desirability.

Various studies have demonstrated the utility of applying a simple bio-economic model in order to generate information for water ecosystem decision-making[16]. This type of model presents a useful tool for relating ecosystem values to decision-making, and involves a number of iterative steps – establishing an economic baseline from which to measure ecosystem changes, linking physical changes in ecosystem status and integrity to changes in these economic values, and expressing the results as indicators or measures that can be integrated into broader economic appraisal or analysis processes. In some cases such models are taken one step further, and

information about costs and benefits are also used to identify financial and economic measures for ecosystem management.

The scope, scale and outputs of such models vary. The most comprehensive, and accurate, picture can be gained from adopting an approach which encompasses the total economic value of the ecosystem as a whole[17] and incorporates the dynamics of economic and environmental processes within a temporally and spatially explicit framework[18]. Data constraints however often force a partial valuation model, and decision-making is often concerned only with specific resources, areas, groups, localities or effects. Various options also exist as to how the results of these models are expressed. Most commonly valuation information is used to feed into economic or investment appraisal processes, and is expressed through traditional cost-benefit analysis indicators such as net present value or internal rate of return. In many cases additional indicators are used to highlight the economic impacts of changes in ecosystem status on specific groups or areas, such as actual or potential contribution of ecosystem goods and services to livelihoods, income, government revenues or wider development processes.

Expressing ecosystem values for decision-making



Water ecosystem valuation: where are we now?

We have described how ecosystem under-valuation has led to land, water and resource use decisions being made on the basis of incomplete or inaccurate information, often resulting in decisions which are neither economically nor ecologically optimal. We also outline the advances made over recent years in finding ways of defining, measuring and expressing environmental values. Ecosystem valuation no longer requires lengthy, cumbersome, and costly data collection and analysis, but has become relatively simple, low-cost and easy-to-implement. Rather than resulting in complex and often purely academic findings, valuation techniques are also increasingly being used to generate practical management and policy information.

These new adaptations of economic concepts, methods and models have enabled ecosystem values to be much more easily and accurately expressed, and have yielded important information and insights. Although water ecosystems remain poorly represented in environmental valuation studies, and still there has been considerably more work carried out in temperate, rather than tropical, ecosystems[19], this situation is beginning to change. A growing body of information is becoming available on the economic value of tropical water ecosystems. This addresses many different countries, ecosystem types and categories of benefits, and develops and applies a wide variety of valuation methodologies. In many cases these studies represent the first attempt to quantify the economic importance of water ecosystems in a country, for a particular ecosystem type, or in relation to a specific set of benefits or beneficiaries.

An important objective of ecosystem valuation is to provide an improved basis for designing better land and resource use policies and management systems[20]. Yet despite the steps forward that have been made in calculating and expressing the value of ecosystem goods and services, a major challenge remains – to ensure that the results of these studies, and the figures they generate, are actually fed into decision-making processes and used to influence conservation and development agendas.

Meeting the challenge: using ecosystem valuation to strengthen river basin management

This publication attempts to address this challenge, and to demonstrate the practical utility of water ecosystem valuation for river basin decision-making. It documents a number of case studies from Africa and Asia where valuation studies have been carried out by IUCN with the specific aim of influencing the policy and management decisions that impact on water ecosystems in river basins.

The case studies deal with key issues in river basin management and use, including choice of conservation regimes, infrastructure development, abstraction and allocation of upstream river flows, land reclamation, and investments to restore or mitigate the effects of ecosystem degradation and loss. They involve the use of a variety of valuation techniques applied to different ecosystem types and situations, including both rural and urban wetlands, freshwater and coastal ecosystems, upper catchments and downstream water ecosystems, protected and unprotected areas. The basic aim of the case studies is to show how water ecosystem benefits and costs can be valued in economic terms, and to point to ways in which this information can point to policy and management recommendations which will in turn increase the equity, efficiency and sustainability of wetland and river basin management.

The case studies also demonstrate that ecosystem valuation does not have to be a costly, complex or purely theoretical exercise. It has a wide range of practical applications to real-world policy and management issues, can easily be integrated into development and conservation decision-making processes, and is able to be carried out in situations where information, time, funds and human resources are extremely limited.

The case studies show that that economic valuation provides a powerful, but currently under-utilised, tool for river basin decision-making. Although valuation cannot by itself overcome the omission of ecosystem concerns, it can make strong arguments and present convincing data to decision-makers which underline their economic importance. And, as the case studies presented in the following chapters demonstrate, failure to factor ecosystem economic values into river basin decision-making can incur high and far-reaching costs to planners and managers, to developers and investors, and to the upstream and downstream communities themselves who live in and depend on the resources found in river basins.

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HIGHLIGHTING THE LIVELIHOOD BENEFITS OF RURAL WETLANDS

Wetlands often play an essential role in rural livelihoods, providing resources for daily use, yielding services that support broader production and consumption opportunities, and acting as a source of fallback in uncertainty or emergency situations. Especially for poorer or more vulnerable sectors of the population, wetlands make an important contribution to economic and environmental security. Many rural economies have grown up around wetland ecosystems, and complex and effective local systems for wetland management and sustainable use have often evolved.

Yet, despite their immense importance in livelihood terms, the local economic value of wetlands is rarely considered to be a major factor when decisions are made about wetland use and management. One reason for this omission has been that local-level reliance on wetland goods and services is so hard to quantify – wetland products are often consumed only within the household and never enter formal markets, and wetlands typically form a integrated part of livelihood systems that cannot easily be separated out from other components of household production and consumption. Yet when wetlands undergo changes in status or management regime, this can have major knock-on effects on the livelihoods of local communities. For the most part these effects have remained unquantified, and thus unseen, when decisions are made.

The case studies presented in this chapter show how valuation techniques can be used to demonstrate the economic importance of wetlands at the local level, especially in terms of uses and benefits that do not show up in formal markets and traditional economic indicators. They focus on the consequences of wetland land and resource management decisions, which are usually made by external agencies and driven by external concerns, on local livelihoods.

In the case of the Barotse Floodplain in Zambia, local-level dependence on wetland resources has an importance influence on the economic desirability and long-term sustainability of future river basin management options. In Ream National Park, Cambodia, economic valuation shows the high opportunity costs that wetland conservation can incur to local populations, and underlines the importance of considering these local costs when designing protected area management plans. The Sri Lankan case of Kala Oya makes it clear both that local communities often depend heavily on traditional wetland management systems, and that livelihood security can be seriously undermined when they are replaced by “modern” development schemes. In Stoeng Treng Camodia, community use and management of fisheries and other aquatic resources are critical to villagers’ livelihoods in the context of interrelated pressures of widespread poverty, poor health, drought and food shortages

An important theme in both these case studies is that ignoring the role of wetlands in rural economic systems can result in decisions that give rise to high, and often untenable, costs and losses to local populations. Just because these costs do not appear in formal markets and economic indicators does not mean that they are negligible – in fact, they often outweigh the benefits of ‘development’ schemes which are based on wetland conversion and modification, and frequently undermine the aims of wetland conservation.

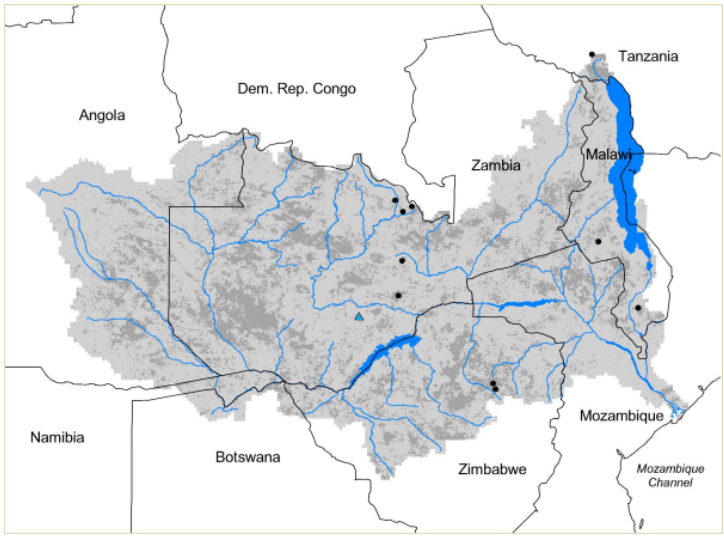
Barotse Floodplain, Zambia: local dependence on wetland resources

Human use of the Zambezi River

The Zambezi River Basin system, with its associated tributaries and wetlands, forms a prominent natural resource spanning several countries in central-southern Africa. The various components of the Zambezi River system, and the use of wetlands in particular, have a high economic value to large numbers of people in the region. Yet, in spite of their obvious importance, the Zambezi's wetlands have been vulnerable to increasing pressures of economic and population growth[1]. Resource over-exploitation, land drainage and encroachment for agriculture, and interference with river hydrology for large-scale hydropower and irrigation schemes are all resulting in wetland degradation. As well as leading to the loss of important biodiversity and habitats, this has had devastating impacts on the rural communities who live beside wetlands and depend on them for their livelihoods.

This case study describes an attempt to articulate the economic value of one of the Zambezi's largest wetland complexes, the Barotse Floodplain in western Zambia. The study formed a component of a project concerned with wetland resource conservation and sustainable use in the Zambezi Basin, with field sites in Malawi's Lower Shire Wetlands, the Zambezi Delta in Mozambique and the Eastern Caprivi Wetlands in Namibia, as well as the Barotse Floodplain itself. A particular focus of the study, and of the project more generally, was to assess the value of local-level wetland resource use by wetland communities. A major motivation for this was that in the Zambezi Basin, as is the case for many river basins, the ecological and economic value of wetlands to rural communities is not fully appreciated when river basin planning is undertaken or when land and water management decisions are made. As a result, such decisions often interfere with wetlands of local economic importance, thereby impacting heavily on the communities who live beside them.

The Zambezi basin



The Barotse Floodplain

After rising in north-western Zambia and passing southward through Angola, the Zambezi re-enters Zambia in Western Province and becomes larger and more consolidated, giving rise to a series of floodplains[2]. These include the Barotse Floodplain and other interconnected areas. The exact extent of the Barotse Floodplain is not easy to determine, because annually flooded areas grade into occasionally inundated parts, and it is also difficult to separate the wetlands influenced by the Zambezi from those fed by other catchments. Broad estimates put the Barotse Floodplain area at approximately 550,000 hectares, and the total wetland cover in the region at some 1.2 million hectares. The floodplain is mainly comprised of grasslands. Although trees are largely absent from seasonally flooded areas, there are a number of small wooded

areas on higher ground[3], and swamp forests are scattered over the area. The Barotse Floodplain is flanked by plateaux of Kalahari sand covered in semi-evergreen woodland, interspersed with low-lying dambos which are characterised by grassland vegetation[4]. The Liuwa Plain National Park and associated areas to the north west of the floodplain are relatively flat, and are waterlogged during the rainy season while remaining extremely dry during the rest of the year[5].

The ecological characteristics and conditions of the Barotse Floodplain, as well as the human production systems it supports, depend largely on the timing and duration of the annual floods[6]. The main wet season runs from November until March, although inundation depends mainly on rainfall in the upper catchment and on seepage from the uplands[7]. The onset of annual flooding varies greatly and may occur anywhere between December and March, although northern parts of the floodplain are generally inundated earliest. The maximum flood level is attained in April, after which floodwaters gradually recede over May, June and July.

In total, the four Districts of the Barotse Floodplain are estimated to contain just under 225,000 people or 27,500 households. Population density, which is generally low in Western Province with fewer than 5 people per km^2, increases steeply around the floodplain. The floodplain area is occupied mainly by the Lozi people, and falls under a dual administration – that of the Barotse Royal Establishment under the rule of the King, or *Litunga*, and the Government of Zambia through Provincial and District line ministries and administrative authorities. The use of floodplain resources was in the past managed according to traditional systems, under the customary authority of the *Litunga*. Today, although formal control over natural resources has been passed over to central and provincial government, the Royal Establishment maintains a great influence on natural resource use patterns and regulations in the region.

The Lozi people are also known as the "plains or water people", and local livelihoods and cultural traditions are linked closely with seasonal flooding. During the dry season, the bulk of local production, economic activities and settlement are focused in the floodplain area. As the plain becomes inundated, most of the population move to the uplands and plain fringes. This annual relocation of people and cattle includes the movement of the *Litunga* in a highly-celebrated traditional ceremony, called the *Kuomboka*[8].

Wetland resources in local livelihoods

Most of the population in the Barotse Floodplain depend on a mixed livelihood strategy, combining crop farming, livestock keeping, fishing and natural resource exploitation. This diversity of livelihood components, many of which depend on wetlands, is an effective strategy for spreading risk, and income and subsistence sources vary at different times, especially according to season. The rural economy is for the most part subsistence-based, and is subject to high levels of uncertainty and variability. About 76% of the rural population in Western Province live in poverty, and lean months are November to January/February when incomes are lowest and expenditures highest, and little food is available[9].

Fishermen on the Zambezi River

Almost all of the floodplain population are involved in crop farming. Of the total area under arable agriculture of 280,000 hectares in Western Province, about 10% is comprised of floodplain farming systems. The main growing season in the floodplain is between November and April, and produces maize, rice, sweet potatoes, sugar cane, fruit and vegetables. Floodplain farming systems are diverse, and include raised gardens (*Lizulu*), rain-fed village gardens (*Litongo*), seepage gardens (wet *Litongo*), drained seepage gardens

(*Sishango*), lagoon gardens (*Sitapa*) and riverbank gardens (*Litunda*).

Most of the cattle in Western Province are found along the Zambezi floodplain and adjoining plains[10], and the Barotse Floodplain is known to be one of the most productive cattle areas in the country[11]. Over three quarters of cattle in Western Province are pastured in the floodplain, including 265,000 head that belong to floodplain residents. The bulk of herds are managed under a system of transhumance and move between the floodplain and adjacent uplands, usually spending January to July in the floodplain and the remainder of the year in the uplands. Primarily driven by the seasonal availability of pasture, annual transhumance is also important for the distribution of manure, and in the floodplain there is a strong interaction between herding, cropping and fishing activities.

The fisheries sector is one of the most important sectors in Western Province, and is mainly concentrated on the floodplains of the upper Zambezi[12], especially the Barotse floodplain[13]. Just over half of the floodplain population are involved in fishing activities. Fish are an important source of protein, and local fish consumption is five times the national average[14]. Bream make up 80% of the catch[15], and a number of smaller fish are also caught such as minnows, tilapia, bottlenose and silver barbels. Fishing is a highly seasonal activity. Between December and April, fish move from the main river channels into the wetlands, where they spawn before the height of the flood[16]. As the floodwaters rise, a phenomenon called “red waters” occurs, where low oxygen water is pushed forward by the floods. Only barbel can survive in this water. The main fishing season takes place as the floodwaters recede, and gill nets are used in the lagoons which have formed and in which fish are concentrated. This activity intensifies from May until December, when fishermen stop fishing in anticipation of the rains. When the floodplain becomes fully inundated, fish are mainly caught using traditional *maalelo* traps, as well as with traps and spears.

The floodplain population also makes use of a wide range of wetland plants, animals and natural resources for their daily subsistence and income. Almost all households harvest grass, reeds and papyrus for use in house construction, thatching, mat and basket production, broom making and fishing apparatus construction. Clay is also important, used for house construction and pottery making. Although the loss of many of the floodplain’s wild mammal populations has meant that hunting has decreased over time, turtles, birds and birds’ eggs form an important supplement to local diets.

Children in Lealui Village, on the Barotse Floodplain

Valuing household wetland use and future management scenarios

The primary aim of the valuation exercise was to assess and articulate the value of wetland goods for local communities. It was carried out in two phases. During the first phase, scoping visits were made to the study area in order to assess the status of existing data, meet with government and traditional authorities, and consult with local villagers. This yielded information about which resource were used, their relative importance and value, and helped in the design of survey instruments and valuation methods for the subsequent main study. During the second phase of the study, household surveys were used to obtain quantitative data about the use of wetland resources. Focus group discussions with community leaders, resource users, wetland specialists, and different socio-economic categories provided a more detailed, and participatory, means of assessing the economic importance of wetland resources to the local population.

The data gathered were analysed using a static economic model to determine the value of each wetland resource. The model modified and extended an existing approach, which had originally been developed in order to assess local and national level returns to wildlife

resources in Namibia[17]. It indicated the financial and economic returns to different wetland utilisation and value-added activities, measured as private net cash income and economic net value added to national income. Values were expressed at the level of the whole floodplain, and as gross and net returns per household.

A dynamic model was then developed to calculate the present net value of wetland resources under different future management scenarios. This scenario analysis used a dynamic ecological-economic model which simulated a simple wetland system and the effects of human activity on that system. A generic Zambezi wetland model was developed, and then adapted to model the Barotse area. The model was run from 30 years before the time of the study to 20 years hence, in order to simulate past resource trends recorded in the study and investigate how these trends would affect future wetland values. Four future wetland management scenarios were identified, each based on likely or planned actions in the Barotse Floodplain region, and applied to the model. These included various combinations of a "do nothing" scenario of continuing resource use and human population growth; a "wise use" scenario based on sustainable levels of wetland resource utilisation; a "protected area" scenario where parts of the floodplain were put under strict protection which required resource utilisation activities to be reduced or curtailed completely; and an "agricultural development" scenario assumed the gradual transformation of floodplain wetlands to large-scale irrigated rice. An additional scenario, "upstream hydrological developments" was identified and described but not modelled quantitatively, as it depended on actions being taken outside the direct study area and because there were at the time no such plans for developments upstream of the Barotse Floodplain.

Integrating livelihood values into wetland planning

The study confirmed the extremely high value of wetland resource use in local livelihoods, and as a way of spreading seasonal risk and uncertainty. In total, local use of wetland resources in the Barotse Floodplain was found to have a net economic value of some $8.64 million a year . At the household level, wetlands were calculated to generate an average net financial return of $405 a year. The major proportion, 83%, of this value was comprised of subsistence values and home consumption, and by far the most valuable products were found to be fish (43% of total, and 73% of household cash income), floodplain grazing (29% of total) and crop production (22% of total).

Financial and economic returns to wetland resource utilisation

	Cattle	Crops	Fish	Wildlife	Reeds & papyrus	Palms	Grass	Clay	Total
HOUSEHOLDS ($/year)									
Gross financial value	120.4	90.8	179.6	5.83	15.12	0.43	8.25	2.39	**417**
Net financial value	120.4	88.7	174.1	0.41	10.72	0.27	8.07	2.33	**405**
Gross cash income	11.5	6.1	52.6	0.01	1.61	0.04	0.30	0.02	**72**
Gross subsistence value	109.0	84.8	127.0	0.42	13.51	0.29	7.95	2.37	**345**
TOTAL WETLAND ($'000/year)									
Gross economic value	3,988	1,447	5,947	12	501	12	272	66	**12,244**
Net economic value	3,908	-75	4,258	10	271	3	221	52	**8,647**
Gross financial value	3,323	2,507	4,956	12	417	12	228	66	**11,520**
Net financial value	3,323	2,447	4,803	11	296	7	223	64	**11,174**
Gross cash income	316	167	1,452	0.3	44	1	8	0.5	**1,989**
Gross subsistence value	3,007	2,340	3,504	12	373	11	219	65	**9,531**

Dynamic modelling indicated that the most economically valuable future management option was wise use of the wetland area, possibly combined with small areas under strict protection – in comparison to a "do nothing" scenario, to putting larger areas under strict protection, or to converting the wetland for the implementation of large-scale agricultural development projects. The economic and financial values yielded by wetland wise use and conservation were found to be most pronounced at the local level. As the area under strict protection is increased, large

financial and economic losses are incurred by local communities who must reduce or curtail their utilisation of wetland resources. The financial benefits of agricultural schemes to local communities, primarily felt through increased employment opportunities, are also likely to be far outweighed by the opportunity cost of lost access to wetland resources of between $1.2 -$3.0 million a year.

Model of economic values associated with future wetland management options

Scenario	**Financial net present value ($ million)**	**Economic net present value ($ million)**
Do nothing	84.2	62.2
Wise use	86.7	64.4
Wise use and 10% protection	85.5	64.5
Wise use and 25% protection	82.7	63.7
Wise use and 50% protection	74.0	58.4
Agricultural development 5,000 ha and no protection	85.4	63.2
Agricultural development 5,000 ha and 25% protection	81.4	62.5
Agricultural development 20,000 ha and 25% protection	79.7	60.9

Developments outside the Barotse Floodplain area itself were also found to have a profound effect both on wetland status and on the local economy and livelihoods. A large number of new hydropower schemes, dams and reservoirs have been identified for development along the Zambezi River although none are currently planned in Angola or north western Zambia, upstream of the Barotse Floodplain. The findings of the study emphasised that any upstream development, if it influenced downstream river flow and flooding, would be likely to incur devastating economic losses to the local communities who depend on the Barotse wetlands.

An important conclusion of the study was the emphasis it accorded to the economic role of the Barotse Floodplain in local livelihoods. Not only is the value of the wetland great in absolute terms, but it also forms a key component of local livelihoods – without access to wetland resources, households would both lose the values accruing from natural resource use and also be separated from an essential source of support and inputs to other forms of production such as crop farming and livestock keeping. For a long time such values have not been a factor in decision-making in the Zambezi Basin: because they are not reflected in official prices and formal markets, they are treated as being negligible. The study made the point that this is clearly not the case. Ecological-economic modelling of future wetland options showed that any management scenario which omitted consideration of these values, and did not allow for the local-level use of wetland resources, would run the risk of being both economically and financially sub-optimal, as well as jeopardising the economic livelihoods of almost a quarter of a million people.

This case study is adapted from:

Turpie, J., Smith, B., Emerton, L. and J. Barnes, 1999, Economic Valuation of the Zambezi Basin Wetlands, IUCN – The World Conservation Union Regional Office for Southern Africa, Harare

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Ream National Park, Cambodia: balancing the local opportunity costs of wetland protection

Re-establishing Cambodia's Protected Area network

After their virtual destruction during the civil war, Cambodia's protected areas are slowly starting to be rebuilt. A protected area network was re-established in 1993 when 23 national parks, wildlife sanctuaries, protected landscapes and multiple use areas were designated under Royal Decree. Since then, the Ministry of Environment has been making efforts to set in place on-the-ground conservation measures, and to develop an enabling national policy and legal framework. Management plans are being developed in five national parks, and a draft Sub-Decree for Protected Areas Management is currently under review by government.

A major challenge facing these emerging laws and management approaches is how to address the high reliance of park-adjacent and park-dwelling populations on protected area resources. To these ends, community-based conservation approaches have been piloted in several protected areas, and the concept of buffer zones has been established as a key component of national protected area planning. Neither system has however yet been institutionalised for the country as a whole, and there are as yet few experiences of their practical application.

Such considerations are especially critical to Cambodia's six coastal protected areas, where high levels of local resource exploitation have impacted severely on natural ecosystems. Rural poverty is widespread on the coast of Cambodia, with more than half of the population classified as poor and lacking in basic amenities such as food, water and adequate housing[1]. Most households have limited access to alternative sources of income and subsistence, and often see the existence of protected areas as a direct threat to their livelihoods.

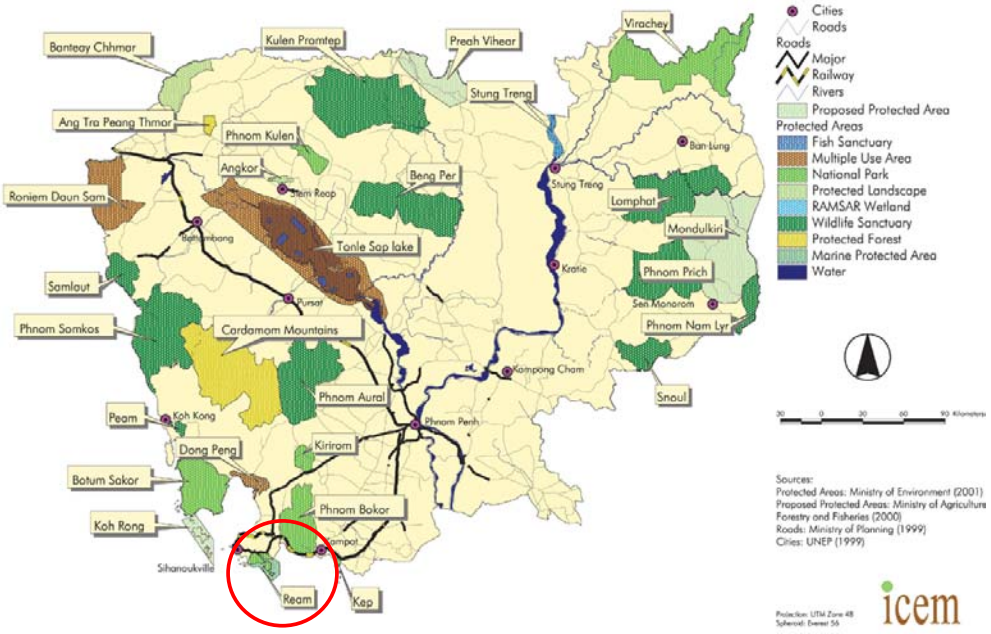
It is clear that if Cambodia's renewed efforts at conserving protected areas are to succeed, then consideration of the economic needs of local communities will be a critical factor in management planning. This case study describes an attempt to assess the economic value of local resource use in Preah Sihanouk (Ream) National Park, a coastal protected area in Cambodia which is piloting both a management planning process and community approaches to conservation. The study aimed to demonstrate the high reliance of community livelihoods on park resources and to quantify the high local opportunity costs of switching from activities that degrade wetland biodiversity. The study underlined the importance of factoring community concerns into park management planning, as well as integrating protected area concerns into socio-economic development planning in surrounding Provinces, Districts and Communes.

Ream National Park

In 1995 Ream became the first National Park to be inaugurated in Cambodia after the civil war. It is located in Sihanoukville Province on the south west coast of Cambodia, and covers an area of approximately 21,000 hectares. Ream is dominated by the estuary of the Prek Toek Sap, featuring extensive areas of mangroves and associated rear mangrove forests and mudflats. Low hills rise to the west of the river, covered with lowland and dwarf evergreen forest, and isolated hills also occur to the east of the river. The northern and eastern portions of the park contain freshwater marshes in association with mangrove and rear mangrove formations. Ream also encompasses the uninhabited islands of Koh Thmei and Koh Ses (totalling 6,000 ha), situated to the south-east. Beaches, rocky shores, seagrass beds and coral reefs are found along its islands and mainland coastal areas.

Ream National Park lies close to the major towns of Kampot and Sihanoukville, and is relatively well-served by infrastructure, including Cambodia's main highway National Route No. 4. As well as providing an important set of products for local consumption, park resources are used commercially. The area in and around the park is an important fishery area used by both local communities and by commercial trawlers and push nets, and also supports some level of tourist activity. Large parts of the mangrove area has been cleared for aquaculture developments, including prawn and crab farming. As a result of prolonged human activities, parts of Ream show signs of intensive use. It is currently estimated that over one third of the Park's area has been heavily modified or transformed by farming, logging, mangrove cutting and clearance for aquaculture, charcoal burning and other resource exploitation activities[2].

Location of Ream National Park



The National Park as a local economic resource

Almost 30,000 people or 5,500 households live in the 5 Communes that overlap or border Ream National Park, and population growth rates are estimated at nearly 3%[3]. Four of these Communes are located on the boundary of Ream, and a total of 13 villages have land lying within the Park's boundaries. Although formerly communities were widely dispersed, settlements became increasingly concentrated along the roadside following the upgrading of National Route No. 4 during the 1960s. This concentration increased during the Khmer Rouge era, as villages grouped together as a security measure. The park-adjacent and park-dwelling populations now include a mix of more recent immigrants (most who came to the area during or after the Khmer Rouge era), and longer-term settlers. The incidence of rural poverty is extremely high, and per household cash income is estimated at less than $1/day[4]. Few households rely on a single livelihood source: the majority of the population combine different economic activities so as to spread risk and to generate sufficient subsistence and income to survive.

With few other sources of income and employment available to them, and a shrinking natural resource base outside the park, local livelihoods depend intimately on protected area resources[5]). Most household income is generated from farming, fishing and forest products collection, and almost all of these resources come from the National Park. Just over a quarter of households depend on farming as their main source of income, cultivating a total area of just under 3,000 hectares inside the National Park. Between a quarter and a third of the population are involved in fishing as their main form of livelihood, with almost 500 boats operating within

and close by to the Park. It is estimated that up to 84% of these fishing and farming households gather firewood from the Park[6], 25% are involved in timber harvesting and 18% collect wild plants for food, medicines and handicrafts[7]. In total, farmers gather more than 50 different wild products from the park, and use more than 200 species of plants for medicines. Nearly 30 species of marine fishes, crustaceans and shells, and 8 species of freshwater fish, are also harvested from Ream.

Valuing community costs and benefits

Ream is one of the five National Parks in Cambodia where a draft management plan has been developed, and where community management arrangements have also been piloted. Between 1997 and 1999 the Ministry of Environment, with the support of UNDP, implemented a project to support the preparation of a zoning and management plan for Ream National Park, construct park facilities, train park staff, and develop institutional arrangements for Park management. This was followed, between 1999 and 2000, by a set of ADB-funded activities which aimed to further develop the management zones and guidelines for Ream National Park, and to demonstrate a process of community participation in marine and coastal resource management.

Ream National Park

As part of the latest phase of the management planning process, draft guidelines have been developed for three proposed management zones of the park[8]. The bulk of the National Park is designated as a strictly protected core zone, comprising the two islands and the mainland forested, wetland and mangrove area. Here all natural resource exploitation is prohibited. The smaller buffer zone along the coastline to the east of the park and the wetlands around the Prek Toek Sap allows for traditional community access and subsistence-level resource use according to co-management arrangements and community regulations developed by recognised groups and approved by the Ministry of Environment. Within the community development zone to the north of the park, rural development activities and settlement are permitted, including village exploitation of forest and fisheries resources.

Despite their exclusion from certain areas and natural resource exploitation activities, the participation of local communities in coastal and marine management forms a central theme in the management plan. One innovation has been the development of community fisheries regulations and organisational structures for co-management of the inshore fishing areas of Ream National Park. Today, 49 Village Fishing Groups and a Village Fisheries Committee work to regulate, conserve and manage marine resources in the Park according to the fisheries management guidelines and regulations that they have developed.

The basic aim of the valuation study was to lend support to these ongoing management planning processes in Ream – to demonstrate their validity in economic terms, as well as to identify the kinds of additional economic concerns and measures that would have to be incorporated into protected area management and into the socio-economic development plans of Sihanoukville Province. An underlying objective was to demonstrate economic assessment methods that could be replicated in other protected areas in Cambodia that might develop management plans in the future. Two principles guided the study: the need to highlight the importance of community-based approaches to park planners, at the same time as finding measurable indicators of protected area benefits that would be meaningful to local authorities and development planners.

The economic value of key resources and ecosystems

The results of the study showed that Ream National Park constitutes an extremely important economic resource for adjacent communities and for the Sihanoukville Provincial economy. Household and village-level surveys found that almost all local residents depend on Park resources in some way for their basic subsistence and income, to a net value of some $1.2 million a year or an average of $220 for every household living in and beside the National Park. In an area where the median family income is estimated at only $316 a year, a third of families earn less than $200, and where half of households can barely provide for their own subsistence (De Lopez *et al* 2001), this figure is extremely significant. The park provides land, resource and services which together contribute fisheries and agricultural sector income of more than $0.5 million a year each, and forest resource values worth $177,000.

The value of local fisheries in Ream NP

A total of 500 boats — 300 un-motorised *touk chaev* and 200 boats with engines — fish within Ream National Park, employing 30% of the population or 1,597 households. The annual catch of 537.6 tonnes is worth a total of $687,291 a year at market prices, or $1,375 per boat. Taking into account the costs of boats, equipment and running costs, this translates into annual net values of $0.515 million overall, $1,031 per boat, or $323 per fishing household.

	Catch (kg/year)	Local price (CR/kg)	Value (US$/year)
Shells	72,000	5,000	92,426
Shells	60,000	3,000	46,213
Prawn	48,000	15,000	184,852
Marine fish	200,000	3,000	154,044
Crab	32,000	8,000	65,725
Small shrimp	30,000	2,500	19,255
Lobster	1,600	25,000	10,270
Squid	24,000	4,000	24,647
Freshwater fish	70,000	5,000	89,859
Total gross value	**537,600**		**687,291**
Average gross value per boat	**1,075**		**1,375**
Total costs			**171,767**
Total net value			**515,525**
Average net value per boat			**1,031**
Average net value per fishing household			**323**

The value of other community land and resource uses in Ream NP

A wide range of forest products are gathered within Ream, worth a total of $190,672 at market prices. Livestock and crop production taking place in the park has a gross value of $520,344. Taking into account the costs of harvesting these products, this translates into a net total value of $721,897 per year.

	Gross value (US$/year)	Net value (US$/year)	Average value per user household (US$/year)
Firewood	125,133	112,062	25
Construction wood	23,659	23,659	18
Medicinal plants	10,788	10,788	11
Food	17,695	17,695	18
Roofing materials	13,397	13,397	84
Sub-total, forest products	**190,672**	**177,601**	
Crops	316,594	316,594	119
Livestock	227,702	203,750	143
Sub-total, farming	**544,296**	**520,344**	
Total, forest products and farming	**734,968**	**697,945**	

Mangroves constitute a particularly important set of park resources, and are also one of the most endangered ecosystems in Ream and other parts of Cambodia's coast. In order to demonstrate the broader economic benefits of ecosystem conservation, the study made a detailed analysis of the returns to alternative uses of the 1,800 hectares of mangroves in the park. A key question posed by Provincial development planners has been if it is worth conserving these mangroves, or whether they should be harvested for immediate income and financial gain, or converted for salt production and aquaculture.

The value of mangrove conservation in Ream NP

In total there are approximately 1,800 ha of mangroves in Ream, with a total volume of 111,645 cubic metres[9]. The mangrove area of Ream National Park is particularly important to the local households who live around, and use, it. Much of the fishery in the area depends on the habitat, nursery and breeding grounds provided by mangrove habitats, and a significant proportion of firewood, medicinal plants and construction materials are also sourced from mangroves. Mangroves act as a carbon sink, prevent saltwater intrusion and coastal erosion, and buffer against storms and floods, enabling human habitation and farming in the villages which lie along the coast. Yet a key question is whether it worth conserving these mangroves, or should they be harvested for immediate income and financial gain, and then turned over to another land use? This is a real threat to Ream. Already part of the mangroves have been clear-cut illegally, a prawn/crab farm has been developed inside the Park over an area of nearly 50 ha, and approval has been given for a 10 ha experimental cockle farm.

A simple cost-benefit analysis demonstrates the high value of mangrove conservation in terms of local socio-economic and environmental benefits. Under realistic recovery and harvesting conditions, clear-cutting the mangroves would yield a one-time income of less than $630,000[10]. Although prawn farms can, under the best conditions, realise a net income of almost $4,500/ha/yr, few actually do. In Koh Kong, a similar mangrove area lying to the west of Ream National Park, half of prawn farms are making a loss — at a realistic productivity rate of 3.6 tonnes per harvest, this loss is nearly $9,950/ha/yr — and in aggregate they show a loss of $1,103 per ha per year[11].

Yet even if only half of the forest, fisheries and agricultural production in surrounding villages depend on mangroves in the Park, their clearance would result in a loss of local income of around $620,000 a year. This figure of $344/ha/yr is a realistic one — data for similar mangrove areas in Thailand estimate local use of mangroves to be worth between $230[12] and $1,200[13] a year, and values in Koh Kong Province exceed $500/ha, including charcoal[14].

In fact many more economic losses would occur from mangrove clearance, such as the damage to houses, infrastructure, farmland, employment, markets and general local welfare that result from the loss of vital environmental functions and ecological services. In Southern Thailand, the economic benefits of mangroves in terms of coastline protection have been estimated to have a value of between $76.5/ha/year[15] and $165/ha/year[16], carbon sequestration benefits $2.2/ha, and mangrove storm protection functions have been valued at $32/ha in Koh Kong Province[17]. Taking into account these indirect economic benefits increases the annual economic value of conserving Ream's mangroves to $900,000 a year. This is far more than the one-off gain (and long-term loss) of clear-cutting the mangroves and turning them over to prawn farms. The economic costs of destroying these valuable natural ecosystems, both immediate and long-term, far exceed the benefits — or, in other words, biodiversity conservation in Ream National Park is a demonstrably economically worthwhile activity to engage in.

	Net value (S$/ha/yr)	Total Value (US$ '000/yr)
Local use	344	619,200
Storm protection	32	57,600
Coastal erosion prevention	122	219,600
Carbon sequestration	2	3,600
Total Value	**500**	**900,000**

The study found that much of the fishery in the Sihanoukville area depends on the habitat, nursery and breeding grounds provided by mangroves, and a significant proportion of firewood, medicinal plants and construction materials are also sourced from them. Mangroves act as a carbon sink, prevent saltwater intrusion and coastal erosion, and buffer against storms and

floods, enabling human habitation and farming in the villages which lie along the coast. By quantifying these benefits, the study showed that conserving mangrove ecosystems in the National Park, and elsewhere along the Cambodian coast, generates significant economic values – both in absolute terms, and relative to the short-term profits earned from the activities that threaten them. Ream's mangroves yield subsistence goods worth almost $600,000 a year, and generate an additional $300,000 a year through the provision of ecosystem services such as storm protection and prevention of coastal erosion in areas surrounding the park. With a overall value of almost $1 million a year and net value of more than $500 per hectare, this is far more than either the one-off income generated through clear-cutting[18] or the returns from conversion to crab and prawn farming[19].

Using economic incentives to offset the opportunity costs of protection

Some reduction in local resource utilisation activities is required by the draft zoning and management plan that has been prepared for Ream National Park. As well as the prohibition of all extractive activities in the core zone, it implies curtailing unsustainable and illegal fishing, logging, charcoal production, hunting, coral collection and agricultural encroachment in other management zones. Yet without access to the basic subsistence, income and employment that the Park provides, many of the 30,000 local people will find it difficult to survive as they lack access to other sources of livelihood. The study therefore showed that, under existing conditions, there will be a significant local opportunity cost to biodiversity protection.

Given the high levels of poverty in park-adjacent communities, and the difficulty of accessing alternative sources of income and subsistence, the local opportunity costs of resource utilisation foregone may be untenable. On the one hand valuation lends strong support to the type of community-based resource management initiatives that have been piloted for inland fisheries in Ream, and suggests that they could usefully be extended to other resources and ecosystems within the protected area. However, by themselves, such collaborative management and sustainable resource utilisation activities – although undoubtedly an essential and necessary part of park management – are likely to provide insufficient economic incentives for park conservation, because they provide no direct alternatives to unsustainable income and subsistence generating activities.

Fisherwomen in Ream National Park

Clearly, further measures are needed to offset the local opportunity costs of protected area conservation. Here, factoring the need to provide alternative and sustainable livelihoods to the residents of Communes that lie inside and adjacent to Ream into Provincial planning becomes critical. Existing Provincial socio-economic development plans, although laying great stress on rural poverty alleviation, take little note of the presence of the protected area and contain few activities aimed specifically at encouraging natural resource conservation. The study underlined the importance of Ream National Park to the long-term development of the area, as an economic asset for which conservation is well worth investing in.

This case study is adapted from:

Emerton, L., Seilava, R. and H. Pearith, 2002, Bokor, Kirirom, Kep and Ream National Parks, Cambodia: Case Studies of Economic and Development Linkages, Field Study Report, Review of Protected Areas and their Role in the Socio-Economic Development of the Four Countries of the Lower Mekong Region, International Centre for Environmental Management, Brisbane and IUCN – The World Conservation Union Regional Environmental Economics Programme, Karachi

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[17] Bann 1997 *op cit.*
[18] De Lopez *et al* 2001 *op cit.*
[19] Bann 1997*op cit.*

Kala Oya River Basin, Sri Lanka: where small irrigation tanks are not really small

Sri Lanka's tradition of irrigation: providing vital support to biodiversity and livelihoods

Sri Lanka has one of the oldest traditions of irrigation in the world, dating back as far back as 500 BC. The famous dictum of the epic hero King Parakrama Bahu I (1153-86) states *"let not even one drop of water that falls on the earth in the form of rain be allowed to reach the sea without being first made useful to man"*. It was around these ancient tank (water storage reservoir) irrigation systems that the economy and human settlements of early Sri Lankan society were organised into a "hydraulic civilization". Unlike in the case of most ancient civilizations, which grew in fertile river valleys and floodwater retention areas, Sri Lankan hydraulic societies were based on reservoir systems and control devices or *biso-kotuwas* for the release of irrigation water. It has been reported that at the peak of its development, the ancient Sri Lankan hydraulic engineers were even called upon to serve in other countries.

Today's map of Sri Lanka, especially the Dry Zone, is dotted with literally thousands of ancient tanks of varying sizes and shapes, some operational and others long abandoned. These ancient tank systems have both ecological and biological importance. A key issue is seasonality and duration of water retention, which has a significant influence on their biodiversity and ecology. Due to natural processes water levels are very low during the dry season, and many tanks dry out completely before being filled again in the rainy season. Their use for grazing cattle during the dry season maintains high levels of nutrients in the tanks – which in turn supports high levels of aquatic biodiversity.

Traditional tank systems thus form a vital component of both the natural and man-made landscape in Sri Lanka. Providing irrigation water, domestic supplies and natural resources to millions of people, they also constitute one of the richest sources of wetland biodiversity in the country.

Yet traditional tank systems are also under severe, and increasing, threat – which is, in turn, both putting in danger livelihood security and threatening the status of biodiversity. These threats arise from multiple sources, including upstream water allocation decisions which marginalise traditional tank systems in favour of seemingly more productive uses such as "modern" large-scale irrigation and hydropower, as well as from siltation and sedimentation arising from unsustainable land use practices in upper catchments.

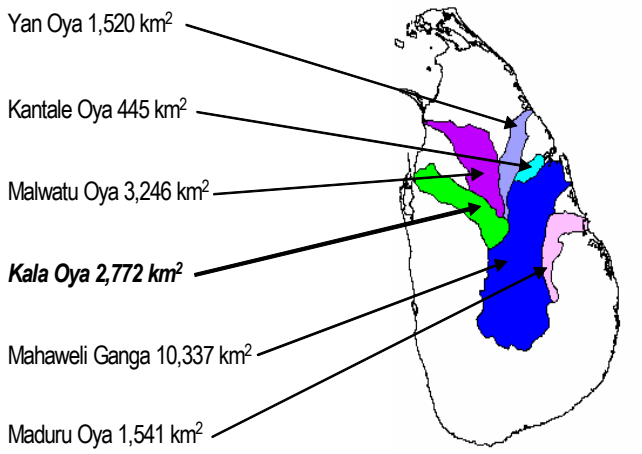
This case study describes an exercise that was undertaken in the Kala Oya Basin of Sri Lanka to assess the livelihood and biodiversity values of traditional tank systems. The Kala Oya Basin has been identified by the government as the pilot river basin to plan and implement integrated river basin management approaches in Sri Lanka. By articulating tank values, the study had a particular focus on integrating downstream wetland values into upstream land use and water allocation decisions, and showing that upper catchment conservation and water allocation to traditional tank systems can yield high, and quantifiable, economic returns.

The Kala Oya Basin

Kala Oya covers an area of around 2,870 km^2. It is one of 103 river basins in Sri Lanka and is situated in the Northwestern dry zone of the country, which averages 1,450 mm average annual rainfall. The elevation of the Kala Oya Basin varies from mean sea level to 600 m at its headwaters.

The Kala Oya Basin is long and narrow, having an average width of about 25 km and length of 150km. It receives water from Sri Lanka's longest river, the Mahaweli Ganga, to meet approximately 75% of its annual demand. Preliminary assessment of water resources of Mahaweli Authority of Sri Lanka (MASL) has provided a water budget with a net inflow of 800 MCM in the Kala Oya Basin. In the lower basin, the majority of water is allocated to irrigation – focusing on rice, the staple food in Sri Lanka. There are about 600 small irrigation tanks within the basin, as well as "modern" irrigation systems including the large-scale Mahaweli Irrigation Expansion Project. About 65% of water is allocated to these larger-scale irrigation systems.

Mahaweli and adjacent river basins



The Kala Oya Basin contains a largely rural population of some 400,000 people, most of whom are engaged in farming as their main form of livelihood. Cultivation of rice and other crops is combined with fishing and the harvesting of wild plants and animals. There is a particularly high incidence of poverty in this area, with just under half of the population being classified as poor according to national indicators (their monthly income is less than $15).

Traditional tanks: a threatened component of the socio-economic, cultural and natural landscape

Traditional irrigation tanks have, for centuries, formed the cornerstone of cultural, economic and environmental life in Sri Lanka's rural areas. Even today, the concept of a tank village symbolises the vitality of water for the sustenance of communities.

Cascades are a series of interconnected tanks organized within the micro-catchments of the dry zone landscape. They serve multiple functions including irrigation, domestic supply, water for livestock and subsurface water for perennial cropping. The main features of a cascading valley are having adequate water in every tank even in a year of below average rainfall and instituting a regulated flow of water from one tank to another down stream, avoiding a sudden influx of large volume of water in order to minimize the risk to tank bund breaching.

The tank is the pivot upon which life in dry zone areas such as the Kala Oya Basin revolves. Situated on relatively higher land, tanks provide water for agriculture, domestic needs and other purposes. They tend to form the heart of the village, around which much social interaction and cultural business is conducted. Villagers also depends almost entirely on the tank for their sustenance.

Paddy fields are located below the tank, and often forest reservations are located above it as catchment protection. The forest provides villagers with firewood and timber, meat and honey, as well as vital grazing for livestock. A part of the forest is, traditionally, used to grow vegetables and grains.

Despite their critical importance, traditional tank systems are under threat, both in the Kala Oya Basin and elsewhere. One major threat is insufficient allocation of water. For the most part, obviously commercial uses such as large-scale irrigation and hydropower tend to be prioritised when water decisions are made. Water scarcity, and the low perceived value of traditional tank systems, mean that small tanks are often seen as an economically unproductive use of water.

Land use practices constitute another problem for small tank systems. In particular deforestation and unsustainable agriculture around and upstream of tanks has resulted in soil loss, meaning that sedimentation and siltation rates are high, leading to the filling of downstream tanks.

Especially since the launch of the Mahaweli Irrigation Expansion Project in the early 1980s, lack of water in the dry season has been identified as a growing problem in the Kala Oya Basin. Mostly in terms of water for irrigation purposes and domestic use, but also to sustain a number of important environmental services provided by the wetlands. Following the expansion project, the area of agricultural land has increased and now includes previously unutilised land surrounding the wetlands. The farming of these buffer zones has left the wetlands vulnerable to sedimentation caused by run offs from the surrounding fields.
There is a real danger that unless current land use and water allocation decisions are changed, and due attention is given to the importance of maintaining and rehabilitating small tanks, the livelihoods of a large sector of the population will be undermined, and vital aquatic biodiversity will be lost.

Valuing tank ecosystems

The aim of this study was to articulate the value of small tank systems in livelihood and biodiversity terms. Working in close collaboration with the MASL, the primary river basin management institution in the country, it thereby intended to integrate downstream wetland values into land use and water allocation decisions in the Kala Oya Basin. At the same time as the valuation study was carried out, a number of training, capacity building and awareness exercises were carried out with MASL staff which focused on how and why to integrate ecosystem economic values into river basin management. This institutional partnership, and accompanying work in capacity and awareness, proved vital to the study's on-the-ground impact.

A small tank in the Kala Oya Basin

A first step was to determine the environmental and economic benefits associated with small tanks in the Kala Oya Basin. Tanks yield a range of direct livelihood values for surrounding villagers. Some of the most important benefits are associated with the provision of water for crops, livestock and domestic uses such as bathing, washing clothes and household water supplies. Additionally, the wild plants and animals associated with tanks are important for local subsistence and cash income. These resources include fish, reeds and edible plants, and the flowers that are collected for use in Buddhist temples and ceremonies.

Tanks also yield several important environmental services. As well as providing habitat and breeding grounds for birds, fish and other aquatic animals, tanks store water and help both to mitigate downstream flooding and maintain and replenish sub-surface and groundwater reserves. The tanks, and the aquatic plants that grown in them, also play an appreciable role in nutrient retention and water treatment for surrounding farms.

A variety of methods were used to value these benefits for two of the sub-catchments of the Kala Oya Basin – the 429 tanks in Rajangana and Angamauwa. Because little information

about tank values was already available, these relied on the collection of original data from local villages and depended heavily on participatory approaches to livelihood assessment and economic valuation. While wetland resources that could be bought or sold (such as various plants and fish) were valued according to their market prices, crops and livestock benefits were valued using effect on production techniques, and domestic water use was valued according to costs of collection and transport. Due to insufficient data, indirect benefits were not valued in cash terms but were estimated according to indices of magnitude.

The results of the valuation study showed that tanks in the Rajangana and Angamauwa sub catchments of the Kala Oya Basin yield an average value of US$ 425 per household per year in terms of water and aquatic resource use, or almost $3,000 per hectare of inundated area. The valuation study also showed that these benefits were particularly important for poorer households, who lacked access to their own wells and for whom alternative sources of income and subsistence were scarce.

The Value of Tank Water and Biological Resources in Rajangana and Angamauwa Sub-Catchments of the Kala Oya Basin (per tank)

Resource	% of households	Value per Household (US$/hh/yr)	Value per Unit Area* (US$/ha/yr)
Paddy cultivation	13%	177	161
Vegetable cultivation	7%	86	39
Banana cultivation	3%	1150	209
Coconut cultivation	13%	238	216
Domestic water	93%	226	1,469
Livestock water	13%	369	335
Commercial water	2%	132	12
Fishery	16%	309	351
Lotus flowers	10%	106	72
Lotus roots	7%	235	107
		Total	**2,972**

** Total inundated area*

Making sense of wetland values in relation to decisions about water and land use in the Kala Oya Basin

Articulating the economic benefits of traditional small tanks makes a strong argument, and provided important data, for including these values into land and water use decisions in the Kala Oya Basin. In particular it helps when the relative returns to different water uses is calculated and compared, and when land use decisions are made.

A recognition that the degradation of small tank wetlands would also result in the loss of water storage for irrigation and domestic use as well as environmental services has led to efforts by the MASL to take action to renovate and conserve small tank systems in the Kala Oya Basin. However these decisions tend still to be based primarily on irrigation needs, and not so much on broader livelihood and environmental considerations.

Locally harvested tank resources

The results of the Kala Oya study were thus also used to demonstrate the way in which environmental economic valuation could be integrated into decisions about how to choose between different tank management options. To date, the preferred tank management option of the MASL has been to mechanically raise

the spill of sedimented tanks in order to rapidly restore their capacity for water storage.

In fact, this tank management option may neither be the most cost-effective nor the most economically desirable one if a broader and more long-term perspective is taken. One reason for this is that raising spills does not in itself solve the problem of tank sedimentation and wetland degradation – it merely postpones it, and does nothing to address its cause.

Based on the valuation study that had been carried out, four different scenarios were evaluated in order to allow an extended cost-benefit analysis of different alternatives for small tank management. These took account of the investment and recurrent costs of different options for tank management, as well as marginal changes in broader livelihood and environmental benefits associated with maintaining the water storage capacity and biodiversity status of small tanks. These scenarios included:

- **Scenario 1: Do nothing.** Here, sedimentation loads remain the same if not increasing and tank wetlands continue to deteriorate.
- **Scenario 2: Raise spill.** Here, the water body will grow and additional land will be flooded, but sedimentation loads remain the same if not increasing.
- **Scenario 3: Raise spill and rehabilitate tank reservation.** Here, the water body will grow and additional land will be flooded and future sedimentation loads reduced, thus prolonging the lifespan of the wetlands.
- **Scenario 4: Remove silt and rehabilitate tank reservation.** Here original tank capacity and seasonality is restored and future sedimentation loads will be reduced, thus prolonging the lifespan of the wetlands and restoring its environmental goods and services.

The extended cost-benefit analysis included both quantitative and qualitative indicators of costs, benefits and accumulated natural capital associated with each of these four scenarios. It showed that without rehabilitation of the tank reservation, any solution to loss of water storage would be short-term, and would also yield lower total economic benefits. In contrast, although costing more, scenarios that involved rehabilitating tank reservations would yield higher net present values, indirect use indices and accumulated natural capital measures.

Option 4, desilting tanks and rehabilitating their reservations, clearly yields the highest net benefits, in both livelihood and environmental terms. Additionally, it also has the likelihood of being the most sustainable and technologically appropriate, because it relies on recurrent works that can be easily carried out using labour-intensive techniques and do not require large mechanical equipment and infrastructure.

Table 1: Cost-Benefit Assessment of Alternative Tank Management Scenarios

	Net Present Value (NPV)					
Scenario	**Investment cost (US$ '000)**	**Operating costs (US$ '000)**	**Incremental tank benefits (US$ '000)**	**Quantifiable net benefit (US$ '000)**	**Indirect use trends (index)**	**Accumulated Natural Capital**
S1: Do nothing	0	0	0	**0**	-7	⬇⬇ NC1
S2: Raise spill	0.4	0	24.2	**23.8**	-4	⬇ NC2
S3: Raise spill and rehabilitate tank reservation	23.3	12.5	64.6	**28.8**	6	⬆ NC3
S4: Remove silt and rehabilitate tank reservation	50.3	12.5	120.7	**57.9**	7	⬆⬆ NC4

Using economic values to promote catchment management and water allocation to sustain small tank systems

The findings of the Kala Oya study underline the importance of looking at livelihood and environmental values when land use and water allocation decisions are made.

They also illustrate the linkages between different parts of river basins, and show how land and water decisions made in one area can have significant economic, livelihood and environmental impacts on other locations and human populations.

The study of small tanks in the Kala Oya Basin provides an example of how such values can be incorporated into decision-making about real-world interventions to sustain wetland benefits as part of river basin management. It shows how taking account of biodiversity and livelihood values can help in making more fully-informed management decisions about land and water that can, in the long-term, prove to be more desirable, and more sustainable, in both socio-economic and environmental terms.

This case study is adapted from:

S. Vidanage, S. Perera and M. Kallesoe, 2005, The Value of Traditional Water Schemes: Small Tanks in the Kala Oya Basin, Sri Lanka. IUCN Water, Nature and Economics Technical Paper No. 6, IUCN — The World Conservation Union, Ecosystems and Livelihoods Group Asia.

Stoeng Treng Ramsar Site, Cambodia: rapid, participatory assessment for wetland valuation

Why are wetlands important?

For the 12 000 people living in the Stoeng Treng Ramsar site, wetlands are a precious source of fish, aquatic animals, waterbirds and building materials. For many communities, the wetland is a vital source of water for consumption and washing and the waterways are an essential means of transportation. The deep pools and flooded forests also provide dry-season refuges and spawning habitats for many important species of fish which migrate throughout the Mekong system.

Economic assessments can help us manage wetland resources by improving our understanding of what drives people's resource use decisions – and why, and to what extent, wetlands are valuable to local communities.

Some economic assessments, however, place emphasis on calculating the quantitative value of a resource. Although information about monetary values can have a powerful influence in promoting conservation of resources, a deeper understanding of the nature of wetland values is required for effective planning and management. In particular:

- How are wetlands important in terms of people's livelihoods, food security and health?
- How are wetlands essential in helping communities cope with external shocks and stresses?
- Who benefits most from the wetlands? Who is most vulnerable to the loss of wetland resources, and why?

Conventional techniques for gathering socio-economic data or assessing the value of wetland resources often rely on the household survey. There are a number of potential drawbacks with applying this instrument, some of which can be overcome by applying "participatory approaches" to economic assessment.

This brief describes a case study application of "participatory approaches" to assess the importance of wetland resources to people from Veun Sean, a small island village located in the Mekong River within the Ramsar site. The study goes beyond quantitative assessment to understand the context in which resource-use decisions are made - and the linkages between poverty and the importance of wetland resources.

Background to the study

Wetlands in Cambodia are vital to the livelihoods of millions of Cambodians, and particularly the food security of many of the rural poor. There are many stakeholders in the management of these precious resources - including government agencies across different sectors and at different levels, private businesses, international and local non-governmental organisations, and the local communities whose livelihoods depend on wetland resources. In Cambodia, however, there are a number of barriers to effective wetlands management, including:

- Lack of co-ordination between different sectoral approaches
- Weak policy frameworks and unsupportive economic environments
- Inadequate information base on which to base wetland policy, planning and management decisions
- Inadequate human and technical resources

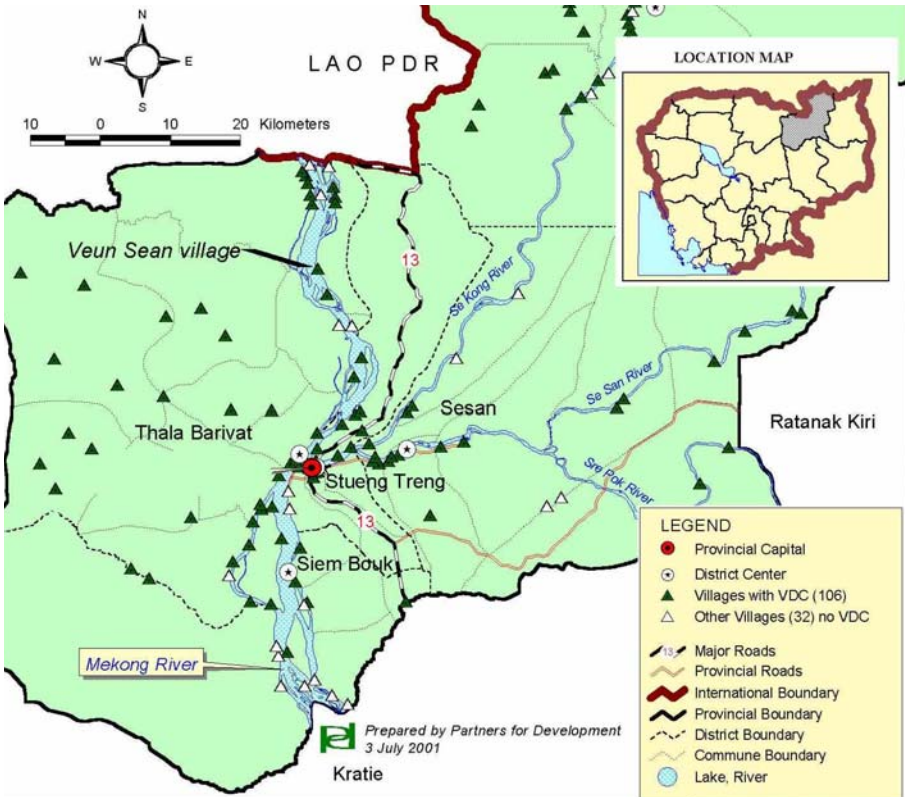
- Lack of options for resource use by local communities.

The Mekong Wetlands Biodiversity Conservation and Sustainable Use Programme (MWBP) is a partnership between the four governments of the Lower Mekong – Cambodia, Laos PDR, Thailand and Vietnam, implemented through UNDP, IUCN and the Mekong River Commission (MRC), supported by the Global Environment Facility (GEF). The MWBP aims to overcome the barriers described above, by promoting an integrated, co-operative approach to wetlands management at regional, national and local levels.

The Ramsar site in Stoeng Treng province, Cambodia, is one of four demonstration sites of the MWBP. The Ramsar site is about 14 600 hectares in area and extends 37 kilometres in length along the Mekong River, from five kilometres north of Stoeng Treng town to the Laos border.

The Stoeng Treng Ramsar site is characterised by rocky streams, small islands, sandy inlets, deep pools, and seasonally inundated riverine forests. The wetlands contain important habitats for several globally threatened species, including many species of fish which migrate throughout the Lower Mekong system – such as the critically endangered Giant Catfish (*Pangasianodon Gigas*).

Location of Stoeng Treng Ramsar Site



A key aspect of the MWBP is the application of economic tools and techniques to support wetlands management for poverty alleviation outcomes in the four demonstration sites. An essential first step is to understand the importance of wetland resources to local communities. This study employed participatory economic assessment methods to assess wetland values in Veun Sean, a small village in the Stoeng Treng Ramsar site.

Veun Sean village is located in O'Svay commune, Thala Borivat district approximately 20 kilometres from the border with Lao PDR. With 36 households and a population of about 150 people, Veun Sean is the smallest village in the Ramsar site. The village households are situated on Khorn Hang island, although the location of land use practices such as cultivation,

non-timber forest products (NTFP) collection and wildlife hunting extends beyond the island to the mainland.

Veun Sean is relatively poor in built and human capital – there is only one well, no electricity, no latrines and poor access to health services. Almost three-quarters of people from Veun Sean cannot read or write.

Fisheries resources are particularly important for the largely agrarian, subsistence households in Veun Sean. However, there is evidence of declines in fisheries resources in the Stoeng Treng Ramsar site. Assessments conducted by Partners for Development (PfD) and Culture and Environment Preservation Association (CEPA) in 200 and 2002 respectively explored the trends and causes of natural resource declines in Veun Sean village. The declines in fisheries, forest and wildlife resources since 1975 reflect the general pressures on such resources in the region.

Towards a participatory approach to wetland valuation

The household survey, commonly applied in economic assessments has a number of potential drawbacks:

- Surveys are often lengthy and complicated, causing interviewees to become fatigued
- The concepts and questions often reflect the perceptions of the researchers rather than the reality of the respondents
- The process by which a survey is administered may introduce inaccuracies due to intimidation by interviewers, biased answers from respondents, or translation misunderstandings

One way to overcome some of these problems is to combine conventional economic research techniques with more flexible "participatory" rural appraisal methods. These methods evolved in response to the need for practical research and planning approaches that could support more decentralised planning and local-level participation in decision-making (IIED 1997 – *Valuing the Hidden Harvest*).

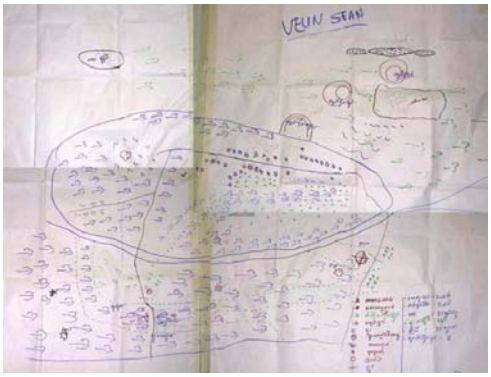
"Participatory" techniques vary in the extent to which they are truly participatory. Generally defined, *rapid rural appraisal* (RRA) methods focus on applying participatory methods to gain information, whilst minimising biases. *Participatory rural appraisals* (PRA) tend to have greater emphasis on sharing knowledge and processes at the local level, and tend to be much longer and open-ended processes. This case study did not emphasise the distinction between these techniques, but developed and applied various activities from both RRA and PRA theory and application.

Stoeng Treng Ramsar Site

These activities enabled villagers in Veun Sean to define and describe wetland values within the context of their own perceptions, needs and priorities rather than categories imposed by the researchers.

Applying the approach

Resource mapping



The resource mapping activity encouraged participants to draw and discuss their village and the location and use of resources.

The resource map is an effective tool for gaining an understanding of the spatial distribution of wetland resources. It is also an interactive activity which can be a good "ice-breaker" between communities and researchers.

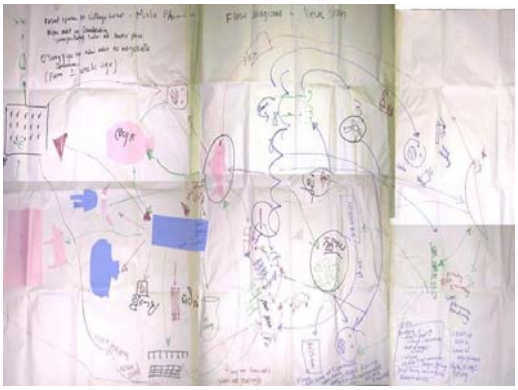
The resource map of Veun Sean village identified deep pools as important fishing grounds, and areas of cultivation and hunting some distance from the village.

Web diagrams of social networks

The *web diagram* was applied to identify the stakeholders in the wetland resource, and to explore social networks within the village, the relationships between villagers and external organisations, and the extent to which different individuals, institutions and organisations have an influence on their lives.

In this activity, separate groups of men and women were invited to identify institutions which were illustrated on paper circles. Institutions from within the village were placed inside a large circle, and external institutions were placed outside the circle. Lines were then drawn between different institutions, to describe the strength of influence between these organisations.

Flow diagram of wetland values



The *flow diagram* activity invited participants to describe the values derived from the wetland resource, and to discuss why these aspects of wetlands are valuable.

The wetland was represented by drawing the Mekong River with flooded forests in the centre of a sheet. An arrow was drawn from the wetland to a fish to illustrate a wetland use. The group then identified and described various benefit flows and market linkages, including: fishing, fish spawning, waterbird hunting, water for cooking and drinking, irrigating cash crops and transport. The group agreed that fish, a valuable source of nutrition and income, was the "most important" wetland resource.

Seasonal calendar of activities

The purpose of the seasonal calendar was to identify key activities conducted by men and women, and to broadly assess differences in time and effort spent between activities and across seasons.

Each group was invited to identify the main activities which they conducted. These were then rated across seasons – wet, dry cold, and dry hot – using piles of between one and ten beans.

It was evident that the key factor which influences the timing of activities across the seasons is rice growing, which is driven by seasonal differences in weather. The *wet season*, when most rice cultivation occurs, is thus the busiest time of year for both men and women.

Wealth ranking

Wealth ranking was conducted to gain an understanding of villagers' perceptions of wealth characteristics, and to provide information so that further activities could assess the linkages between wetland resources and poverty.

A group of six individuals (three men and three women) were selected with assistance from the village chief. The group discussed the different characteristics of different "wealth groups", and then categorised individual households.

A measure of wealth consistently identified by all members of the group was a household's ability to grow rice sufficient to meet the needs of the family throughout the year. Rich families were identified as growing sufficient or excess rice, medium families as facing "rice shortage" for six months, and poor and very poor families for nine or ten months. During this activity, the group noted that in response to rice shortages, poorer households generated income to purchase rice by selling fish and wildlife.

Relative ratings

The rating exercises were directly linked to demonstrating relative values of the wetlands and fisheries resources. The approach undertaken reflected the experiences drawn from previous activities. Ratings were conducted using piles of one to five beans.

1. *Wetland values* were first identified in the wetland resource flows diagram. A variety of wetland values were identified. Many of these values represented consumptive use of wetland resources – such as fishing, traditional medicines and wildlife. Other values related specifically to consumptive or non-consumptive uses of water – drinking, washing, irrigation and transportation.

The group unanimously rated fish as "five", representing the highest level of relative importance.

2. The aim of the *problem discussion* activity was to identify some of the key problems faced by households, the underlying causes of these problems, and ways in which households respond.

Lack of access to hospital services was described as a major factor contributing to health problems. The impact of recent droughts and the lack of buffalo to prepare land were described as major underlying causes of rice shortage. Declining fish stocks were also identified as a significant problem.

3. The results from ratings of *food sources* suggest that, in Veun Sean, the types of food consumed are not strongly related to level of poverty. Most people, independent of level of wealth noted that rice was a staple and that fresh fish and prahoc (preserved fish) were also very important. One key difference, however, is that poorer households suggested that aquatic animals were an important source of food because they were readily available the entire year, whereas wealthier groups could choose not to consume aquatic animals.

4. Ratings of *sources of income* revealed that poorer households have fewer options for generating income – although it appears that they may be more dependent on generating income to purchase the staple food, rice. Fish (mostly sold to middlemen) and cash crops are relatively important income sources for all households.

5. A key difference in *types of expenditure* between poorer and wealthier households is that poorer households spend a relatively greater proportion of their income on rice.

Sources of income

Rating	Poor	Less poor
●●●●●	Fish	Fish, livestock
●●●●	Cash crops	Cash crops, turtles, lizards
●●●	Turtles, lizards, livestock	Cogon grass
●●	Wildlife	Wildlife, vegetables, rice, small shop
●	NTFP, work on other farms	Work outside village, rice, rice milling, bamboo, rattan

Types of expenditure

Rating	Poor	Less poor
●●●●●	Rice	Medicine
●●●●		Petrol, cooking ingredients
●●●	Medicine, clothes	Rice, hospital, school, fishing gear
●●	Hospital, fishing gear, agricultural tools, seeds, petrol, household goods, cooking ingredients, social contributions	Piglets, clothes, seeds, agricultural tools, household goods, wine and cigarettes
●	Fish, livestock meat, weddings, boat purchases, transport	Social contributions, transport, weddings

Wetland values – how much?

Targeted household surveys were also conducted to complement and verify the participatory activities. A key aim of the household survey was to provide additional quantitative information about the wetland values described in the participatory activities.

Responses to several household survey questions could be used to estimate the value of the fisheries resource. However, many of these responses could have been biased due to variability of activities and resource use across space and time. For example, inaccuracies arise from:

- Aggregating units – for example, how much fish caught in a year?
- Averaging quantities across periods of time.

To limit this bias, information about the quantitative value of fisheries was verified using different methods: responses from a variety of survey questions, group discussions and participatory activities. The quantitative assessment confirmed the fisheries resource is more valuable to poorer households, because of its importance as a source of income.

Fish value: Riel per household per year

Value	Average	Poor	Less poor
Fish consumed	500 000	600 000	500 000
Income from fish	1 200 000	2 000 000 (77% total)	600 000 (56% total)
Total	**1 700 000**	**2 600 000**	**1 100 000**

The value of other wetland uses was then estimated using the relative ratings of different wetland uses. Using this method, the average value of the wetland to a household in Veun Sean village was calculated as approximately US$3000 per year.

Wetland values: Riel per household per year

Rating	Value	Wetland uses
●●●●●	1 700 000	Fishing, washing, cooking/drinking
●●●●	1 360 000	Transportation
●●●	1 020 000	Construction material, firewood
●●	680 000	Aquatic animals, waterbirds, reptiles, irrigation, traditional medicines
●	340 000	Floodplain rice, recreation, dolphins
Total	**12 900 000**	(4000 Riel = US$ 1)

Summary of key assessment results

- The wetlands resources are integral to the livelihoods of Veun Sean villagers. Many households depend almost entirely on water from the Mekong River, which is the only means of transport from the village to services such as markets and medical centres. In Veun Sean, the value of wetlands is about 13 million Riel ($3200) per household per year.
- It appears that the poorer households are more dependent on wetland resources for providing food security and income. They are also likely to be more vulnerable to losses in fisheries and wetlands resources, particularly in terms of their capacity to deal with shocks and stresses such as poor health, drought, and livestock deaths. On average, the value of the fisheries resource is 1.7 million Riel ($425) per household per year. However for a poorer household, fisheries are worth about 2.6 million Riel ($650) per year. Much of this value is derived from income earned from selling fish, which is used mainly to purchase the food staple, rice.
- Except for the few most wealthy households, many households depend on wildlife caught with traditional methods for income. For the very poor, aquatic resources in paddy fields and small streams are a key source of nutrition.
- Deep pools are recognised as important conservation areas, but are traditional fishing grounds for Veun Sean villagers.
- Households with greater capacity to grow rice are perceived by other households as wealthy, appear to be less directly dependent on wetland resources for nutrition or income, and have greater capacity to cope with external shocks and stresses.
- Many internal and external institutions were identified. However, it appears that households rarely have contact with provincial government agencies. Many focal points and working committees within the village, established previously by NGOs, are currently inactive. Villagers identified CEPA, an NGO which is currently working on community fisheries and community forestry, as particularly influential.

Discovering the linkages between wetland resources and livelihoods

Both participatory activities and the quantitative assessments demonstrate that wetlands resources are essential to the livelihoods of the villages from Veun Sean. Fisheries, wildlife and aquatic resources are vital both in terms of nutritive value. These resources also ensure food security by providing a source of income for households.

In addition to providing day-to-day resources on a routine basis, wetlands are also vital in ensuring that households can cope with external stresses and shocks. If stresses affect productive activities, such as cultivating rice and raising livestock, these can to a certain extent be substituted with collection and capture of wild resources such as fish, wildlife and aquatic animals. All households in Veun Sean, but particularly the very poor, are vulnerable to pressures which limit their capacity to cultivate land to grow rice and produce – such as the ongoing stress of limited access to land, or shocks such as drought, livestock death, or human illnesses.

Rice-growing, for example, is a key economic activity and "rice shortage" (the inability to be self-sufficient in rice production due to lack of access to labour or land) is a major pressure facing most households. For these households, access to wetland resources is vital on a year-to-year basis, and more so when faced with other stresses such as poor health and drought.

For many households in Veun Sean, the pressures of poor health, drought and rice shortages appear to reinforce each other. Poor health limits a households' capacity to work on the land, resulting in low rice yields – which are further lowered by drought. This emphasises the importance of owning buffalo to assist in rice-growing. However, during periods of drought, buffalo are more likely to suffer sicknesses or to die. Furthermore, when faced with rice shortages, households must spend their income on rice and may face difficulties purchasing buffalo or health services.

In this context of interrelated pressures of poor health, drought and rice shortages, both fish and non-fish wetland resources are critical to villagers' livelihoods – for both nutrition and income. In terms of meeting day-o-day needs, as well as coping with periods of external stresses and shocks, the protection and maintenance of fish stocks is vital to all households of Veun Sean.

However, it is equally critical to consider *access* to these fisheries and other wetland resources. The poorest households have limited access to land, labour, transport to markets, health care, or alternative sources to income. They are particularly dependent on fisheries resources on an "as-needs" basis to generate income to purchase rice.

In the Stoeng Treng Ramsar site, strategies to conserve and protect the fisheries resource must consider the biological importance of the habitats in the region as spawning and dy season refuges. However, it is critical that this information be considered in light of local-level dependencies on and access to the resources. In this context, participatory research methods for economic assessment should be a key tool used in the planning process – to gain an understanding in the importance of wetlands resource to local communities.

This case study is adapted from:

J. Chong, 2005, Valuing the Role of Wetlands in Livelihoods: Constraints and Opportunities for Community Fisheries and Wetland Management in Stoeng Treng Ramsar Site, Cambodia. IUCN Water, Nature and Economics Technical Paper No. 3, IUCN — The World Conservation Union, Ecosystems and Livelihoods Group Asia, Colombo

QUANTIFYING THE IMPACTS OF UPSTREAM DEVELOPMENTS

Most major river systems are now used intensively in order to provide water for irrigation, energy, industrial and domestic uses, and large amounts of public and private funds have been invested in these infrastructure developments. Increasingly, river flows are being subjected to detailed measurement and planning, so as to calculate the needs of different water users and to allocate water to the uses which are seen to generate the highest possible social and economic returns.

Unfortunately these water allocation, infrastructure development and river basin planning decisions have often ignored a vital component of both water demand and supply – natural ecosystems. The main focus of investment has been on the capital and equipment required to abstract and distribute water resources, and has rarely considered the need to invest in managing the ecosystems and catchments that ensure regular and clean water supplies. An overriding focus of water allocation has been the uses which yield the highest financial or returns or commercial profits, usually without allowing for the needs – or economic productivity – of water-based ecosystems.

Especially over the last three decades, upstream infrastructure developments have taken their toll on wetlands because they have left insufficient flows, or made insufficient investments, to maintain the functioning of natural ecosystems. In many cases it is only recently that the economic and ecological costs of water-based developments have become apparent, or that the downstream impacts of water abstraction have started to be appreciated. Increasingly, there is pressure both to restore the wetlands and water-dependent ecosystems that have been impacted by past developments, and to factor the economic costs of downstream ecosystem degradation into future investments.

There is usually a clear, and demonstrable, economic cost to ignoring wetland values when water allocation decisions are made and upstream water-based developments are designed and implemented. Meanwhile, allowing sufficient flows for water-based ecosystems yields tangible economic benefits, and does not necessarily detract from opportunities to harness water for other uses and developments.

The case studies described in this chapter illustrate the ways in which wetland valuation can influence river basin planning by underlining the fact that wetlands are economic users of water. The case of Waza Logone in Cameroon shows how valuation data can provide an economic justification for restoring wetland ecosystems that have been affected by infrastructure development, and the case of the Tana River in Kenya also demonstrates how such data can be incorporated into conventional techniques for the economic appraisal of water-based projects. The case of the Indus Delta in Pakistan uses information about wetland values to underline the importance of meeting ecosystem demands for freshwater within the context of broader river-basin planning and water allocation. In both Sekong Province Lao PDR and the Pangani River Basin Tanzania, it is clear that the conservation of upper catchment land and forests is critical both to downstream water supplies and to upstream livelihoods.

An underlying theme in all of the case studies is that ecosystem water demands have also to be considered alongside other economic uses of water, and that investments that allow for these needs stand a far higher chance of long-term success, and positive development impact, than those which deny that natural wetlands, like other development and land use options, are both productive and economic users of water.

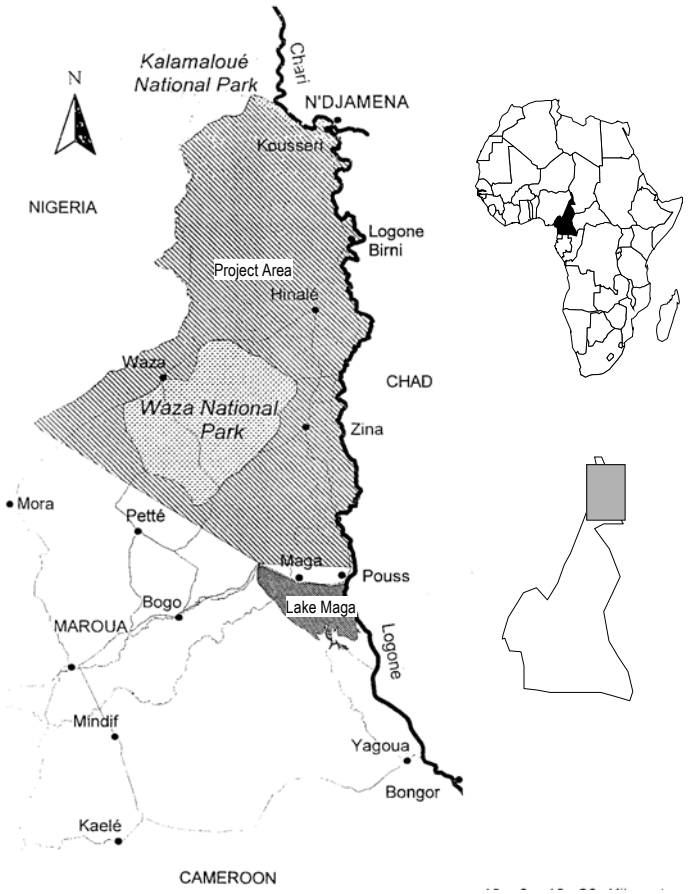
Waza Logone Floodplain, Cameroon: economic benefits of wetland restoration

Irrigating Cameroon's drylands

More than 59% of Cameroon's freshwater resources, and 86% of freshwater surface area, is comprised of floodplains. Water shortage and inappropriate river and floodplain water management are cited as major threats to their ecology and biodiversity, especially in drier areas[1]. Over the last 10-15 years the construction of dams and canals has been encouraged within and upstream of many of the country's floodplains, particularly by the Rice Development Authority, SEMRY, to encourage grain cultivation by the sedentary farming population. As well as having devastating impacts on floodplain hydrology and ecology, this has impacted heavily on the fisherfolk and pastoralists populations who traditionally rely on their freshwater resources and flooding regimes. Yet, for the most part, these values have not been taken into account when irrigation schemes are constructed.

This case study describes an exercise that was undertaken to assess the economic effects of floodplain degradation in the Waza Logone region, a semi-arid ecosystem in northern Cameroon that has been severely impacted by upstream water diversion for irrigation. By demonstrating the economic benefits of reinundation, and the high economic costs of flood loss to date, the study intended to present an economic justification for government and donor investment in flood release measures to restore the hydrology, ecology and biodiversity of the Waza Logone floodplain.

Location of Waza Logone



The Waza Logone Floodplain

The Waza Logone floodplain covers an area of some 8,000 km^2. It is located in the Extreme North Province of Cameroon, bordered by Nigeria to the west and Chad to the east. The floodplain comprises about 10% of the total surface area of major riverine wetlands in the West African Sahel. It represents a critical area of biodiversity and high productivity in a dry area, where rainfall is uncertain and livelihoods are extremely insecure. Just under 220,000 people are estimated to live in the Waza Logone region, approximately 60% of whom (or 85% of the rural population) rely on floodplain and wetland resources for their basic income and subsistence. The 1,700 km^2 Waza National Park is also located in the floodplain, and is recognised as having one of

the richest wildlife populations in the West African Sahel, including giraffes, elephants, lions and various species of ungulates[2].

The high productivity of the Waza Logone region depends to a large extent on the overbank flooding of the Logone River and the seasonal rivers Mayo Tsanaga, Mayo Boula and Mayo Vrick. The flooding cycle begins with the first important rainfall in May, which saturates the soil and starts to fill the deepest depressions[3]. The discharges of the Mayo Tsanaga and Mayo Boula reach the floodplain in August, and by September or October the area is inundated by overbank flow from the Logone River, lasting until November or December. The almost total lack of relief in the region means that the flood spreads over a large area: more than 3,000 km^2 of the 8,000 km^2 floodplain. By December, the residual floodwaters are drained back in to the Logone through the Logomatya River, and north to Lake Chad through the El Beid River.

Reversing the effects of flood loss

Since 1979 the inundated area of the Waza Logone floodplain has been reduced by approximately 964 km^2 or almost 30% of the original flooded area (Mott MacDonald 1999), due in large part to the construction of a rice irrigation scheme by SEMRY. The establishment of embankments blocked breaches of the Logone and entrances of the Mayo Aretékélé and Petit Goroma, and deprived the Logomatya of its main supply[4]. The Maga Dam sealed up water courses entering the Pouss depression, stored water originating from Mayo Tsanaga, Mayo Boula and Logomatya, and caused the Mayo Gourgoulay to dry up. In total, these construction works resulted in a 70% reduction of water supply to the floodplain from the Mandara Mountains, and an almost complete curtailment of the water supply from the Logone.

The reduction in inundated area has had a number of negative impacts on the ecology, biodiversity and socio-economy of the Waza Logone floodplain, including:

- Reduction in ***crop agriculture***: prior to the loss of floods, floating rice and floating sorghum, and flood recession sorghum were cultivated, and farmers also depended on natural floods to provide water to their fields.
- Loss of ***fisheries***, including an estimated 90% decline in fish yields within flood-fed wetlands[5], and reduction of the capacity of the area to provide nursery for fish stocks in the wider river systems of the Logone and Chari. The Waza Logone floodplain supports a large and complex fishery, both in its main river channels and permanent lakes, and in flood-fed and seasonal creeks, ponds, depressions and wetlands.
- Decrease in ***dry-season pasture***: floodplain pastures, locally-known are yaérés, provide important dry-season grazing resources in an otherwise dry area. From December onwards, when floodwaters have receded, the floodplain is used for pasture both by sedentary farmers and by nomadic and semi-nomadic pastoralists from other parts of the Extreme North Province of Cameroon and from neighbouring Nigeria and Chad. Prior to the loss of floods, it is estimated that some 200,000-300,000 head of cattle and 20,000-50,000 sheep and goats spent the long dry season in the floodplain. Most pastures in the formerly flooded area have now lost their perennial grass cover, leaving only degraded grasslands of inferior quality and smaller area.
- Loss of ***plant resources***, including grasses, shrubs and trees that are used for house construction, beekeeping, handicraft production, woodfuel, wild foods and medicines. A variety of perennial grasses, founded in flooded areas, are harvested from flooded areas and used for thatching houses and constructing fishing baskets.
- Decrease in ***wildlife populations***, including reductions in the number of kob, and the complete disappearance of buffalo, waterbuck, bushbuck and common duiker in Waza National Park[6]. Bird populations and migratory habitats outside the NP have also diminished. Wildlife supports a number of economic activities, such as tourism, sport and subsistence hunting.
- Reduction in ***surface water*** availability, affecting water holes and water courses that are used for domestic and livestock water supplies and for water transport, especially in dry seasons. The almost total lack of relief in the Waza Logone region means that

floodwaters are spread and retained over a large area. The coverage of the floods, and the length of their retention, makes a significant difference to the presence of watercourses, waterholes, flooded depressions and small streams. The floods feed, and leave water in, these water sources, some of which last the dry season and others of which provide year-round water sources for wildlife, human and livestock use.

Building on work carried out two decades ago, a number of options for setting in place engineering works to allow for flood re-release in the Waza Logone region were identified in the early 1990s. Pilot releases of floodwater from the Logone River were subsequently implemented in 1994 and 1997. These modified and opened the channels of two watercourses which connected the Logone to the Logomatya, and had been blocked by the SEMRY works: the Petit Goroma (1994) and the Aretékélé (1997). These resulted in an annual increase in the area flooded of around 200 km^2 and led to a marked recovery in the number of waterbirds and certain mammals, an increase in fish production, improvement and extension of pasture, and changed agricultural opportunities.

In 1999 a revised and updated proposal for reinundation was made. This focused on two main zones for release: from Lake Maga, which usually has excess water in August and September; and from the zone immediately to the north of the rice cultivation area of the irrigation scheme. The proposal consists of three different options, each allowing a different level of additional flows and level of floodplain restoration. All of these reinundation options have the potential to make a significant contribution towards rehabilitating the hydrology, ecology and biodiversity of the Waza Logone floodplain and to restoring the human production systems that depend on it.

Seasonally flooded wetland in Waza Logone

Valuing floodplain reinundation

The aim of the study was to estimate the economic value of reinundation, and economic costs of flood loss, with a view to justifying investment in flood release measures in the Waza Logone floodplain. It built on and updated three previous pieces of work: a preliminary cost-benefit analysis of reflooding options made by Delft Hydraulics and the Centre for Environmental Science of the University of Leyden in 1994[7]; a study on the economic benefits of floodplain inundation carried out in 1998-99 by the Centre for Environmental Science[8]; and a cost-benefit analysis of the proposed reinundation programme carried out in 1999[9]. The current study aimed to relate floodplain values specifically to the reinundation options that were being considered, so as to present to decision-makers and investors a measure of the economic desirability of investment in flood release works.

The study involved a number of steps, which together resulted in an economic assessment of flood-related benefits. First, the broad parameters and scope of the study were defined. It was decided that the study would focus on incremental values – in other words the additional values that would result from flood release over the current situation, considering only changes in floodplain economic benefits and costs that are directly caused by reinundation. The major focus of the study was on on-site benefits that accrue inside the floodplain region and are received by the floodplain population. Although reinundation may result in a number of off-site economic impacts, such externalities were not the primary focus of this study. All benefits and costs were to be calculated as net values, so as to avoid double counting, and the study valued only benefits that were believed to be sustainable in environmental terms.

A second step was to identify the economic values associated with the inundation of Waza Logone floodplain, and could be valued given available techniques and information. These

focused mainly on direct values such as dry-season pasture, fisheries, flood-fed and flood-recession agriculture, use of floodplain grasses for thatch and basket making, beekeeping and honey production, water transport, and surface and sub-surface water supplies. Additionally, inundation gives rise to a number of flood-related economic costs, which were considered in the study. As well as direct expenditures on constructing and operating flood release infrastructure, there would be an opportunity cost to reinundation in terms of loss of crop cultivation and gum arabic harvesting areas, and additional crop damage resulting from increased populations of wildlife and birds.

A third step was to define the methods and data needs for floodplain valuation. Here, a variety of techniques and methods were used. Market price techniques were only found to be applicable to fish and rice trading, water transport, and grass used for fishing baskets. For the benefits and costs that could not easily be valued through the application of market prices, three additional methods were used to value flood benefits: effect on production techniques (for example pastoralists livestock production), the price of alternative or substitute resources (for example thatching grass), and mitigative or avertive expenditures avoided (for example loss of year-round surface water supplies).

Information was collected by carrying out a number of field surveys, as well as consulting with existing documents and reports – including those produced as part of earlier cost-benefit analyses. The resulting costs and benefits of flood release, and flood loss, were modelled over time, allowing for the gradual restoration of floodplain resources and benefits, and computed as single net present values for flood loss to date and for each scenario of reinundation. An additional cross-check on the robustness of the figures was provided by carrying out a sensitivity analysis to see how the results would be affected by changes in discount rate, levels of benefits, flooding coverage and climatic conditions.

Using economic values to promote investment in flood release measures

Annual flooding originally inundated an area of 3,382 km^2, or nearly half, of the Waza Logone floodplain. The study showed that, before the construction of the SEMRY scheme, the value contributed by this flooding to the regional economy was over $10 million a year, or more than $3,000/$km^2$ of flooded area. Since then, the inundated area of the Waza Logone floodplain has reduced by almost 30%, incurring annual economic costs to the local population of more than $2 million.

Economic costs of flood loss in the Waza Logone region

	Total Loss ($ mill/yr)
Pasture losses	-1.31
Fisheries losses	-0.47
Agriculture losses	-0.32
Grass losses	-0.29
Surface water supply losses	-0.02
NET COST	**-2.40**

The valuation study underlined the positive economic impact of the pilot flood releases of 1994 and 1997, showing that they had added a value of over $800,000 a year through restoring floodplain goods and services. Relating these changes to further recovery of floodplain ecology and biology showed that the reinundation options currently under consideration would generate incremental economic benefits of between $1.1 million and US $2.3 million a year over the current situation, translating into positive net present values of between $5.6 million and $7.8 million when investment and operation costs were taken into account. On a per capita basis, this equates to $50 added economic value per floodplain-dependent member of the population.

Incremental benefit of reinundation over current situation

	Additional flow (m3/s)	Reflooded area in average year (km^2)	Incremental net benefit of flooding ($ mill/year)	Net present value of investment ($ mill @ 10%)	Benefit:cost ratio of investment
Maximum flood release option	215	867	2.32	7.76	6.57
Middle flood release option	165	687	1.78	7.19	6.13
Minimum flood release option	115	479	1.15	5.61	4.66

A large amount of donor and government funding has recently been made available for projects to address poverty alleviation concerns in Cameroon. To date, proposals have been focused mainly on the provision of basic services, infrastructure and income-generating activities for the urban and rural poor, rather than on environmental conservation and restoration activities. The results of the valuation study both presented a convincing argument for investment in flood release measures in the Waza Logone floodplain as a mechanism for rural poverty alleviation and sustainable livelihood development, and also highlighted the high economic costs to poor rural populations of having failed to take environmental values into account when the original investment in the SEMRY irrigation scheme was made.

This case study is adapted from:

IUCN, 2001, Economic Value of Reinundation of the Waza Logone Floodplain, Cameroon, Projet de Conservation et de Développement de la Région de Waza-Logone, Maroua

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Indus Delta, Pakistan: economic costs of freshwater flow loss

Water-based developments in Pakistan

Pakistan's vast irrigation network comprises three major storage reservoirs, 19 barrages or head works, 43 main canals with a conveyance length of 57,000 km, and 89,000 watercourses with a running length of more than 1.65 million km[1]. The system feeds more than 15 million hectares of farmland, affording Pakistan the highest irrigated to rain-fed land ratio in the world. This impressive irrigation system is, however, exacting a heavy toll on the environment. In particular there is concern that the abstraction of large volumes of water from rivers has, in many cases, left insufficient flow to meet the needs of downstream ecosystems. Coastal and marine regions, because they lie at the end of rivers, have been impacted most heavily by upstream water abstraction.

Failure to recognise downstream ecosystem needs has often led to water allocation decisions being made that are neither economically nor ecologically optimal. Contrary to the dominant development imperative that favours the allocation of water to large-scale, commercial uses such as dams, reservoirs, irrigation and hydropower schemes, Pakistan's ecosystems, too, are economic users of water. Yet the economic benefits of water-based ecosystems are rarely factored into river basin planning, or into water allocation decisions. The economic costs and losses arising from such omissions can be immense, and often irreversible, impacting on some of the most fragile ecosystems and the poorest and most vulnerable human groups. This case study describes the economic costs that have occurred as a result of inadequate freshwater allocation to the Indus Delta in Pakistan. Especially, it focuses on the crippling environmental economic costs that upstream water allocation decisions have incurred to poor local populations, manifested through declining agricultural yields and fisheries production.

Managing freshwater flows in the Indus River

The Indus River has a total length of more than 3,000 km and a drainage area of some 950,000 km[2]. Almost 90% of the water in the upper portion of the river basin comes from glaciers located in the Himalaya and Karakoram mountain ranges, which border China, Pakistan and India, and the Hindu Kush, which borders Pakistan and Afghanistan. The Indus travels southwards across Punjab and Sindh Provinces in Pakistan before entering the Arabian Sea through a delta close to the border with India.

The Indus Delta

The Indus Delta is a typical fan-shaped delta, built up by the discharge of large quantities of silt washed down from upland and mountain areas. The present Delta covers an area of about 600,000 hectares and is characterised by 17 major creeks and innumerable minor creeks, mud flats and fringing mangroves[2]. The mangrove ecosystem

of the Indus Delta is perhaps unique in being the largest area of arid climate mangroves in the world. As annual rainfall is so low in the region, mangroves are almost wholly dependent upon freshwater discharges from the river, supplemented by a small quantity of run-off and effluents from Karachi.

The total available freshwater flow in the Indus is about 180 billion m^3, carrying with it some 400 million tonnes of silt[3]. Over the last 60 years a series of dams, barrages and irrigation schemes have been built in upstream parts of the River Indus. Today, it is estimated that up to 60% of the Indus water is used to feed Pakistan's irrigation networks, and that the Indus watershed irrigates up to 80% of Pakistan's farmland[4]. There has for some time been a high level of controversy surrounding the allocation of the waters of the Indus River, in particular between competing uses in different Provinces. Recurrent disputes over water usage led the government to set in place the Indus Water Accord in 1991, which apportioned the use of the river's water between the four provinces of Pakistan. It also recognised – for the first time – the need to allow some freshwater discharge into the delta to safeguard the ecosystem, specifying a minimum flow of 12 billion m^3. In 1994, because of drought and water shortages, Punjab Province however demanded and got a break from the 1991 Water Accord and a subsequent higher reallocation based on historical use.

As a result of upstream water abstraction, mainly for irrigation, by the time the Indus reaches the Kotri Barrage (some two thirds of the way into Sindh Province, or 200 km from the Arabian Sea), there is inadequate flow to maintain the natural ecosystems of the Indus Delta. The annual flow reaching the Delta before the 1994 break from the Water Accord was less than 43 billion m^3, and quantities of silt discharged estimated to be 100 million tonnes/year[5]. Even at this level the amount of freshwater reaching the Delta was argued to be insufficient to maintain healthy natural ecosystems, and had resulted in severe saltwater intrusion and salinisation. With the existing reduction in flow, downstream Sindh Province already claims it is short of the minimum 12 billion m^3 of water needed to maintain the Delta.

The economic significance of the Indus Delta

Loss of freshwater flow, and consequent saltwater intrusion, has had devastating effects on the ecology and human economy of the Indus Delta. Land in the area has become unsuitable for agriculture, and potable water sources have become very scarce or have disappeared altogether. In Thatta, a predominantly agricultural District in Sindh Province which is situated where the Indus river flows into the Arabian Sea, almost a third of land has been affected by saltwater intrusion. It is estimated that up to 0.5 million hectares of fertile land in Thatta and adjoining areas[6], or about 12% of total cultivated area in the entire Province[7], is now affected by sea water intrusion. As well as crop losses, this has resulted in severe damage to livestock through rangeland depletion, shortage of fodder, pasture and watering areas, and a resulting mass migration of both livestock and human populations out of the area.

The human population in and around mangrove forests on the coast of Pakistan is estimated to total 1.2 million people, nearly 900,000 of whom reside in the Indus Delta[8]. Of these, a predominantly rural population of more than 135,000 depend on mangrove resources for their livelihoods[9]. Reductions in freshwater inflows have had tangible impacts on mangrove ecology, and on the fish populations that rely on them for breeding and habitat. At least three quarters of the Delta's rural population depend, directly or indirectly, on fishing as their main source of income, and most of Pakistan's commercial marine fishery operates in and around the mangrove creeks on the coast of Sindh Province. A large proportion of fish and crustaceans spend at least part of their life cycle in the mangroves, or depend on food webs originating there[10]. The annual value of catch from mangrove-dependent fish species in the Indus Delta is estimated at around $20 million. Shrimps are also particularly important, with a domestic value of $70 million and an export value of about one and a half times this figure, and the export of mud crabs contributes an additional $3 million to the regional economy[11].

Over 60 percent of the rural population also use the Delta's mangroves as their major source of domestic fuel, estimated to account for around 18,000 tonnes of firewood[12] which is worth up to

$460,000 a year[13]. Mangroves are also used by coastal villagers as fodder for domestic animals. In addition to cattle, sheep and goats kept permanently in the Delta, it has been estimated that at certain times of the year about 16,000 camels are herded into the mangroves[14]. In total, the Indus Delta's natural ecosystems are thought to contribute about 67,000 tonnes of leaves and 20,000 tonnes of grasses as livestock pasture and fodder each year, together worth up to $1.35 million[15].

Valuing the economic costs of saltwater intrusion

The loss of freshwater to the Indus Delta, and consequent saltwater intrusion and natural habitat degradation, is manifest in a wide range of economic benefits foregone, including economic costs related to mangrove loss and reduction in agricultural land use opportunities. This valuation study aimed to generate information about economic costs that could be factored into upstream water allocation decisions, and especially used to support demands for the maintenance of freshwater flows to the Delta. As the economic benefits associated with mangrove and brackish water ecosystems had already been extensively studied before (Khalil 1999, Mahmood and Ali undated), the valuation exercise focused on the inland impacts of saltwater intrusion on crop agriculture and freshwater fisheries.

The study covered three Talukas (the administrative sub-unit below a District) in Thatta District of Sindh Province: Keti Bandar, Ghora Bari and Kharo Chan, with a combined population of some 155,000 people. This area has been most heavily impacted by seawater intrusion in the Indus Delta. Valuation relied primarily on data collected at the Village, Taluka and District levels. Primary data collection, through field visits, involved surveys of farming and fishing communities, interviews with government line departments, and consultations with other public sector and non-governmental organisations. Where data already existed in the form of statistics from Federal and Provincial Government publications, these comprised the bulk of secondary sources. The study entailed collecting data on the ecological impact of sea intrusion and economic data on agricultural and fisheries products, and establishing a link between reduced freshwater flows, saltwater intrusion, and loss of household production.

Using valuation to show the economic benefits of allocating water to ecosystems

Analysis of the data collected during the study showed that reduced freshwater flows, and consequent ecosystem degradation, had impacted heavily on local livelihoods and economic production in the Indus Delta area. Both aggregate crop production and fish catch had declined steadily as salinity had increased. The three Talukas or 30,000 households considered in the study had incurred average annual losses of $70,000 in crop damage and $45,000 from reduction in fish catches as a result of saltwater intrusion. On a broader level, other studies had shown that rapidly escalating mangrove loss has seriously jeopardised the livelihoods of more than 135,000 people who rely on mangrove products to a total economic value of some $1.8 million a year for fuelwood and fodder, and a coastal and marine fisheries sector that generates domestic and export earnings of almost $125 million[16].

The study presented a number of strong policy recommendations. Most importantly, it underlined the economic necessity of proposed freshwater releases downstream of the Kotri Barrage, in order to curtail the spread of saltwater into the Indus Delta. It showed that this was essential not just to safeguard the flora and fauna of the region, but also to sustain the livelihoods of the Delta population. The study findings also had wider implications. Upstream water demands from the Indus, already intense, will grow still further in the future. Pakistan's socio-economic development plans depend heavily on expanding land under irrigated crops[17], and a large number of new developments are planned which indicate that freshwater available to the Indus will continue to reduce[18]. The status of the Delta's natural ecosystems has already become critical, and the rural economy of the region faces an emergency situation as a result.

The phenomenon of sea intrusion into the Indus River Delta has become one of the most politically-charged environmental issues in Pakistan today. Competition over water allocation

within river basins, especially between upstream and downstream areas, between large-scale and subsistence-level uses, and between commercial and ecosystem uses, is becoming a source of severe economic and political conflict. In many ways the Indus Delta case study epitomises a national situation which has already reached crisis point, and is likely to deteriorate still further in the future. For now, national policies have opted to allocate scarce water so as to maximise financial and commercial returns to agriculture – often at the cost of natural ecosystems, and of some of the country's poorest communities. Yet there is growing concern that the failure to factor ecological economic values, or economic losses, into river basin planning is resulting in decisions being made about water allocation that are neither ecologically nor economically optimum. As long as the economic value of ecosystem needs for freshwater flows is marginalised in national decision-making, these conflicts are likely to escalate.

This case study is adapted from:

Iftikhar, U., 2002, 'Valuing the economic costs of environmental degradation due to sea intrusion in the Indus Delta', in IUCN, Sea Intrusion in the Coastal and Riverine Tracts of the Indus Delta - A Case Study. IUCN – The World Conservation Union Pakistan Country Office, Karachi

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[14] Khalil 1999 *op cit.*, Meynell and Qureshi 1993 *op cit.*

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Tana River, Kenya: integrating downstream values into hydropower planning

Hydropower development on the Tana River

The Tana River has a length of some 1,000 km, rising in the Aberdare and Mount Kenya ranges of central Kenya and running through the arid and semi-arid lands in the eastern part of the country to enter the Indian Ocean through a fan-shaped Delta which covers approximately 1,300 km^2. The Tana's catchment covers an area in excess of 100,000 km^2, and contains more than 4 million people. The Tana River is the only permanent river in this extremely dry region, and constitutes a vital water resource for all sectors of the human population.

The Tana River is also heavily utilised for hydropower. To date, five major reservoirs have been built on the upper reaches of the Tana: Kindaruma (1968), Kamburu (1975), Gitaru (1978), Masinga (1981) and Kiambere (1988). Together, these schemes provide nearly three quarters of Kenya's electricity requirements. Dam construction has however had a major influence on the river's downstream flow and physical characteristics, most notably through regulating waterflow and decreasing the frequency and magnitude of flooding. A new hydropower scheme, the Mutonga-Grand Falls dam, has recently been proposed for construction on the Tana River below these existing dams.

This case study describes a valuation exercise that was carried out as part of a pre-project environmental assessment of the likely impacts of dam construction on downstream ecosystems. With a variety of design options being considered for the proposed Mutonga-Grand Falls dam, the study aimed to quantify the environmental economic costs and benefits of further changes to the Tana's hydrology. It yielded figures which could be integrated into more conventional economic cost benefit analyses of the proposed investment. To date economic appraisal had considered only the physical costs of dam construction and the financial and economic benefits arising from power generation, and had made little allowance for design options that would mitigate or avert the environmental impacts of flood loss. Providing comparable data on environmental costs and benefits allowed for a much more thorough economic analysis of the predicted returns to different investment options, and a better indication of the likely profitability of building flood release measures into dam design.

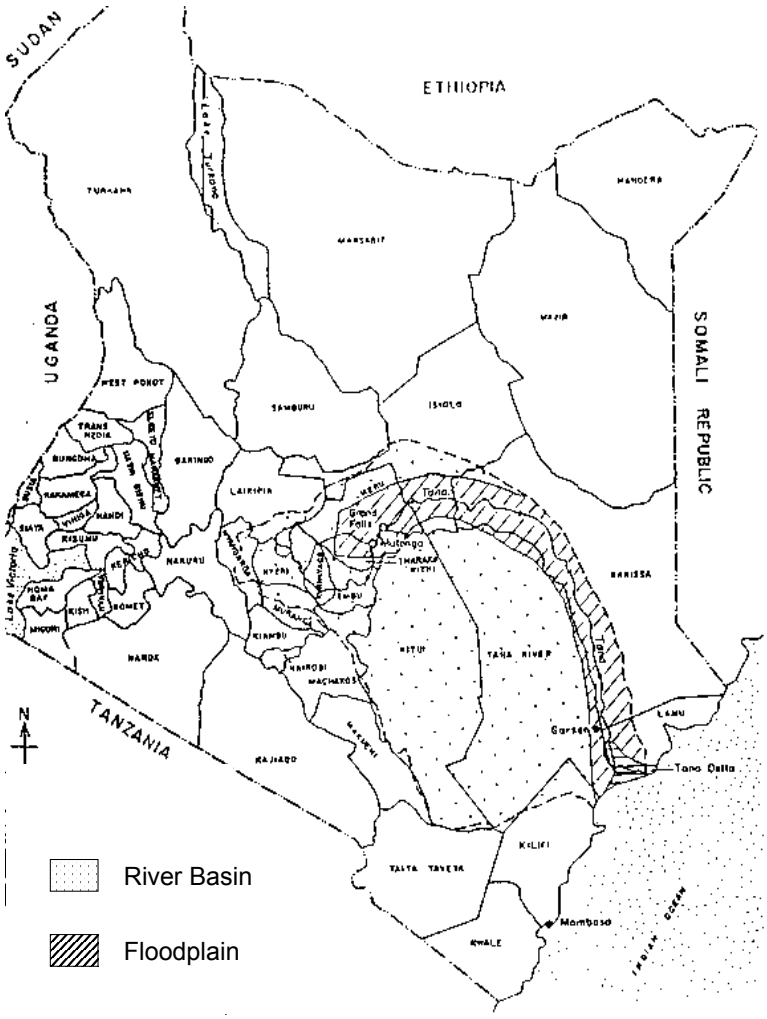
Impacts of the proposed Mutonga-Grand Falls Hydroelectric Scheme

A variety of options are being considered for the proposed Mutonga-Grand Falls dam, with a reservoir surface area of between 100 and 250 km^2, impounding time of between 9 months and 2.5 years and a rated power output of between 60 and 180 MW. All of these options will have some influence on downstream riverflow, compounding the effects of the 5 dams that have already been constructed on the Tana River. Prior to the construction of the existing dams, the Tana River used to flood its banks, usually twice a year. These biannual floods would inundate the floodplain and delta area up to a depth of 3 metres, supporting grasslands, lakes, seasonal streams, riverine forest and mangrove ecosystems. Since 1989, when the last dam was commissioned, flooding has decreased dramatically in volume and frequency.

The proposed Mutonga-Grand Falls dam would be the last stage in complete control of the Tana's waters, as after construction there would be no appreciable addition to its flow except in extreme events occurring every 5 and 10 years. This would effectively end the regular bi-annual floods, cut off most of the floodplain from water, and significantly lower the local water table. Reservoir construction would reduce the sediment loads transported down-river, and stabilisation and regulation of waterflow would lead to deepening of the river channel and limit

meander and oxbow formation. Changes in downstream ecosystems and biodiversity, which have already been heavily impacted as a result of existing dam construction, would be hastened and exacerbated. These include reduction in the area and composition of floodplain grasslands, lowering of surface and groundwater sources, loss of fertile riverbank sediment depositions, reduction in swamps, ox-bow lakes and seasonal water bodies, senescence of riverine forest areas and mangrove degradation due to inadequate freshwater flows.

Location of Tana River



Flood loss and the local economy

Almost 200,000 crop farmers, livestock keepers and fisherfolk live permanently in areas that are directly adjacent to the Tana River and the Tana Delta. In total, it is estimated that over a million people depend on the river's flooding regime for their livelihoods, including an additional 800,000 nomadic and semi-nomadic pastoralists as well as seasonal fisherfolk and fish traders. Almost 2.5 million livestock, including over a million cattle, rely on the Tana's floodplain grasslands and water bodies for dry season pasture and water[1]. With no other permanent water sources in the region, the Tana provides the only source of emergency and drought pasture, and in years of extreme low rainfall cattle populations more than double[2]. As the flooding regime has decreased, dry season pasture and watering points have become limited to the area that is directly adjacent to the river. Traditional patterns of transhumance have been disrupted, grazing pressure has increased, and there has been intensified conflict between pastoralists and floodplain agriculturalists over land and resource use on the Tana's banks[3].

About 115,000 people practice flood recession and riverbank farming around the Tana, which provides the only source of land in the region that is suitable for arable agriculture. These farmers depend both on floodwater to irrigate their crops, and on the depositions of fertile sediments that the floods bring. With dam construction, the possibilities for floodplain agriculture have diminished considerably, and it is likely that after the construction of the Mutonga-Grand Falls scheme cropping will be limited to riverbanks only[4]. Many farmers also depend on fishing as a source of income and household protein, and there is a thriving trade in fresh and dried fish in the main towns and cities of the area. The Tana River, Delta and estuary area support both subsistence and commercial fisheries, providing the main livelihood for more than 50,000 people[5] and yielding a freshwater catch of up to 500 tonnes a year[6]. Dam-related changes in river hydrology have already reduced the area and longevity of flood-supported wetlands and mangrove areas, as well as diminishing fish populations and diversity in the main river channel. It is thought that additional dam construction will rapidly exacerbate this decline in fishing area and catch[7].

The Tana River region contains unique species and habitats which are not found elsewhere in East Africa. Six protected areas are located in the river and delta area, including some of the few remaining riverine forests which support at least four endemic plant species, three of the four primates that are endemic to Kenya and two endemic bird species, and savannahs and grasslands that contain populations of large mammals such as hippopotamus, zebra, oryx, hartebeest, topi, lion, hyena, cheetah and leopard[8]. As well as supporting tourism activities, forests and wildlife are also utilised by local communities. Approximately a third of local populations in the Tana River and Delta region regularly hunt, and rely on fuelwood, construction materials, medicines, boat building materials and wild foods sourced from natural forest[9]. Forest and grassland areas, in particular, have been heavily impacted by dam construction, leading to changes in wildlife and plant species composition and numbers[10].

Valuing downstream flood loss

The aim of this study was to quantify the economic costs arising from flood loss and resulting downstream ecosystem degradation. The results were targeted specifically at influencing on-going economic appraisal and dam design processes, and so attempted to present a set of data that could be easily incorporated into the traditional cost-benefit approaches that were being used as a measure of dam profitability. To date consideration of the economic desirability of the dam had focused almost exclusively on physical construction costs and power generation benefits, and the choice of options for dam design had been driven primarily by considerations of cost effectiveness and revenue maximisation. This valuation study introduced an additional element of costs and benefits into project analysis and decision-making: those related to the environmental economic impacts of flood loss.

Flood recession agriculture on the banks of the Tana River

The valuation study was carried out as a component of an environmental impact assessment of the dam. It therefore had access to detailed data on flood-dependent ecosystems and human production systems, hydrological models of the river system, and likely impacts of flood reduction on biodiversity, ecology, hydrology and economic output. The study did not involve detailed primary data collection: rather, it was used to influence what kind of information was collected as part of other studies, and to collate and analyse these data in order to yield estimates of the economic values associated with flooding. For the most part, valuation focused on assessing and quantifying data that were collected on ecological and economic changes that had taken place to date as a result of existing dam construction, and assessing the economic implications of future changes that were predicted as part of a detailed river basin modelling exercise. The

Dried up irrigation intake, downstream of Tana dams

main method used for valuing flood-related economic impacts was to identify and analyse the changes in production and output that had already occurred, and would be exacerbated in the future, as a result of dam construction.

Analysis of data was carried out so as to yield a set of figures that could be related to each major ecosystem or sector that would be affected by dam construction, and which formed the subject of individual thematic studies carried out as part of the environmental impact assessment. It also generated a set of economic indicators of the overall ecological desirability of different dam design options, which could both be related to the conclusions of the environmental impact assessment and to the findings of prior cost-benefit analyses of the project.

Using ecosystem valuation to influence infrastructure planning

The findings of the study confirmed the extremely high, and quantifiable, costs of designing the Mutonga-Grand Falls dam in a way which would lead to continued reductions in downstream flooding. It showed that the construction of dams on the upper reaches of the Tana River had already imposed significant economic losses on downstream systems in terms of lost production, estimated to have incurred a net present cost of some $27 million, and that the incremental cost of building an additional dam would also be high, with a median present cost of almost $20 million.

Net present costs of dam construction with flood loss

	Cost to date of existing dams (US$ mill)	Median incremental cost of Mutonga-Grand Falls (US$ mill)	Human population affected
Livestock pasture and water	11.14	9.02	850,000
Floodplain agriculture	1.16	0.43	115,000
Commercial freshwater fisheries	0.32	0.21	3,600
Subsistence freshwater fisheries	0.92	0.60	50,000
Commercial marine fisheries	0.08	0.05	1,000
Subsistence hunting	1.04	0.58	31,000
Forest and mangrove utilisation	0.30	0.23	1,000
Domestic water supplies	8.36	5.68	45,000
Urban water supplies	3.42	2.33	18,750
TOTAL	**26.74**	**19.13**	**1,115,350**

The study also highlighted the significance of dam-related flood loss for local populations. The livelihoods of more than 1 million people have already been affected by changes in the Tana's flooding regime, and one of the poorest sectors of this population – nomadic and semi-nomadic pastoralists – bear almost half of the downstream economic losses associated with dam construction. The study also quantified the heavy toll that dam construction has had on floodplain farming, freshwater and marine fisheries, forest and wildlife use, and domestic and urban water supplies. Although largely unquantifiable, these economic losses have also been linked to severe, and escalating, social and cultural costs related to the loss of traditional livelihoods, growing pauperisation, social change and increasing conflict over scarce natural resources.

The major implication of the valuation study, and the wider environmental impact assessment of which it formed a part, was the strong support it lent to investing in measures which would

mitigate or minimise the effects of dam construction on downstream riverflow and flood regimes. By presenting estimates of the environmental cost of dam construction which could be integrated into more traditional economic appraisal frameworks and balanced against the gains and profits from electricity generation, it showed that some of the dam design options that had initially been indicated to be unprofitable – such as extending the commissioning period so as to permit adequate downstream flows and flooding, and construction of the reservoir and dam to allow for bi-annual flood simulation – would in fact yield the highest economic net present values and rate of return if environmental costs and benefits were taken into account. Incorporating such values into the economic appraisal process showed that such mitigative measures were not only economically desirable in the light of the new dam under consideration, but had an additional economic premium because they could also potentially reverse some of the changes – and economic costs – that had occurred as a result of dam construction to date on the Tana River.

This case study is adapted from:

Emerton, L., 1994, An Economic Valuation of the Costs and Benefits in the Lower Tana Catchment Resulting from Dam Construction, Acropolis Kenya, Nairobi

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Sekong Province, Lao PDR: economic returns from natural forests

The rich yet undervalued forests of Lao PDR

Among countries in Asia, Lao PDR is noted for its high forest cover (> 50%). However, this figure is steadily decreasing at an average rate of 100,000-200,000 hectares per year[1]. A major reason is that decision makers heavily undervalue the forest as a resource. The forest is mostly perceived in terms of its commercial value, not its importance for biodiversity and local livelihoods.

There is however a growing recognition of the importance of protecting watersheds and securing local livelihoods and some efforts are how being undertaken in Lao PDR to increase forest cover. The efforts include reducing slash and burn and developing reforestation programmes. However, given the high dependence of local communities on NTFP harvesting for their livelihoods, there is an ongoing debate about whether degraded forests should be transformed into plantation forests to increase long-term national and provincial income, or whether they should be allowed to regenerate naturally thereby favouring biodiversity and protecting the livelihoods of the current and future generations.

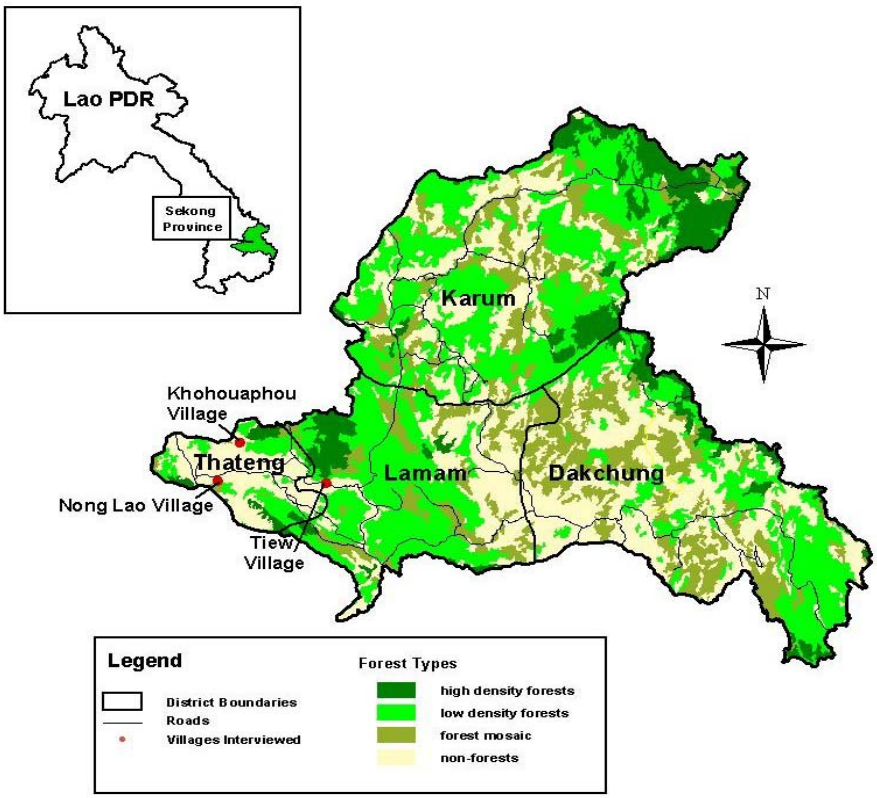
To inform this debate, and to demonstrate the links between biodiversity and current sectoral priorities and development needs in Lao PDR, IUCN and WWF jointly carried out a study to calculate the economic returns from conserving forests in Sekong Province. The main objective of this study was to influence development and economic sectors to integrate biodiversity concerns into their policies, plans, and budgets by highlighting the economic value of maintaining natural regeneration forests.

Sekong Province: rural poverty and abundant natural resources

Most of the pristine forest in Lao PDR is located in the south of the country, which includes the province of Sekong. The provincial government estimates that about 66% of Sekong's households are poor. GDP per capita is estimated to be at US$ 120, way below the national average at US$ 420, and the majority of those living in Sekong experience rice shortages every year. As of 2001, population in the province reached a total of 71,386 people, 35,987 of which were female. The total land area is 7,665 km^2 and Sekong is bordered by Vietnam to the east, Attapeu Province to the south, Saravane Province to the north, and Champassak Province to the west. Sekong is the second smallest province in Lao PDR and has the lowest population density of any province in the country (9.5 persons/km^2)[2].

While being a poor province in terms of financial capital, Sekong is very fortunate when it comes to natural capital. It is part of the Central Annamites, which has been identified as one of five priority regions of the WWF's Ecoregion Conservation Program in Indochina. Of particular importance is the presence of a wide range of rare, endemic and threatened taxa therein, including several large mammals such as the Tiger, Clouded Leopard, and the Asian Elephant. Douc Langur, Dhole, Asiatic Black Bear, and Sambar have also been recorded in Sekong. Bird diversity is also high in the area, with a total of 178 species identified in the above survey, including three of international importance – Crested Argus, Green Peafowl, and Spot-bellied Eagle Owl. The Ratchet-tailed Treepie and Great Hornbill were also observed. The diversity of fish, amphibian and reptilian species is most likely very high due to large expanses of undisturbed habitat and abundant watercourses, albeit there is a lack of scientific studies and inventories in this regard.

Forest cover in Sekong Province



Livelihood sustenance vs. economic development

The Annamites offer a significant source of livelihoods of its inhabitants, who mostly rely on forest resources for the following:

- Biodiversity-based activities, e.g. agriculture and aquaculture
- Non-timber forest products (NTFPs)
- Timber
- Watershed protection, such as for flood prevention and urban water supply
- Hydropower and associated activities

With the high level of poverty prevalent in Sekong many rural communities have difficulty meeting subsistence needs, especially at the end of the dry season, when NTFPs become an important component of their diet. Moreover, the incidence of acute malnutrition and chronically energy deficient children is high in Sekong relative to other provinces in Lao PDR[3].

Economic development therefore rates high on the provincial agenda and given the relative good state of the forests in Sekong, the provincial government has put forward a strategy to increase income by making use of its natural resources, mostly by harvesting timber and exporting these to bigger cities within the country. At the same time, in compliance with national strategies, a vital component of the five-year socio-economic development plan for Sekong is to stop slash and burn activities and to further arrest forest degradation. In order to meet national and provincial quotas on timber harvesting while simultaneously increasing the forest cover, certain portions of degraded forests, the current state of which were mostly due to slash and burn activities, are being allocated for tree plantations. Such schemes will necessarily compete with the alternative of letting forests regenerate naturally in the favor of biodiversity and livelihood sources.

Measuring Sekong's forests: economic values

Economic Benefits From, and Beneficiaries of Sekong Forests

Benefits/ beneficiaries	Village/ Community Level	Provincial Government	Watershed Catchment	Global Community
NTFP Harvests	X			
Timber Revenues		X		
Watershed Protection			X	
Carbon Sequestration				X
Biodiversity Conservation				X

The economic value of Sekong forests being measured refers to direct and indirect use values only and is derived through the following study sub-objectives:

- Estimate the direct use values of Sekong forests in terms of their contribution to livelihoods
- Estimate the financial returns from sustainable use of forests, mainly in the form of sustainable timber harvesting
- Estimate the indirect use values of Sekong forests in terms of their contribution to watershed protection, biodiversity conservation and carbon sequestration

The study does not try to capture option and non-use values, as doing so would require extensive surveys. Hence, the figures reported here are minimum, so to speak, and can easily become larger if more types of economic values could be captured and measured. As can be seen in the graph below, the values that will be estimated will pertain to all types of beneficiaries, albeit not all benefits accruing to the global community will be captured.

Two methods were used to compute for NTFP values. The first method consisted of the use of market prices of goods, where available, together with estimated quantities of harvest. Focus group discussions (FGDs) were conducted in three villages to get specific species and quantities harvested in a year. The second method applied was the Participatory Environmental Valuation (PEV) technique, whereby local villagers expressed the value of NTFPs within the context of their own perceptions, needs and priorities rather than through conventional cash-based techniques[4]. Cash measurements are of little relevance to subsistence economies, and values are better expressed through a numeraire that is accepted and accorded a high value in the village. It is important to note, though, that the numeraire must have a market value, even if the respondents are not aware of what it actually is. In the Sekong study, rice was used as the numeraire, given that it is the staple crop planted and eaten. Villagers were then asked to rank all the products extracted from the forest, including rice, by placing counters on each product harvested. The number of counters would signify the importance placed on that particular product. The value of each product was then expressed relative to the value placed on rice. Results of the PEV and the FGDs were then compared and used to validate each other. Ideally, the survey should have been done in a random fashion, covering more respondents. Due to the usual limitations of time and budget, this was not achieved. Nevertheless, the results should be taken to reflect relative amounts, and can be used for providing bases for policy recommendations, but not to calculate and extrapolate values for the whole country.

Natural forest area in Sekong

As mentioned the indirect use values considered in this study are composed of watershed protection, biodiversity conservation and carbon sequestration. Watershed protection refers to the function of the forest in protecting downstream users, such as irrigation facilities, micro-hydro power supplies, lowland agricultural production and fishery resources that fall within the watershed's catchment area, against floods and sedimentation. The production value of fisheries, agriculture, and hydropower, both existing and potential, are estimated. Also the presence of the forest facilitates the protection against damages from floods and erosion. The avoided costs from these damages are thus what would represent the value of watershed protection from Sekong forests. Biodiversity conservation services of the forest are estimated using the "revealed willingness to pay" of the government as expressed by its expenditures for forest conservation. Finally, for carbon sequestration, the benefit-transfer method (BTM) was used. BTM is an approach that involves taking the results from one or more primary economic studies with estimated values for similar impacts, and modifying and transferring them to the area being studied.

Sekong forests – how much are they worth, and for whom?

The forests of Sekong Province offer a wide range of economic and financial values that prove to be substantial and numerous. Estimates of direct use values show that the estimated annual value of NTFPs is between US$ 398 to 525 per household, figures which are way above the provincial average income of US$ 120. NTFPs thus prove to be a very important source of non-cash income for Sekong households, particularly for the poorest group. Moreover, the absolute value of NTFPs seems to be positively correlated with knowledge about the forest and its resources. As households veer away from poverty though, the relative contribution of NTFPs towards their livelihoods decline. Nevertheless, they still form a considerable portion of total income.

Sekong forest economic benefits

Type of Use/ Benefit	Annual Value (US$)	Annual Value (US$/ha)
1. Direct Uses		
a. NTFP	4,906,942 – 6,472,725	398–525
b. Timber Revenues	605,000	10.35
2. Indirect Uses		
a. Watershed Protection		
a.1 Fisheries & aquatic resources	135,919	0.47
a.2 Agricultural Production	714,550	2.5
a.3 Micro-hydropower facilities	792-5,367	.003 - .02
a.4 Potential hydropower supply	67,255,472– 455,575,755	233 - 1,581
a.5 Flood Control	26,597,000	92.3
b. Biodiversity Conservation		
Conservation Expenditures	1,887	0.07
Bioprospecting	13,658 - 68,289	0.11 – 0.55
c. Carbon Sequestration	649,400,000	1,284

As far as timber revenues are concerned, Sekong forests provide huge earnings for the provincial government. In 2003, the projected revenues could amount to US$520,000 and tax earnings could reach $85,000, bringing in a total value of $605,000 for the province. Caution should be applied, though, in relying too heavily on timber revenues, as history has proven that unsustainable logging will only lead to huge economic and environmental costs. Whatever short-term gains brought about by continuous logging can easily be wiped out by the long-term negative impacts it causes.

Approximations of indirect use values only further emphasize the importance of natural forests to people's lives. Watershed protection functions, in the form of erosion and flood control, allow

for enormous economic costs to be avoided. Hydropower generation is made possible, and allows for renewable energy production. Biodiversity, which is intricately interlinked with human existence and quality of life, is conserved because of the presence of forests. Finally, natural forests regulate the atmosphere through the sequestration of carbon, preventing global warming damages from occurring. Rough estimates are summarized in table 2.

Comparing the above findings with the average household income in Sekong province proves that the economic benefits provided by natural forest are of a substantial magnitude. Therefore, judging from the results, conserving natural forests in Sekong is a worthwhile undertaking and it thus becomes imperative that goals, which the provincial government set out to pursue, such as improved livelihoods and sustainable development and utilization of natural resources, should translate into the promotion and conservation of natural forests in order for them to succeed in the long run.

This case study is adapted from:

R. Rosales, M. Kallesoe, P. Gerrard, P. Muangchanh, S. Phomtavong and S. Khamsomphou, 2005, Balancing the Returns to Catchment Management: The Economic Value of Conserving Natural Forests in Sekong, Lao PDR. IUCN Water, Nature and Economics Technical Paper No. 4, IUCN — The World Conservation Union, Ecosystems and Livelihoods Group Asia.

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Pangani Basin, Tanzania: catchment conservation for downstream water flows

As water resources become increasingly scarce in Africa, the need for the use of economics to aid in decision-making and management becomes apparent. Indeed, global experience shows that economic approaches may achieve the best results. Water is the basis of the economy as well as essential for human life and biodiversity. The Pangani River Basin in north-eastern Tanzania provides a good starting point for evaluating the economic issues around water resources and how economics can be used to improve their management to align with national goals.

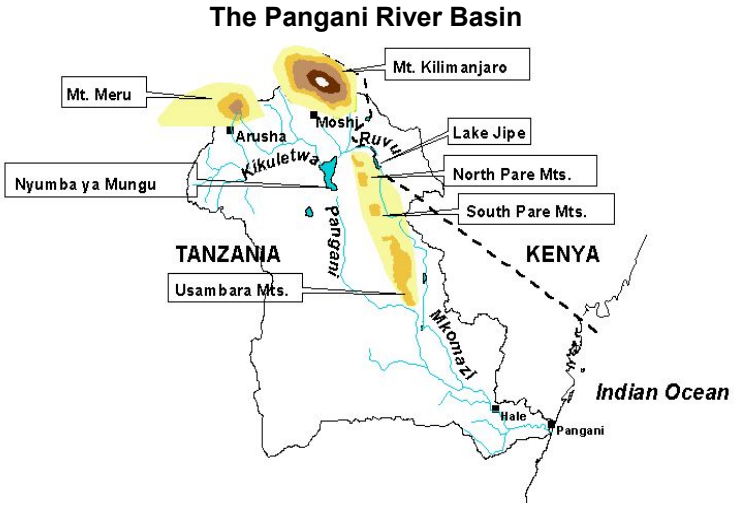
Tanzania has committed itself to an ambitious poverty reduction strategy, and plans to transform itself into a middle-income country by 2025. This will require massive economic development and growth. Yet Tanzania faces water scarcity in some cases, at least partly due to the inefficiency with which water is allocated and used. This scarcity has been exacerbated by population and economic growth which has not been accompanied by improved resource management. Fortunately Tanzania has adopted a progressive National Water Policy that aims at sustainable development and management of water resources. A Water Resources Strategy and Legislation are being drafted. For the first time, water allocation will consider both human needs and environmental protection. In addition, the policy aims to implement fees for financing water resources management and to use economic and other instruments to manage the use of water resources and ensure long term sustainability.

The principal concerns affecting water resource management in the Pangani basin are:

- **Threats to water supply** – due to climate change, forest degradation, inefficient uses and pollution;
- **Increasing demand for water** – due to population and economic growth;
- **Shortages for power generation** – due to upstream water abstraction and siltation of dams;
- **Conflicts over water resources** – between different sectors and between upstream and downstream users;
- **Environmental degradation** – due to reduction in water flows necessary to sustain ecological processes and sustainable livelihood practices;
- **Insufficient funds for water resources management** – inadequate government funding exacerbated by lack of income from users;
- **Cultural heterogeneity** – the diversity of users and their relationships with the environment creates challenges for water management.

The Pangani River basin and its management

The Pangani River drains a basin of 43,000 km^2 in north-eastern Tanzania and a small part of Kenya. The basin contains fourteen districts and two municipalities, falling within the Kilimanjaro, Manyara, Arusha and Tanga Regions of Tanzania. Mount Kilimanjaro and Mount Meru provide the main source of river flow, and the basin also drains the Pare and Usambara Mountains in the north-east. Numerous tributaries drain the mesic highland and upper basin areas, whereas water is far more scarce in the arid lowland areas, with the Pangani River being a prominent feature in the landscape.



In addition to several small natural lakes, a dominant feature is the 14,000 ha Nyumba ya Mungu Dam located on the Pangani River in the upper basin. Several wetlands exist in the basin, most notably the Kirua swamps downstream of Nyumba ya Mungu which covers 90,000 ha.

The highland and upper basin areas are characterised by urbanisation, densely populated rural areas and cultivation. The lowlands have scattered croplands associated with smaller settlements, usually close to the Pangani River. Arid rangelands make up much of the remaining landscape. The total population of Pangani River Basin is approximately 2.6 million. Population growth rates are up to 4.0% in the highland areas (Arusha Region) but relatively low towards the coast (1.8% in Tanga Region).

While water supply depends primarily on precipitation in the highland areas, it is greatly affected by management of the whole catchment, particularly in the highlands. Natural forest cover encourages infiltration of water during the rainy season, which is then released gradually, maintaining flows throughout the year. As forest and other vegetation and soil cover is degraded, so less water infiltrates and more water is lost during flood periods. The quality of water supply is also affected by catchment activities which lead to soil erosion and pollution.

Water resources of the Pangani River Basin plus three much smaller basins (total 56 000 km2) are managed by the Pangani Basin Water Office, which allocates user rights for water. Most water allocated is to the higher lying areas. The natural environment has not been considered as a consumer of water and has therefore not received direct water allocations. Indeed changes in the management of Nyumba ya Mungu Dam since 1994 have led to reduced downstream flows and the consequent drying up of a large proportion of the Kirua Swamp. Environmental resources have been effected as far as Pangani estuary, where saltwater intrusion is a problem, and the associated near-shore environment, where some farming and fisheries are thought to have declined as a result of decreased freshwater flows.

The Value of Water Consumption

Domestic Consumption

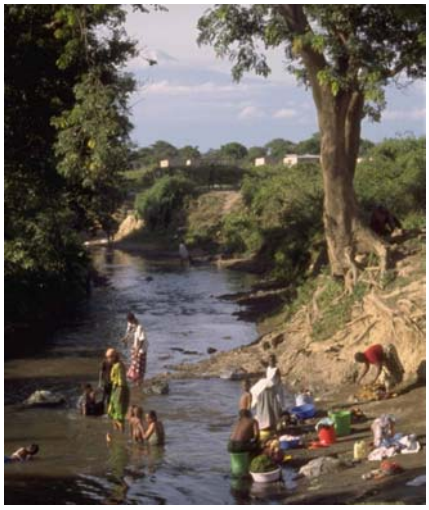
Domestic consumption of water could be argued to be the most important type of water use in the basin, in that it is vital to human wellbeing. Tap water is supplied to major urban areas, smaller towns and a large number of rural villages. However, a large proportion of the population relies on fetching their own water from rivers and wells (rural population of Pangani River Basin = 2.16 million, urban population = 427,000). Urban consumption is estimated to be in the region of 70 litres per person per day, while rural consumption is about 37, 22, 18 and 28 litres per person per day in the highlands, upper basin, lowlands and coastal areas respectively.

The value of water for domestic use is probably better reflected by the willingness to pay, demonstrated through trade of water in rural areas, than by prices set by authorities in the urban areas. Water prices are equivalent to Tsh 1,500, Tsh 1,250 and Tsh 1,200 per m^3 in the highlands, lowlands and at the coast respectively, far higher than the prices charged by PBWO. Total willingness to pay for, or value of, domestic water supplies in Pangani River Basin is estimated to be in the order of Tsh 37 – 46 billion.

Irrigated Agriculture

Agriculture is the biggest user of water with over 50,000 ha of fields irrigated in Pangani Basin. This includes large commercial estates (mainly coffee, also sugar), flower farming and small-scale mixed cropping. Small-scale farmers have plots of about 0.1 – 0.2 ha in the highlands, increasing to 0.8-1.5 ha in the lowlands.

Rural water users



Coffee is Tanzania's largest export crop, and is produced on large estates and by small-holders. Production is strongly correlated with rainfall and irrigation inputs. Large scale coffee production in the study area consumes an estimated 1,000 m3 per ha per year (excluding processing), generating an average income of about Tsh 700 – 6,000 per m3 of water consumed. Sugar production is mostly large-scale, but it is also grown by small-scale farmers. About 85% is sold locally, the remainder being exported. Sugar consumes about 12 – 17,000 m3 per ha per year (excluding processing), with an average value of roughly Tsh 30 – 100/m3 water. The greenhouse-based cut-flower industry covers a total of 80 ha, and is mostly for export. Water consumption is estimated to be about 18,250 m3 per ha per year, but average value is estimated to be as high as Tsh 3,500 – 5,300/m3.

Small-scale farmers make use of an estimated 2,000 traditional furrows which tap water supplies from springs and rivers. Some of these have been improved in more modernised irrigation schemes, with the result that efficiency of water use ranges now from less than 15% to over 50%. Over 20 different crops are grown by small-holders in the basin, with most farmers growing a variety. Maize is the most ubiquitous crop, both in irrigated and non-irrigated areas. Coffee is grown by most households on Mount Kilimanjaro and Mount Meru. This is usually in association with bananas, grown by almost 90% of households in this area, and maize. Bananas are also grown by about a third of households in the lowlands. Tomatoes are grown in all areas, but tend to be more frequent in irrigated areas, particularly in the highland area. Beans are very commonly grown in the upper basin and highlands, but not in the lowlands.

While the highlands are too cool for rice production, it is a major crop of irrigated areas in the upper basin, and is planted to a small extent in the lowlands, in irrigation areas or in close proximity to flooding areas. Farmers in the highlands and upper basin that do not have access to irrigation concentrate their efforts on maize, beans and onions, as well as a variety of fruits and vegetables. Sugarcane is a very minor crop on smallholder farms, but grown throughout the basin. Cassava is only grown in the lowlands, as are peri-peri, paprika and fiwi. Okra is more commonly grown in the lowlands. Around the Pangani estuary, farmers concentrate on coconuts, betelnuts, cassava, sweet potato and pumpkin, as well as maize and bananas, but there is very little irrigation.

Survey data from a small sample of households throughout the basin suggests that income from crops is typically in the range of Tsh 350,000 – 600,000 per household per year. However, much higher incomes have been reported from traditional furrow systems in the upper basin, in some cases higher than that of improved irrigation schemes.

Nevertheless, it is easily demonstrated that irrigated areas produce higher incomes per ha than fields without irrigation in the upper basin. This was not necessarily the case in the Kirua swamp area, where similar incomes are obtained from crops grown within regularly-flooded areas to that from furrow irrigation areas nearby. The non-irrigated agriculture around Pangani estuary yielded similar incomes per ha to the rest of the lowland areas. Estimated average gross income per m3 of water used ranges from Tsh 100 – 1,400, depending on the area of the basin and the type of irrigation.

Average value added per m^3 water in different uses. These are rough estimates only*.

Type of use	Estimated water consumption	Estimated average value (Tsh per m^3)
Domestic use	18 – 70 m^3/head	1200 – 1500
Coffee estates	1000 m^3/ha	723 – 6205
Sugar estates	12 – 17 000 m^3/ha	32 - 101
Flower farms	18 250 m^3/ha	3500 - 5300
Small scale irrigation		
Highland traditional furrow	3000 m^3/ha	211
Upper basin traditional furrow	3000 m^3/ha	475 – 574
Upper basin improved schemes	850 – 1195 m^3/ha	574 – 1400
Lowland traditional furrow	3000 m^3/ha	109
Livestock		
Highlands (dairy cattle)	36 m^3/head	2263
Upper basin (dairy & beef cattle)	27 m^3/head	860
Lowlands (beef cattle, goats)	18 m^3/head, 2.5 m^3/head	479 – 926
Aquatic ecosystems	?? m^3/ha wetland	Still unknown
Hydro-electric power production	2.4 -19 m^3/kWh	73 – 300(?)

*Estimates are based on a study conducted in Oct-Nov 2003, which entailed interviews with TANESCO, municipalities, estate managers, irrigation scheme representatives, and 203 households in 14 villages in four parts of the basin. For full details see Turpie *et al.* (2003).

A note on water values

It is important to note that the average values presented here are not values upon which water allocation decisions should be based. The average value of water in different productive activities is a problematic concept, because it is impossible to 'allocate' the net benefit of a production activity to any one of its inputs, such as water. The measure that is actually required is the net marginal value of water in different uses. This is the added value gained by adding an extra unit of water to any particular use. As more water is allocated to any particular use, the added value will diminish. This sort of value is determined by the construction of data-intensive production functions in which the change of output can be predicted for a change in water input, and should be the focus of future studies.

Livestock

Livestock are kept throughout the basin. In the highland and upper basin areas, households keep small numbers of cattle and goats and sometimes sheep. In the densely-populated highland and upper basin areas, most cattle are stall-fed ('zero-grazing') dairy cattle, but a few households in the upper basin have larger herds (up to 32), which are grazed. In the lowlands, cattle and goat herds are much bigger, and almost all associated with the Maasai community, who are also the only community keeping donkeys. Other tribes in this area keep very few livestock, mainly small number of goats. Very few households keep livestock close to the coast. Income per unit of water consumed ranged from Tsh 480 - 2,300, being highest in the highlands, but was also high for Maasai herds in the lowlands.

The Value of Water

Environmental Goods and Services

Water supply in the Pangani River Basin is crucial to the functioning of the basin's aquatic ecosystems. Apart from the intrinsic value of these ecosystems, they provide goods and services that contribute to the economic wellbeing of inhabitants of the basin. These include aquatic plants, such as reeds, sedges, mangroves, food and medicinal plants, and aquatic animals, including fish, crocodiles, hippos and water birds that can be harvested for household consumption or sale. The supply of all of these goods and services is affected by the quantity and quality of runoff in the catchment. Their value is determined by the degree of use and the sustainability of that use.

On average, households derive modest incomes from aquatic resources, increasing from a very small amount of income in the highlands to a fairly large amount in Pangani estuary. Fisheries are the major source of income from aquatic resources, but palms also make a substantial contribution. The value of plants such as reeds and sedges are small, but this belies the degree to which they are used. Their low value is due to their relative abundance. The value of mangroves is probably underestimated. Although income from aquatic resources is small, they are significant in the context of overall household income. The perception by households themselves is that aquatic resources contribute some 4 – 23% of household income (including subsistence values).

Urban water users

Linking the values of aquatic ecosystem goods and services to flow is more problematic, however. Calculation of the average value per m3 water would require relating the supply of these goods and services to the overall annual flows in different parts of the basin. This would not be a particularly useful measure, however, since the relationships between flow and the production of ecosystem goods and services is complex, and yet to be studied in the Pangani River Basin.

More importantly, as is true for all of the values reported in this study, the average values calculated are not as important as understanding the marginal value of water in different uses. For example, how will reed supply change if water allocation to the environment changes in a particular area? Such estimates can only be made in conjunction with a scientific study.

Overall average value per household derived from harvesting of aquatic resources (including value added in processing), averaged across user and non-user households (Tsh per year)

	Highlands	Upper basin	Kirua Swamp	Pangani estuary
Food & medicinal plants	63	815	2 383	170
Reeds, sedges and grasses	2 120	2 433	2 852	0
Palms	0	4 269	4 434	86 721
Mangroves				7 890
Reptiles, mammals & birds		6	8	
Fisheries		392	33 883	693 012
Average total income per household	**2 183**	**7 915**	**43 560**	**787 793**

Hydropower Production

The Pangani River makes a substantial contribution to Tanzania's electricity supply. The country's power supply is mainly from hydropower, with three Hydro-electric power stations in the basin, at Nyumba ya Mungu, Hale and New Pangani Falls, contributing 17% of the country's capacity. The power output never reaches the installed capacity, however, due to shortages of water flow. Power production at Nyumba ya Mungu relies on storage of water in the dam during rainy seasons and then a relatively constant release of water through the turbines.

This regulation by the Nyumba ya Mungu dam also ensures a relatively even flow to the downstream power stations at Hale and New Pangani Falls. The latter are more modern and translate flow into power far more efficiently, with New Pangani Falls being 8 times more efficient than Nyumba ya Mungu in terms of output per unit of water. The average price

obtained per unit of power is Tsh 73/kWh. However, the value of power generation in terms of its impact on national economic output would be far higher.

Incentives for Sustainable Water Resources Management

Influence of Sectoral policies on water supply

National policies have an impact on how water resources are used and managed. Policies which have negative impacts are those which directly or indirectly promote natural resource exploitation (e.g. catchment deforestation) or weaken control of catchment resource use. Some of these same policies can also have positive impacts, however, depending on how they are translated into action. For example, privatisation and trade-liberalisation can create opportunities for greater efficiency and environmental friendliness when they occur in conjunction with incentive measures such as marketing standards and tradable pollution permits (see table on the right).

Sectoral policies also have major implications for water resources in the Pangani River Basin. While the environmental sector policies such as forestry, wildlife, environment, fisheries, beekeeping and water generally promote sustainable practices that would enhance water supply, policies such as agriculture and minerals do not have sufficient emphasis on curbing environmental damage and in some instances inadvertently promote it.

The result of the existing policy and management background is that there is little incentive for landowners to conserve catchment areas important for water supply, for industries and households to curb pollution, or for anyone with access to water to use it sparingly.

Landowners in important catchment areas are not rewarded for conserving forests and soil, which would usually carry a cost to the landowner. There is little to effectively discourage polluting water supplies, since regulation is weak. Access to water itself is technically regulated, but enforcement of these regulations is weak. Not all users are required to pay for their water, and among those that are, there is a general culture of non-payment for water for a whole range of users including urban domestic use and irrigation use. Indeed, even the structures that regulate flow into irrigation canals are often modified by local users so that they can draw off greater flows. When water is free or effectively free, there is no incentive to use it efficiently or to invest in technology that improves efficiency. This is especially true where such improvements are costly. Crop choices may not be optimal if water resources are not seen as a scarce input. The open access nature of water created by a weak system of control not only promotes over-utilisation but exacerbates conflicts as upstream users will take as much as they can, thereby depriving the downstream users of the valuable source.

Macro-economic policies that can have negative or positive effects on sustainability of water use (depending on context)

Policy	Negative	Positive
Civil service and public admin reforms	✓	
Market liberalisation	✓	
Financial sector reforms	✓	
Reducing government expenditure	✓	
Deregulation of forex controls	✓	
Privatisation	✓	✓
Trade liberalisation	✓	✓
Fiscal reforms	✓	✓
Export promotion and globalisation	✓	✓

Integrating economic instruments into sectoral policies

The new water policy proposes that all water users will be charged, and charges will include instruments such as pollution charges. Provided this can be enforced, appropriate fees and

penalties should create incentives for conserving water resources and abating pollution. The issue of catchment degradation will also need to be addressed.

Economic instruments that should be employed as incentive mechanisms include:

- **Water pricing:** encouraging efficient use and generating revenues for catchment management
- **Tradable water rights:** to promote efficiency of water use
- **Pollution charges:** to internalise the external costs of pollution and generate revenues for rehabilitation
- **Tradable pollution permits:** to internalise the external costs of pollution and create the incentive for abatement
- **Subsidies and taxes:** to penalise damaging activities and reward conservation efforts
- **Watershed conservation payments:** paid by the PBWO to the catchment managers (public and private) in return for certain management actions that enhance water supply services.

There is a wide array of economic instruments which can be integrated into sectoral policies and contribute to sustainable management of water resources. Some of the sectoral policies have already recognised the need to include these instruments in their Acts while other sectors are still contemplating this.

The survey and consultations with stakeholders conducted by Mkenda and Ngaga (2003b) showed that there are good prospects for introducing economic instruments for environmental management in Tanzania. The use of user charges, fees, taxes, royalties and fines is widespread in the country, even if they were not necessarily put in place for regulating behaviour with respect to the environment and water resources, but for revenue generation. The fact that such instruments are in place makes it easier to adapt them in various policies as economic instruments for sustainable water resources.

Financing Integrated River Basin Management

A drastic improvement in the management of the basin's water resources will require improved funding. As it is, the Pangani Basin Water Office cannot meet their obligations adequately with their existing funding. This stems from (a) inadequate provision from central government (via the Ministry of Water and Livestock Development) and (b) inadequate recovery of water user fees. The result of this is that the PBWO has inadequate resources for planning, enforcement and monitoring, let alone for setting in place a system for the optimal allocation of water resources.

In 2003-2004, most of the PBWO's finances came from user fees (65.9%), including a TANESCO royalty (30%) which is divided between established water basins. In 2005-2006, the TANESCO royalty will become as less significant component of the PBWO budget as it will be shared amongst all nine river basins.

There is an enormous capacity to increase the revenues from user fees due to the large degree of non-payment, and due to the fact that most users are currently not charged for water use at all. Improved collection should be the priority, but this will require ensuring the equity of the water user fee system as well as improving the enforcement capacity

Catchment forest in the upper Pangani basin

of the PBWO.

The way forward

The increasing scarcity of water resources in the Pangani River Basin calls for strategic water resources management that will ensure the sustainability of water supply and the goods and services supplied by aquatic environments, as well as the efficient and equitable use of these resources. Sustaining water supplies for the numerous users in the basin will depend on reducing losses due to catchment degradation and wastage due to inefficient practices. The former will need to be addressed by creating incentives for catchment managers to maintain catchment forest areas, preferably through a system of 'payments for ecosystem services' which involves payment by those that benefit from the service, via the PBWO, to catchment managers. The price increases required for this will also serve as a demand management tool that encourages more efficient use of the water that is allocated to various uses.

Before water is allocated among different user sectors, it will be necessary to allocate sufficient water to aquatic ecosystems to maintain ecosystem functioning and the values derived from them. This can be achieved with the help of an 'instream flow assessment' which takes both ecological and socio-economic factors into account.

It is possible that ecological requirements can be met by better water management without compromising the amount of water that can be utilised. The allocation of remaining flows needs to be done in such a way as to achieve maximum economic benefits from water within the constraints of certain equity and sustainability considerations. This will best be achieved through more rigorous study of the economic benefits of water in alternative uses in different parts of the catchment, together with the use of a multi-criteria decision tool that can take other goals into consideration.

A project intervention in Pangani Basin will begin to explore some of these relationships by collecting information on the economic, environmental and social costs and benefits of various water allocation scenarios.

This case study is adapted from:

Turpie, J.K., Ngaga, Y. and Karanja, F. 2003. A preliminary economic assessment of water resources of the Pangani River Basin, Tanzania: Economic value, incentives for sustainable use and mechanisms for financing management. IUCN — The World Conservation Union Eastern Africa Regional Office, Nairobi

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COUNTING THE COSTS OF URBAN WETLAND RECLAMATION

Urban wetlands are being rapidly modified, degraded and otherwise interfered with. A major reason for this is that wetlands are seen as having little or no value compared to "developments" which yield more immediate and obvious profits. Yet although financial and economic analysis has played a major role in encouraging and justifying the spread of industrial developments and urban settlements into wetlands, it has rarely considered the economic costs that are associated with wetland exploitation and reclamation. Decisions have been made on the basis of only partial information, because they have omitted consideration of the value of the wetlands themselves.

It has become clear that that biological and ecological arguments, alone, are not enough to ensure that urban wetlands will be conserved. Wetlands have to be demonstrated to make a tangible contribution to urban development requirements if they are to be maintained in towns and cities. But just as urban planners have traditionally seen little need to take environmental values into account when they make land use decisions, so environmental managers have rarely presented a convincing economic justification for wetland conservation in an urban setting.

Despite their low perceived value, urban wetlands however often contain important biodiversity, generate essential ecosystem services, and provide some of the few remaining green spaces left for city dwellers to enjoy. All of these attributes generate a wide range of economic benefits. These types of values have a particular importance in countries where levels of urban poverty are high and public sector budgets are low. Wetlands often help to fill the gap between the level of basic services and amenities that governments are able to provide, and that which rapidly increasing urban populations demand.

Both of the case studies described in this chapter demonstrate how economic arguments can provide a strong – and much needed – justification for urban wetland conservation. They illustrate that wetland status is not just a biological or ecological concern, but is also an economic and development issue. It is clear that, for cities such as Kampala, Colombo or Vientiane, the question is not whether processes of industrialisation and urbanisation should take place – of course they should, because they form a key part of most developing countries' future economic growth, and generate obvious social and economic benefits. Rather, it is becoming increasingly obvious that it is necessary to question the ways in which these developments are conceptualised, planned and implemented. When urban developments encroach on wetland ecosystems, they almost always give rise to immense social and economic costs. Not only do these costs typically accrue to the poorest and most vulnerable sectors of the population, but they can undermine the very aims of urban development itself – better provision of services, acceptable standards of living, and income and employment generation.

Nakivubo Swamp, Uganda: managing wetlands for water quality

Planning for urban development in Uganda

Wetlands in Uganda cover some 30,000 km^2, or about 13% of the country[1]. Although almost all of the wetlands in the country are under threat in some way, those located in towns and cities face the perhaps the most intense pressures. Over the last decade Uganda has entered a period of rapid economic growth, infrastructural rehabilitation and urban expansion. Already over 14% of the country's inhabitants live in cities, and urban populations are increasing at a rate of more than 5% a year – almost twice the average in rural areas[2]. There is a growing demand for housing and land for settlement, rapid construction is taking place, and industrial and commercial activities are increasing. To date, most of these developments have been implemented in the absence of proper planning and controls, and have involved wetland drainage and reclamation[3].

Slowly, ways of carrying out urban planning are beginning to change. The Wetlands Inspection Division of the Uganda Ministry of Water, Lands and Environment – the national government agency mandated with wetlands management in Uganda – has started to work closely with urban planners. For one of the first times in Eastern Africa, valuation is being used to give a more complete picture of the economic desirability – and long-term viability – of reclaiming wetlands as part of urban development programmes, and to point to ways of managing them as an integrated component of city landscapes and services.

This chapter describes a pilot study carried out in Nakivubo Swamp in Kampala, Uganda's capital city, which focused on the economic value of wetland wastewater purification and nutrient retention functions. The study made the point that, contrary to the dominant development imperative, residential and industrial development in Kampala's wetlands does not necessarily make good economic sense, and cannot be based only on consideration of immediate financial gain. These expectations of private profits also have to be balanced against the broader social and economic costs which arise from urban wetland degradation and loss.

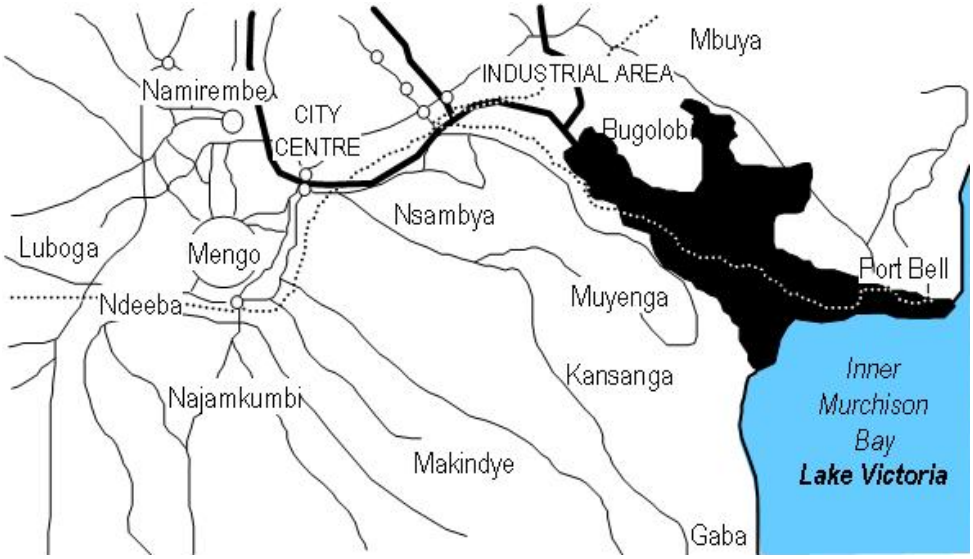
Nakivubo Swamp

Almost one sixth of Kampala, or 31 km^2, is covered by wetlands[4]. Despite the designation of most of the city's wetlands as "green corridors" in the 1994 Kampala Structural Plan, many have been zoned for urban expansion and development and have either been converted to industrial uses or have gradually been taken over by settlement[5]. Today it is estimated that about three quarters of the city's wetlands have been affected by human activities to a significant level, and up to 14% are seriously degraded[6]. If current trends continue, there is a real danger that Kampala's wetlands will soon be modified and converted completely.

Of the twelve main wetland areas of the city, Nakivubo Swamp is the largest. Covering a surface area of 5.29 km^2, it has a total catchment extending over 40 km^2. The wetland is fed by the Nakivubo River and its tributaries the Katunga, Kitante, Lugogo and Nakulabye. It is dominated by papyrus (*Cyperus papyrus*) grading to dry land through cat tails (*Typha sp.*) and common reeds (*Phragmites sp.*), with a large area on the north east side covered by *Miscanthidium* grass. The wetland is bisected by a railway line, running from the city to Port Bell on the shore of Lake Victoria. This effectively divides it into two zones of human influence. While wetland areas to the south of the railway are still relatively intact, northern parts have been modified substantially. Much of the shallow upper zone has been reclaimed for settlement and industrial development, or is under cultivation. The deeper, lower zone below the railway

line comprises a floating papyrus swamp, and contains only a small amount of cultivation on its fringes.

Location of Nakivubo in Kampala District



The wetland runs from the central industrial district of Kampala, passing through dense residential and industrial settlements before entering Lake Victoria at Murchison Bay. More than 100,000 people live on the fringes of the wetland, including both high cost housing estates and low-cost, high-density settlements and slums. To the north of the wetland, Kampala's main industrial area contains more than 200 large, medium and small-scale enterprises. These include breweries, soft drink manufacturers, distillers, oil and soap factories, dairy producers, abattoirs and meat processors, fish processors, paint producers, tanneries, bakeries, metal works and garages, plastic and foam industries, saw mills, battery manufacturers, pharmaceutical industries, shoe makers and paper makers. Although like most wetlands in Kampala Nakivubo has been subjected to a gradual process of conversion and reclamation, it currently faces some of the most extreme threats and pressures. The area around Nakivubo, including the wetland itself, are regarded as prime sites for urban development – due to their proximity to the city centre and industrial district, as a result of land shortage in the city, and because land prices are still relatively cheap as compared to other parts of Kampala.

The role of the wetland in wastewater purification and nutrient retention

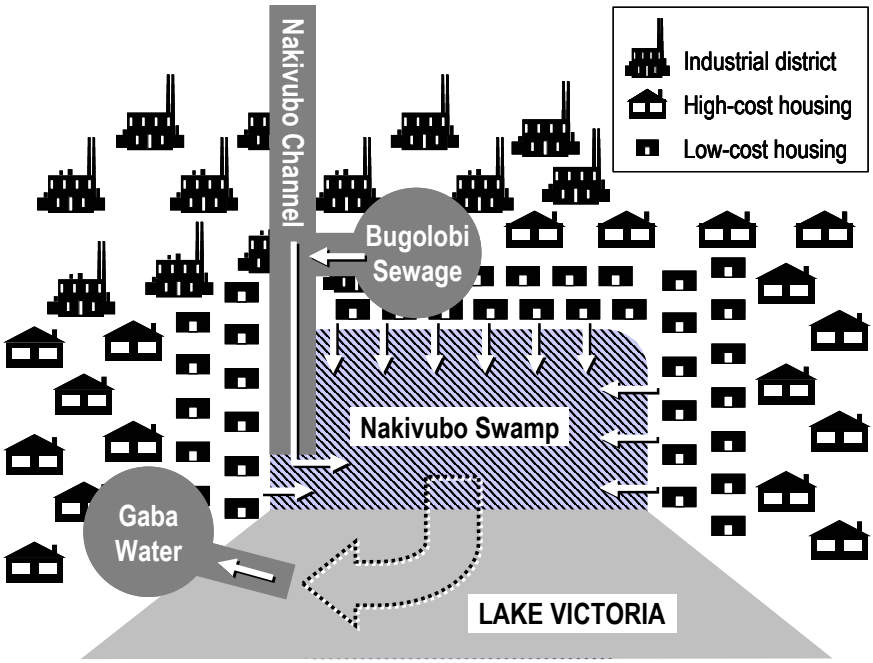
Nakivubo's characteristics and location means that it provides a unique and important set of services to Kampala's dwellers. It functions as a buffer through which much of the city's industrial and domestic wastewaters pass before being discharged into Lake Victoria at Murchison Bay. The Nakivubo River and its tributaries, which flow into the wetland, provide the main drainage channel for Kampala. They carry wastewater from the city centre, industrial area, and residential zones. Up to 90% of Kampala's residents are not connected to a piped sewerage supply and so these wastes are largely organic. Together they are equivalent to the raw sewage produced by almost half a million people – or 40% of the population of Kampala (COWI/VKI 1998). The outflow for Kampala's sewage treatment works, at Bugolobi, also runs into the wetland. Partially treated sewage is mixed with the untreated effluents already in the Nakivubo Channel before entering the wetland, where it contributes about 7% of the total nutrient load, equivalent to an additional flow of sewage from about 7,000 persons[7].

The majority of the low-cost residential settlements abutting Nakivubo are excluded from the municipal sewerage system. More than 33,000 persons discharge domestic wastes into the wetland, either as runoff into the surface waters which enter it or through groundwater inflows from the infiltration of rainfall on hills beside the swamp, from pit latrines, septic tanks, soak pits

and leaking waste pipes. At least three other point sources of wastes enter southern parts of the wetland directly, including effluents from Uganda Breweries and two sewage outflows from Luzira Prison. Nakivubo Swamp also receives industrial effluents. Up to a third of the enterprises in the industrial area have no treatment facilities, and so dispose of their wastes directly into the wetland. Effluents and pollutants contained in these untreated wastewaters, and in the industrial wastewaters which have passed through Bugolobi sewage treatment works, include detergents, lubricants, oils, acids, xenobiotics, nitrates, phosphates and heavy metals such as zinc and mercury.

At the same time, the intake for all of Kampala's piped water supply is located at Gaba, some 3 km to the south west of the wetland's outflow into Murchison Bay. Nakivubo plays a significant role in maintaining the quality of both the city's water supply and the open waters of the Murchison Bay part of Lake Victoria. The wetland has a high nutrient retention capacity, and is effective in removing bacteria and microbes. It physically, chemically and biologically eliminates pollutants and sediments from the wastewater which passes through it, and reduces the pollution load entering Inner Murchison Bay through mineralisation and sedimentation processes. Of particular significance is the capacity of wetland plants to remove phosphorus and nitrogen, the accumulation of suspended solids, pollutants and pathogenic organisms in the wetland's bottom sediments and their decomposition, the conversion of heavy metals from soluble to insoluble forms and the dilution of effluents effected through density currents caused by the difference in temperature between wetland and bay water.

Wastewater loads entering Nakivubo



Valuing Nakivubo's services

The Nakivubo study aimed to quantify the value of wetland wastewater purification and nutrient retention functions, so that they could be balanced against the potential gains from wetland conversion for industrial and residential developments. It was the first time that any attempt had been made to quantify the value of Ugandan wetlands' ecosystem services. A key concern was thus to choose methods which would not require complex, lengthy or costly primary data collection, which could be easily replicable in other Ugandan wetland sites in the future, and which were achievable given the time, financial resources and human capacity available for the study. At the same time it was necessary to produce an economic argument and set of recommendations which were convincing to urban planners and decision-makers, were defendable, and would stand up to outside scrutiny.

Two valuation methods were applied to the case of Nakivubo: the avoided costs of replacing natural wetland functions with man-made alternatives, and the foregone expenditures on mitigating or offsetting the effects of wetland loss. Either one of these values represents an estimate of the minimum economic benefit of the wetland in terms of alternative expenditures saved by not having to supply equivalent wastewater purification and nutrient retention services through other means. The study focused on assessing the value of Nakivubo in treating domestic wastes, as they contribute by far the greatest quantity of wastewater and highest proportion of the total nutrient load entering the wetland, both at the present time and for the foreseeable future. Industrial wastes, although containing much higher concentrations of toxic substances, currently add less than a quarter of total nutrients, and only yield low loads of heavy metals, BOD and COD.

Replacement costs included two components: connecting Nakivubo channel to an upgraded Bugolobi sewage treatment plant which could cope with the resulting additional wastewater load, and constructing elevated pit latrines to prevent sewage from low-cost settlements from entering the wetland. All of the data required to calculate these values were readily available. The additional capital and recurrent expenditures required to link Nakivubo Channel to the Bugolobi treatment works, and to extend its capacity to serve a population of more than half a million people had already been calculated by the National Water and Sewerage Corporation. The fact that these figures had been prepared as part of a feasibility study for a project that did not, in the end, take place merely served to highlight the importance of the existing services provided by Nakivubo. Information on the cost of building elevated pit latrines was acquired from a similar part of Kampala whose proximity to a wetland meant that there was a high water table and recurrent waterlogging.

The major mitigative or avertive expenditure required to offset the effects of impaired water quality arising from wetland loss would be to move the inflow for Kampala's water supply to an alternative location sited away from the outlet of wastewaters into Inner Murchison Bay. Again, estimates of these costs had already been prepared some years earlier, and were updated and incorporated into the study.

In addition to calculating the economic value of wastewater purification and nutrient retention functions, it was also necessary to estimate the costs incurred in managing the wetland to provide these services. The cost of constructing multiple outflows from Nakivubo Channel, and their reticulation across the wetland, had to be deducted from the economic benefits of Nakivubo's waste treatment and water purification functions.

Although the presence of Nakivubo wetland results in a significant improvement of the quality of water entering Inner Murchison Bay, its waste treatment and water purification services are currently not being utilised to their full potential. This is because the two outflows of Nakivubo Channel, through which the majority of wastewater and between 75-85% of nutrients enter the wetland, do not spread wastes over the whole wetland area. Wastewater currently spends only 0.5-2 days in the wetland, and mainly accumulates in lower parts to the south of the railway bridge. To optimise wetland management for both its waste treatment functions and for maintaining ecological integrity, there is a need to spread wastes over a greater area, so as to utilise the upper wetland to its full capacity and to increase the time that wastewater is

Nakivubo swamp, looking towards Kampala

retained. Information was available about the costs of constructing and maintaining earth channels to carry and disperse wastewater, which could easily be related to the length and positioning of outflows that were required from Nakivubo Channel.

Integrating wetland values into the urban landscape

The results of the valuation exercise showed that the wastewater purification and nutrient retention services of Nakivubo Swamp have a high economic value – between US$ 1 million a year (using replacement cost methods) and $1.75 million a year (using mitigative expenditures methods). Even taking account of the costs of managing the wetland so as to simultaneously optimise its waste treatment potential and maintain its ecological integrity (some US$ 235,000) results in a significant net benefit.

These figures provided a powerful economic argument against further drainage and reclamation of the wetland. The study showed that the existence of Nakivubo Swamp saves the Government of Uganda's National Water and Sewerage Corporation a considerable sum of money each year, as it currently provides a much cheaper way of dealing with Kampala's wastewaters than other, man-made, options. There are currently insufficient public funds to invest in the infrastructure required to replicate these natural services. As well as having a lower cost, Nakivubo's natural ability to purify wastes is far simpler than artificial waste treatment and water purification facilities because it is based primarily on the use of human labour and simple earth channels to spread wastewaters across the wetland.

Another argument arising from the study that urban planners and decision-makers found convincing was that loss of wetland functions would give rise to untenable economic costs for some of the poorest sectors of the population, as well as imposing high economic costs on the public sector agencies who have the responsibility for providing basic services and assuring an acceptable standard of urban living. In Kampala, these groups are simply not in a position to bear such losses or expenditures.

The findings generated by the study lend strong support to various recommendations that have been made over recent years that that Nakivubo Swamp should be fully recognised to be, and designated as, an economically important and environmentally sensitive area within the city's zoning and structural planning processes. It also supports the call in Uganda's National Wetland Policy that reclamation of wetland areas for urban development should be curtailed[8]. The future survival of the wetland will depend largely on such public actions being taken. Although the value of wetland services are both large and influential at the level of the overall urban economy and social welfare, it does not instantly translate into private profits. As long as the firms and individuals who are currently modifying and reclaiming Nakivubo continue to do in the absence of proper planning and controls, they are unlikely to take these broader values into account.

This case study is adapted from:

Emerton, L., Iyango, L., Luwum, P., and Malinga, A., 1999, The Economic Value of Nakivubo Urban Wetland, Uganda, Uganda National Wetlands Programme, Kampala and IUCN — The World Conservation Union, Eastern Africa Regional Office, Nairobi

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Muthurajawela Wetland, Sri Lanka: safeguarding protected areas in cities

Maintaining wetlands in Sri Lanka's coastal cities

The south west coastline of Sri Lanka represents one of the most densely populated, intensely urbanised and heavily industrialised parts of the country. There is extreme pressure on the natural environment, and wetland ecosystems in particular are under severe threat. Land use planning processes have paid little heed to the need to maintain green spaces for Sri Lanka's city-dwelling populations, and have almost always resulted in development decisions which have taken place at the cost of the few remaining urban and peri-urban conservation zones.

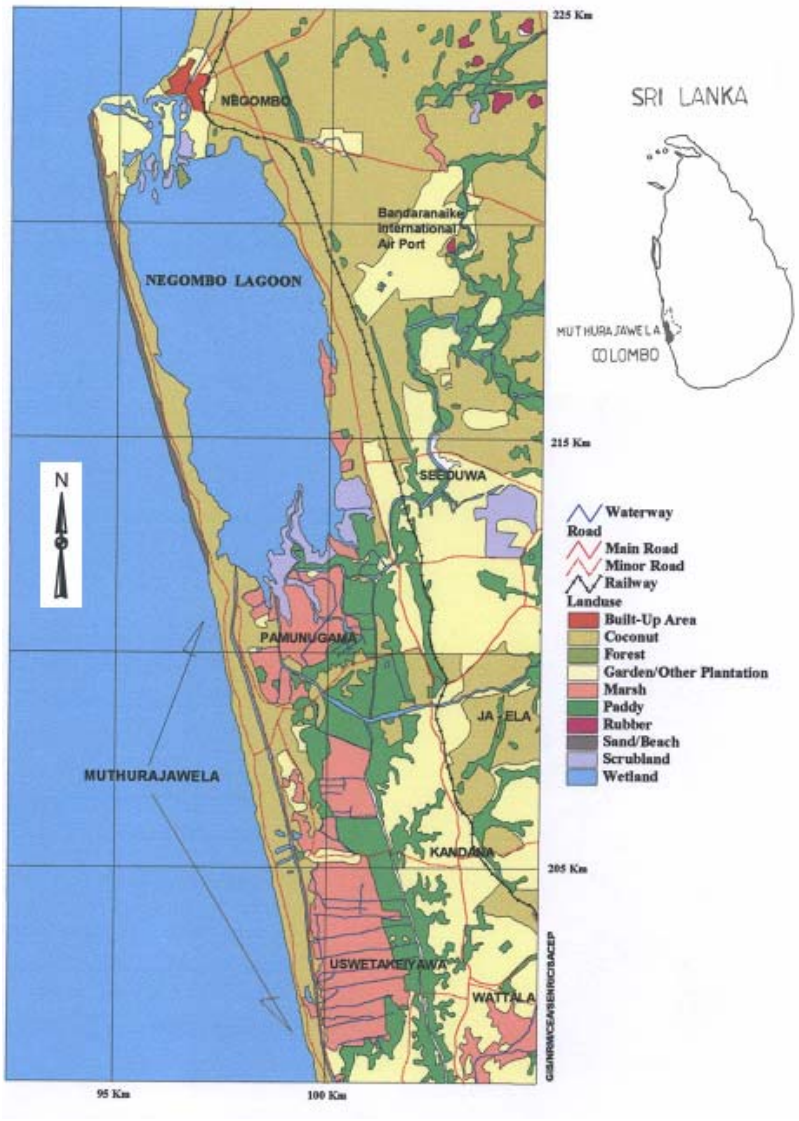
This case study describes an attempt to assess the economic value of Muthurajawela Wetland Sanctuary, situated just to the north of the capital city, Colombo. Both wetland ecosystems and urban parks are poorly represented in Sri Lanka's national protected area network, and Muthurajawela fulfils an almost unique role because it combines both these attributes. Although during the mid-1990s a land use masterplan was developed for the area, and a wetland management plan was established for Muthurajawela, there is serious concern about the future of this protected area. Within the context of a renewed effort to conserve the area more effectively, including a proposed extension to the Wetland Sanctuary, the valuation exercise aimed to develop and apply integrated biodiversity-economic assessment methods that could be used to identify critical threats, major benefits, and key actions required to support the management of Muthurajawela as a conservation zone.

Muthurajawela Wetland Sanctuary

Muthurajawela Marsh is the largest saline coastal peat bog in Sri Lanka, and covers an area of some 3,068 hectares. It is runs alongside the Indian Ocean and is located between 10-30 km north of Colombo, in Gampaha District. Together with the contiguous Negombo Lagoon (3,164 hectares), Muthurajawela forms an integrated coastal wetland system of high biodiversity and ecological significance. It is listed as one of 12 priority wetlands in Sri Lanka, and in 1996 1,777 hectares of the northern section of Muthurajawela was declared a Wetland Sanctuary. The Sanctuary contains a high diversity of both flora and fauna, including several endemic and nationally threatened species, and also provides an important area for migratory birds. Because of the presence of these natural habitats and species, Muthurajwela is a popular recreational destination, primarily attracting educational or school trips and day visitors from nearby Colombo.

Muthurajawela Sanctuary represents a "conservation island" in the midst of intense urban and industrial development. It remains one of the few wetlands in the Colombo area that has not been reclaimed for agriculture or filled in for development. More than 300,000 people live in the Muthurajawela-Negombo area and just under 5,000 people live in and around the marsh itself, half of whom are squatters and about three quarters who live on unauthorised landholdings. About 80% of industries in the country are concentrated in Colombo and Gampaha Districts[1]. Areas to the north, south and east of the marsh contain a large number of industries and commercial enterprises. It is known that in 1991 there were almost 150 industrial units in and around Muthurajawela marsh and Negombo Lagoon, including vehicle and electrical goods repair and garment makers[2]. Today this number has undoubtedly increased, as much of the southern part of Muthurajawela has been now turned into an industrial area.

Location of Muthurajawela



As well as harbouring important biodiversity the Wetland Sanctuary provides a range of ecological and hydrological services. Muthurajawela receives and retains high loads of domestic and industrial wastes, and sediment and silt loads, from both surrounding and upstream areas. Wetland plants facilitate sediment deposition, before water enters Negombo Lagoon. They also act as a filter for through-flowing waters, and assist in the removal of nutrients and toxic substances. During the rainy season large volumes of water enter the wetland system, from rainfall, through run-off from surrounding higher grounds and via floodwaters from the Dandugam Oya, Kalu Oya and Kalani Ganga which feed the marsh. Muthurajawela buffers these floodwaters and discharges them slowly into the Negombo Lagoon. The maximum water storage capacity of the marsh has been estimated at 11 million cubic metres, with a maximum discharge of 12.5 cubic metres per second and a retention period of more than 10 days[3]. By maintaining surface, near-surface and possibly groundwater levels, the marsh also plays a major important role in local freshwater supplies. These functions are particularly important for local households, many of whom lack a piped water supply and rely on shallow-dug wells.

Water quality and fisheries production in downstream Negombo Lagoon are heavily dependent on these wetland services. Muthurajawela acts as a source of freshwater to the tidal delta, and is critical in moderating salinity and pollution levels. Its sheltered waters, flooded vegetation and mangrove areas all constitute important breeding grounds and nurseries for freshwater and marine species of fish and crustaceans. Downstream of the marsh, Negombo Lagoon has a high productivity for fisheries of an estimated 150 kg/hectare/year[4] involving more than 3,000 families from 26 villages[5]

The impacts of land use zoning around the wetland

The location of Muthurajawela Wetland Sanctuary in a rapidly developing urban area makes it an extremely vulnerable ecosystem. Large parts of the freshwater marsh system have been altered, and a variety of canals, drains, bunds, sluices and culverts present evidence of various attempts to manage waterflow, combat flooding and prevent saltwater intrusion. There is a long history to these human modifications. As early as the 15th century a canal was constructed (now referred to as the Dutch canal, running along the eastern side of the marsh from the Kalani Ganga into Negombo Lagoon), and extended along with other works under Dutch occupation in the 18th century. In the 19th century the British constructed the Hamilton canal, running along the western side of the marsh, parallel to the sea. Since then, a network of dikes and waterways have been built which link and extend the Dutch and Hamilton canals.

After Independence, in 1947, successive national governments have made plans to further develop Muthurajawela for agriculture and settlement. In 1965, a scheme was identified to completely fill and polderise the marsh in order to provide land for the relocation of slum residents from Colombo. Although this plan was never implemented, it resulted in encroachment into the marsh. Since the 1970s housing development has increased still further, and a number of permanent settlements have been established around the fringes of the Wetland Sanctuary. Most of today's population originally migrated into the area after the mid-1970s, attracted by the relatively low price of land and the lack of enforcement against moving into state-owned areas.

Today, the marsh is subject to intense pressure from surrounding industries and settlements. Low-cost housing borders, and in some case encroaches upon, the wetland. The large Ekala-Ja Ela Industrial zone lies to its east and a new industrial area has been developed at the southern end of the wetland. Bandaranaike International Airport and Negombo town (with an estimated population of 150,000 people) are both located to the north of Muthurajawela,. The Colombo-Katunayake Expressway, linking Colombo with the industrial areas and airport, is in the process of being built and cuts across the borders of the Wetland Sanctuary.

There have been considerable changes to the biodiversity, ecology and hydrology of the marsh area as a result of these activities. Large amounts of wastes now enter the marsh from adjacent households, fishing boats, tourist facilities, agriculture and industries[6]. Currently at least two thirds of the households living around the marsh have no proper latrine facilities, and discharge untreated sewage into the wetland[7]. Of the 150 or so industries in Ja-Ela and Ekala, 64 generate effluent, 17 have high domestic loading of over 10 m^3/day by water consumption, and only 13 have any kind of treatment facility (Ministry of Policy, Planning and Implementation 1993). In total, it is estimated that the marsh and lagoon area receive raw or partially-treated sewage from a population equivalent to 200,000 people. Land filling and reclamation in the marsh area for industry, infrastructure and settlement has also increased local erosion and siltation[8]. By 1999, annual sediment loads entering the marsh were estimated at 147,000 tonnes a year form the Dandugam Oya and Ja-Ela, and 62,000 tonnes a year from the Hamilton Canal[9].

Muthurajawela supports important artisanal and commercial fisheries

As Muthurajawela has been degraded and reclaimed, hydrological linkages to appropriate discharge points have been cut off, meaning that excess water and peak flows cannot move easily into Negombo Lagoon. Over recent years the intensity and frequency of flooding has increased dramatically in low-lying fringes of the marsh[10]. In severe rain, the Hamilton Canal

and other watercourses overflow, and inundate surrounding areas. Today, floods occur in adjacent settlements at least two times a year during the wet seasons[11], and during every rainfall period more than 1,000 households in the marsh area are affected by flooding[12]. Important breeding habitat for freshwater, brackish water and marine fish species has been reduced and water quality has fallen, with especially high levels of BOD and COD around industrial and residential areas indicating organic loading and pollution[13].

As a result of growing concern about these sources of ecosystem degradation and biodiversity loss, the government decided in 1989 to freeze all public and private sector development proposals until an environmentally sound Masterplan was developed for the Muthurajawela Marsh. The Greater Colombo Economic Commission (now the Board of Investment) was instructed to prepare this plan. The publication of the Masterplan for Muthurajawela Marsh and Negombo Lagoon in 1991[14] led to a land use strategy being proposed for the future, based on dividing the Muthurajawela-Negombo area into various development and conservation zones[15].

The Master Plan was accepted by the government in 1992, and implementation commenced, including the development of a special management plan for the conservation zone[16]. The Department of Wildlife Conservation was charged with managing the conservation zone, the Department of Fisheries was made responsible for the fishery in Negombo Lagoon, and the Forest Department was mandated with the management of mangrove areas. A detailed plan for the conservation zone was prepared, and in 1996 an area of 1,777 hectares in the northern part of the marsh was declared a Wetland Sanctuary under the Fauna and Flora Protection Ordinance.

Valuing the benefits of Muthurajawela Marsh

Despite the existence of a management plan for Muthurajawela conservation zone, there remains serious concern about the future of the Wetland Sanctuary. Encroachment and degradation continues, and infrastructural developments and industrial expansion are still occurring close to – and sometimes within – the marsh area. A clear need has been identified to strengthen existing 4conservation activities in the Wetland Sanctuary.

A first step in these renewed efforts was to provide the basic biophysical and socio-economic information required to update wetland management activities. The first detailed biodiversity assessment ever made of Muthurajawela Wetland was carried out between November 1999 and April 2000[17]. It resulted in the identification of critical species, habitats, threats and proposed management actions.

The valuation exercise aimed yield a set of complementary data which could provide backup to, and additional justification for, the recommendations arising from the biodiversity assessment. Just as the biodiversity assessment had used Muthurajawela Wetland Sanctuary as a demonstration site to develop and apply a set of general criteria for the identification of critical habitats in wetland ecosystems, so the economic study aimed to develop, apply and document methods for the integration of economic concerns into biodiversity assessment procedures which would then be more generally replicable within the context of wetland conservation in Sri Lanka. Economic assessment procedures were designed so that each stage corresponded to an equivalent step in the biodiversity assessment process applied in Muthurajawela, and analysis and conclusions pointed to economic measures that could provide direct support to the management recommendations provided in the biodiversity assessment.

Women gathering fuelwood from wetland tree species

Using economic tools in the Wetland Sanctuary's management plan

The principal recommendation yielded by the earlier biodiversity assessment was that Muthurajawela Wetland Sanctuary should be accorded Ramsar site status, and that the northern part of the marsh should be added to the existing protected area in order to assure adequate protection of critical species and habitats. The economic study provided a credible economic rationale for these actions, showing that continued conservation of the Wetland Sanctuary would yield considerable benefits.

Direct use values that depend on the Muthurajawela Marsh, including sustainable local resource use and recreation, are worth more than half a million dollars a year. The provision of localised ecosystem services such as flood attenuation, industrial and domestic wastewater purification and year-round surface and sub-surface water supplies have an annual value in excess of $7 million a year. The wetland's support to downstream fish productivity in Negombo Lagoon contributes a value of almost $225,000. Together these translate into economic benefits of just over $2,600/hectare/year for the whole of Muthurajawela Marsh, or non consumptive use benefits of $4.4 million for the Wetland Sanctuary. More than 30,000 people, most of them poor slum dwellers and fishing households, gain from these economic goods and services.

Economic value of Muthurajawela

	Value ($/year)	Value ($/ha/year)
Flood attenuation	5,394,556	1,758
Industrial wastewater treatment	1,803,444	588
Agricultural production	336,556	110
Support to downstream fisheries	222,222	72
Firewood	88,444	29
Fishing	69,556	23
Leisure, recreation and recreation	58,667	19
Domestic sewage treatment	48,000	16
Freshwater supplies	42,000	14
TOTAL	**8,072,111**	**2,631**

The biodiversity assessment specified five management actions that were required as a matter of urgency to address the current threats to the wetland. Dissemination of the findings of the valuation study met the first two aims: raising awareness on wetland values, and documenting the socio-economic status of Muthurajawela. The valuation study also specified a series of economic tools and measures that could lend support to the three other management actions specified – promoting sustainable revenue and income-generating activities, encouraging ecosystem restoration activities and initiating prompt and punitive action against wetland-degrading practices.

The valuation study's findings underlined the high economic benefits that could accrue from wetland restoration, but also indicated that any reduction in extractive wetland activities would constitute real economic losses to local households. A package of economic incentive measures, including value-added and income generating activities, was identified as essential to providing the necessary support to local landholders undertaking wetland restoration. Ways of capturing and retaining wetland benefits as revenues for the Department of Wildlife Conservation, the agency mandated to manage the Wetland Sanctuary, were also highlighted by the valuation study as central to the management of the extended conservation area. Information on the high economic benefits yielded by Muthurajawela Marsh additionally provided a reference point for ensuring that penalties for wetland degradation are realistic, and reflect the real costs of damage caused. The study recommended that penalties for wetland damage through infrastructural and industrial expansion should be set at levels that are considerably higher than is currently the case, and are closer to the real costs incurred, either to act as an additional disincentive against wetland degradation or else to make available sufficient funds to remedy or mitigate their effects.

This case study is adapted from:

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That Luang Marsh, Lao PDR: the importance of wetlands for urban populations

Wetlands in Lao PDR: a precious but threatened resource

Rivers, water bodies and other natural and constructed wetlands are estimated to cover just under 945,000 ha or 4% of Lao PDR, including 254,000 ha around the Mekong and other major rivers, 57,000 ha of large reservoirs, 96,000 ha of swamps and wetlands, 480,000 ha of rice fields, 10,500 ha of fish ponds, and 47,500 ha of small reservoirs, ponds and weirs. In turn, the goods and services that these water-based ecosystems yield form a central component of socio-economy, food security, income and subsistence – at national, local and household levels.

Although the majority of Lao PDR's population – over 80% – live in rural areas, there has been rapid urban expansion over recent years. Wetlands continue to form an important component of city landscapes – both as a source of aquatic plants and animals that are consumed for food and sold for income, as well as through the important water quality and supply services they provide. Yet, despite the importance of their goods and services, these water-based ecosystems are being rapidly degraded as urban areas grow and wetlands are reclaimed, converted and modified to make way for new settlement, agriculture and infrastructure.

This case study describes an attempt to value the goods and services associated with That Luang Marsh in Vientiane, Lao PDR. The study was carried out by IUCN, WWF, the Lao National Mekong Committee, and the Science Technology Environmental Office of Vientiane Municipality with the aim of examining the economic value of urban wetland biodiversity and its importance to people living around the wetland as well as the larger urban area of Vientiane. The overarching goal of the study was to demonstrate the importance of sustainable management of wetland areas and the need to incorporate them into urban planning and decision-making, to communicate this information in a practical and policy-relevant form, and to point to concrete measures for integrating the sustainable management of wetland areas into urban planning and decision-making.

That Luang Marsh

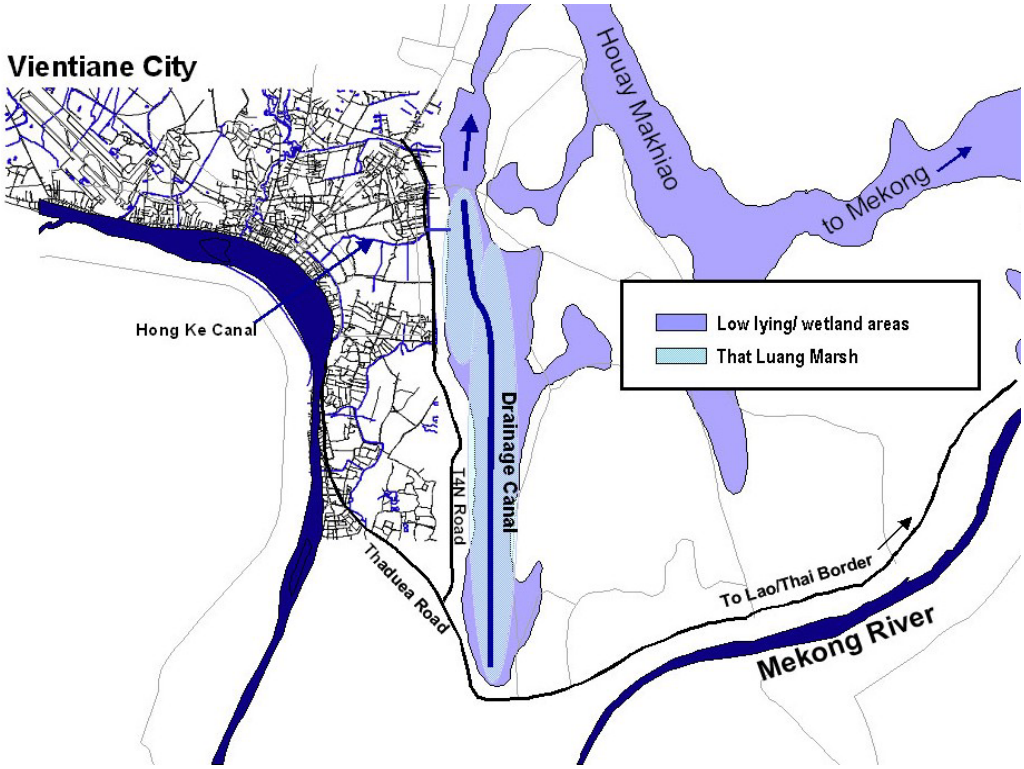
The changing face of That Luang Marsh

Vientiane, the capital city of Lao PDR, has an estimated population of 161,000 people in its core urban area[1]. The municipality is divided into 112 villages, with a total area of approximately 30 km^2. It also contains almost 1,500 km^2 of permanent and seasonal waterbodies, floodplains, swamps and marshes.

That Luang Marsh, the largest remaining wetland in Vientiane, is located on the eastern edge of the city. The wetland system combines freshwater marsh, seasonally-flooded grasslands and shrublands, and peat shrubland. It covers around 20 km^2, and collects water that drains from Vientiane and surrounding areas, including the Hong Ke stream (which is fed by the city's drainage canals). Water flows out of the wetland via the Houay Mak Hiao River into the Mekong River, about 64 km south east of the city.

The area around That Luang Marsh is densely settled, and registers high rates of population growth and urban expansion. The number of people living around the marsh more than tripled over the 1990s, from just over 2,000 households or 14,000 people in the early 1990s to more than 7,000 households or 38,000 people in 2000.

Location of That Luang in Vientiane



As Vientiane has grown, so That Luang Marsh has been modified. Agricultural expansion and drainage works, in particular, have had a large impact on the wetland over the last 20 years. Until the 1970s That Luang Marsh was mainly forest. At that time the Governor of Vientiane declared that land for rice cultivation in the wetland would be made available to anyone who wished to clear it. In order to facilitate paddy farming, as well as to reduce flooding in the city, two drainage culverts were also installed, at the north and south ends of the wetland.

By the 1980s 700 ha of the marsh had been put under rice, and in 1986 a further drainage canal was constructed through the entire wetland. This new canal had the effect of changing the natural waterflow regime, diverting That Luang's outflow from flowing directly into the Mekong south of the marsh, to flowing North through Houay River[2]. Because these hydrological changes lowered the water level on either side of the canal and facilitated dry season irrigation, large additional portions of That Luang were further converted into farmland. Today rice cultivation covers up to 1,000 hectares of the wetland. There are also areas of vegetable gardens and a number of small, medium and large fish farms located along the margins of the wetland.

Urban expansion and development projects have also involved the reclamation of large areas of marsh for industrial and residential construction, and for infrastructure. In 1999 the T4N road was improved, running along the western side of That Luang Marsh. This also led to the growth of new shops, businesses and residences along the improved road.

Valuing the role of That Luang Marsh in the Vientiane's urban environment

Despite its altered state, That Luang Marsh continues to provide a number of economically important goods and services to Vientiane's urban dwellers.

Almost half of the marsh-adjacent population depend on wetland resources in some way for their livelihoods. Wetland-based activities include rice and vegetable farming, fishing and harvesting of aquatic plants and animals, and collection of other non-timber forest products.

That Luang Marsh also provides a range of ecosystem services that are critical to the functioning of the city, and to the basic standard of living of its human population. Urban flood control, wastewater treatment and sanitation processes are heavily dependent on the presence of the wetland, and the services it yields[3].

That Luang Marsh receives domestic sewage discharge from a large proportion of Vientiane city by way of several canals. While Vientiane has a sewerage system, there is currently no functioning waste treatment facility near the urban area. Sewage is either hauled to a waste treatment plant 17 kms outside of the city limits or, more commonly, discharged into natural waterbodies, either as raw wastes or as seepage from septic tanks. Sewerage and sanitation systems rely on the infiltration of wastewater into the ground. However due to the low soil permeability and the high groundwater table in Vientiane, many soakways fail to operate efficiently meaning that sewage is discharged from tanks and drains directly into urban wetlands. As a result a considerable quantity of household waste and sewage is discharged into Nong Chang, and then flows into That Luang Marsh before entering the Mekong. Textile, detergent and paper plants discharge directly into open drains without any treatment, and contribute wastewaters into That Luang Marsh. There are two tanneries – although the larger of these has sophisticated treatment facilities, in practice wastes bypass these and are discharged untreated. The brewery on the southern shore of That Luang passes waste through an oxidation pond, but tests carried out in the past have shown high levels of nutrients remaining in the discharge. Stormwater from the urban area also drains into That Luang Marsh, making it the basis for flood control in the municipality.

Unfortunately, wetland encroachment and reclamation is taking its toll on the provision of these important goods and services. Flora and fauna populations, and diversity, have decreased markedly over the last decade, particularly as a result of agricultural conversion and canalisation of the wetland. Loss of wetland area and species has also resulted in a decline in the capacity of That Luang to provide flood control and wastewater treatment functions.

The aim of this study was to articulate the value of That Luang's ecosystem goods and services, in order to demonstrate the economic benefits associated with wetland conservation and sustainable use and to provide policy and development recommendations that would maximise wetland economic benefits in support of improved livelihoods and urban planning.

Market price-based approaches were used to measure wetland direct values, including contribution to agricultural production and the value of wetland resource use. That Luang Marsh's indirect values were measured using a variety of techniques. The value of flood control was estimated by examining damage costs avoided through flood prevention. Replacement cost techniques, looking at investments in alternative treatment costs, were used to value wastewater purification services.

What are That Luang's ecosystem goods and services worth?

The results of the study showed that That Luang Marsh is an extremely important resource to both adjacent villages and to the larger area of Vientiane. Household and village level surveys found that wetland goods support income generating activities and provide additional products that are essential to people in the area. The direct benefits of the wetland to local people make

up 40% of the total value of the wetland and come from goods such as rice, garden products, fish, aquatic invertebrates and plants, and small mammals, reptiles and birds.

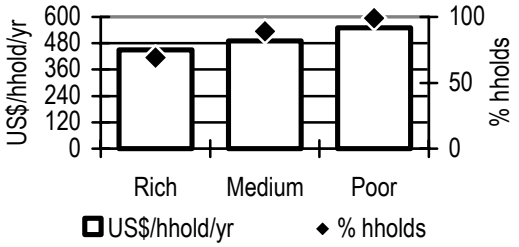
That Luang Marsh – Direct Benefits

Type of Use/Benefit	Annual Value (US$/yr)
Rice cultivation	350,000
Vegetable gardens	55,000
Aquaculture	180,000
Capture fisheries	1,100,000
Non-fish wetlands	350,000
TOTAL	**2,035,000**

Capture fisheries in particular is an extremely important component of local livelihoods. Ninety percent of households that collect wetland goods collect capture fisheries. The average annual value of capture fisheries collected is between US$391-565/household/year and capture fisheries is a particularly important livelihood strategy of lower income groups.

The relationship between household income and fisheries value

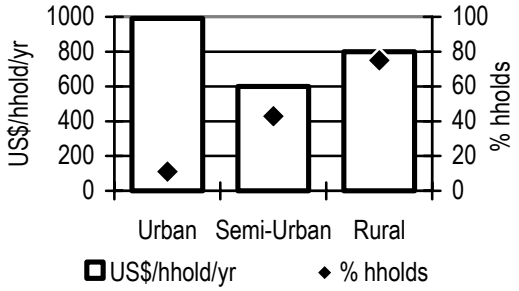
Although capture fisheries are important for all households living around That Luang Marsh (more than two thirds engage in this activity), they are particularly important for less well-off. Data show that both the incidence of fishing and its total value increases as household income status declines. This underlines the importance of incorporating capture fisheries into local poverty reduction strategies.



Non-fish aquatic products also form an important component of wetland goods and resources. Aquatic vegetation is the most important of these products because it is commonly collected by a large percentage of people living in the area. Morning glory (*Ipomea aquatica*) is a natural wetland plant that is eaten throughout Laos and grows extensively in That Luang Marsh. Culturally it is very common for people living around the wetland to collect morning glory and even high income households will collect small amounts for their own consumption or as a supplement to poultry feed. 97% of households that collect wetland products collect morning glory, much of which is sold to markets around Vientiane.

Urbanisation and wetland resource harvesting

The degree of urbanisation varies significantly among the villages that are located around That Luang Marsh, as does the incidence and value of wetland resource use. Although a significantly higher proportion households in less-urbanised villages tend to engage in wetland product collection, the value of these resources tends to be greater in both relative and absolute terms in more urban villages. A major reason for these higher values is that urban plots tend to be much smaller, allowing less space for gardens and livestock production – alternative sources of food and income.



All wetland goods are grown or collected by a wide variety of households living around the marsh and range from income generating activities to local consumption. Wetland goods are of particular importance to the urban poor. As Vientiane continues to expand and there is less room for household gardens and small scale livestock production, resources from That Luang Marsh will likely become an increasingly important component of the livelihood strategies of this income group.

Wetland services result in benefits that affect a larger audience of people then those that are directly using wetland resources. That Luang Marsh provides major ecosystem functions to people living in the Greater Vientiane Area including flood control for Vientiane City, sanitation and water purification for areas of Vientiane and villages around the Marsh.

That Luang Marsh – Indirect Benefits

Type of Use/Benefit	Annual Value (US$/yr)
Flood protection	2,800,000
Wastewater purification	71,000
TOTAL	**2,871,000**

Integrating wetland values into future urban development planning

Vientiane continues to grow, and That Luang Marsh is under increasing threat – especially from the rising number of reclamation projects which aim to support the expansion of residential and industrial development.

Although Vientiane City has a masterplan, zoning system and development control procedures, the implementation of these procedures has had a limited effect on urban development[4]. Urban planning in and around That Luang Marsh has been carried out in a largely *ad hoc* and uncoordinated manner. While the impact of individual projects may be relatively low, the cumulative effects of urban development have the potential to seriously degrade wetland goods and services.

There is a critical need to control reclamation projects that are cutting into wetland areas. The impacts of the loss of wetland biodiversity and ecology are already being manifested through a reduction in the food security and income status of a large proportion of urban dwellers, especially the poor. Current physical and infrastructural conditions in the city result in poor drainage, frequent urban flooding, and inefficiency of soakaways and septic tanks as mechanisms for dealing with household and commercial wastes. At present That Luang Marsh fulfils an important function in mitigating floods and upholding water quality in surrounding areas.

In the light of the centrality of these wetland goods and services to the urban population, and given that they are still under-provided by other means, That Luang Marsh continues to form a critical component of Vientiane's economy and water infrastructure. With wise use and sustainable management, and if taken seriously as a critical and integrated component of urban planning, their economic potential and ability to provide goods and services could be maximised still further – to the benefit of all people living in the Greater Vientiane area.

This case study is adapted from:

Gerrard, P., 2004, Integrating Wetland Ecosystem Values into Urban Planning: The Case of That Luang Marsh, Vientiane, Lao PDR, IUCN – The World Conservation Union Asia Regional Environmental Economics Programme and WWF Lao Country Office, Vientiane

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This project aims to develop, apply and demonstrate environmental economics techniques and measures for wetland, water resources and river basin management which will contribute to a more equitable, efficient and sustainable distribution of their economic benefits at the global level and in Africa, Asia and Latin America, especially for poorer and more vulnerable groups.

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