The Value of Traditional Water Schemes:

Small Tanks in the Kala Oya Basin, Sri Lanka

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EXECUTIVE SUMMARY

Sri Lanka has one of the oldest traditions of irrigation in the world, dating back as far back as 500 BC. It was around these ancient tank (water storage reservoir) irrigation systems that the economy and human settlements of early Sri Lankan society were organized 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.

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 favor 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. The reduced capacity of the reservoirs will result in less irrigation water available for downstream lands and livelihood benefits to the community.

The study quantifies the benefits associated with tank goods and services, and underlines their high economic and livelihood value to local communities. It also looks at the economic returns to different options for restoring and maintaining the traditional tank system. These results reveal that removing silt and rehabilitation of tank reservation is the most feasible option, which could improve the services, provided for a longer period of time and give the highest economic return.

The study concludes by making recommendations about economic and financial instruments to strengthen tank management. Although the government spends lot of resources to maintain the tanks, the communities around the tanks are not happy and complain about the low quality of the work. In order to internalise their concerns, a mechanism with appropriate provisions to involve community in tank management needs to be developed.

Such a mechanism should respect the rights and responsibilities of the various stakeholders towards specific resources as well as the treatment of what is considered as common resources. In the case of water for example, there would need to be agreement amongst farmers as to allocation for cultivation, but also agreement amongst the broader membership regarding the allocation of water for cultivation and allocations for the ecosystem and for domestic uses.

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LIST OF ACRONYMS

ADB RETA	Asian Development Bank's Regional Technical Assistance
ASD	Agrarian Services Department
CBA	Cost Benefit Analysis
CEA	Central Environmental Authority
CVM	Contingent Valuation Method
DCFOS	District Committee of Farmer Organizations
DCS	Department of Census and Statistics
DWLC	Department of Wildlife Conservation
FGD	Focus Group Discussions
GA	Government Agent
ID	Irrigation Department
IWMI	International Water Management Institute
MASL	Mahaweli Authority of Sri Lanka
MCM	Million Cubic Meters
MEY	Maximum Economic Yield
MSY	Maximum Sustainable Yield
NEA	National Environmental Act
NEAP	National Environmental Action Plan
NSF	National Science Foundation
NWRA	National Water Resources Authority
NTFP	Non Timber Forest Products
PRA	Participatory Rural Appraisal
PGIA	Postgraduate Institute of Agriculture
RA	Rajangana–Angamuwa sub catchments
RBO	River Basin Organizations
RBPM	River Basin Planning & Management Division, MASL
RWRMA	Regional Water Resources Management Agencies
TEV	Total Economic Value
UOC	University of Colombo
WANI	Water and Nature Initiative, IUCN
WMB	Water Mediation Board

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 Kala Oya River Basin, Sri Lanka, forms one of the demonstration sites for the project. The Kala Oya component, being carried out collaboratively between IUCN — The World Conservation Union Sri Lanka Country Office and the Mahaweli Authority of Sri Lanka, has as its aims to assess the livelihood and biodiversity values of traditional tank systems and to identify economic instruments for tank management. A variety of activities were carried out under the project in the Kala Oya Basin, including technical studies and research, capacity building and training, awareness and education, and the development and piloting of economic tools for river basin management.

INTRODUCTION:
Integrating ecosystem values into Kala Oya Basin planning and management

Aims of the project

This project aims to demonstrate the integration of wetland economic values into river basin management. Project partners from different regions, selected demonstration sites reflecting issues relevant to their regions, within the broad objectives listed above. In Sri Lanka, the Kala Oya basin was selected as the demonstration site. The components planned and implemented in the first year are presented in this report. Sri Lanka's project has two components; the first is a valuation exercise addressing a specific management issue (conducted in year one) and the second is, to provide economic/financial instruments, that can facilitate the implementation of specified recommendations, to tackle the management issue (which will be conducted in the 2nd year). In this respect, studies for identification of possible economic and financial tools for wetland conservation and sustainable management, will be carried out. Further, the results of those studies will be shared with the Mahaweli Authority of Sri Lanka (MASL), the Agrarian Services Department (ASD) and the Irrigation Department (ID). These results will also be utilized to assess the viability of restoration and maintenance of traditional tanks, to meet biodiversity and ecosystem, livelihood and poverty alleviation goals.

Rationale for the Kala Oya Basin as demonstration site

A Water Resource Policy is currently being formulated for Sri Lanka, which encourages water management through a comprehensive river basin oriented approach. At the same time, the Kala Oya Basin has been selected as a pilot area for integrated water resources management approaches, under the transformation of the Mahaweli Authority into a River Basin Authority.

Through our involvement in this project we aim to:

- Provide better understanding and communication of the economic linkages between man made wetland status and wider river basin characteristics by demonstrating the value of manmade wetlands in the Kala Oya basin
- Identify basin-wide economic causes of wetland degradation and loss and
- Use economic mechanisms to support wetland conservation, as an integral part of sustainable development in river basins, demonstrate linkages between macroeconomic and poverty reduction concerns and conservation planning and practice.

Substantial changes have taken place in the legal, institutional and management aspects of water resources in Sri Lanka, since the development of the WANI project proposal in late 2002. The country is now passing a critical period with respect to how, and by whom, the water resources of the country are to be managed. It was agreed at the national stakeholder meeting, that the pilot sites of the project will be reviewed again, in keeping with the latest developments of the country's water resource management and the objectives of the WANI economics project.

Allocation of water for maintaining wetland environmental services, is neglected in the main irrigation systems due to a lack of understanding, of the benefits of such services. The sub basin of Kala Oya (demarcated by the command area of the Kala Wewa tank up to the Rajangana Wewa tank) was selected as the primary area for the detailed studies. This area was also used to set up the planning unit for implementing the WANI economics project in Sri Lanka.

Information generated by the project will assist the newly formed River Basin Planning Unit of the Mahaweli Authority and other potential River Basin Management agencies, as suggested in the National Water Resources Policy. Further, these ecosystem values will help the National Water Resources Authority, the Ceylon Electricity Board and the Department of Irrigation, in their water allocation decisions.

Scope of project activities

Within the broad technical areas of assessment and valuation, of wetland and river basin goods and services, certain issues and concerns are accorded particular emphasis in project activities and at demonstration sites. These include:

- Developing and applying methods for valuing wetland and water ecosystem services at the pilot site in the Kala Oya River Basin.
- Integrating environmental economic costs and benefits into macroeconomic and sectoral development planning and strategies, at national, basin and site levels.
- Identifying community-level economic incentives for wetland conservation and sustainable use.
- Identifying pro-poor economic and financial measures that target the most vulnerable households and individuals in wetlands and river basins.

The main environmental services provided by the wetlands of the sub basin will be assessed, using environmental economic techniques (selected priority wetlands in the sub basin were studied for this purpose) for both the wet season and dry season. Finally, the economic feasibility of the different options available for maintaining the small tanks in the basin will be assessed, comparing benefits of maintaining wetland environmental services with the forgone cost of irrigation water by allocating them for wetland maintenance. Depending on the feasibility, recommendations could be made to make decisions on maintaining small irrigation tanks, to provide benefits to the people for longer durations.

This project will focus on the application of economic tools, for developing basin-wide approaches to ecosystem management. There will be a particular focus on integrating downstream wetland values, into upstream land use and water allocation decisions. The economic assessment will focus on valuing natural and man-made wetland ecosystems, with a view to demonstrate the benefits associated with maintaining on-site and upstream hydrology, and ecological integrity. In the Kala Oya basin, valuation will focus primarily on assessing the local level use of wetland goods and services.

The project intends to identify environmental economic, financial and legal instruments, which can be incorporated into emerging river basin management plans. These instruments in turn can be used for integrated water resource management. An integrated economic and legal/policy analysis, will form a key component of the project, in order to ensure that the identified tools have the necessary backup and legitimacy in national policy and law, as well as to provide specific recommendations for the emerging national water policy. Economic instruments for river basin planning will focus on national and basin-wide guidelines and procedures, for integrating wetland values into development planning and appraisal.

Originally, there were two sites identified for the WANI economics project in Sri Lanka. Later, together with the project partners it was decided to concentrate the studies only at the Kala Oya basin. The other site was the Ruhuna Basin. The main reason for this decision was to avoid diluting the efforts and to provide more concrete inputs to the Kala Oya pilot studies commenced by the MASL. This matter was discussed at the national stakeholder meeting with the key stakeholders of the project.

Field studies were conducted in collaboration with MASL's Kala Oya River Basin Secretariat staff, Irrigation Department's regional staff, Department of Agrarian Services Provincial staff, and members of farmer organizations and fisheries societies.

In addition to the above, down stream wetland economic values generated by the Kala Oya mangroves were also assessed, to demonstrate the importance of this unique ecosystem, to the local communities. Kala Oya being the main fresh water source for the mangroves, at the Kala Oya estuary, changes in flow will affect the health of the mangroves and the livelihood of the people.

Project partners and beneficiaries

The key institutional partner of the project is the Mahaweli Authority of Sri Lanka; presently working towards piloting basin-wide integrated water resource management in the study area. MASL has implemented the Accelerated Mahaweli Development Project; Sri Lanka's biggest development project (costing over 2 billion US$) in recent history. Mahaweli, the longest river of the country covers approximately a third of the Sri Lanka's land in its basin.

The rest of the institutional partners are the National Water Resources Authority, Ceylon Electricity Board and Department of Irrigation; who are large-scale upstream users of waters of the river. The Postgraduate Institute of Agriculture (PGIA) is the key partner in the project for valuation and designing of the economic instruments. The local communities in the basins who depend on man-made and natural wetlands for their livelihoods, are also key intended beneficiaries in the project. These populations face high levels of poverty, and rely heavily on traditional irrigation systems and natural resource use. Over a third of the population in the North Western Province of Sri Lanka, where the Kala Oya Basin is located is classified as poor, and more than 44% of the Kala Oya basin population belong to the poorest segment of the country, receiving Samurdhi welfare support.

THE SITE: Water, ecology and socio-economy in the Kala Oya Basin

National development goals and indicators

Sri Lanka is an Island with a land area of 6,570,134 ha and a coastline of approximately 1,600 km. About sixteen percent of the land is cultivated permanently, and another 13 % of land is categorized as cultivable lands. Natural and planted forests cover 27.6 % of the total land area. Sri Lanka consists of a coastal plain, and a central mountainous area rising up to elevations of 2,500m. These mountains are the highest points of catchments, of hundred-and three major rivers of the country. Mahaweli, is the longest river of the country and it has been diverted for agriculture and hydropower generation. This has so far, been the biggest development project of the country undertaken two and a half decades ago, by the MASL.

Key development indicators

Policy makers of the country faced several major challenges at the beginning of 2002 that required immediate attention, to enable the economy to recover from the contraction Sri Lanka experienced, in 2001. The main challenges were: to find a lasting solution to the ethnic conflict, that had weakened economic growth for nearly two decades; to accelerate wide economic reforms, sorely needed to improve the efficiency of the economy, optimise use of resources and encourage private sector led growth; and finally, to reduce the high fiscal deficit, thereby bringing inflation and growing public debt under control.

In 2002, the Sri Lankan economy recovered from the setback it experienced in 2001 by benefiting from: improved domestic conditions resulting mainly from the peace process, strong fiscal consolidation efforts, accommodative monetary policy, renewed commitment to structural reforms, and a more favourable international environment. Economic growth rose progressively during 2002 and recorded an annual growth rate of 4 percent, in contrast to a contraction of 1.5 percent, the previous year. The services sector accounted for about 80% of the overall growth in 2002, while the agriculture sector contributed to the growth by approximately 13%.

Table 1: Selected macroeconomic indicators for Sri Lanka

Item	80-89 Avg.	90-97 Avg.	1998	1999	2000	2001	2002
GDP (real) growth rate	4.2	5.2	4.7	4.3	6.00	-1.5	4.0
GDP deflator	11.8	11.1	8.4	4.4	6.7	12.4	8.3
GDP (nominal) per capita in US$	362	618	879	863	899	841	872
Unemployment as a %	n/a	13.2	9.2	8.9	7.6	7.9	9.1
Balance of payment, current A/C	-8.1	-5.7	-1.4	-3.6	-6.4	-1.5	-1.6
Population below US $1/day							6.6%
Population below US $2/day							45%
Human Development Index							0.741

Source: Central Bank, 2002

National development goals

Under the theme regaining Sri Lanka, the main development goals are; to achieve a 10% growth rate to overcome debt crisis, by increasing productivity and efficiency in all sectors of the economy. Thereby, it is expected to alleviate poverty and create 2 million new employment opportunities. Other development goals include, reduction in the proportion of people living in extreme poverty by half between 1990 and 2015, enroll all children in primary school by 2015, make progress towards gender equality in primary and secondary schools by 2015, reduce infant and child mortality by two-thirds, reduce maternal mortality by three-quarters, provide access for all who need reproductive health services, and implement national strategies for sustainable development. The expectation is; to expand activities of all sectors of the economy by increasing investments, elevating productivity and thereby achieving higher income levels. - Another expectation is to stop the war and move into restoration of peace, in order to have an environment in which higher investments are made in all major sectors of the economy, through policy reforms. Further, there is an expectation, to encourage & facilitate more productive use of all resources necessary in an internationally competitive economy. Some of the key areas include; employment, education & human resource development, investments, new business development, public-private partnership, land, natural resources use, agriculture development, trade, and strengthening regional & international economic relationships.

Additionally, a high emphasis will be given for infrastructure development, such as a better road network including highways and rural electrification, supply of telephone facilities and rural water supply schemes for the rural poor.

Rural people, mainly depend on natural resources of their vicinity such as land, forest, inland water bodies and marine resources. It seems that they are both the cause, and victims of resource degradation, attributed by insecure land use and user rights and uncontrolled access to natural resources. Therefore, it is envisaged that greater participation of communities, NGOs, private sector and the government will be needed to overcome the problem of resource degradation (Royal Netherlands Embassy, Arcadis Euroconsult and IUCN 2000). Population growth and economic expansion have caused deforestation, forest degradation and reduced biodiversity. Also, this has contributed to irregular water flows, soil erosion, and triggered shortage of fuel wood (Asian Development Bank, Sri Lanka Forest Resources Management Project, final report 1999).

The private sector will be encouraged to invest in new forest plantations. As the country has a rich wildlife, capitalization on it through programs such as nature-based eco-tourism will raise the income of rural poor. Models successfully employed in countries such as Costa Rica, encouraged local communities to establish buffer communities on the outskirts of Protected Areas (PA's). Thus, existing farmer organizations or Community Based organizations established for this very purpose could be encouraged to engage in wetland management and maintenance, with the technical support of government agencies.

A hydraulic civilisation

Historically, one of the fields in which Sri Lankans have displayed rare skills in managing nature and its riches, is undoubtedly in the development of water resources. The map of Sri Lanka, particularly its Dry Zone, is dotted with literally thousands of ancient tanks of varying sizes and shapes, some operational and others abandoned. It was around these ancient tank systems, that the economy and human settlements of early Sri Lankan society were built, developing itself in to a 'hydraulic civilization'. Unlike 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 irrigation water. It has been reported that at the zenith of its development, the ancient Sri Lankan hydraulic engineers were even called upon to serve in other countries. Similarly, the urban water and sanitation systems, as seen at Anuradhapura and Sigiriya with their ponds and fountains, bear ample testimony to the ingenuity of ancient Sri Lankans, in the field of water resource management (NSF, 1999).

It has been reported that Sri Lanka was practicing irrigation as far back as 500 BC. The practice of irrigation in the country has a tradition of over two millennia, and Sri Lanka's ancient civilization has been as one of the oldest in the world. The famous dictum of King Parakrama

Bahu the 1st, the epic hero of the Polonnaruwa period, states that ‘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’. This denotes a lofty ideal and no doubt reflects an enlightened knowledge of irrigation policy and engineering. No large-scale engineering works appear to have been constructed after the decline of the Polonnaruwa period in the 12th century AD. Thus, most of the irrigation works were left to ruin in the course of time as the country was invaded and ruled by various foreigners from 1505 to 1948.

Historical background of the small tank cascade system

In the old system of tank cascades, each tank did not have a settlement or a village. There were tanks to serve specific purposes. The tanks located at the highest elevation of the entire tank system and across the main stream of the cascade, served the purpose of detaining silt and debris. Also it reduced the energy of flowing water that caused erosion. In the system, there were tanks within the forests areas also serving the purpose of maintaining a micro-eco system that helped improve the ground water table. There were tanks to store excess water during the rainy season, for use in the dry season. The cascading tank system is constructed according to the physical nature of the tank, and to withstand the rough conditions of the dry zone.

During ancient times, the entire agricultural system had been governed according to a set of established norms aimed at optimum utilization of land and water resources. A tank itself had several features i.e. a reservation in the catchment vegetation around the tank, small pits on the feeding canals in order to reduce siltation and lengthen storage life and a system of natural purification of water. In addition to agricultural production benefits, the small tank cascade system offered several other benefits such as fish breeding, flood control, maintenance of the water table, extending the period of water availability, soil conservation and reduction of siltation. Small tanks and the landscape around them, had been time tested for their adaptation to the local environment. There had been a management system and a system of collecting water taxes in place. An officer was in charge for collection of taxes and was responsible for water management.

The system started declining due to several reasons and a large number of tanks were completely abandoned. Several of such tanks were restored later. The present status characterizes low and variable cropping intensity, low harvest ratios and crop yields, and deforestation in the catchments. Social problems are considered to be serious and resource degradation and depletion have appeared to be intense.
The institutional arrangements have been subjected to a series of change, and the orderly manner within which tank resources were managed in the past has disappeared.

Water resources in the Kala Oya Basin

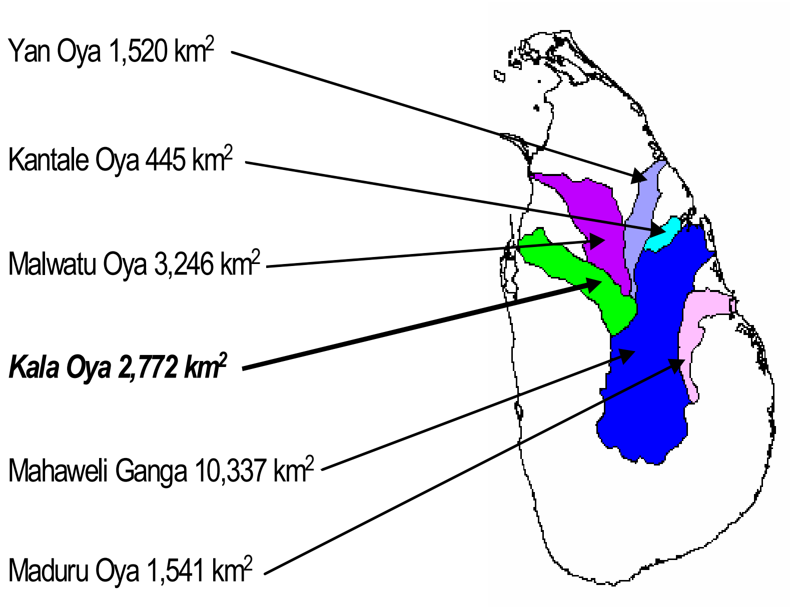
Kala Oya, is one of the 103 river basins in the country, situated in the Northwestern dry zone of Sri Lanka. Its basin area is around 2,870 sq km. Its elevation varies from mean sea level to 600 m above MSL at its headwaters. The Kala-oya basin is long and narrow, having an average width of about 25 km and a length of 150km. There are about 600 minor irrigation tanks including abandoned tanks within the basin, which provide many services to the local communities, in addition to providing irrigation water. Kala Oya cut across North Central, Central and North Western Provinces of the country. Contents of this chapter on Kala Oya basin have been drawn heavily, from the Interim Reports prepared by River Basin Management and Planning Unit of MASL.

Sri Lanka has two major climatic zones; wet and dry. The wet zone covers approximately one quarter of the country, and receives around 2,400 mm of average annual rainfall from the two monsoons, namely, the South-West monsoon which runs from April to September and the North-East monsoon which runs from October to March. The remaining area of the country, is in the dry zone with around 1,450 mm of average annual rainfall, leaving a narrow strip of an intermediate zone in between two main climatic zones of the country. Around 75% of the Kala

Oya Basin area is situated in the dry zone, and this area has only one rainy season i.e. from October to January.

The Kala-oya basin receives water from the Mahaweli River, to meet approximately 75% of its annual demand via the Bowatenna diversion. The Bowatenna reservoir has two tunnels: one to divert water for irrigation in the Kala Oya, Malwathu Oya and the Yan Oya basins, by a four mile long and 18ft diameter tunnel, while the other, after power generation at the Bowatenna power house, to use water for downstream irrigation systems.

Figure 1: The Mahaweli and adjacent basins



Source: The Kala Oya River Basin Project

The preliminary assessment of water resources of MASL, has provided a water budget of a net inflow of 800 MCM in the basin. A Deep confined aquifer occupies about 7% of the basin area, and is located in Wanathavilluwa area, towards the lowermost area of the basin in the coastal belt. These are relatively deep aquifers and cannot be exploited by shallow, smallholder tube or dug wells. These also have relatively high recharge rates. At present this aquifer is providing the entire potable water requirement of the people in the Wanathvilluwa Divisional Secretariat area, through numerous high capacity wells operated by the National Water Supply and Drainage Board.

Cascade based watershed approach

A larger part (around 50%), of the Kala Oya Basin is in the North Central Province, where 457 tank cascade systems are located (Panabokke et al, 2002). The tanks in the Kala Oya basin are members of 68 ancient cascade systems of North Central Province (MASL 2002).

Cascades are a series of interconnected tanks, organized within the micro-catchments of the dry zone landscape, supposed to 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 capacities of tanks are so small that it can support only single Maha season cultivation, with any residual water used for limited dry zone cropping in Yala. The annual cropping intensity is only around 100%, typically 75% in Maha and 25% in Yala.

The Rajangana sub-catchment of the Kala Oya, has been selected for the study. The sub basin consists of irrigation systems and tanks which are managed by the MASL, the Irrigation Department and the ASD. The ASD manages all the minor tanks, which serve a command area less than 80 Ha outside the Mahaweli area. The Mahaweli development area (Rajangana and Angamauwa sub catchments - RA) and the non Mahaweli development areas (Giribawa, Mahagalkadawala, Mahaliyanagama and Pulanchiya cascades–GMMP cascades) were identified for purposes of detailed economic assessment, after field observations and consultations with MASL, the ID and the stakeholders.

Small tanks and irrigation systems

These irrigation systems managed by MASL and ID, contribute to the hydrology of traditional tanks indirectly linked to the system. Those tanks contribute to the local economy, through direct benefits and provide a number of indirect benefits through different functions and services. Most of the tanks end up with a little water during Yala (lean season). Since irrigation water does not seep through the paddy fields much, there is less rainfall and the storage in the tanks diminishes. Hence, there is a reduction in most of the services provided by these tanks, until water is received in the next irrigation season.

Rajangana/ Angamuwa catchments receive water from the Mahaweli canals, coming from the Kala Oya reservoir, which is filled with the water diverted from the Mahaweli river, in addition to the rain water received from its large catchments. The ASD catchment area is a cascade of old tanks which get water from the rainfall, and the spill water of the upstream tanks.

Since the wetlands in the RA catchments area receive most of its water from the Mahaweli irrigation system, either directly or indirectly, farmers are able to cultivate paddy and other field crops in both seasons. Some of the tanks are used by the Mahaweli irrigation system as storage tanks that get water directly from the channels, while other tanks (isolated tanks) receive water from seepage. When these storage tanks and canals distribute water for paddy fields, excess water flows to the next tank. These tanks, which do not receive water directly from irrigation canals, are called isolated tanks.

These isolated tanks have been given a major emphasis in this study, as these tanks are rarely rehabilitated due to the understanding that they do not have much importance, from an irrigation perspective. However, other tanks, which are directly connected to the main irrigation canals, are rehabilitated by the MASL to increase or to maintain storage capacity.

Table 2: Tanks in the Kala Oya study area

Area	No. of Tanks	Managed by
Mahaweli Area Rajanagana /Angamuwa sub Catchment	Working 332 Abandoned 11	MASL 93 ASD 223 ID & Other 16
Non-Mahaweli Area Giribawa, Mahagalkadawala, Mahaliyanagama, Pulanchiya Cascades	Working 86	ASD 86

Source: The Kala Oya River Basin Management Secretariat

Major Reservoirs

The major reservoirs in the Kala Oya basin, are managed and maintained by two government institutions, i.e. the MASL and the ID. The minor tanks are maintained by, the ASD. The biggest reservoir in the Kala-oya basin is Kalawewa, having a storage capacity of 128 MCM while Rajangana has a capacity of 101 MCM.

The Kalawewa reservoir, having three major irrigation sluices, has the following command areas: Left Bank 6.100 ha, Right Bank 13,570 ha and Yoda Ela 4,700 ha. Part of the water used in Right Bank is transferred to the Malwathu Oya basin, to irrigate areas coming under Nachchaduwa, Nuwara wewe and Tissa wewa tanks, and to meet the domestic water demands of Anuradhapura City.

Wetlands

A large number of important wetlands including man made and natural wetlands, are situated in the Kala Oya basin. These wetlands are very important for the sustainable livelihood of the basin community, as they contribute to various uses such as purification of water, bio-diversity, water quantity regulation, fishery, recreation, tourism etc depending on their strategic location in the basin.

As the entire livelihood of the area depends on agriculture and its related business, the demand for irrigation water is very high. A major proportion of regulated water in the lower valley of the basin is used in the irrigation sector. The domestic and Industrial uses are comparatively low in quantity, as most of the domestic uses are non-consumptive. The industrial demand is negligible. The average annual releases for the Kala-Oya Basin stand at 1,150 MCM. This figure includes return flows from upper irrigation areas, and excludes releases from approximately 600 minor tanks spread over the basin. Out of the above quantity 65% of the water is used by the MASL managed areas and the balance by the ID. The number of minor tanks within system H is about 160 and the balance 440 is outside the system. The tanks which have less than 80 Ha of command area outside system H, are managed by the ASD in association with the farmer organizations of the tank. Both MASL and ASD conduct agriculture seasonal meetings (“kanna resweem”) before the season starts, and inform the farmers about water availability of the tank, expected rainfall, suitable crops for the season and necessary information about proper management of the water and irrigation systems.

Kala Oya Estuary

The Kala Oya estuary, located in the western coast of North Western Province in Sri Lanka is rich in bio-diversity. The mangrove and fisheries ecosystems in the lagoon area, have been threatened by increased population pressure and industrial activities. The poor community in the lagoon area depends on the ecosystems for their livelihood activities. The pressure on the ecosystems, is believed to be exceeding sustainable levels.

It was reported that, the mangrove cover in the estuary area has declined from 1181ha to 431ha from 1981 to 1992 (Dayaratne *et al,* 1997). Mangroves of the Puttalam area are widely extracted for both subsistence and commercial purposes. Amarasinghe (1988) reported that, 55% of the household around the Puttalam estuary used mangroves as firewood. This figure has further increased as a result of the influx of refugees/internally displaced persons to the area.

Coastal resources of the Kala Oya basin include varied biotopes such as mangroves, sea grass beds, sand dunes, lagoon systems, bar reef marine sanctuary, etc. A bar reef marine sanctuary (306 km^2), with very high significance of biodiversity, is situated at the sea mouth of the Kala Oya basin. The well being of the bar reef marine sanctuary is of vast ecological and economic importance, as the reefs within the sanctuary function as an integral part of a larger economic system, adjacent to coastal water.

Land use

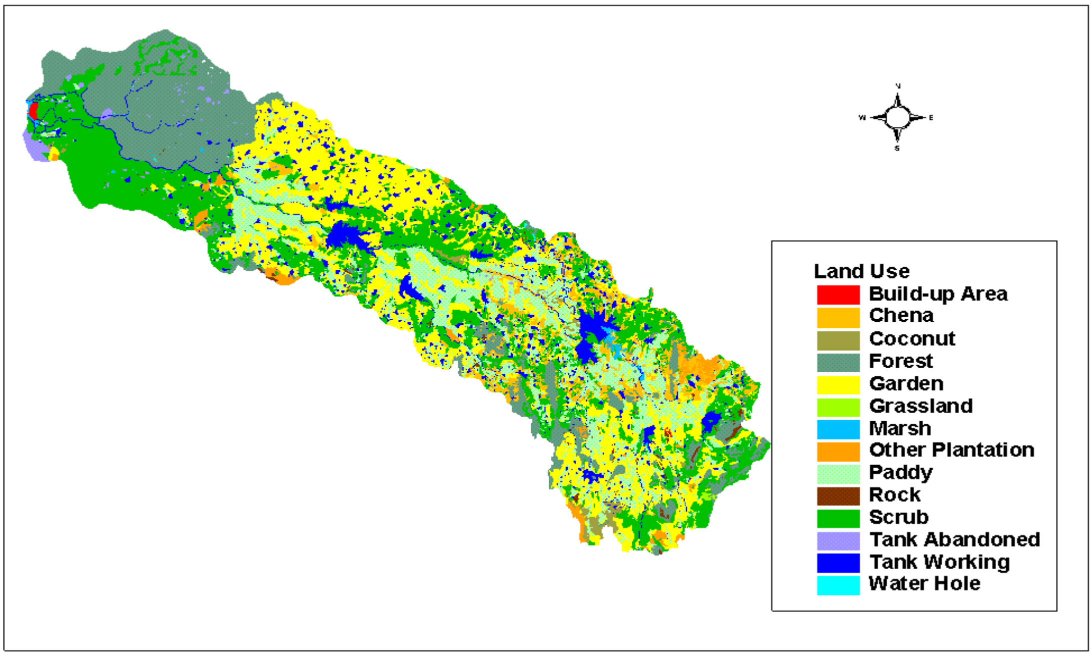
Scrub lands, gardens, forest and paddy cover almost 80% of the land area in the basin. The table below provides details of different land uses in the area.

Table 3: Land use in the Kala Oya Basin

Item No.	Use of Land	Extent (Ha)	Percentage
1	Build up area	1,722	0.6%
2	Chena Cultivation	15,230	5.3%
3	Coconut Cultivation	2,595	0.9%
4	Forest	51,227	17.8%
5	Garden	67,166	23.5%
6	Grass land	159	0.1%
7	Marsh land	914	0.3%
8	Other plantation	4,334	1.5%
9	Paddy	42,608	14.8%
10	Rock and Erosion	1,335	0.5%
11	Tank (working)	19,584	6.8%
12	Tank (abandoned)	2,223	0.8%
13	Water Hole	161	0.1%
14	Scrub	78,022	27.3%
Total		287,280	100%

Source: River Basin Planning & Management Division, MASL

Figure 2: Land use in the Kala Oya Basin



Source: River Basin Planning & Management Division, MASL

Since irrigation systems are available in the basin, most of the land is utilized for cultivation and the rest used for settlements, forest, pasture and non-agricultural activities. The lowland is traditionally used for growing rice in the wet season. As rice is the staple food of the county, most of the land is used for growing rice in the wet season and other field crops in the dry season. When irrigated water is available, farmers prefer to cultivate rice even in the dry season.

The highest land uses are scrub jungle (27%), home gardens (23%), forest (17%) and paddy cultivation (15%) of the basin.

Each household of the settlers is given 2 ½ acres of irrigable land and ½ acre non-irrigable land on which the homestead is located. Farmers are settled in hamlets, and as far as possible in homogeneous groups. i.e. their cultural and geographical background is kept in mind. The main idea in settling the people in homogeneous groups is, to make the socialization process under the new environmental conditions easier. (M.M. Karunanayake, 1983).

Socioeconomic status

Secondary data available with regard to the socioeconomic status is discussed in this section. The two main sources of the data discussed in this chapter are those of the Dept. of Census and Statistics and the baseline survey conducted in the Mahaweli System H (year 2001). Secondary data at DS division levels were collected. It was discovered that the data at different DS divisions are available only in respect of certain periods and cannot be compared with other DS divisions. Hence it is difficult to analyze this data at this juncture.

Basin population

The following table presents the current and forecasted population, in the basin at DS division level.

Table 4: Population and poverty incidence in the Kala Oya Basin

Divisional Secretariat	Population in 2001	Samurdhi Recipient Households
Anuradhapura District		
Nochchigagama	20,665	2,128
Palagala	26,319	4,572
Rajanganaya	30,298	2,855
Tambuttegama	36,397	2,108
Thalawa	34,188	2,647
Ipalogama	31,312	3,461
Kekirawa	24,284	2,263
Galnewa	30,335	2,878
Palugaswewa	825	109
Tirappane	216	39
Sub Total	*234,839*	*23,060*
Matale District		
Naula	3,343	640
Dambulla	43,396	6,717
Galewela	58,538	9,350
Pallepola	949	141
Sub Total	*106,226*	*16,848*
Kurunegala District		
Galagamuwa	14,455	2,739
Giribawa	24,595	4,887
Polpitigama	4,967	719
Ehetuwewa	11,678	1,679
Sub Total	*55,695*	*10,024*
Puttalam District		
Wanathawilluwa	4,626	568
Karuwalagaswewa	9,963	1,688
Sub Total	*14,589*	*2,255*
Grand total	**411,349**	**52,188**

Source: River Basin Planning and Management Unit, MASL

Since some of the DS divisions fall partially within the basin, the population estimates for the basin were calculated by MASL merely on the basis of land area. The baseline survey carried out by MASL in year 2001 covering 2,500 farmer families in 30 DCFOS, revealed the current socioeconomic situation of system H which covers 34% of the Kala Oya basin. The number of recipients of Sri Lanka's largest Social assistance programme i.e. "Samurdhi", accounted for 44%of the total number of families living in the basin. This programme distributes monthly coupons which can be used for obtaining food items, and kerosene from co-operative shops. Families who receive less than Rs 1500 per month, are identified as Samurdhi beneficiaries. Their benefits varied from Rs 100 – Rs 1000 per family, depending on their family size and income.

The age profile in system H shows that about 63% of the population is in the working age (18 to 60 years of age), while 80% are in the labour active age group (14-60 years of age). About 6% of the population are above the age of 6 and have not received and formal education, while 5% of the population have a tertiary level of education, like diploma certificates and University degrees.

Housing & access to services

There are 56 % permanent, 21% of semi permanent and 23% of temporary houses, where the dwellers are currently residing, in System H. The types of toilets used are categorized as "water sealed", "pit latrine" & "other" and yet another category as "not having a proper toilet". The percentages of these are 60%, 38%, and 2% respectively. The domestic water requirement of the dwellers in the area is supplied through private well water, pipe borne and common wells. The percentages of households using these sources are 88%, 0.2%, and 11.8% respectively. Electricity is supplied to 45% of the houses and only 1% of the households have telephones.

Key Development Indicators

The unemployment rate is 11.2% for the working age group in system H, with 8% of the working age group actively seeking employment. The current employment profile is presented in the following table.

Table 5: Employment categories

Field of Employment	Percentage (%)
1. Farming	72.0
2. Textile & garment industry	6.1
3. Security Forces	5.4
4. Other	16.5

Source: River Basin Planning and Management Unit, MASL

The average net annual family income, is estimated at Rs. 99,892.00. It has also been revealed that, over 25% of the families earn more than 10,000/- per month. The main sources of income and the percentages are presented in the following table.

Table 6: Main sources of income

Sources of Income	Percentage (%)
1. Farming	57.0
2. Permanent Employment	18.5
3. Self Employments	6.9
4. Livestock	2.1
5. Wages Labour	10.8
6. Lease of Lands	3.9
7. other	0.3

Source: River Basin Planning and Management Unit, MASL

In 1995/96, the average monthly income of Matale, Kurunegala, Puttalam, and Anuradhapura was estimated at 4550/=, 5143/=, 5718/=, and 6083/= respectively. (Household and Income survey, 1995/96, DCS).

Poverty, livelihoods and wetland ecosystems

Livelihood dependence on small tanks

Rural livelihood is tied up with tanks, as the main supplier of resources to the people in the village. The tank provides water for their main income generation activities, i.e. cultivation of paddy and other field crops. In addition, through sub surface water it provides water for other crops in home gardens. Hence, the tank maintains the water levels of the wells in their home gardens, and makes the water drinkable, as soil in the region consists of fluorides and salts. Dissanayake and Weerasooriya (1985) have reported that the ground water in some areas of North Central Province (the major part of the Kala Oya basin is in this province) contains excessive amounts of fluoride (MASL, UOC, 2003). The wells located near the tank hold quality water, since seepage water from the tank dilutes the hardness and fluoride content.

People are able to bathe and wash their clothes easily at the tank, as all do not have their own wells. Some of the households have to use the tank even though they have their own wells, due to the poor quality of the water in their wells. Due to the hardiness of water, it is difficult to apply soap in this water. Further, white clothes mainly school uniforms, cannot be washed using well water as they turn off-white.

The people, cattle and other animals in the area also get drinking water and fodder from the tank. In addition, these tanks provide other marketable goods like fish, lotus flowers, lotus roots and sedge, in addition to having many indirect uses.

People living around the tank have formed farmer organizations and appoint a person called "Jala Palaka" i.e. water controller, who is supposed to release water according to the requirement of the farmers and the domestic users. The normal practice is that the water controller retains some water in the tank for domestic purposes.

The water holding capacities of these tanks have gone down drastically due to siltation, and the low spill ways which were lowered to integrate with other tanks, at the beginning of the Mahaweli Development project. Raising the spill ways and de-silting the tank are the two basic options available for increasing capacity, while, at the same time, encouraging better practices in cultivation to reduce soil erosion, maintaining reservations and frequently cleaning the tank to reduce the growth of water weeds.

Wetland valuation can be carried out in three stages i.e. estimation of Direct Use Value, Indirect Use value and Non-Use value. Twenty three tanks of the Mahaweli and non-Mahaweli areas were valued for direct uses and qualitatively assessed for indirect uses.

Wetland resources and poor

The study team looked at the utilization of wetland resources, by poor and rich households. Around 40 percent of the households living around the tank receive Samurdhi benefits. There are around 72% of families fully engaged in agriculture, and in around 18% of the households at least one of the family members are employed, either by the Government or by private institutions. Only around 7% of households are considered as rich, possessing tractors for agriculture and other vehicles like vans and lorries in addition to their land. Most of these 'rich' households have their own wells, and overhead tanks for storing water. If the water is not hard due to being mixed with salts in these wells, these people rarely go to the tank for bathing.

All the households who own land use the tank for agriculture. Even poor people cultivate lands on "Anda" system (land tenure mechanism) where poor people cultivate paddy lands with the assistance given by the landlord. In this method, the landlord spends on fertilizer and chemicals, and tenants give an agreed portion of the harvest to the landlord. Mostly, this portion equals one fourth of the harvest. If the landlord supplies the seeds, fertilizer and chemicals the share will be half of the harvest.

In 1983, new settlements were established and each family was given two and half acres of paddy lands and one half acres of upland, for housing and to maintain a home garden with other field crops. Since all the land in the area except reservations were distributed among the farmers, succeeding generations do not have enough land to cultivate in the area. Some of the youth have migrated to cities to work in factories, or have joined the military forces which have a high demand for young men and women, due to the conflict in North and East of the Country. Others, who did not move out of the village, have had to share the land with their parents, brothers and sisters for cultivation. If the family is large this 2 ½ acres land is not enough to share. Hence, some of them get married and settle in reservations illegally or remain with their parents and opt to work as daily paid labourers in other lands. Since, the demand for labour is very low and highly seasonal in paddy cultivation, these families face numerous economic problems. Usually, these families (around 5%) who do not have their own land to cultivate are considered poor in these villages. They are the people who mostly use the resources of the tank for their living. They engage mainly in fishing full time or collecting lotus flowers and roots.

In addition to these families, there are a few families (only a family or two per village) who lease out their land to another villager, though it is illegal, and work as labourers.

According to the categorization of villagers these are the people who are considered 'poor'; All the others, though they have difficulties in cultivation due to the high prices of fertilizer and chemicals, with paddy prices remaining the same are not considered poor by them.

Major threats and issues in the basin

Siltation and sedimentation

Both man-made and natural wetland areas harbour high levels of biodiversity in Sri Lanka. Especially, the ancient tank systems have both ecological and biological importance. A key issue in the Kala Oya Basin is seasonality and duration of water retention in these traditional tanks, 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.

Wetlands in the Kala Oya Basins are currently under a threat of siltation and sedimentation, arising from unsustainable land use practices in the catchments. Especially, siltation has reduced the water holding capacity of tanks and made the excess water overflow to the sea, during the rainy season and the period of Mahaweli water releases.

Salinity

Large irrigation projects accompanied with inadequate drainage, are known to raise salinity levels; thereby posing a threat to agricultural production and the environment. In Sri Lanka, the main areas affected by salinity problems are located near the coast, or are irrigated lands in the dry zones of the country.

Studies examining the salinity situation in Sri Lanka are very limited. There are no compiled records that report areas which are severely affected, or data that indicates a trend. Likewise, studies providing data on the relationship between wetlands and salinity levels are also very scarce. In the present report, information on these linkages is therefore based on expert statements and opinions, and the current salinity status of the project area.

Even though salinity is not a general problem in the project area, lower lying lands have become waterlogged, where the groundwater table has risen to less than one meter below the soil surface. Waterlogged areas are vulnerable to salinization, and the impact on surrounding areas can be quite severe, causing the loss of both wet and dry seasonal crops. Studies conducted prior to the Mahaweli irrigation project, have shown that about 5% of the paddy fields were affected due to salinity, mostly emerging from underground reserves (Sikurajapathy et al., 1983 & Handawala, 1983). More resent results by Thiruchelvam and Pathmarajah (1999), indicate that around 23% of the farmers were operating under high salinity conditions, and that the affected land had increased to 7% of the total farming area. These farmers are experiencing crop damage caused by salinization, and in certain areas the damage may accounts for as much as 25% of the yield. The high salinity levels can be ascribed to the dry climate, poor drainage practices, use of drainage water for irrigation and inefficient irrigation management (Thiruchelvam and Pathmarajah, 1999).

In addition to crop loss, other potential negative impacts following salinization involve ecosystem degradation, diminished surface water quality, and increased public health risk.

Farmers owning affected fields have adopted mitigation methods, such as organic matter application, flushing, use of ameliorates, and increased drainage. The financial gain from reduced salinity can be as high as Rs10 per kg of rice. Other studies have shown that the most viable and cost effective approach to salinity control is adequate surface drainage, (Sumanaratne and Abegunarwardena, 1993 & Herath, 1985). Installing drainage systems will leach out soluble salts, is another solution. Per hectare, an adequate system would require approximately 8 plot drains (tertiary), 4 field drains (secondary) and 2 field drainage channels (Thiruchelvam and Pathmarajah, 1999).

According to MASL, the drainage canals had originally been laid out between every two fields. Those were sufficient to drain the whole system of excess water. However, farmers reportedly clear only the irrigation field canal, and not the drainage canal. Furthermore, MASL's operation and maintenance activities have so far mainly focused on the irrigation canals. In some places, even the field drainage canals are being cultivated! As a result water logging and salinization have become problems in these areas.

In Thiruchelvam and Pathmarajah (1999), it is expressed that there is considerable scope for growing trees and shrubs to deplete the groundwater table, and reduce the salt problem under irrigated conditions. Biological drainage using salt tolerant and fast growing tree species is less expensive than a capital-intensive technological solution. Farmers may justify tree planting on economic grounds. Therefore, income-generating trees such as banana, mango and fast growing fuel-wood species like Eucalyptis, Ipil Ipil, and Casuarina could be planted in tank bunds, canal areas and in other vacant irrigated areas.

NATIONAL FRAMEWORKS: Legal and institutional context to water resources planning and management

Since the creation of the Irrigation Department in 1900, and particularly since the 1930s, the anthropocentric use of water has been driven by national, centrally conceived plans, as in contrast to the village-level focus of indigenous water regimes, and early colonial strategies. The engine driving this centralization was a growing desire to maximize food production, as measured in terms of national output. For such designs of large scale agriculture, investments in village-level infrastructure were deemed inadequate, and planning was shifted towards the ID and away from the Government Agent who hitherto had been responsible for Provincial and village level planning.

There are several laws and regulations that deal with water management

- Mahaweli Authority of Sri Lanka Act, No. 23 of 1979
- Irrigation Ordinance, No. 32 of 1946
- Water Resources Board Act, No. 29 of 1964
- National Water Supply and Drainage Board Act, No. 2 of 1974[1]
- Flood Protection Ordinance, No. 4 of 1924
- National Environmental Act, No 56 of 1980[2]
- National Environmental (Procedure for approval of projects) Regulations, No. 1 of 1993
- Gazette Extra-Ordinary No. 772/22 of 1993
- Gazette Extra-Ordinary No. 1104/22 of 1999
- Gazette Extra-Ordinary No. 859/14 of 1995
- Gazette Extra-Ordinary No. 978/13 of 1997

Several other laws provide for the direct conservation of wetlands as protected areas,3 but these (apart from the National Environmental Act) will not be considered in this study, since the study's focus is on how wetland conservation can be promoted, in legal frameworks of the non-conservation sectors.

Legislation

Mahaweli Authority of Sri Lanka Act, No. 23 of 1979

This was enacted to establish the MASL, (the Authority) for the purpose of implementing the largest water management projects undertaken in Sri Lanka – the Mahaweli Development

[1] Amended by National Water Supply and Drainage Board (Amendment) Act, No. 13 of 1992
[2] Amended by Acts Nos. 56 of 1988 and 53 of 2000
[3] Fauna and Flora Protection Ordinance, No. 2 of 1937 (as amended by Acts Nos. 44 of 1964, 1 of 1970 and 49 of 1993); Fisheries and Aquatic Resources Act, No. 2 of 1996; and the National Environmental Act, No 56 of 1980

(hydro electricity and irrigation) Scheme. In doing so, the powers vested in the Authority, as described below, have ensured virtual monopolistic control, over the planning and implementation of all activities in areas touched by the Scheme.

The Act confers on the Minister the authority to declare, with the approval of the President, any area that in his/her opinion can be developed with water from the Mahaweli river, as a 'Special Area'.[4] In such Special Areas, the MASL is required to carry out a wide range of functions including overall planning,[5] optimizing agricultural productivity and employment potential,[6] and conserving the environment[7]. To enable the MASL to function, it is vested with wide powers in Special Areas that include construction and operation of infrastructure, necessary for irrigation[8] and the generation of hydroelectricity,[9] as well as involvement in various settlement and agricultural activities.

These powers are directed at enabling the MASL to implement its development mandate and the only provision dealing with the environment is similarly oriented, focusing on and being limited to the protection of watersheds and control soil erosion.[10]

The virtually absolute power of the MASL within Special Areas is further reflected in S. 22 which empowers the MASL to discharge powers and duties arising from other laws listed in Schedule B of the Act in such Areas. Further, powers over the acquisition of land in Special Areas is provided by S. 23 which empowers the MASL to acquire any land required for the Scheme's implementation under the Land Acquisition Act.

Irrigation Ordinance, No. 32 of 1946[11]

This ordinance is principally concerned with the creation and management of irrigation infrastructure, and is administered by the ID at the center, and through GA and several committees at various local levels. For the purposes of this study that is primarily concerned with legal provisions for the incorporation of wetland values into water resources management planning, this Ordinance contains few provisions of relevance. It does not contain any express concept of integrated planning. The single administrative arrangement that could have required environmental considerations to be taken into account when planning irrigation works, is the Advisory Committee required by S. 6 for every major irrigation work. However, the composition of such committees, are limited to stakeholders with interests primarily in agriculture, whilst representation of any agency with a mandate for environmental management is wholly absent.

Water Resources Board Act, No. 29 of 1964

This Act establishes the Water Resources Board mandated to advise the Minister regarding a wide range of aspects related to water management, including formulation of national policies; regulation of water uses; development as well as the conservation of water resources. This includes the prevention of pollution and control of soil erosion.[12] Overall, the Act views water as a multi-faceted resource, required for human development as well as for the maintenance of

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4 S. 3(1)
5 S. 12(a)
6 S. 12(c)
7 S. 12(d)
8 S. 13(1)
9 S. 13(2)
10 S. 13(3)
11 As amended by Acts. Nos. 1 of 1951 and 48 of 1968, and by Law No. 37 of 1973
12 S. 12

ecosystems and other natural systems.[13]

This holistic approach to water management is further emphasized, in the requirement of integrated management plans for the conservation, use and development of water resources,[14] and the clear appreciation for inter-agency co-ordination and basin-level planning.[15]
Inter agency co-ordination is to be effected through an Inter-Departmental Advisory Committee, that includes the Forest Department, but not the Ministry in charge of the subject of Environment or the Department of Wildlife Conservation - the two agencies with the primary mandates over wetlands.

Nevertheless, this Act is the only legislation currently in force, that seeks to develop a multi-sectoral approach to water management with a clear mandate for diverse interests, beyond traditional anthropocentric water uses, to be included in the planning process. Unfortunately, the Water Resources Board has not been an active player in national water management planning, with the result that the provisions described above have been under-utilized.

National Water Supply and Drainage Board Act, No. 2 of 1974

This Act establishes the National Water Supply and Drainage Board for the purpose of providing a supply of fresh water for public, domestic and industrial purposes[16] and for operating public sewages systems.[17] The Board supplies fresh water, in both urban as well as rural areas, primarily through the tapping of surface water, and in some instances, through the extraction of ground water from aquifers. For this purpose, the Act empowers the Minister, with the concurrence of the Minister in Charge of Local Government, to declare by Order, any area to be an area of authority of the Board.[18]

Despite the Board's mandate having clear implications for the sustainability of wetlands that supply the fresh water, the Act, and its amendment in 1992, do not contain provisions, requiring prior consultation with agencies and other affected or interested parties, when planning water supply schemes. The Acts also do not contain provisions that lay down principles, such as the recognition of watersheds, to be applied in such situations. Furthermore, as only irrigation schemes (water supply schemes connected to agriculture) are Prescribed Projects under the National Environment Act (see below), these schemes are also not subject to Environmental Impact Assessments, and thus the certain and potential environmental impacts of water extraction from a wetland cannot be ascertained.

Nevertheless, in practice access to such areas (the Labugama lake for example) is restricted, requiring permission from the Board. Such protection however is likely to be driven by concerns over water quality than any environmental considerations.

National Environmental Act , No 56 of 1980 and relevant regulations

The relevance of the National Environmental Act (NEA), is derived from Part IV C which establishes the requirement of conducting Environmental Impact Assessments (EIAs) and Initial

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[13] S. 12(f)(ii)
[14] S. 12(g)
[15] S. 12 (h), (j) and (k)
[16] S. 16(i)
[17] S. 16(ii)
[18] S. 15(i)

Environmental Assessments (IEE) in relation to certain development projects. EIAs are applied routinely to state-sector projects, but only to those private sector driven projects,[19] that fall within the category of a Prescribed Project listed in Gazette Extra-Ordinary No. 772/22 of 1993[20] made under the National Environmental Act. EIAs are implemented by Project Approving Agencies (PAAs) as prescribed by the Minister in charge of the Subject of the Environment under S. 23Y of the NEA, and through Gazette Extra-Ordinary No. 859/14 of 1995.[21]

The procedure for carrying out an EIA, is set out in the National Environmental (Procedure for approval of projects) Regulations, No. 1 of 1993. Under S. 5 of these Regulations, a proponent of a Prescribed Project is required to send preliminary details of the project to the relevant PAA as early as possible in the project pipeline; which in practice, is generally once the proposal is cleared by Cabinet after a cost-benefit analysis and once donor funding is secured. The information provided is used by the PAA to establish the terms of reference for conducting an Initial Environmental Assessment[22] or an EIA[23] – a process known as environmental scoping. The scooping process is to include consultations with all concerned agencies and other interested parties, including members of the public, through meetings and written submissions.[24] On the results of the scooping exercise, the PAA will decide on whether the Project Proponent should be asked to conduct an IEE or EIA, and will develop a terms of reference for carrying out such a study based on the results of the scoping exercise. This therefore, represents the first and critical stage in the EIA process where wetland values may be highlighted, in terms of both financial and other ecosystem service perspectives, and factored into the terms of reference of an IEE or EIA for more detailed consideration.

Once completed, the report of an IEE is to be made available to the public by a notice published in the Gazette and in one national daily newspaper in the Sinhala, Tamil and English languages. This invites the public to make written comments to the PAA within 30 days of the first appearance of the notice.[25] These comments are to be forwarded by the PAA to the Project Proponent[26] who is then required to respond to the PAA in writing within six days of the receipt of the public comments.[27] The Proponent is expected to make every effort to consider alternatives and mitigatory measures in it response. On the basis of the Project Proponent's responses, the PAA is to either approve the project subject to specified conditions[28] or reject the project with 60 days.[29] A similar system applies where an EIA is deemed necessary.[30]

The project planning process in the state sector

Development projects undertaken by the state sector are generated as project proposals, by line agencies in keeping with their respective policies and mandates. These concepts are passed through the cabinet of Ministers and then through the Department of National Planning (DNP) of the Ministry of Finance, where a cost-benefit analysis of the project proposal is carried out to determine the project's financial/ Social feasibility. Project proposals deemed to be financially/ Socially feasible are resubmitted to the Cabinet of Ministers with observations from

[19] S. 23Z, National Environmental Act, No. 56 of 1988
[20] Amended by Gazette Extra-Ordinary No. 1104/22 of 1999
[21] Amended by Gazette Extra-Ordinary No. 978/13 of 1997
[22] A preliminary report that identifies whether the potential impacts of a particular project are significant enough to require the conducting of the comprehensive EIA.
[23] S. 6(ii)
[24] Ibid
[25] S. 7(ii)
[26] S. 8(i)
[27] S. 8(ii)
[28] S. 9(i)
[29] S. 9(ii)
[30] See sections 10 to 14

the Ministry of Finance. Projects not found to be financially/ Socially feasible will be removed from the project pipeline. Once approved by the Cabinet, donor funds are sought. If successful, proposals will be submitted to an Environmental Impact Assessment (this process is described separately below). If cleared by the EIA process, the funds are sent to the National Budget, from which funds are allocated for the project by Parliament.

As a project proposal will generally only progress in the project pipeline if it is found to be financially/ socially viable, the initial cost-benefit analysis represents a critical stage as far as the fate of a project is concerned. Ensuring that the full range of services provided by wetlands at this stage, is thus crucial. This is especially so, in a scenario where a project may be required to ensure adequate environmental flows, but cannot be justified through a traditional approach of considering only agricultural values.

The fact is that there are presently no written criteria, stipulating the range of values to be incorporated in such an analysis. This also means that where wetlands are included, there is no way of ensuring that the full range of wetland values will be included.

In other words, projects that are potentially beneficial to wetland conservation and the environment in general may fall foul of the cost-benefit analysis, and not progress beyond this stage.

Institutional changes in the water sector

The past few years have witnessed a growing interest on the part of the Government, in the management of the country's fresh water resources. This has resulted from a growing awareness, both nationally and internationally, that access to fresh water is fast becoming a critical issue the world over. With a population of approximately 19.1 million people, projected to reach 23 million by 2025[31] and unpredictable weather patterns, Sri Lanka is no exception in this respect.

Introducing reforms with regard to fresh water management at the policy, legal and institutional levels, has thus been high on the agenda of recent governments in Sri Lanka. This has resulted in the development of a Draft National Water Resources Policy that seeks to establish the objectives, principles and institutional framework for future water management in the country. Although still in draft form, the following inferences regarding the future directions in this sector may be derived from the Draft of October 2003.

The Draft, which applies to only fresh and brackish water,[32] recognizes that growing competition between sectoral users of water, is likely to precipitate a crisis in water supply if reforms capable of reconciling such conflicts are not effected. The Draft Policy also recognizes the conclusion, regarding the existing management framework in that, despite the many laws and institutions, the framework has not succeeded in effectively dealing with competing demands for water.[33]

If the Principles and Objectives of the Draft Policy are read together, several progressive concepts that support the objectives of this study emerge. As part of the Principles guiding future water management, it is recognized that water has a social, environmental and economic value, although this section also states that priority in terms of water allocation, will be given to drinking, sanitaion and livelihood use.[34]

[31] Draft National Water Resources Policy, October 2003, p.2
[32] Ibid
[33] Supra. n.35

[34] Supra. p.3

These statements are supported by the objective that the State will ensure adequate access to basic water needs of all people, while maintaining fresh water ecosystems. The status of the environment in the overall Draft Policy is further clarified, in the statement that poverty alleviation strategies based on water management should not result in further environmental degradation.[35] In terms of policy implementation, the framework is to be set by a National Water Resources Plan[36] in which river basins, sub-basins and aquifers will be the focal units for future management of water resources[37] – a significant step forward in terms of linking upstream and downstream interests.

The institutional mechanism for administering the policy, also foresees the creation of new institutions in the form of a four tier institutional arrangement, consisting of a National Water Resources Authority (NWRA), Regional Water Resources Management Agencies (RWRMAs), River Basin Organizations (RBOs), and a Water Mediation Board (WMB). The NWRA, as the central body, will be responsible for overall planning, coordination and monitoring at the national and river basin levels, and is to function as an independent decision-making body with regard to all aspects of water, with its regulatory functions delegated to the next tiers.

RBOs are to be established in specified river basins, or groups of basins and, in conjunction with the NWRA and RWRMAs, are to be responsible for the formulation and monitoring of water resources management plans at the basin level. RBOs are also envisaged as the critical link to provincial, divisional and other local stakeholders.

The establishment of the WMB represents an attempt to provide an independent appeal tribunal appointed by the Minister in charge of Water resources management.

These institutions are to be supplemented by Regional Water Resources Councils (RWRCs) that will act in an advisory capacity for planning water management, at the regional level. Its membership is to consist of representatives from government, academia, the private and NGO sectors, water users and RBOs.

Though the Draft Policy calls for enabling legislation, exactly how the system is to function, and what opportunities are provided for ensuring due consideration for wetland and other environmental concerns, will depend on the specific powers and duties bestowed on each of the institutions, and provisions for linking each tier with the others.

For the time being, however, it remains unclear how, as an independent decision-making body, the NWRA and its accompanying institutions will liaise with existing agencies and bodies with mandates over various aspects of water management. It appears that the institutional framework envisaged by the Draft Policy, seeks to establish a further level of parallel mandates at the center, and at the provincial and local government levels.

Analysis and Recommendations

An examination of the existing legal framework pertaining to the management of fresh water resources, throws up a classic scenario of a framework that has failed to keep pace with strategies required to deal with modern natural resource management issues. Typical features of this made clear from this study are, the sectoral, single user approach to water allocation, as seen in all the legislation with the exception of the Water Resources Board Act, and the absence of provisions that recognize the need for cross-sectoral consultation. The pervasive

[35] Supra. p.4
[36] Ibid
[37] Supra. pp. 3 & 4

nature of these features, seriously limits the opportunities for multi-user planning, which is what is required, if the full range of wetland values are to influence the allocation of water for wetland conservation.

The current planning cycle for state-managed projects, also displays the need to link the cost-benefit analysis and the EIA process more closely in terms of timing, as it appears that two aspects of a project are being assessed independently of each other. The harmonization of these two assessments would allow the project-pipeline to provide more balanced and cohesive decisions, by enabling the full costs and benefits of a proposed project to be reflected, after considering issues and potential alterations to project design and mitigatory measures. The direct linking of the cost-benefit analysis and EIA process would thus provide a balance between traditional, financially defined development objectives and other environmental and social considerations that are today recognized, through the concept of 'sustainable development', as forming indivisible components of development.

The decisive role of the cost-benefit analysis will also work to the detriment of wetlands, in situations where a scheme is necessary for ensuring a threatened water supply to wetlands fed by a river system, if such an analysis is undertaken without reflecting the full range of wetland values.

This is clearly demonstrated in the case of the Anawilundawa Sanctuary and Ramsar Site where sand mining in the Daduru Oya (from which water is transported to the tanks via an anicut) has necessitated the construction of further infrastructure if a regular and adequate supply of fresh water for the wetland's functioning is to be ensured. However, Funds for such a construction are currently not forthcoming, since it is not financially feasible based on the traditional valuation of the wetland based on agricultural production.

The lack of provisions in existing laws, is to be expected given the strong production-oriented interests that caused the legislation dealing with water management to come into being. This narrow focus in relation to a multi-dimentional resource such as water, moreover, is a symptom of the broader practice of a sectoralized administrative system practiced during the colonial era, and faithfully followed during the post independence period. One of the consequent problems facing attempts to introduce a new culture of integrated water management practices is, the task of bringing together over a century of divergent sectoral mandates, bureaucracies and attitudes within a novel policy paradigm. The danger in attempting to achieve the degree of cohesion required for effective integrated management within such a deeply engrained sectoral context is the further proliferation of additional layers to the administrative structure, in the form of coordinating mechanisms. In a centralized environment where critical decision making is vested in a few bureaucrats, the creation of additional mechanisms, for requiring the informed participation of these same people, appears to be impracticable.

On the basis of the above analysis, the following recommendations may be made:

- Amend the project pipeline to require the const-benefit analysis and EIA to be conducted simultaneously.
- Where the existing legislation and institutions are to be part of any new legislation and institutional frameworks for integrated water management, ensure that the existing legislation is amended to the effect that, clear duties and mechanisms are for integrated water use planning are articulated.
- Conduct comprehensive valuations of all major river basins, paying particular attention to critical wetlands in each basin, to ensure that reliable wetland values are available when conducting cost-benefit analyses.

METHODOLOGY:
Valuing ecosystem goods and services in the Kala Oya Basin

Role of valuation in major conservation and development policies

It has been mentioned in the NEAP, that Environmental Economics should be applied in several sectors to manage resources in an efficient and sustainable way. Also, it has pointed out that incentives on various sectors should be given, to ensure sound management of environmental resources. It has been highlighted in the plan, that it is mandatory to carry out an Environmental Impact Assessment on any major development activity, that would cause a considerable impact on the environment. In conducting EIAs, economic tools for valuation of environmental resources needs to be used.

The draft National Environmental Policy of 1998-2001, emphasized a course of action, which when implemented, would maintain the vitality & integrity of Sri Lanka's natural resources & living environment. The report has also given due recognition to use economic instruments, for better management of environment. Recognizing that awareness along with incentives, could change human behaviour, it has emphasized the use of economic instruments, such as polluter pay, reduce consumption, incentives for recycling & reuse as good strategies for controlling environmental pollution.

Economic valuation theory

The increased focus on environmental issues during the last 3-4 decades, has led to the development of economic valuation methods for non-market goods. The methods have been used especially, for monetarizing the value of environmental benefits, in order to incorporate environmental considerations in an extended cost-benefit analysis, alongside market goods. The welfare economic theory assumes that, effective markets are able to allocate scarce resources, according to consumer preferences. The objective of economic valuation of environmental benefits is, to produce a basis for decision-making, which makes it possible to allocate society's resources, in accordance with the individual preferences of the population.

Environmental decisions are usually based on physical or biological analyses, possibly supplied with estimates of the social costs, which various environmental measures and initiates will create. From a welfare economic point of view, this approach is considered, a political short cut. Natural science is able to provide information on the effects of human activities on air, water, eco-systems etc. But such scientific results do not show how to weigh environmental benefits against other goods. Even though the costs of environmental policies are often included in decision-making, there is no economic measure of the environmental benefits created by the effort. Thus the components, which we compare, are incommensurable, i.e. physical or biological components on the one hand and economic components calculated in monetary units on the other. Therefore, one cannot determine whether society would have been better off allocating more, or fewer resources, to the environmental field.

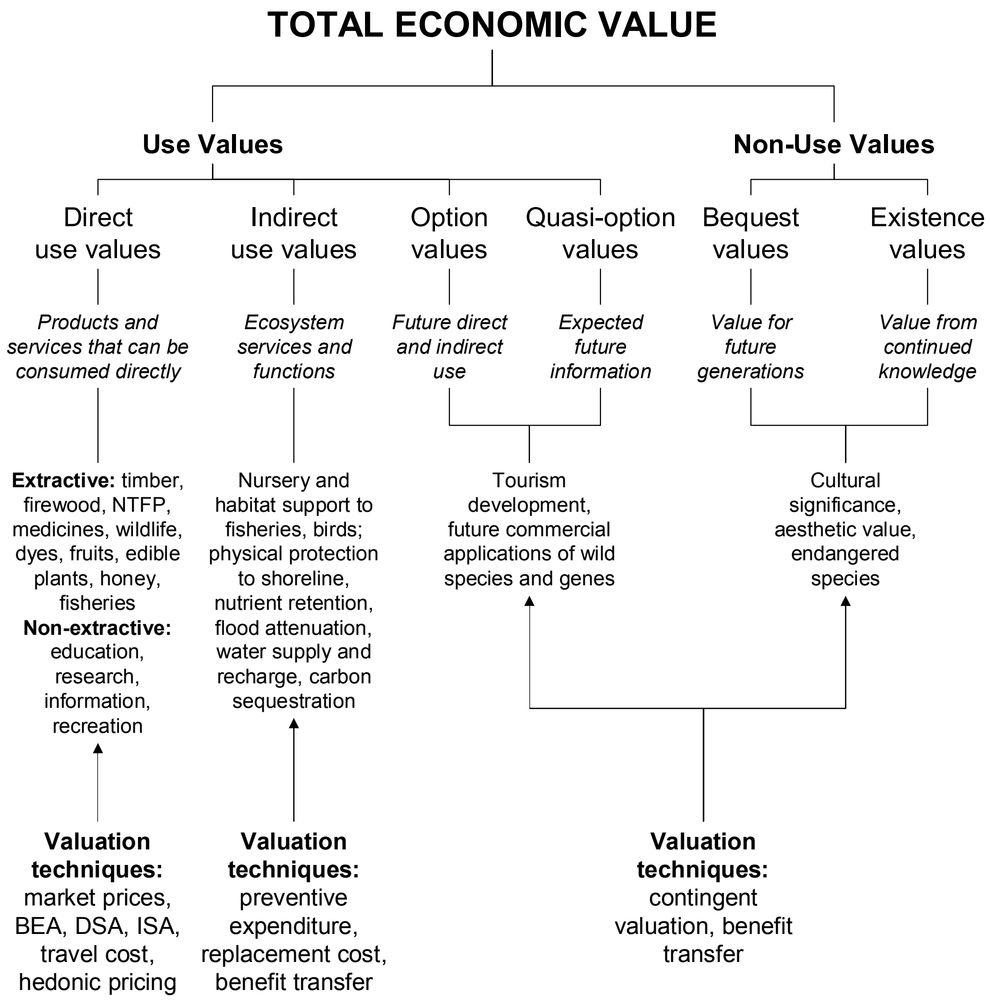
The changes in environment, caused by over-exploitation etc., are economically relevant, because they affect the welfare of society. This happens indirectly through affecting costs of production, and directly through changes in e.g. the population's health and possibilities of aesthetic and cultural experiences. Economic valuation measures these welfare effects in monetary units. Subsequently it is possible to conduct a cost-benefit analysis, showing whether or not a project will increase social welfare. A project should only be accepted if the total amount of benefits, is greater than the total costs.

The concept of benefits and value in welfare economics

The natural environment is a prerequisite for human existence, as we know it. The absolute value of nature is thus, infinite. Therefore, it only makes sense to value marginal changes in the quality of nature and environment. What is to be considered as marginal changes depends on, e.g. physical and biological assumptions about the tolerance thresholds of nature, and ethically defined comprehensions of what human beings should or should not do, in relation to nature.

In a welfare-economic sense, value originates from individual preferences for various goods, market as well as non-market, and the willingness to substitute between them (see Freeman, 1993). The value of a unit, of a given good, is measured as the amount of another general good, which the individual is ready to relinquish, in order to obtain an extra unit, of the good in question. The general good used for measuring value is, usually money. This is not due to the fact that money is of value in itself, but rather that money is, a numeraire for the large variety of items in the bundle of consumer goods. Accordingly, the objective of economic valuation is not to attach a (market) price to all non-priced goods, but rather to reveal the social value of non-market goods.

Figure 3: Total economic value, attributes and valuation techniques for mangrove ecosystems in Kala Oya



Environmental value categories

The environment/nature, provides a large number of physical, biological and aesthetic benefits, which directly or indirectly enters into production and consumption. Together with labour and produced capital goods, environmental benefits enter into the economic processes, which satisfy human needs. Environmental benefits can be categorized as use values, option values and non-use values.

Direct use value: The benefit people experience from direct use of environmental goods, either personally (e.g. recreational areas) or as a production factor (e.g. NTFPs, fish stocks, etc.)

Indirect use value: Includes a wide variety of ecosystem functions and services. This concerns, e.g. water quality and flow, filtration and decomposition of polluting substances, etc.

Option value: Defined as the value individuals experience from knowing that they have the opportunity, to use existing environmental benefits, e.g. recreational areas.

Non-use values: Values, which people ascribe to environmental benefits, without the direct use of them. The fact that people ascribe value to nature benefits, independent of their use, can partly be due to the satisfaction from merely knowing that they exist (existence value), partly the wish to show consideration for the welfare of future generations (bequest value).

Valuation methods

Economic valuation of environmental benefits has been practiced since the 1950s. The USA is leading in this area; here, economic valuation is incorporated in environmental policy decision-making. A driving factor in the development of valuation methods has been increasing demands for economic efficiency analyses in American environmental legislation. In the following section, we will investigate in more detail the methods used in economic valuation, including methods, which do not lead to valuation in the strict sense, but rather to pricing of non-market goods.

Valuation versus Pricing

There are different theoretical approaches to monetarization of non-market goods; preference based and non-preference based, respectively. The methods based on preferences attempt to estimate behavioural relationships in the form of demand functions, or marginal willingness to pay functions, i.e. the connection between the price level and the amount demanded. (A relationship, which could be observed statistically, if the good were traded in a market). In other words, valuation methods attempt to disclose people's willingness to pay (e.g. through taxes) for goods with no market price. The estimated willingness to pay function reflects individuals rate of substitution, between the non-market and the relevant bundle of market goods. The value of a given environmental undertaking is computed in terms of welfare measures, i.e. changes in consumer surplus due to changes in the quality or amount, of the environmental benefit in question. Let us consider e.g. measures taken to limit the pollution of groundwater. To evaluate such a policy one must elicit the maximum amount of income (purchasing power), people are willing to give up in order to ensure that certain groundwater quality standards are observed.

The non-preference based methods can be described as pricing. Pricing methods are not based on the economic behaviour of individuals, but usually on the costs connected with realizing, a given environmental objective. If we use the groundwater example again, a policy requiring a certain standard for the nitrate content in groundwater can be priced, as the social cost incurred by realizing this standard. Cost relations are of course extremely relevant, when assessing an environmental policy. But pricing does not show whether people's willingness to pay "meets" the costs – nor if there is willingness to pay for an even greater effort.

Thus, pricing does not answer the fundamental question of how scarce resources should be allocated, between environmental objectives on the one hand and fulfilment of other human needs, on the other.

Pricing methods

When monetarising environmental benefits based on market prices, there are several approaches, e.g:

- Opportunity cost method: This monetarises the benefits of a non-market environmental resource, based on the costs of ensuring similar benefits through alternative activities. For example, the "price" of pure groundwater for drinking water supplies, can be calculated as the treatment costs of removing nitrate and various chemicals from groundwater. The method does not show whether or not consumers' preferences/willingness to pay for the purity of groundwater is larger or smaller than the costs of maintaining the current standard.

- Replacement costs: The price of an environmental benefit can be considered equal, to the cost of producing a similar environmental benefit in other ways. If a pond is abolished in connection with construction work, the loss of this amenity can be priced as the cost of establishing a similar pond in a nearby-area. This method is limited to environmental resources that can be recreated with qualities, which are reasonably similar to those lost. Even when this is physically possible, it is not certain that the affected individuals are willing to pay an amount equal to the cost of replacement.

Pricing methods are usually easier to apply than the preference-based valuation methods, but, from a welfare economics point of view, pricing is not necessarily the correct way, of measuring the social value of benefits connected with environmental policy initiatives.

Contingent valuation method

The Contingent Valuation Method (CVM) stipulates a scenario for the preservation or production of a non-market good, e.g. an environmental good. Having explained the characteristic of the good, the rules of provision, access, method of payment etc., respondents are asked to state their willingness to pay (e.g. through taxes) for the good in question. Various interviewing techniques and statistical methods have been developed to prevent strategic behaviour by respondents. Also, statistical methods are applied to test the consistency between stated willingness to pay and the assumptions of economic theory regarding rational economic behaviour.[38]

In addition to questions about willingness to pay, Contingent Valuation surveys also include a number of questions concerning the respondent's preferences for, or use of, the valuated good, together with demographic and socio-economic characteristics. De-briefing questions are often asked, to clarify whether the respondent has understood the scenario in question. The collected demographic and socio-economic data is subsequently used for analyses of validity, typically using regression analysis, to investigate economic behaviour.

Benefit transfer methods

Conducting economic valuation by state-of-the-art criteria is time-consuming – and costly. Hence, the interest in reusing the results of previous valuation studies – referred to as benefit transfer – is increasing. Benefit transfer is a transfer of valuation estimates or functions, from a research area (i.e. an area, in which a valuation study has been conducted) to a project area (i.e. an area where one wishes to evaluate a project before a possible implementation). There are three methods of benefit transfer: 1) Transfer of unit values; 2) Transfer of adjusted unit

[38] A detailed description of the various techniques in contingent valuation can be found in Mitchell & Carson (1989), together with Garrod & Willis (1999). Hanemann & Kanninen (1998) go through the statistical methods used for analysing (binary) CV response data.

values and 3) Transfer of the entire valuation function from the original study (see e.g. Garrod & Willis, 1999). The simplest procedure is transfer of unit values, e.g. the estimated willingness to pay per ha of a re-established nature area. It will often be necessary to adjust the unit values, e.g. by considering differences in income between the research area and the project area. From a methodical point of view, the best procedure would be to transfer the entire estimated valuation function from the original study – with the various explanatory variables, regarding socio-economic and geographic characteristics etc. However, data limitations often set narrow limits on the extent to which the original estimates can be calibrated.

Considering the limited possibilities of correcting the numbers, selecting the proper valuation studies becomes the essential criterion, regarding the reliability of the transferred benefit estimates. Desvousges et al. (1992) identify five criteria for selecting valuation studies for the purpose of transferring benefit estimates:

- The employed valuation studies must fulfill state-of-the-art criteria for economic valuation
- The studies must thus contain regression results, describing the willingness to pay, as a function of socio-economic characteristics etc.
- The research area and the project area must, to the greatest extent possible, contain coinciding characteristics regarding the natural setting, as well as the pattern of utilization
- Consumers´ substitution possibilities between various environmental benefits in the research area, must be similar to the substitution possibilities found in the project area.

Experiments with the methods of benefit transfer show, that there is a considerable uncertainty connected with this sort of benefit evaluating (Garrod & Willis, 1999). Yet, benefit transfer is recommended as an acceptable procedure by e.g. American and British environmental agencies (see U.S. EPA, 2000 and U.K. Treasury, 2000). All things considered, it seems that one can get a fair impression of the orders of magnitude for various environmental benefits through benefit transfer. As far as possible, however, actual policy-analysis should be based on data collected through primary research.

Study methodology

Participatory techniques were used as the principal methodology, for collecting information about the multiple uses of the selected wetlands. Most of the tank users live in the vicinity of the tank, and they earn their living mainly from agriculture, livestock, and the resources extracted from the tank. Paddy is the main crop while other field crops like vegetables, chillies, onion, banana etc are also cultivated in the highlands, using the water provided by the tank directly and indirectly through subsurface water. Other main direct services of the tank are providing fish, flowers, lotus roots which have a good demand as a nutritious food, sedge, edible leaves and water for bathing and washing. Chairmen of the village tank organizations, officials of the ID and the MASL, and village level government administration officers called Grama Niladaris were interviewed prior to the meetings held with the community, to discuss the existing and past management systems of tank resources. It focused mainly on identifying all the different uses of the tank, and then ascertaining how they help to upgrade the livelihood of villages. These discussions were very helpful to prepare the interview guide for the FGDs.

Further, the discussions with the Chairmen of the village farmer organizations were very helpful, in providing initial information about the study, and to introduce the team members before the study commenced. In this respect the letters issued by the Manager, Kala Oya river basin, in Sinhala, were very useful as all the farmers knew him by name. Otherwise, the communities are suspicious about outside visitors to the village and could think there may be hidden objectives which are not favourable to the villagers. The main reasons for this suspicion is due to, two popular issues in the country at present. One is the new economic reforms which are going to be implemented in the country. As a result of new economic reforms in the country, a new water policy was prepared. There were discussions about charging a fee for water used for agricultural purposes, as water is a depleting resource. Moreover, it is a common observation that paddy farmers overuse water due to poor knowledge of paddy cultivation and inadequate agricultural extension programmes.

In order to make the water use more efficient, the Government was planning to implement the policy of, charging a fee for water. As farmers in this region are poor, and they do not have enough surpluses to pay for water, all of them oppose and are threatened by this policy. Hence, when an outsider comes in and tries to collect information, they are suspicious of their intentions, and assume that the data collection is connected in some way to the new water policy.

The other factor is that there are some rumors, that certain organizations approach poor communities with offers of assistance to upgrade their living standards, and insidiously try to convert them to other religions. Due to these two reasons, team members always clearly informed the community, the community leaders and the officials about the study and its objectives. The team emphasized very often, that they were there to learn from the community, and not to impose any new ideas on them. They also explained their intention to transfer this knowledge, to the policy makers and the other decision making authorities.

Consequently, people were very happy and proud, that their ideas and experience of wetland related resources were at least published and would reach the top administration. It is their contention, that they would not have a life without the tank, and that these tanks should exist for many more centuries, for future generations also to use. "Village life in Sri Lanka is essentially dependant on monsoon rains. The small tank, from a hydraulic engineering perspective, is a little evaporating pan, but from a water and soil conservation ecosystem perspective, it is the heart of the dry zone village. A small tank is stable and sustainable with the drought resisting capability of a large reservoir to augment it." (Mendis D.L.O. 2002).

Field Survey for primary data collection

The study team conducted 46 FGDs with the villagers living around the tanks, located in the Nochchiagama Block of the Mahaweli irrigation area and the Giribawa cascade of the Non-Mahaweli irrigation area during a period of 4 months from August 2003 to November 2003. Two discussions were held at each tank, to collect the information separately for direct and indirect uses for 2003. A sample of twenty three tanks (all the isolated tanks in the Nochchiagama block and the Giribawa cascade), which range from 3.2 Ha to 71.3 Ha in full supply level water spread, represent different sizes of all the tanks in the Mahaweli and Non-Mahaweli areas.

Most of the meetings were held at village community centers. Where there were no community centers, the meetings were held at the Chairman's house or their gardens. At the beginning of the meeting, participants were made aware of the objectives of the meeting and the purposes of the project.

In addition, a general idea about PRA was given, and then they were comfortable enough to provide the information according to their knowledge and to comment on other's ideas. Key informants and leaders of the village were identified, and the study team met them individually or as a group in later stages, to collect additional information.

A group of informants always consisted of around 10 to 15 people, as the study team wanted to get the participation of all the users, of wetland resources. As there are many groups who enjoy different resources of the tank, the group was some what large, but the study team was careful to complete the session within one hour, to avoid boredom. Since getting information about a common resource from the community is very rare in practice, and at present these tanks are faced with several problems due to poor maintenance, all the people were eager to discuss the issues in depth, in order to find sustainable solutions for safeguarding the tanks.

Further, as all the people in this region speak the same language, there were no language barriers in the discussions. It was also beneficial that Sri Lanka as a country, possesses a high literacy rate, and almost all these farmers could read well and understand. Therefore, the record keeper who used flipcharts for writing down information, was able to check with the informants frequently.

Assessment of management alternatives

Based on the valuation studies conducted at the tank level, management options were evaluated under four scenarios. The main objective of this section is to evaluate the different options available for increasing the wetland's storage capacity, and the costs and benefits associated with doing so, to influence the decision making process and to secure sustainability. All services and their marginal changes associated with the 4 scenarios below should be identified:

Option 1: Status quo – sedimentation loads remain the same if not increasing and the wetlands continue to deteriorate

Option 2: The storage capacity is increased by raising the spill – the water body will grow and the land will be flooded, but sedimentation loads remain the same if not increasing

Option 3: The storage capacity is increased by raising the spill, and the reservation is rehabilitated – same as above, but now sedimentation loads are reduced adding to the lifespan of the wetlands

Option 4: The storage capacity is increased by removing silt, and the reservation is rehabilitated – increases the chance of seasonal flooding and brings back the wetland to its original state.

DIRECT VALUES:
Use of water and wetland resources

According to the selected sample, there are around 150 families near a village tank and they engage in many income generating activities like crop farming, fishing, keeping livestock and extracting lotus flowers, roots etc from the wetland. Around 10 - 15 percent of families have two and half acres of paddy cultivating plots, which are directly fed from the tank and all other families have agricultural lands fed from Mahaweli irrigated water. Direct use values of agriculture, livestock raising, industry, fishery, water plants, sedge and all the domestic uses are estimated, in these two sub catchments. In this respect, only the services provided by the tank have been valued. Paddy cultivation and the other field crops fed directly from the tank were considered. The productivity change of banana and coconut trees in the home gardens, which are in the tank command area of the tank, was also estimated.

Arable agriculture

In addition to the main crop i.e. paddy, cultivated in both the Maha and Yala seasons depending on the availability of water, home gardens are cultivated with different crops like red onion, chillies, banana, coconut, papaw and vegetables available in the tank command area. This includes home gardens using the tank's water and rainwater. These crops consume different amounts of water at different seasons, as they are usually planted in the rainy season. In the case of coconut, the farmers' idea is that, the trees within the tank periphery give a higher yield due to the rich sub surface water level around the tank.

Table 7: Cultivable area and number of farmers in wetlands

Area Cultivated under the tank (Ha)	No of tanks	No of farmers per tank	No of silted tanks
0-10	53	11	50
11-20	86	18	81
21-30	50	26	46
31-40	22	38	20
41-50	25	37	23
51-60	12	62	12
61-70	10	43	9
71-80	13	63	13
81-90	12	77	9
91-100	8	70	8
101 – 150	18	110	16
151 & Over	16	219	12

Source: Kala Oya River Basin Management Secretariat

Paddy

Due to the government policy on maintaining a good price for paddy, which is the main crop cultivated by the Sri Lankan farmer, a kilogram of paddy is bought at Rs 13.50 by the government organizations. The harvests of paddy in the two seasons are different due to the water received from rainfall and the tank, and it is 197.6 bushels per Hectare in Yala and 215 bushels in the Maha season. According to the estimates of the farmers, the Department of Agriculture and the North Western Province, the cost of production of paddy per Ha in this region including imputed labour costs, management costs and land rent, is Rs. 57866/= and Rs. 55965/= in Maha and Yala respectively. Land value per year was estimated, using the rent paid by the tenants. Usually, tenants grow paddy and pay the land rent in kind at the end of season, after harvesting. It is around 20 bushels per acre. Most of the agricultural lands here are owned by the original recipients, who received the land under the Mahaweli irrigation project

Table 8: Economic returns per hectare of water spread for irrigated paddy production (per ha)

Season	Extent (Ha)	Yield (Bushel/ha)	Price (Rs/kg)	Cost (Rs/ha)	Economic return (Rs/ha)
Maha	1.98	215	13.50	57866.00	11875
Yala	1.49	197.6	13.50	55965.00	4052

Source: Primary survey data collected at the Kala Oya Basin 2003

The economic return per Hectare of the water spread of the tank for irrigated paddy production is, Rs 15,928/=.

Banana

There are small scale banana plantations (one plot is less than 0.4 Ha in size), in the command area and around 10 -15 trees in every home garden. Four hundred trees are planted in an acre (1 Ha = 2.47 acre) and an average harvest per acre is around 1200 bunches per year.

The average weight of a bunch is 9 kilograms and the price of one kilogram is around Rs. 12.00. Cost of production per acre, including land rent and labour, is Rs. 53350.00 per year. The land rent for paddy is used for bananas as well and the cost of production (including labour) of bananas is estimated using the North Central Province agricultural information.

The economic return per Hectare of the water spread of the tank for banana cultivation is, Rs. 20717.12

Coconut

Coconut trees are very popular among villagers, as this tree helps people in many ways. Sri Lankans use coconut milk for most of their curries and “Pol Sambol” i.e. a kind of salad prepared with chillies, salt and scraped coconut is a popular dish. Young coconuts are used as a sweet drink. The timber of the coconut tree is in good demand in the construction industry, while woven coconut leaves are used for thatched roofs of poor houses, huts, cattle sheds etc. Therefore, this tree is commonly available (around 6 trees) in all home gardens in this region. The trees, grown in the command area of the tank, yield around 10 nuts extra than those of outside the command area. Cost of production includes land rent and the costs of watering, as villagers do not use fertilizer or any other inputs.

Table 9: Economic returns per hectare of water spread for coconut production (per ha)

Area cultivated (Ha)	Increased Yield per Ha (nuts)	Price (Rs/ Nut)	Economic return (Rs)
0.26	12000	7.00	21433.00

Source: Primary survey data collected at the Kala Oya Basin 2003

Economic return per Hectare of water spread for Coconut cultivation is Rs. 21,433.00

Other Field Crops

Even though the farmers in the Mahaweli area are frequently encouraged to cultivate other field crops(OFC), which give higher income and utilize a lower amount of water by the irrigation authorities, farmers prefer to cultivate paddy, mainly because of their experience in paddy cultivation and the availability of water in the tank.

A general idea among water officers is that farmers can be motivated to cultivate OFCs only when there is not enough water for paddy, otherwise they do not want to take the risk of cultivating new crops. Hence, the land area used for OFCs like chillies, B' oinion, Cucumber and "Kohila" (Lassia Spinosa) is low, and the number of farmers engaged in the cultivation of OFCs are also low. As the sample available for OFC related data collection is small, production data has been adjusted to the Department of Agriculture data. Moreover, only B'onion and Chillies are considered for the valuation as the extent of other crops are not so significant among the selected sample, though there small plots of bitter gourd, cucumber and Kohila.

Table 10: Economic returns per hectare of water spread for OFC production (per ha)

Crop	Area cultivated (ha)	Yield (Kg/ha)	Price (Rs/ Kg)	Cost of production (Rs/ha)	Economic return (Rs/ha)
B'Onion	0.01673	10690	20.00	76422	2298
Chillies	0.01455	1482	117.50	69012	1529

Source: Primary survey data collected at the Kala Oya Basin 2003, Dept of Agriculture

The economic return per Hectare of water spread for cultivation of other field crops is Rs. 3828.00

Domestic water use

As the tank is very close to the village, almost all the villagers, (around five hundred people including children), use the tank for bathing and washing cloths even though they have wells in their lands. The villagers have an opportunity to use Mahaweli water, when it is released from April 20 to July 15 and November 1 to January 20, at least up to 80 days within these two periods, though the release is not continuous. Having a bath, washing cloths and getting children bathed is a major routine of the day for rural women in this area. It is very common to see, hundreds of people at every tank in the afternoon, and particularly in the evening. Not only women and children but also men who return from their work come to the tank in the evening. Some of these people use their bicycles, motor bicycles and tractors to travel to the tank. This is actually a relaxed activity for them because it gives them an opportunity to swim, and meet friends and neighbours at the tank, after finishing their work. Everyone enjoys bathing at the tank rather than at their own wells, if the quality of the water is better. Even rich people (only around 7 percent) who usually bathe at their wells, come to the tank when they have visitors with them, who desire to experience the novelty of a bath at the tank.

After considering all these factors, an average villager normally uses the tank for around 228 days per year, for bathing and washing clothes. The period between August to October is a dry period for this area, and there is hardly any water in wells and Mahaweli irrigation canals. Therefore people from near by villages also use the tank during this period. Although it is difficult to count the number of people who use the tank during this period, observations and the villagers' estimate is around 600 persons per day, including the village people in the dry season and around 350 during the other period. In case this tank is not available, all these people have to go to another tank, which is situated around a walking distance of 30 minutes.

Table 11: Economic returns per hectare of water spread for bathing and washing clothes (per ha)

Period	No of days	Average No of people per Ha	Average travel time to the next tank	Value of a labour hour(Rs)	Economic return (Rs)
Dry period	90	27.27	30 minutes	31.25	76818
Other period	138	15.9	30 minutes	31.25	68636
Total					**145,454**

Source: Primary survey data collected at the Kala Oya Basin 2003

Drinking Water

Drinking water is one of the major issues faced by the people in the basin, due to the low quality of water in the tanks and the hardness of water in the wells, containing minerals and salts that prevent soap from lathering freely. However, people who live close to the command area of the tank are fortunate enough to get fresh water throughout the year. The water in all the wells located in the command area of the tank, and near the irrigation canals are free of hardness. There are a few wells scattered sporadically in the same village, free of hardness; yet it is difficult to ascertain the reasons for this. According to the results of the survey conducted in the area, a family can reach a fresh water well within 15 to 25 minutes, in case the well in the command area of the tank dries up. Some water remains in the tank below the sluice gate; this is called “dead storage” and it helps to maintain the water level of the near by wells. In addition, water controllers of the tank are always concerned about keeping a little water in the tank for domestic use, and for serving the near by wells without releasing it for agricultural purposes in the dry season.

During the Maha season, water in the homestead wells is adequate. However, during Yala, wells become unreliable (particularly at the tail end of the system). The water supply of many wells located near irrigation channels fluctuate, depending on seepage from the channel. When well water is inadequate, farm women are required to walk up to one-half miles to obtain drinking water, involving a considerable investment of time and energy for them. (Water Management Synthesis Project, System H of the Mahaweli Development Project)

The average number of families using the wells in the command area of the tank is around 25. They go to the well twice a day to bring drinking water for the whole family. It is mainly women with their children or girls who go to the well to bring water. Most of the time men and grown boys engage in agricultural work, or other types of businesses. It is the women, who habitually collect water.

Some of the families boil water to remove its hardness before drinking, but the common practice is that, if one well which provides drinking water dries up they go to another well. However, the opportunity cost of labour for bringing drinking water is not estimated for the study.

Livestock

Most of the villagers rear cattle and goats as an additional income generating activity. Around 258 animals from the village and another 100 from nearby villages come to the tank to drink water. These animals are rarely washed at the tank. According to the observations carried out by the study team, a farmer has to spend around 5 minutes per animal per day for 228 days per year, to provide water for these animals if the tank is not available, as animals are able to use the Mahaweli water in the remaining period of the year. On all other days animals can drink water from the Mahaweli canals. Only around 100 cows eat fodder at the tank reservation, and others get their fodder from different sources. There is a special category of milking cows in the area; these cows are not sent out of their sheds for water or fodder. The estimate of labor requirements for feeding cattle was calculated based on the information collected from the owners, of this special category of milking cows.

Table 12: Economic returns per hectare of water spread for watering cattle (per ha)

No of Animals per Ha	No of days	Average time for providing water per animal	Value of a labour hour(Rs)	Economic return (Rs)
16.3	228	5 minutes	31.25	9,661.95

Source: Primary survey data collected at Kala Oya Basin 2003

The value of the labour hours which villagers can save per Hectare of water spread since the tank provides drinking water to the cattle is, Rs. 9661.95

Around 86 animals are on the tank reservation for grazing for 7 to 8 hours per day, from July to October, and they consume around 9 kg of grass per day. There is enough grass by the sides of the canals in the Maha and the remaining Yala season (around 120 days per year), The cattle consume only around 2.25 kg per day in the tank reservation. Including travel time, a villager has to spend around one hour to collect 7 to 8 kilograms of grass.

Table 13: Economic returns per hectare of water spread for providing fodder to cattle (per ha)

Period	No of days	Average No of animals per Ha	No of kg per day	Average weight of grass a person can collect per an hour (kg)	Value of a labour hour(Rs)	Economic return (Rs)
Dry period	116	4	9	7.0	31.25	18,642.8
Other period	120	4	2.25	7.0	31.25	4,821.4
Total						**23,464.2**

Source: Primary survey data collected at the Kala Oya Basin 2003

The value of the time saved per Hectare of water spread since the tank provides fodder to cattle and goats is, Rs 23,464.2

Water use in brick making

Since the area concerned is a rural area, and many inhabitants earn their living from agriculture, there is hardly any industry except, small scale brick producing centers. This activity also takes place only within the period of three months in the dry season from July to September. There are around 5 families engaged in this industry, and they use up around two barrels of water (200 liters each) per day in this three month period.

If water is not available at this tank, these industrialists have to transport the water from another tank, situated around two kilometers away. Two wheeler tractors are capable of carrying two water barrels (400 liters) at a time and cost Rs 60 per trip.

Table 14: Economic returns per hectare of water spread for use in brick making (per ha)

No of liters per day Per Ha	No of days	Cost of transportation per liter (Rs)	Economic return (Rs)
90.90	90	0.15	1227.7

Source: Primary survey data collected at the Kala Oya Basin 2003

Costs involved in transporting water from another tank is, Rs 1227.72 per year/ per Hectare of water spread.

Other wetland resources

Fishery

Fishing is the main income generating activity supported by the tank, and around 25 people are engaged in fishing in a tank. There are only 10 full time fishermen here, and others do part time fishing mainly for their consumption. As the tank is not so big there are no mechanized boats. Only 3 inch to 3.5 inch nylon fishing nets are used for fishing.

Table 15: Economic returns per hectare of water spread for fishing

Type and No. of Fishermen per Ha	Catch per person in dry season (Kg)		No of days per fishing season		Price (Rs)		Income
	Dry	Wet	Dry	Wet	Dry	Wet	
Full-time – 0.454	13	8	50	250	50	55	64,695.00
Part Time – 0.68	3	1	50	250	50	55	14,450.00
Total							79,145.00

Source: Primary survey data collected at the Kala Oya Basin 2003

Cost of production per hectare of water spread in fishing including labour is, Rs 44,355.00

Economic return per Hectare of water spread for fishing is Rs. 34,790.00

Flowers/ Roots

Almost all tanks in these catchments are covered with lotus and sedge. The density of lotus growth becomes high, when the water depth of the tank becomes low due to siltation.

The tanks in the Mahaweli area do not dry out completely, and their depths goes down dramatically in the dry season, which in turn favours lotus growth. Lotus flowers have a high cultural attraction, mainly in relation to Buddhism. Hence, there is a great demand for lotus flowers generally on full moon days, particularly in the months of May and June. In addition, there is a demand for flowers throughout the year in Anuradhapura; a sacred city where more than a 2500 year old "Bo" tree which is a branch of a tree that gave Lord Buddha shelter, is located. Some of the vendors come from Kelaniya, a city close to Colombo, to collect the flowers. Benefits of flower collection isn't transferred to the villagers as most of the time vendors directly come and collect them. Hence, the market price of lotus flowers is considered, and transport costs are added to the total cost. Though it is difficult make an estimate of its value, almost all the villagers enjoy offering lotus flowers to the statues of Lord Buddha at their temple.

Table 16: Economic returns per hectare of water spread for harvesting lotus

Type	No/ Kg per Ha per year	Price	Cost of collection including labour/Ha	Value
Lotus Flowers	3849 flowers	Rs 2.50 per flower *	2485.64 **	Rs 7136.86
Lotus Roots	1045.45 kg	Rs 21 per kg	11363.64	Rs 10590.81
Total				**Rs 17,727.67**

Source: Primary survey data collected at Kala Oya Basin 2003
Note:* Average market price of a lotus flower at Kelaniya and Anuradhapura; ** includes transport costs

Sedges

Most of the households around the tank do not buy mats. They weave them using sedge of the village tank. There is no economic gain as the process is highly labour intensive.

Table 17: Economic returns per hectare of water spread for harvesting sedge

No of families involved per Ha	No. of mats per family/year	Market value of the product	Cost of production (labour) per mat	Total value of the product
4.77	5	Rs 250	Rs 250	0.0

Source: Primary survey data collected at Kala Oya Basin 2003

The labour cost for weaving a mat is, Rs. 250
The economic value of the tank for providing sedge = 0.0

Summary of values

Table 18: Economic returns per hectare of water spread for a tank

Product	Economic Value per Ha (Rs /ha/year)	Economic value per Ha (US $/ha/year)
Paddy	15,928	161
Other Field crops	3828	39
Banana	20,717	209
Coconut	21,433	216
Domestic Use	145,454	1469
Livestock	33,125	335
Industrial use	1,228	12
Fishery	34,790	351
Lotus Flowers	7,136	72
Lotus Roots	10,591	107
Sedge	0.0	0
Total	**294,230**	**2,972**

Source: Primary survey data collected at the Kala Oya Basin 2003

Status on wetland functions and services – where are we?

As shown above, the economic values associated with the direct use of wetland resources, are quite tangible and fairly easy to calculate. As a proxy, the values are often simply based on market prices. However, wetlands also provide indirect benefits through a number of services and functions that are much more difficult to estimate. Valuing these in economic terms requires site-specific knowledge of, e.g. the hydrological conditions and surrounding ecosystem characteristics as well as the economic linkages that help realize the value of these functions and services.

For quite some time, wetlands have been acknowledged as providers of environmental services and goods. Likewise, their influence on the water cycle and linked ability to perform hydrological functions is recognized and supported by a large number of studies.

However, the previous generalized stereotype, of wetlands always reducing floods, promoting groundwater recharge, retaining nutrients, purifying water, and regulating river flows, is being challenged by a comprehensive study done by Bulluck & Acremann (2003). Bulluck & Acremann (2003) present the findings of 169 published wetland studies across the world and reaches the following main conclusions:

- Wetlands are significant in altering the water cycle
- A significant number of studies show, that floodplains reduce or delay floods; whereas wetlands in the headwater of river systems may just as likely increase flood peaks
- There is strong evidence that wetlands in general evaporate more water than other land types; such as forests, savannah or arable land, and that higher evaporation rates occur throughout the year
- Two-thirds of the studies show that wetlands reduce the water flow, in downstream rivers during dry periods
- Many wetlands exist because they overlie impermeable soils or rocks, and therefore interaction with groundwater is limited

The need for knowledge about the specific functions and services performed and provided by a wetland, and the economic linkages are, besides being important when estimating economic values, also necessary in order to achieve an adequate and successful incorporation of wetlands in national, regional and international policy formulation, on water resource management.

The interpretation of whether wetlands are beneficial or not, besides depending on the specific characteristics of the services provided (e.g. flood reduction or generation), depend highly on who is impacted. People living in flood prone areas, will obviously value wetlands that reduce floods differently, than wetlands that generate them. From an ecological point of view, floods may even be considered an essential element of the river flow regime, which facilitates nutrient exchange and breeding cycles. Also, ecologists will most likely see evaporation as an important process stimulating plant growth, whilst water management authorities often see it, as a loss of a potential resource.

Identifying and assessing the functions and services for the selected tanks

Acknowledging the above, important factors determining the selection of tanks for valuation in the Kala Oya basin, have been; the availability of previous studies and data surrounding the specific functions and services provided by the tanks. Reviewing this information and conducting interviews with various experts as well as the local communities depending on the tanks, has led to the identification of several prevalent wetland functions and services. The functions and services that have been identified by this project for further analysis are:

1. Ground and sub-surface water recharge
2. Nutrient and sediment retention
3. Biological diversity

The above functions and services will in the following sections be examined individually, and their importance will mainly be described based on linkages to agriculture and consumption. Part of these linkages and their value have been revealed and estimated in the previous chapter, dealing with direct values. Specifically, the value associated with ground and sub-surface water availability has been examined. However, calculating the total value for each identified service and function, on a site-specific level has not been possible, because of inadequate data. As a consequence, valuing the expected marginal changes in ground and sub-surface water recharge, nutrient and sediment retention, and biological diversity, has also not been possible, under the four scenarios.

However, a value-range per acre is presented for each function and service as a best estimate, until data availability permits actual calculation of the site-specific values. The range represents a 90% confidence interval, expressed in 1990 prices, of 39 other wetland valuation studies used in a meta-analysis by Woodward and Wui. While benefit transfer by many is perceived as an uncertain method, transferring valuation estimates from a research area (i.e. an area, in which a valuation study has been conducted), to a project area may actually provide important information on the likely magnitude of the values. A common critique in connection with benefit transfer is that the research area and project area are often different. It could be in size, the functions and services provided or differences in the socio-economic characteristics of the areas.

In our case, the biases associated with using benefit transfer are seen as minor; partly because the adopted value-range only has an illustrative purpose, and partly because the values do not enter into the cost-benefit analysis. However, for the purpose of further discussion, the expected impacts on tank services and functions (e.g. ground and sub-surface water recharge), under the four scenarios are qualitatively illustrated by plusses (+++, ++, +) and minuses (---, --, -); the number of which will indicate the expected impact of the scenario.

Ground and sub-surface water recharge

In Sri Lanka, most wetlands are actually ancient water storage tanks created by man, many centuries ago. This includes the ones selected in this study. The main purpose of constructing these tanks was, to provide water for agriculture and domestic consumption in the dry seasons. Since these wetlands were not naturally created in the first place, it is fair to assume that without human intervention they would not have existed. The importance of human influence is furthermore illustrated, by the fact that many tanks in the study area are drying out, because of sedimentation and poor management. Put in another way, the tanks need to be maintained in order to recharge ground and sub-surface water.

In a study done by Cooray and Jayawardene (1982), the principal source of groundwater recharge has been identified as the irrigation system itself; i.e. infiltration from tanks and channels. The importance of the tanks is further supported, by the fact that the direct effect of precipitation on the groundwater table is found to be minor, except in the wet season when the soil is saturated and water can be retained for a longer period.

Thiruchelvam and Pathmarajah (1999) found that the groundwater table in the Kala Oya Basin, had generally risen in areas under the Mahaweli irrigation project. The higher groundwater table was recorded to affect shallow tube wells, in areas close to irrigation channels and to facilitate water-logging, in low lying fields. At the same time, people living around the selected tanks reported that they had experienced, decreasing water levels in their wells since the irrigation project started; especially in the dry season. Clearly the location of wells has a major influence on the water level. Wells located adjacent to irrigation channels are more susceptive to recharge, than wells located in the command areas of the tanks. The decreasing water levels being experienced in wells located in the command areas are linked to the availability of water in the tanks. Since many tanks are loosing their storage capacity due to sedimentation, they are under increasing threat of drying out during periods of the dry season. Furthermore, since the initiation of the Mahaweli irrigation project, demand for tank water has increased. The irrigation channels on the other hand, are provided with adequate water throughout the dry season.

Unless the storage capacity is therefore improved, the wells dependent on the tanks for recharge, risk losing their value.

The 90% confidence interval found in Woodward and Wui, for ground and sub-surface water recharge was US$ 6-2,571 acre/year. Evidently, the distribution of values is very large between the examined studies, which further underlines the importance of site-specific information.

Below, the expected impacts on ground and sub-surface water recharge, under the four scenarios are illustrated -

Scenario	Expected impacts
1	- - -
2	- -
3	+
4	+ + +

Based on the assumption that the tank's storage capacity will continue to decrease under scenario one, the impact on ground and sub-surface water recharge is perceived as very negative.

In scenario two the same will eventually happen even if increasing the spill extends the time horizon, since sedimentation loads will remain high without proper management of the reservation area.

Under scenarios three and four, the combination of increasing storage capacity along with managing the reservation will overall favour, water recharge. However, increasing the storage capacity by removing silt will also benefit water penetration. In terms of ground and sub-surface water recharge, scenario four is therefore seen as the best option.

Nutrient and sediment retention

Many wetlands, have the ability to act as natural water filtering stations, by storing nutrients, specifically nitrogen and phosphorus in their soil and vegetation, and trapping sediments. For every wetland, there is however a limit as to how high the nutrient concentration can be, without causing adverse effects on, e.g. biodiversity. Accumulating nutrients stimulates eutrophication, especially in smaller water bodies, where the carrying capacity towards nutrients is fairly low. Although eutrophication is a natural process, it can be greatly accelerated by human activities such as agriculture. Increasing the rate at which nutrients and organic substances enter aquatic ecosystems, will add to the eutrophication process and stimulate algae growth. Increased algae growth can hurt the ecosystem in two ways. First, by blocking sunlight, causing underwater grasses to die, and thereby destroying important underwater habitats, on which many species rely, including fish and waterfowl. Secondly, by using dissolved oxygen in the process of decomposing dead algae; a life sustaining resource required by other aquatic species. On the other hand, the high levels of nutrients are expected to benefit the rice production, since tank water is mainly used for irrigation.

According to the MASL, water quality is becoming an important issue, in the project area (Mahaweli Authority Interim Report, 2002). The overuse of agro chemicals (fertilizers, pesticides etc.) in agriculture is perceived as a threat to the water quality in the tanks. Furthermore, most of the small and medium sized tanks have shown eutrophication problems due to the accumulation of nutrients.

Generally, a wetland's ability to retain nutrients is seen as a benefit. But as indicated above, the present nutrient concentrations have for the smaller tanks, led to circumstances that are somewhat problematic. Evidently, there are both benefits and costs associated with the current nutrient status of tank water, in the Kala Oya. Thus, isolating the value of the nutrient retention function is difficult. Calculating a net effect of the function, would require a detailed analysis regarding the impacts of water quality on the different water uses, e.g. irrigation, consumption, and habitats. Furthermore, information would be needed as to how many nutrients the tanks actually store. Since such data is not available, it is assumed that the benefits and costs offset each other in the smaller tanks. However, the expected marginal change associated with the four scenarios, will still be qualitatively illustrated and the confidence interval found by Woodward and Wui, as US$ 126-1,378 acre/year indicates the value of the retention function, held by large tanks where eutrophication is not yet a problem.

Scenario	Expected impacts
1	- -
2	-
3	+ +
4	+ +

Again, scenarios one and two are seen as having a negative impact since no nutrients and sediments will be retained, once the tank has dried out. The slight difference in qualified impacts can be explained by the time element of when the tank is expected to dry out, under the two scenarios.

Besides conserving the tanks under scenarios three and four, the management of the reservation, is viewed as very important and beneficial by slowing down agricultural runoff, thereby facilitating the retention process. Scenarios three and four have been assigned the same impacts, since it is unclear exactly how the differences in water surface between the two scenarios will influence this function.

Water quality assessment conducted by MASL

MASL has conducted a water quality study, in collaboration with the University of Colombo, at 33 locations along the Kala Oya river. In this study, researchers identified many factors to measure the quality of water, since suitability of drinking, bathing and irrigation water depends upon several factors associated with characteristics of water, soil, plant and climate.

In order to identify the services provided by the wetlands in water purification, the following sample locations were considered.

1. Kala Wewa Tank intake I
2. Kala Wewa Tank intake II
3. Kala Wewa Tank outlet I

4. Kala Wewa Tank outlet 2
5. Rajanagana Tank intake
6. Rajangana Tank outlet
7. Angamauwa Tank intake
8. Angamauwa tank outlet

Ten monthly records from January 2003 to November 2003 were analyzed. Five times out of ten, observations at the intake of Kala Wewa Tank reflected that, Dissolved Oxygen ratios (DO) were below the required rate[39] (should be more than 5 for bathing and recreation). DO ratios are above the required ratio in all these three instances at the discharging location of the tank. These results were replicated at the Rajangana and Angamuwa tanks too.

Table 19: Water quality at selected wetlands (2003)

Location	Jan	Feb	Mar	May	June	Jul	Aug	Sep	Oct	Nov
Rajanagna Tank (intake)	7.3	3.3	7.4	5.6	4.2	6.1	5.6	0	6.3	4.8
Rajangana Tank – LBC	7.5	6.4	6.4	4.7	7.4	7.1	6	5.5	7.4	8.4
Angamuwa Tank (Intake)	7.7	5	6.9	5.8	3.7	5.6	3.6	0.8	1.8	5.8
Angamuwa Tank (down stream)	7.3	5.9	7.7	6	6.9	7	7.4	5.8	7.7	7.4
Kala Wewa intake I	6.9	6.2	3.9	5.4	5.3	5.3	4.9	4.3	4.9	4.8
Kala Wewa outlet 1	8.7	5.4	6.5	6.9	7.6	8.3	6.4	Na	7.0	8.6

Source: River Basin Planning & Management Division, MASL

Under standard sampling conditions, the surfaces of all 33 sites of the Kala Oya basin were analyzed for microbiological parameters. The presence of Coliform bacteria was observed only in three sites, before the Kala wewa tank. It was also noted that, there is a contamination by Faecal bacteria at the site 7 – Dambulu Oya stream.
The water from these sites will ultimately be collected in the Kala wewa tank and is used for irrigation. No other surface water bodies beyond Kala wewa were contaminated with microbes. The exposure to sunlight in the tank itself, which has a large surface area, would have affected the bacterial growth leading to the fact that no microbes were detected beyond the Kala wewa tank. (MASL, Uni. of Colombo).

Biological diversity

Although freshwater ecosystems only cover 1% of the earth's surface, they are home to more than 40% of the world's species, and 12% of all animal species, (RAMSAR website).

In the case of Kala Oya, the tanks provide important habitats for a wide range of species, including migratory birds and waterfowl, amphibians and fish. Their economic importance, as food and income sources, has been established in the previous chapter. Many of these species also provide a large part of the people's daily nutritional intake and might even be perceived as having healing or religious value. In the Kala Oya, the snakehead (Channa spp.) is believed to be important for pregnant women.

An additional value is reflected in some species ability, to act as bio-control agents benefiting the surrounding farmers. Pests in the form of insects, crabs and rodents are consumed by these species. A certain species of frog (Limnonectes limnocharis), is even renown for its ability to consume large quantities of pest insects. Many larger birds such as owls, eagles and hawks hunt rodents. Also aquatic bird species such as cranes, storks, and herons, feed on insects and crabs that pose a threat to rice production.

The tanks also provide habitat for a variety of flora. The most important from a livelihood perspective is the lotus. Lotus flowers, as mentioned earlier, are used for religious purposes and the stem is widely harvested for consumption. However, the lotus is being threatened by the

[39] OECD criteria cited from Kala Oya Biodiversity Assessment Study

water hyacinth, which is and alien invasive specie that is of no use to the local community. The water hyacinth has competitive advance over the lotus, especially, in the smaller tanks where nutrient levels are high. Besides out-competing the lotus, the water hyacinth also has a negative impact on biodiversity, since it has the ability to completely cover the water surface: something that many wetland species, especially the aquatic birds and waterfowl, do not favour.

In Woodward and Wui, the value of biodiversity is listed as US$ 95-981 acre/year. For the four suggested scenarios the expected impacts can be seen below.

Scenario	Expected impacts
1	- -
2	-
3	+ + +
4	+ +

The disappearing of tanks associated with the first two scenarios is seen as having a negative impact on biodiversity, whilst increasing water quantity is seen as a benefit. Compared to scenario four, scenario three is perceived as the best option towards biodiversity, since raising the spill would cause the flooding of a larger area thereby creating a more diverse supply of habitats.

SCENARIO ANALYSIS: Economic implications of alternative basin management options

The need to consider alternative basin management scenarios

Since the launch of the Mahaweli irrigation expansion project in the early 1980's, 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 un-utilized land surrounding the wetlands. The farming of these reservations has left the wetlands vulnerable to sedimentation, caused by run offs from the surrounding fields. There is a distinct possibility that, unless the current land use is changed, that certain wetlands will be lost in the future due to sedimentation.

Only a part of sediments that enter a reservoir is trapped in it, while the rest goes to downstream reservoirs. Therefore, sediment inflows to reservoirs are assumed to come from the immediate catchment, and from outflows of upper reservoirs. It was assumed that 75% of the incoming sediments are trapped in the reservoirs in the present study, based on the NEDECO (1979) report. This leaves 25% of sediments as inputs to the downstream reservoir, assuming the reservoir system is in equilibrium. The analysis requires conversion of the weight of the sediments to volume, and the specific weight of 1.35 tons/ m2 was used in this conversion. A linear relationship was assumed, between sediment deposits and reduction of live storage capacity. This is a reasonable assumption, since less than 1% of the live storage capacity is lost annually in all reservoirs (Gunathilaka H.M. 1998).

Losing wetlands would also mean loosing water storage for irrigation, and domestic use, as well as environmental services. Apparently MASL has realized this, and is planning to increase the storage capacity of certain man made wetlands, by raising the spill. However, decisions are still purely based on irrigation needs, and not on environmental considerations. Furthermore, just raising the spill will not solve the problem, but only postpone it, since sedimentation loads will remain the same or even increase. In order to secure the existence of these wetlands without any future interventions, it is believed that rehabilitating the reservations, as silt traps, should also be considered along with the option of, simply removing the silt.

The reduced capacity of the reservoirs will result in, less irrigation water available for downstream lands. In estimating the loss of irrigable area, it was assumed that two seasons per year are cultivated in downstream and that the reservoirs are filled, twice a year. Since Sri Lanka has bimodal rainfall pattern, with two distinct monsoons, this assumption is necessary. The lost irrigable area was estimated assuming 1 meter hectare of water use per season. This value is based on the average water use in the Mahaweli system B and C farming areas (IIMI 1994). The results indicate, that every year about 165.5 ha of downstream lands will be added to lost irrigation capacity. According to the estimates, as of 1993, a total of 1304 ha of irrigable area has been lost from the original capacity of the Mahaweli development programme (Gunathilaka H.M. 1998).

Management options

i) Keep the tanks as they are - Here, sedimentation loads remain the same if not increasing, and tank wetlands continue to deteriorate.

ii) Raise the level of the spill in tanks – Here, the water body will grow and additional land will be flooded, but sedimentation loads will remain the same if not increase.

iii) Raise the level of the spill, in tanks and manage the reservation properly – Here, the water will grow and additional land will be flooded and future sedimentation loads reduced, thus prolonging the lifespan of the wetlands.

iv) De-silt the tanks and manage the reservation properly – 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.

Due to the high crop intensity of the area mainly with Mahaweli water (Kala Oya irrigation water) traditional tanks face a severe threat of siltation. Farmers cultivate up to the reservation of the tank, and some times within the reservation also, as irrigated water is available. These practices cause a high rate of sedimentation in the tank. As a result, water storage of the tank is reduced and the growth of the water plants like lotus, water hyacinth and sedge is increased. These different kinds of water plants are a threat to the water quality and increase the rate of siltation in the tank. When the water level is increased in the rainy season, some of the plants like lotus and sedge sink in the water and perish. However, water Hyacinth and Lotus usually store nutrients and help to purify water. Due to the lower storage capacity, cultivable land under irrigation in both Yala and Maha seasons is going down. Low storage of the tank mainly affects the Yala season, as the tank provides more than 75% of the water requirements for paddy cultivation in this season, as rainfall is very low. As farmers depend mainly on rainfall in the Maha season, paddy cultivation starts in the rainy period, and then receives irrigation supplies. The water requirement from the tank is low in the Maha season stands at around 33% of the total requirement.

According to the experience of the people, the water capacity of the tanks has halved within the last 40-50 years. The rate of filling of the tank with sediments and water plants has been accelerating for the last 20 years, due to the increased acreage cultivated under the Mahaweli Development programme. Mahaweli farmers are able to cultivate paddy and field crops, in both seasons and upgrade their livelihoods with irrigation water supplied by the irrigation scheme. One of the major issues here is that, some of the Mahaweli farmers who cultivate near the reservations, expanded their land by encroaching on the reservations, since they have enough water from Mahaweli canals. In this respect they do not think that they contribute towards sending large amounts of sediment to the tank, while avoiding natural sediment traps in the reservations.

Table 20: Investments in different management options (Rs mill, shadow prices)

Management Options	Initial Cost	Operating Costs
Option 1	0.0	0.00
Option 2	0.036	0.00
Option 3	2.316	1.24
Option 4	4.980	1.24

Source: Estimates of the study team

The cost of increasing the spillway is, Rs Mn 0.036 in 2003. No operating costs are involved in the case of option 2. However, costs of resettlement of the farmers who live or cultivate close to the tank reservation, and yearly maintenance costs are involved under option 3. Since heavy equipment is required for de-silting and removing the soil out of the site, option 4 is an expensive and time-consuming task. In order to maintain the reservation and the tank properly, water plants like water Hyacinth, Salvenia etc. should be frequently removed in addition to the maintenance of the reservation area. All this work involves a large amount of labour, and it is estimated that 500 man days are required per year (total net present value is Rs Mn 1.24).

At present, some of the tanks do not have reservations at all or some have a very limited area, as a reservation though there are regulations to allocate an identified area of land, from the highest flow level of the tank as the reservation. Due to the lack of efficient enforcement of these regulations on protecting reservations, no one can identify the correct boundaries of the reservations today. Further, one hardly sees any emphasis on increasing the quality of the reservation, by growing trees and using other sediment traps.

Option 1: maintaining the status quo

Considering the above factors, it is assumed that 2% of the live storage capacity is lost annually in these tanks, mainly due to the sedimentation and the high density of water plants of the tank. This assumption is more reliable and agrees with the findings of Gunathilake1998, i.e. loss of 1% of the capacity only from soil erosion of the catchments, as a threat of water plants is not available in Gunathilake's study area.

Further, it is assumed that the acreage of paddy will also be reduced in the future in line with the loss of capacity of the tank. Under option 1, there will be a 2% annual drop of acreage of paddy cultivation in the Maha season; there will be a 3% annual drop in the Yala season, which depends mainly on tank water.

Option 2: Raising spill levels

Option 2: Since the level of the spill is raised, there will not be any decrease of acreage of cultivation, in a short period of time but perhaps after around five years (according to the previous experience at the site), a decrease in the water capacity will commence, mainly due to the very small area of reservations, covered by water with the increased spill way. Villagers and irrigation engineers have experienced that some of the tanks which were rehabilitated earlier without proper reservation, maintenance and cleaning the water plants well, deteriorated within a 3 to 5 year period of time. Hence, a decrease in acreage at the same rate of option 1 can be expected after 5 years. The capacity of water storage will not be affected, under options 3 & 4 which can give a continuous water supply to the paddy fields in its command area, mainly due to the proper management of reservations.

As explained earlier, the water capacity of the tank affects the cultivation of vegetables and perennial crops. The Yield of coconuts will also be reduced with the low subsurface water level.

Option 3: Raising spill levels and manage reservation

Option 3: As the depth is not so great water plants like water hyacinth, sedges will still be harmful to the tank. There will be a lower rate of silting compared with options 1 & 2. Even though the storage capacity is increased, the quantity of evaporation is higher, with expanded water spread.

Option 4: Desilt tanks and manage reservation

Option 4: This will be a better option and will present no deteriorating situation. An increase in the productivity of crops can be expected, due to the high level of availability of water. Siltation will be low, with the properly managed reservations. Since the depth is higher, water storage increases without expanding the surface area.

Impacts of alternative scenarios

Domestic Use

Almost all the people in the village go to the tank to bathe in the dry season, as there is very little water in their own wells and the Mahaweli canals. If these canals are nearby, villagers use the canal to bathe and wash cloths when Mahaweli water is available. Under option 1, the level and the quality of water in the tank will go down soon in the dry season. Then, the people can use the tank only for a fewer number of days, in the dry season. So it is assumed that there will be an annual rate of a 2% decrease, in the number of days on which people can use the tank, in the dry season. It will be only for 1.5 percent in the other period, when Mahaweli and rain water will be available. It is assumed that the population has grown at the average rate population growth i.e. 1.2 percent.

Productivity

Since the water level of the tank decreases, the sub-surface water level in the surrounding area will also be low. Therefore any increase in productivity in all these crops cannot be expected under option 1, even with the improved varieties, fertilizer and chemicals. A 0.5% annual increase in productivity is assumed in option 2 and 3, since water is available for cultivation. However, it is also assumed that the rate of productivity growth is higher (1% per annum) in option 4, since storage capacity is increased to provide enough water for the cultivation.

Upasena and Abeygunawardene (1993), found that production loss has a strong positive relationship with water loss, that loss is Rs 75.14 per one hour's loss of water according to 1993 prices. This outcome is in line with the assumption considered in this study.

Fishery

When the water level in the tank fluctuates severely between the dry season and the wet season, it badly affects the fish population. Fishermen also increase their effort when the catch is high and these too, affects the growth of the fish population. Moreover, the quality of water decreases in line with the water level, and limits the rate of growth of the fish population. It is assumed that there will be a 250 kg (Water management Synthesis Project, 1983) annual drop in the catch per water spread Hectare.

Lotus Flowers/ Lotus Roots/ Sedge

Yield of all these three products will increase with the high sediment rate, and low water level. Hence there will be a 1% annual growth in all these three products, under option 1. It is assumed that the growth of these plants will be less in the first five years, with the slightly increased water depth, and thereafter there will be higher growth under the option 2. Since water depth is considerably increased and most of the plants would be removed with de-siltation it is assumed that there will be a negative growth under the option 4. (Please see annex 1).

Drinking water for livestock

It is expected that the number of animals in the area will increase, with the population. However the number of days on which animals are able to use the tank for drinking water, will decrease (1% annual drop in option 1) due to the scarcity and low quality of water.

Fodder for Livestock

When the tank is shallow and does not retain much water, animals can use the tank for a greater number of days (1% annual increase in option 1) for fodder in both the dry and wet seasons.

Cost benefit analysis of wetland conservation

The financial and economic feasibility of conservation of wetlands, is assessed using the estimated direct and indirect use values of the average size tank, which is 22 ha in size in its full supply level. Only the direct use values of wetlands are considered, in the financial and economic analysis and values of indirect use are not incorporated into the analysis for two reasons. One is that, due to the difficulty in finding reliable data for valuing indirect uses, the outcome is not as reliable as direct use values. The second thing is that direct use values itself, justify the validity of conserving tanks for future use.

Distortions like inflation, taxes and subsidies are removed from the prices in the economic analysis using economic conversion factors. These conversion factors were developed by the Ministry of Policy Planning and Implementation (1992), Sri Lanka.

Table 21: Conversion factors

Sector	Conversion Factor
Aggregate Conversion factors	
Average Conversion Factor	0.785
Investment Conversion Factor	0.906
Agriculture Conversion Factor	0.785
Primary Inputs	
Surplus Labour	0.722
Sectoral Conversion Factors	
Paddy	0.697
Other Food Crops	0.870
Livestock	0.774
Forestry	0.841
Other Agriculture	0.723
Transport	0.814

Source: Ministry of Policy Planning and Implementation 1992

The same document suggests the use of a 6% social discount rate, for the economic analysis. All the wetlands are able to provide their services for a longer period of time with a minimum level of maintenance. A 30 year period was considered for the economic analysis.

The incremental economic Net Present values for providing direct uses of the tank are presented below.

Table 22: Incremental economic net present values of direct uses (shadow prices)

Siltation rate of the tank	Incremental Economic value of Option 1 Rs mn	Incremental Economic value of Option 2 Rs mn	Incremental Economic value of Option 3 Rs mn	Incremental Economic value of Option 4 Rs mn
2%	0.0	2.40	6.40	11.95

Source: Estimates of the study team

All the options are economically feasible as the tank is already providing many services, and the suggested investments are not so big, in all the four options comparing to the services it provides. Option 2 & 3, also show slightly higher economic returns than option 1. Option 2, 3 & 4, definitely provide more economic returns when the values of indirect uses are also taken into account. Indirect uses are estimated qualitatively in this study, and they are presented below.

Table 23: Qualitative estimates of indirect services

	Ground and sub-surface water recharge	Nutrient and sediment retention	Biological diversity	Total
Option 1	- - -	- -	- -	7 -
Option 2	- -	-	-	4 -
Option 3	+	++	+++	6 +
Option 4	+++	++	++	7 +

Source: Estimates of the study team
Note: Please refer the section 4.3 for the detailed information about indirect services

It is necessary to consider the value of the Natural Capital, at the end of the project period. According to the options defined, there will be a low value for the Natural capital (NC1) due to deteriorated wetlands after 30 years. Due to well maintained reservations, these ancient tanks, which are more than 500 years old, will be able to provide services for another few centuries. Hence, the value of natural capital (NC 4) in option 4 will be very high, in comparison to other options. It is expected that there will be a lower value for NC 3 as the reservation is smaller than in option 4.

NC1 < NC 2 < NC 3 < NC 4

Table 24: Estimated values of services under different options

	Incremental NPVs of Direct Uses	Qualitative estimates of Indirect Uses	Value of the accumulated Natural Capital at the end of the project period
Option 1	0.0	7 -	NC 1
Option 2	2.40	4 -	NC 2
Option 3	6.40	6 +	NC 3
Option 4	11.95	7 +	NC 4

Source: Estimates of the study team

These results reveal that option 4, is the most favorable action which can improve the services provided for a longer period of time, and give the highest economic return. It is clear that option 4 gives a higher amount incremental net present value of direct uses, than that of option 3. This difference is mainly due to the higher capacity and the larger reservation of the tank under option 4. The reservation area of the option 3 is smaller, as the water spread is larger with the raised spill level.

Poor Villagers around the small tanks, have been sharing the water and other resources for centuries without any conflict, mainly due to the water utilization practices of the village lead by Wel-Vidnane (Traditional Irrigation Headman), and the sufficient amount of resources available in the tanks. However, villagers feel that revenues and quality of benefits are decreasing as a result of the deterioration of the valuable ecosystem; the small tank. The living conditions of these people will become worse if they lose the revenue gained from the tank. If the tanks are left without proper maintenance, only the people who are engaged in extracting lotus products will be able to continue with their activities, and others will not be able to enjoy the benefits, due to the depletion of the ecosystem.

Table 25: Percentages of households engaged in different income generating activities, and their income

Resource	Percentage of Households	Value per Household (US$ / hh / yr)	Value per Unit Area* (US$ /ha /yr)
Paddy cultivation	13%	177	161
Other Field Crops cultivation	7%	86	39
Banana cultivation	3%	1150	209

Resource	Percentage of Households	Value per Household (US$ / hh / yr)	Value per Unit Area* (US$ /ha /yr)
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**

Source: Primary survey data collected at Kala Oya Basin 2003
Note: * - Total inundated area

Around 44% of the total households of the basin, are recipients of the Samurdhi benefits, since they make less than Rs 1500/ (US $ 15) as a monthly income; This is the poverty line introduced by the Samurdhi Authority. Therefore, maintaining and rehabilitating small tanks is, no doubt, an effective investment, which is economically, environmentally and socially feasible, to address issues of poverty in rural areas. This investment, will keep the villagers around the tank economically healthy, while providing environmental services to the whole country, and the world through biodiversity conservation. Further, the heritage of the system of small tanks will exist, for another number of centuries for future generations, to obtain benefits.

OTHER IMPORTANT BASIN VALUES: Cascade systems and the Estuary

Cascades

Giribawa, Mahagalkadawala, Mahaliyanagama and Pulanchiya cascades are not new settlements like the Mahaweli area, and they have different sizes of plots for cultivation and living. In terms of climate, this area is not as favorable as the Mahaweli area. It is very dry, and people have to depend totally on the tank or the wells. They do not receive water from external irrigation systems. This is a cascade[40] of tanks, and those tanks at the far end receive water only from rainfall. The tanks down stream receive water from rainfall, and the water spilled or released from the upstream tank of the cascade. Though the crop intensity of the Maha season in the tank area is 100 percent, it becomes very low in the Yala season. While cropping intensity of the Yala season ranges from 30 –50 percent in medium size tanks, at times it becomes 0 – 10 percent in smaller tanks.

Here, due to the shortage of water, only one season is cultivated and living standards are low in comparison to the Mahaweli area, except the households that have a large extent of land or households that have some lands in the Rajanganaya irrigation system (which is a very large irrigation system), or who engage in occupations outside the village. The lifestyle of the people also improves when they have enough land to cultivate. For instance, people near the “Pahala Giribawa” tank have enough land to cultivate and they are full time farmers. Hence, no one in the village catches fish or extracts lotus products from the tank. They buy fish from sellers who come from other villages.

Almost all of the tanks in these cascades, dry out completely in the dry season, since they don’t get water from the Mahaweli irrigation system. This also breaks the regeneration cycles of all water plants. Therefore the growth of lotus and other plants are lower in these tanks, in comparison to the Mahaweli area. The same situation applies to the fishery, as the regeneration of fish is very low after the dry season. Some of the farmer organizations are able to control catching fish in the dry season, and at least to return fingerlings and small fish to the tank.

Table 26: Water spread at full capacity of working tanks in GMMP Cascade area

Range in Ha	No of Tanks
1 – 5	48
5.1 –10	21
10.1 – 15	7
15.1 and over	10

Source: Kala Oya River Basin Planning & Management Office

The common view held of these tanks is, that of an untouched reservation. As water is not available above the tank area, the reservations are protected and siltation is low compared to the Mahaweli area. But due to the bad practices of farmers, a higher load of sediment comes to the tank through the canals, which flow through paddy lands of the upstream tank of the cascade.

As mentioned in regard to the Mahaweli area, the soil gates which are used for blocking water temporarily in the paddy field, are removed and the excess water in the paddy field flows into the next tank with soil. A gate is around 2-3 kg of soil and one acre of paddy land has around 10 gates. These gates release around 25 kg of soil into the tank in one season. These stocks of

[40] Connected series of tanks organized within the meso-catchments of the dry zone landscape, storing conveying and utilizing water from an ephemeral rivulet. (Madduma Bandara 1985) –cited from Panabokke C.R. 2002

sediments are in addition to natural soil erosion. Also rainwater which flows through the fields and the irrigation canals which deliver water with high pressure, bring a larger amount of sediment to the tank.

Since there is no other sources of water like irrigation canals in the area, people mostly use the tank for bathing and washing clothes. In addition, a larger number of animals including cattle use the tank for water and fodder.

Table 27: Economic value of water spread per hectare of a tank in GMMP Cascade

Product	Economic Value per Ha (Rs/ha/year)	Economic value per Ha (US $/ha/year)
Paddy	28,705	290
Banana	5,302	54
Coconut	14,718	149
Other field crops	689	7
Domestic Use	225,366	2,276
Livestock	93,921	949
Fishery	16,953	171
Lotus Flowers	1,544	15.6
Total	**387,197**	**3,911**

Source: Primary survey data collected at Kala Oya Basin 2003

Economic value per water spread Hectare of this cascade, is higher than that of the Mahaweli area. Because there are 2 to 3 large tanks (e g: water spread of 37, 56.2 and 71 Ha) in this randomly selected cascade, with a larger number of dependants, while the largest one in the sample of Mahaweli area is 35.9 Ha.

Estuarine mangroves

The WANI Sri Lanka component joined hands with the ADB sponsored Coastal Resources management project in Puttalam, to include a component on estimating the benefits derived by the local communities, from the mangrove forest at the lower most segment of the basin of the Kala Oya estuary. Kala Oya empties its waters to the Puttalam lagoon located in the western coast of North Western Province in Sri Lanka. The mangrove ecosystem at the river mouth of the lagoon, is unique and being threatened by increased population pressures and industrial activities. The poor community in the lagoon area, depend on the ecosystems for their livelihood activities. However, the pressure on the ecosystems is believed to be exceeding sustainable levels.

Study area and critical ecosystems

The chosen mangrove vegetation selected for this study, is located around the Kala Oya delta, which opens out to the Puttalam lagoon. Amarasinghe and Perera (1995), estimated that the mangrove cover in the area was about 1837 ha. This quite elegant, green patch is believed to be the most pristine mangrove area remaining in Sri Lanka. Preliminary studies reveals that about 1000 out of 3690 families living in Vanathawilluwa Administrative Division, depend on fishery and they are directly or indirectly reap the benefits of mangroves in the area. Villages are closely attached to the vegetation as it provides essential spawning grounds, for many species of fish, and increases the productivity of lagoon fishery as well as off lagoon fishery. Occasionally, they use the mangrove to extract fuel wood as an energy source, timber for shed construction, wildlife and fish for subsistence, and some edible and medicinal plants.

The water demands of the community for drinking, and for other domestic purposes is met through water drawn from the Kala Oya. Therefore the water quality of the river basin towards inland, is such an important factor for their livelihood activities. Presently the community travel

2-3km along the river towards inland, to collect water for their drinking purposes, as the river stretches close to their village comprise of brackish, saline water. As stated by the village community, they need 2-3 cans/day with the capacity of a 35 liter can to meet their water requirement. It is considered that the mangrove vegetation in the area provides such an important ecological function, of preventing saline water intrusion to inland waterways.

As a result of heavy rains and spilling of river water from Kala Oya, the area is subjected to floods 2-3 times/year. This deprives the people of their livelihood activities, especially, adversely affecting fishing activity and upstream agricultural production such as paddy. In the year 2003, there about 100 acres out of 500 acres paddy, yielding 80-100 bushels/acre, were lost due to floods in the Eluwankulama area of Vanathawilluwa Divisional Secretariat (Personal communication with divisional Agricultural Officer). The flood control function is considered to be one of the main ecological services provided by the mangrove vegetation. Anthropogenic activities, in particular of the mangrove vegetation could lead to deprivation of this service, and thus to more damages by floods.

Dayaratne et al (1997), stated that the mean annual concentration of nitrate and phosphate in the Puttalam lagoon was 0.1408 and 0.4525mg/l. It was also stated that these concentrations represent a non-polluted aquatic environment. However after the rains, the level of nitrate and phosphate concentrations in the Kala Oya and Mi Oya estuaries have risen, to levels amounting to 0-6mg/l. This could be considered as a typical polluted water environment. Agrochemicals in surface runoff is also said to be contributing to the elevated levels of pollutants in the Puttalam Lagoon. Thus, the control of pollution of water bodies has been identified as one of the major indirect services of the mangrove. It also identified that Gangewadiya area could be developed into tourist's hotspot because of its aesthetic beauty, enhanced by Green vegetation along the Kala Oya estuary. Its close proximity to Vilpattu National Park adds to the attraction. Experts believe that there is huge potential for ecotourism to be developed in this area. Particular Mangrove vegetations are also believed to be the home for a wide range of bird species. .

Sri Lanka's coastal line is heavily affected by sea erosion, resulting from habitat destruction for industrial and urban development activities, sand mining and coral mining etc. Mangroves protect the erosion of coastlines; thus preventing the loss of valuable agricultural land and property. It is quite evident that the mangrove ecosystem in the Kala Oya delta gives protection to the coastal line as well the riverbank.

Despite these beneficial uses of mangrove ecosystems, the vast amount of mangrove habitat surrounding the Puttalam Lagoon area has faced destruction due to commercial purposes. Especially, in order to convert them in to prawn farms. A wide destruction has taken place from 1981 to 1992, leaving around 993 ha of mangrove cover in the Puttalam lagoon. (Amarasinghe and Perera, 1995). Over the years, with increasing population and influx of displaced people from North and East, pressure on the lagoon has increased. In the absence of well-defined property rights and the open access nature of the resource, people resort to swift destruction of habitats as the marginal productivity of existing prawn farms gradually decline. People tend to migrate to places where the marginal productivity to resource is very high.

Selected components for the economic valuation: the valuation techniques and the data requirement

Considering the time, resource and data constraints, this study is focused to value certain benefits of the mangrove ecosystem around the Kala Oya Delta, which are economically significant to surrounding socioeconomic activities. The selected economic issues, valuation techniques, data required and their importance relevant to study site are compiled in the following table.

Table 28: Selected values, valuation techniques and data requirements of mangrove valuation

Products and Services	Valuation technique	Data Requirements
Fuelwood	Prices, substitute prices, surrogate market prices	Harvest rate, cost data, harvester inputs
Wildlife	Market prices	
Shoreline and river bank stabilisation	Benefit transfer, change in productivity, preventive expenditure	Secondary information
Floodwater control	Preventive expenditure, damage avoided	Secondary information (relief assistance, infrastructure cost)
Prevention of saltwater intrusion	Damage avoided	Estimates from previous studies
Pollution control	Avertive expenditure, benefit transfer	Secondary information
Breeding grounds for fish	Benefit transfer	Establish functional forms, mangrove area
Carbon sequestration	Benefit transfer	Establish functional forms

Economic analysis of the mangrove ecosystem

Direct use benefits of the mangrove ecosystem

Mangrove forests are directly harvested for a number of products such as timber, fuel wood etc. The direct user value of the mangrove in terms of the local use is, the net income generated from the mangrove by local people.

It was reported that from 1981 to 1992, the mangrove cover has been reduced from 1181ha to 431ha. Mangroves of the Puttalam area are widely extracted for both subsistence and commercial purpose. Amarasinghe (1988), reported that 55% of households around the Puttalam estuary used mangroves as firewood. This figure has further increased as a result of the influx of the refugees to the area. In 1986, it was estimated that 12,000kg of bark was extracted annually, from the Dutch bay. (Amarasinghe 1988)

Conducted surveys indicated that there are about 53 households in Gangewadiya, and about 90% of them depend on fishing related activities. Villages are closely attached to vegetation as they provide essential spawning grounds, for many species of fish, increasing the productivity of lagoon fishery as well as off lagoon fishery. Occasionally they use the mangrove to extract fuel wood, as an energy source, timber for shed construction and making tools, wildlife for meat, fish for subsistence, honey, and some edible and medicinal plants. Not only the households of Gangewadiya, but also people of surrounding villages like Elluwankulama, reap the direct benefits of the resource. It was hard to access accurate information as most of them pretended not to be the users of the resource. Assuming that 50% of 300 households of surrounding villages and the islands are reaping the fuel wood benefits, the monetary value of such benefit equals to 218,000/= Rs/year considering the purchase price of firewood equals to 30Rs/houshold/week. In deriving such figure, the opportunity cost of labor is considered to be zero as such activity is mostly done by women, of whom a majority are unemployed and engaged in household activities.

Households use Keriya, Manda, Briya, Kadol trees for shed construction. It was estimated that the value of the timber is Rs 2570/shed. Preliminary surveys reveal that around 75% households use timber for their shed construction and that its value amounts to Rs. 584,000/year.

People use wildlife for their subsistence purposes. It was quite difficult to extract such information from the households. However, it was revealed that hunters kill at least one animal per month.

The price of one kg of meat was 100Rs regardless of the type of meat. Primary investigations revealed that the average weight of animal was about 60-100kg. Assuming an average weight of 80 Kg/animal, and a recovery rate of 60%, the net value of meat equals to 57,600 Rs/year.

It was also revealed that the community extracts some other products such as honey, medicinal plants, Rhizopora bark, and edible plants for their livelihood. Even though these products have some economic value attached to them such values are not taken into account in this analysis. It was difficult to gather information of such extracts, as these activities are not practiced frequently.

Considering the all these activities, the direct use value of the mangrove habitat amount to 859,792/Rs/yr or US$8956/ha/yr. We believe that this figure is a lower bounced estimate of the actual direct use values of the mangroves.

Indirect uses of the mangrove ecosystem

Healthy mangrove areas contribute to enhance the marine fish production by providing nursery and breeding grounds to the critical habitat. Costanza et al (1989), estimated that an annual economic value of $62.66/ha for coastal wetland, impacts on commercial fishery productivity. Project report (ADB, 1993), cited that an Indonesian study conducted by Giesen et al, (1991), estimated a much higher annual value of 600$/ha. It also cited that these values did not capture the benefits to local residents, who fish in the lagoon channels and tidal creeks.

Barbier et al (2002), conducted a study to identify the impacts of mangrove deforestation on artisanal and marine demersal and shellfish fisheries in Thailand. The welfare impacts of mangrove deforestation are estimated, under different elasticity of demand assumptions. Under pure open access, the welfare losses estimated for mangrove deforestation in Thailand of 30 km^2 annually ranged from $12000 to $408000, depending on the elasticity of demand.

Assuming that the mangrove patch of the Kala Oya delta is similar to that of Thailand, and following Barbier et al (2002), it can be said that 625481kg of Dermasal fish and 43412kg of Shell fish are attributable to the mangrove vegetation of the Kala Oya delta. Considering the average price of Demersal and Shellfish to be equal to Rs. 150/kg and 300Rs/kg respectively, the approximate value of 1800ha of mangroves contribution to fish productivity is Rs 106 million per year. Here, the effort is measured in terms of the hours spent in fishing equaling 6hrs and the area of mangroves measured in terms of sq km equaling 18 sq km.

Other Indirect services considered at the study
Pollution control
Shoreline and River bank stabilization and storm control
Carbon Sequestration
Floodwater control
Prevention of saline water intrusion

Economic benefits from mangroves in the Kala Oya Delta

Estimated economic benefits of the mangroves in the Kala Oya Delta are summarized in the table given below.

Table 29: Estimated economic value of mangroves in Kala Oya Delta

Economic Benefits	Value Rs million/year
Fish productivity	256.90
Pollution control	81.00
Shore line/ River bank stabilization	76.62
carbon sink	10.56
Flood Attenuation(damage avoided in terms of agriculture)	0.81
Timber	0.58
Preventive expenditure through saline water intrusion	0.19
Flood Attenuation(damaged avoided in terms of relief assistance)	0.08

Economic Benefits	Value Rs million/year
Wildlife	0.07
Fuel wood	0.22
Total Value	**427.04**

Source:IUCN Sri Lanka Country Office, ADB (2002)
Note: Rs 96 = US$ 1

The estimated economic benefits of mangroves, considered in this study show that the mangrove habitat in the Kala Oya delta has a greater impact on the livelihood activities in the area, and thus to enhance well-being of the society. Even in the absence of a robust primary research of the mangrove area, due to time and data constraints, the empirical values show that the annual economic benefits to the community equals Rs.197 million/year. The approximated value attached to one ha of mangroves equals Rs109583/year or US$ 1115/year.

In quantifying the economic value of mangroves, some of the direct, indirect, optional and existence benefit are not taken into consideration. This is done so that the value attributable to a mangrove ecosystem is an underestimation rather than the actual value. The key economic intuition behind this valuation is, to give insights to policy makers to determine whether the mangrove areas should be preserved, or raise the question on whether they should be converted to alternative income generating activities or any other development activities. Since it was evident that the significant contribution of mangroves came from indirect service functions, altering such stochastic ecological services could generate a huge environmental cost in the long run. Thus, the incorporation of estimated economic values in to mainframe decision-making processes would be so vital and would help to derive better mangrove management policies.

RECOMMENDATIONS: Needs for conserving small tank ecosystems

Monetary resources for tank rehabilitation

The government of Sri Lanka, has been allocating a significant amount of resources for rehabilitation of the existing small tanks in the dry zone, since independence. This was occurring through the Department of Irrigation, the MASL and the Department of Agrarian Services, and was able to attract a number of foreign donors also for maintaining these tanks as a large number of households in the dry zone engage in agriculture and other economic activities under these small tanks. However, at present those tanks are in danger due to many reasons such as siltation, pollutants of fertilizer & chemicals, water plants, degradation of reservations, population pressure, increased number of cattle and the high intensity of cultivation in the catchment areas.

Although the government spends lot of resources to maintain the tanks, the communities around the tanks are not happy and complain about the low quality of the work and its sustainability. The main complaint is that most of the time, rehabilitation work takes place at the tank bunds and the sluice gates, but not in the tank. The communities request is, to increase the capacity of the tank to the level what it was 20 -25 years ago. However, the irrigation engineers of government authorities say that de-siltation is not cost effective and sustainable. It may be true that the de-siltation of tanks is not cost effective, as far as irrigation benefits are concerned, but if all the benefits valued in this study are considered, it will be unquestionably cost effective. However, the issue on sustainability will remain as de-siltation itself does not solve the problem unless effective measures are implemented, to prevent further soil erosion in the catchments.

Since these tanks which show characteristics of a common property, provide many benefits to the region and the country, in particular to the households living around, government intervention in maintaining them is justifiable. Further, these tanks help the region to keep the unemployment rate low since many can find employment through tank related activities like cultivation, fishery, extraction of lotus roots & flowers etc. In addition to the environmental services provided, these tanks help the community to enjoy healthy life by providing nutritious food and water for washing & bathing.

Therefore, as shown in the previous chapters, economic analysis of costs of rehabilitation and the benefits will show the effectiveness of maintaining them properly.
Moreover, tools like extended cost benefit analysis will be really necessary to compete with the large number of budget requisitions submitted to the National Treasury which maintains a very limited amount of funds. In order to conduct a proper economic analysis, the officials of irrigation authorities who prepare those proposals should be trained to value the direct and indirect services of tanks, and how to integrate them into the proposals.

Maintenance of tank reservations

Further research is necessary to identify agricultural practices, which increase the soil erosion. A properly organized campaign of extension services is very important, to disseminate the findings and to introduce better practices to reduce the soil erosion, which is harmful to the tanks and the yields of the cultivation. In addition, community empowerment and law enforcement programmes should be developed to protect and maintain the reservations.

Community participation

Farmer participation in irrigation management, in both major and minor irrigation systems, is not a new concept for Sri Lankans. However, due to many reasons this concept was not practiced well, especially after the "Vel Vidane" system collapsed. Government intervention in rural development, sometimes, with the assistance of donor funding, keeps the farmers away from the irrigation maintenance activities. For instance, the Mahaweli development project, due to its massive workload, implemented the rehabilitation and maintenance work with well established contractors to finish the work in time, without disturbing the cultivation of crops for a longer period. As a result, a tendency was developed towards increasing farmer's dependency on government institutions.

At present, since the government has not been investing enough resources for maintenance and rehabilitation, farmers well understand that these tanks are deteriorating and providing less services. Therefore, they are willing to participate in the maintenance activities and to conserve the wetlands which have been giving livelihood for centuries. It is very important to get the involvement of the villagers not only in water management, but also in maintenance and rehabilitation, because then they will use to protect them continuously while extracting the resources. Since farmers are not able to contribute in cash due to the poor income and other productivity issues, it is better to use their in kind contribution – labour as an initiative. One can expect a behavioral change in tank conservation with their contribution, which would make them feel a sense of ownership. Hence, the focus of a second phase of the project will be assessing the willingness of beneficiaries for tank rehabilitation and maintenance, and analyzing the policy related issues on participatory management of tanks.

BIBLIOGRAPHY

Balasubramanian, R. and N. K. Selvaray (2003): Poverty, Private Property and Common Pool Management: The Case of Irrigation Tanks in South India, Working Paper no. 2-03, SANDEE.

Barbier, E., Acreman, M. and D. Knowler (1997): Econimic Valuation of Wetlands: A Guide for policy Makers and Planers, Ramsar Convention Bureau, Gland.

Bulluck, A. and M. Acremann (2003): The Role of Wetlands in the Hydrological Cycle, Hydrology and Earth System Sciences, 7(3), 358-389.

Cooray, A.T. and P. H. Jayawardene (1982): Ground Water Hydrology in the Mahaweli System H

Gunathilake, H.M.(1998), An Economic Analysis of Soil Conservation in the Upper

Mahaweli Watershed of Sri Lanka (Unpublished)

Handawala, J. (1983): Occurrence of Saline and Alkaline Soils in Dry Zone of Sri Lanka, Department of Agriculture, Sri Lanka.

Heal, G (2000): Valuing Ecosystem Services, Ecosystems 3, 24-30.

Herath, H.M.G. (1985): Economics of Salinity Control in Sri Lanka: Some Exploratory Results. Paper submitted for publication in Agricultural Administration

IIMI, (1986), Participatory Management in Sri Lanka's Irrigation Schemes

Karunanayake, M.M.,(1983), Irrigation Systems in Sri Lanka

Kotagama H.,Thrikawala S.(1998) Environmental Valuation Studies and Estimated Unit values in Sri Lanka

MASL, University of Colombo, (2003), Studies on the Water Quality Kala Oya Basin

MASL, EML Consultants, (2003) Kala Oya Bio diversity Assessment Study

Mendis, D.L.O.,(2002), Water Heritage of Sri Lanka

Panabokke, C.R., Sakthivadivel R., Weerasinghe A.D.(2002), Small Tanks in Sri Lanka: Evolution, Preset Status and Issues

Roral Netherlands Embassy, Arcadis Euroconsult and IUCN (2000), Environmental Sector Study – Sri Lanka

River basin Planning & Management Division, MASL (2003), First Interim Report on Kala Oya Basin Comprehensive Plan

River basin Planning & Management Division, MASL (2003), Second Interim Report on Kala Oya Basin Comprehensive Plan

River basin Planning & Management Division, MASL (2003), Third Interim Report on Kala Oya Basin Comprehensive Plan

Sikurajapathy, K., Jayawardena, S. N. and M. A. Roonge (1983): Survey of Suspected Salt Affected Soil in Paddy Lands in System H, Mahaweli Authority, Sri Lanka

Sumanaratne, N. and P. Abegunawardena. 1993. An Economic Evaluation of the Salinity Problem in Inginimitiya Irrigation Project: In Maintenance and Operation of

Irrigation/Drainage Schemes for Improved Performance, Paper presented to the Asian Regional Symposium, Beijing, Peoples Rep. of China, 24-27 May 1993.

Thiruchelvam, S. and S. Pathmarajah (1999): An Economic Analysis of Salinity Problems in the Mahaweli River System H Irrigation Scheme in Sri Lanka, EEPSEA Research Report, International Development Research Centre, Ottawa, Canada.

Upasena W.J.J. and Abeygunawardene P.,(1993), Economic Value of irrigation Water in Dewahuwa irrigation Scheme

Water Management Synthesis Project, MASL (1983), Diagnosis Analysis of Farmer Irrigation Systems on the H-Area of Kalawewa in the Mahaweli Development Project

Woodward R.T. and Wui Y. S. : The Economic Value of Wetland Services: A Meta-analysis, Department of Agricultural Economics Texas A&M University.

ANNEX:
Assumptions used in scenario analysis

	Option 1	Option 2 Year 1	Option 2 Year 5	Option3	Option4
Paddy					
Acreage drop due to lack of water in Maha - yearly drop	2.0%	0.50%	2%	0.25%	-1%
Acreage drop due to lack of water in Yala - yearly drop	3.00%	0.50%	3%	0.50%	-1%
Productivity - yearly Increase	0.0%	0.50%		0.50%	1.0%
Vegetables					
Acreage drop due to lack of water - yearly drop	2.00%	0.25%	2%	0.25%	0%
Productivity - yearly Increase	0%	0%		0.0%	1.0%
Perennial crops					
Acreage drop due to lack of water – Banana	2.00%	0.25%	2%	0.25%	0%
Acreage drop due to lack of water – Coconut	2.00%	0.25%	2%	0.0%	0%
Productivity - yearly Increase	0%	0%		0%	1.0%
Domestic Use - Bathing/ Washing					
No of days used -Yearly drop due to scarecity and law quality of water - Dry Season	2.00%	0.50%	2.0%	0.5%	-1.0%
No of days used -Yearly drop due to scarecity and law quality of water - Other Seasons	2.0%	0.50%	2.0%	0.5%	-1.0%
Population growth	1.2%	1.2%		1.2%	1.2%
Fishing -- Based on the extent of the tank					
Lotus – Flowers					
Yearly increase of flowers as depth of the water level is decreasing	1.00%	0.25%	1%	0.5%	-0.5%
Lotus – Roots					
Yearly increase of roots as depth of the water level is decreasing	1.00%	0.25%	1%	0.5%	-0.5%
Sedges					
Yearly increase of sedges as depth of the water level is decreasing	1.00%	0.25%	1%	0.5%	-0.5%
Drinking Water for Livestock					
Yearly increase of livestock with the population increase	1.00%	1.2%		1.2%	1.2%
No of days -Yearly drop due to scarcity and law quality of water	1.00%	0.25%	1%	0.5%	0%
Fodder for Livestock					
Yearly increase of livestock with the population increase	0.0%	1.2%		1.2%	1.2%
yearly increase of no of days as area of fodder is increased - dry season	1.00%	0.25%	1%	0.5%	0%
yearly increase of no of days as area of fodder is increased - other period	1.00%	0.25%	1%	0.5%	0%

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