# Multiple Benefits of Small Irrigation Tanks and their Economic Value
## - A case study in the Kala Oya Basin, Sri Lanka

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Sri Lanka and Asia Region

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# LIST OF ACRONYMS

| | |
|---|---|
| ASD | Agrarian Services Department |
| CBSL | Central Bank of Sri Lanka |
| DAD | Department of Agrarian Development (Present name of ASD) |
| ID | Irrigation Department |
| MSL | Mean Sea Level |
| MASL | Mahaweli Authority of Sri Lanka |
| MCM | Million Cubic Meters |
| NTFP | Non Timber Forest Products |
| OFC | Other Field Crops |
| RA | Rajangana–Angamuwa sub catchments |
| RBO | River Basin Organizations |
| RBPM | River Basin Planning & Management Division, MASL |
| TEV | Total Economic Value |
| UOC | University of Colombo |
| WANI | Water and Nature Initiative, IUCN |

# 1. INTRODUCTION

## 1.1 Small Tanks in Sri Lanka

The ancient tank system, built by the kings of yore, no doubt brought prosperity to the country and supported people's livelihoods in the eras of foreign invasions. These livelihoods were environment friendly, and had the capacity to feed many a generation who constructed more and more tanks and huge dagabas or temples. Even today, perhaps a thousand years later, most of our rural people use these tanks for irrigation and other purposes. Due to the multiplicity of uses it is very difficult to estimate the number of people who really depend on the tank system. There are thousands of tanks in the dry and intermediate zones of Sri Lanka. Of the different types of direct and indirect benefits these tanks provide, paddy cultivation is considered the key activity generating the main economic return.

There were different types of features such as Kulu-wewa, Perahana, Gas-gommana, Kattkaduwa etc. in the tanks of the old cascade systems serving in different ways towards the sustainability of the system. The tanks at the higher elevations and in the forest, called Kulu Wewa trapped silt and debris, and this prevented or retarded the silting up of the larger reservoirs, for centuries. The kuluwewas also controlled soil erosion by reducing the speed of run-off water, and served the animals in the forest which made it unnecessary for them to come out of the forest for water. This reduced human-animal conflicts.

The tanks are the life time friends of the community. The communities living around the tanks derive many benefits. Even today there are many cultural events which take place annually around the tank, mainly as a show of gratitude. Since the dry zone gets rainfall only between October and January, the settlers are totally dependent on the water stored in these tanks for the rest of the year. The homestead wells are also fed by seepage from the tanks.

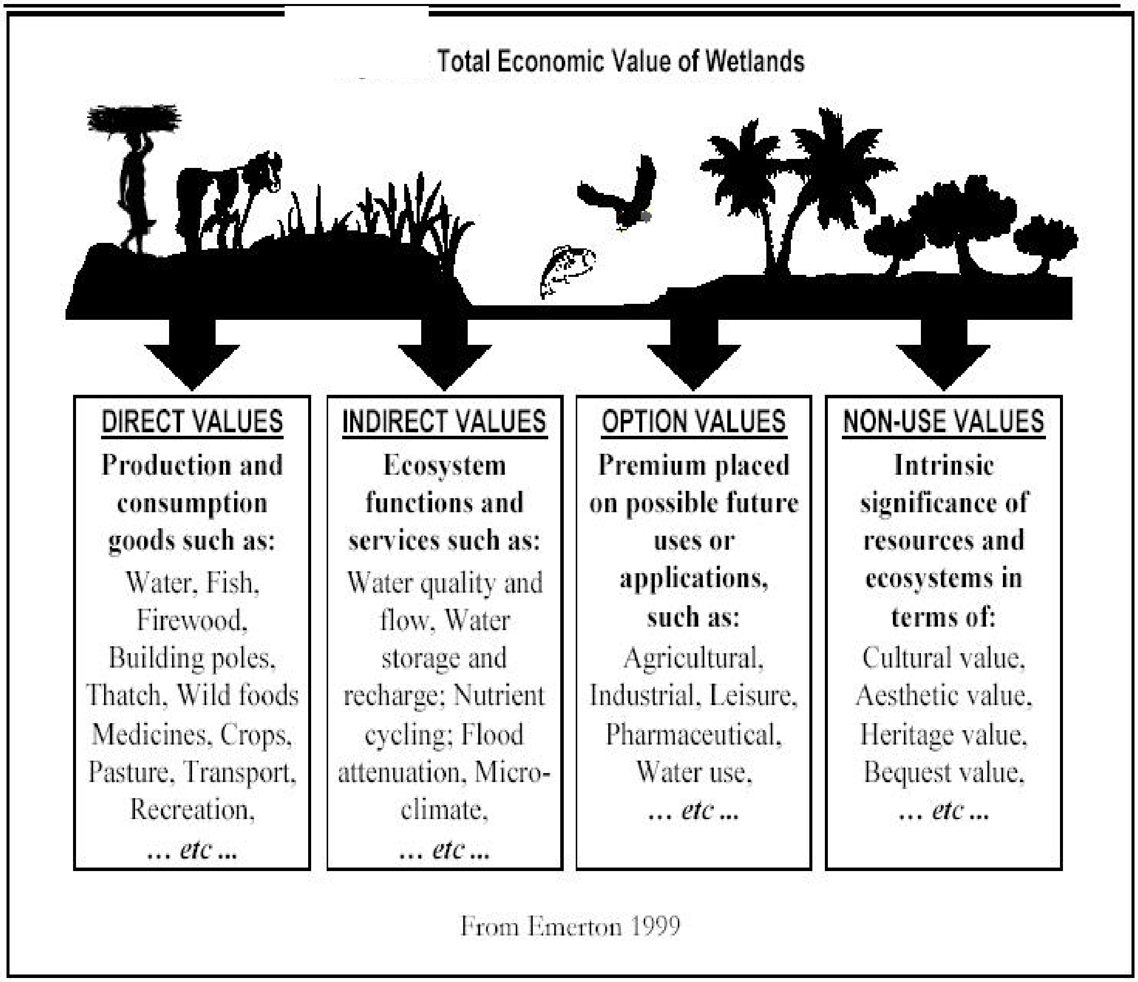
There are special features of the tank such as "Gas Gommana" – a small forest patch, "Perahana" – a filter for silts, 'Kattakaduwa" etc, which have helped the community and nature in the sustainable use of the tanks for centuries. According to the Villagers, up to 2 to 3 decades ago almost all the ancient tanks had these features and as a result these tanks functioned efficiently and effectively. The Gas Gommana which is a strip of large trees located in the catchment, just above the water level of the tank, serves as a wind break thus reducing evaporation losses. This is very important in the dry zone as evaporation is high during the 6 to 7 months dry period. To have an adequate supply of water, at least up to the next rainy season, evaporation should be minimized.

The Perahana acts as a filter and prevents eroded soil, from agricultural lands in the catchment, reaching the tanks. These silt traps is the secret behind the long period of sustainability of tanks. As a result, these tanks have escaped siltation for centuries and have continuously served the people and nature. Unlike other features the Kattakaduwa is located beside the tank bund in the command area, and it consists of a marshy land with small wetlands beside it. Biodiversity is very high in this small plot of land, and it is a common land where villages obtain medicinal plants, firewood, poles for their agricultural equipment, poles for fences etc. This plot of land helps to prevent water with salts seeping into the paddy fields, and minimises water seepage through the bund. [t1]

The tank itself is an ecosystem which is rich in biodiversity and provides numerous environmental benefits. The villagers around the tank used to manage their resources under a "Welvidane" or village leader, who was generally a respected senior farmer. They observed an agreed set of meaningful norms for sustainable use and in this way shared resources without conflict. This tradition, called "Bethma", was a good example of sharing the limited water supply in the dry zone with equity. Under this system, farmers collectively decided the total extent to be cultivated during the season according to the availability of water. Thereafter each farmer was allocated a plot for cultivation. In addition, there were sustainable methods of maintaining the tank. Every season all the farmers collectively repaired the tank bund and removed silt from the tank bed. This practice removed some of the silt which had collected in the tank during the previous season. The Welvidane, supervised the whole process and ensured that all the farmers were engaged in the assigned tasks, including the maintenance of the tank reservation. In turn he was given an agreed quantity of paddy from each and every farmer's harvest.

### 1.2 Services Provided by Small Tanks

Agriculture is the main source of employment of rural populations. They cultivate under major and minor irrigation schemes, as well as under rain-fed conditions. Padaviya, Gal Oya, Uda Walawe, Rajangana, Kantale and Mahaweli are some of the major irrigation schemes served by large reservoirs which were developed in the last century. The Mahaweli programme provides water for many purposes including electricity generation, paddy and other field crops cultivation, and around 131,630 families are engaged in cultivation under the Mahaweli scheme in different districts of the country (MASL,2002). In addition to these large irrigation systems there are thousands of small tanks which provide water for cultivation in the dry and intermediate zones. These tanks are rich in a number of other resources such as fish, sedges, edible plants and flowers etc, and help communities, who live in the vicinity, in maintaining their livelihoods. The main users of these tanks are paddy cultivators who, a few decades ago, were expected to participate in managing and maintaining these tanks. However, there are other direct beneficiaries like fishermen, domestic water users, industrialists, extractors of flowers and edible plants. The indirect ecosystem functions of wetlands are water recharge, flood control, nutrient retention, microclimate stabilization, water storage, maintaining water flow and purification of water. Tanks purify water received from the fields above and provide water to the wells, and the nearby cultivated lands in addition to the lands in its command area, through seepage. In addition, the conservation of biodiversity in the ecosystem and carbon sequestration in the forests in its immediate catchments benefit not only the people here but people the world over.




Source: Emerton, L 2003

The IUCN Sri Lanka Country Office implemented a project on integrating wetland ecosystem values into river basin management in collaboration with the Mahaweli Authority of Sri Lanka. The project aimed to demonstrate integration of wetland economic values into river basin management at the Kala Oya basin, as a pilot demonstration site. The study also set out to demonstrate the feasibility of managing small irrigation tank systems for biodiversity and ecosystem conservation, and achieving livelihood and poverty alleviation goals. Key activities of the project are:

- 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.

Further, this project focused on the application of economic tools, for developing basin-wide approaches to ecosystem management. There was a particular focus on integrating downstream wetland values, into upstream land use and water allocation decisions. The economic assessment has focused 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, the valuation study mainly concentrated on assessing the local level use of wetland goods and services.

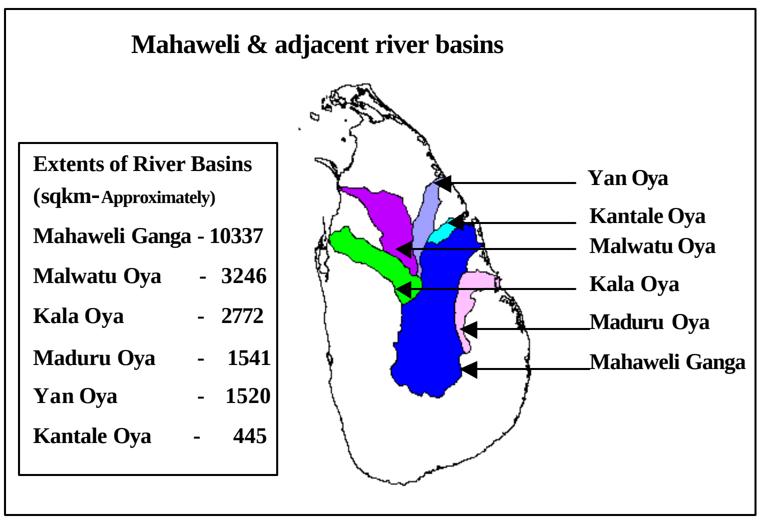
This paper focuses mainly on the direct and indirect services provided by the small tank ecosystems and possible techniques for valuing those which can be utilised in decision making regarding water and resource allocation.

# 2. KALA OYA RIVER BASIN – THE PROJECT SITE

## 2.1 Background of the Study Area

The Kala Oya basin is one of 103 river basins in Sri Lanka. It is around 2,870 sq km in area and 76% of the basin is situated in the northwestern dry zone of Sri Lanka. Its elevation varies from sea level to 600 m above mean sea level (MSL) at its headwaters. The Kala Oya basin is long and narrow - 150 km long and about 25 km wide on average. 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 cuts across North Central, Central and North Western Provinces of the country.

Kala Oya basin receives water from the Mahaweli[1] River, via the Bowatenna diversion, to meet approximately 75% of its annual demand. Bowatenna reservoir has two tunnels: a four mile long, 18 ft diameter tunnel to divert water for irrigation in the Kala Oya, Malwathu Oya and Yan Oya basins, and another to take spent water from the Bowatenna power house to downstream irrigation systems.




Source: Kala Oya River Basin Secretariat

The Rajangana- Angamuwa sub-catchment of the Kala Oya was selected for the study. The sub basin consists of irrigation systems and tanks which are managed by the Mahaweli Authority of Sri Lanka (MASL), the Department of Irrigation (ID) and the Department of Agrarian Development (DAD). DAD manages all the minor tanks outside the Mahaweli development area. The Mahaweli development area (Rajangana and

[1] The longest river of the country

Angamuwa (RA) sub catchments) and the non-Mahaweli development areas (Giribawa, Mahagalkadwala, Mahaliyanagama and Pulanchiya cascades –GMMP cascades) were selected for detailed economic assessments after field observations and consultations with MASL, ID and the stakeholders.

The MASL and the ID managed larger scale irrigation systems such as Rajangana and Mahaweli System H contribute to the hydrology of the traditional tanks. While some of the traditional tanks are directly connected to irrigation systems, others are indirectly connected and get only drainage water from the major irrigation systems. All these tanks contribute to the local economy directly through irrigation and indirectly through a number of other functions and services. Most of the tanks have very little water during Yala (lean season) and this is hardly sufficient to provide even seepage to the adjacent paddy fields. Hence, there is a reduction in most of the services provided by the tanks until water is received in the next rainy season.

Rajangana and Angamuwa catchments receive water from the Kala Oya reservoir, which receives water diverted from the Mahaweli river, in addition to rain water from its large catchments. The DAD-managed catchment area is a cascade of old tanks which receives water from rainfall and the spill water of the upstream tanks.

Since the wetlands in the RA catchments 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 tanks are utilized by the Mahaweli irrigation system as storage tanks and they get water directly from the channels while other tanks receive water from seepage and drainage. When water from storage tanks are distributed to the paddy fields, the excess flows to a tank nearby. These tanks which do not receive water directly from irrigation channels, are called isolated tanks (isolated from the main irrigation system).

These isolated tanks are given a major emphasis in this study as their management is neglected in the belief that they do not play an important role from an irrigation perspective. The tanks directly connected to the main irrigation channels are well managed by the Mahaweli Authority or the relevant agency.

**Table 2.1 Number of tanks in the study area**

| Area | No. of Tanks | Managed by |
|---|---|---|
| Mahaweli Area<br>Rajanagana/Angamuwa sub catchment | In use - 332<br>Abandoned - 11 | MASL - 93<br>ASD - 223<br>ID & Other - 16 |
| Non-Mahaweli Area<br>Giribawa, Mahagalkadawala, Mahaliyanagama, Pulanchiya Cascades | In use - 86 | ASD - 86 |

Source: Kala Oya River Basin Management Secretariat

Rural livelihoods are closely associated with the tank as it is the main supplier of resources to the people in the village. The tank provides water for their main income generating activity which is the cultivation of paddy and other field crops. It also provides water through seepage for their home gardens and maintains the water levels of the wells in their home gardens. The seepage water in fact improves the quality of the well water and renders it potable. Dissanayake and Weerasooriya (1985) reported that the ground water in some areas of North Central Province (major part of the Kala Oya basin is within this province) contains excessive amounts of fluoride. However, a recent study found that the wells located near the tanks hold quality water since seepage water from the tank dilutes the hardness and fluoride content (MASL, UOC, 2003).

All the homesteads do not have wells. Others resort to the tank for bathing and washing clothes. Some who own wells also use the tank due to the poor quality of their well water. Soap does not lather in well water due to its hardness and white clothes such as school uniforms turn off white in some areas.

Cattle and other animals also depend on the tank for drinking water and fodder Tanks are also a source of marketable items like fish, lotus flowers, lotus roots and sedges in addition to having many indirect uses.

People living around the tank form farmer organizations and appoint a person called "Jala Palaka" which, means water controller. He ensures an equitable distribution between farmers and the domestic users in consultation with the users. The normal practice is to retain some water in the tank to meet domestic requirements in the dry period.

The water holding capacity of the tanks have been drastically reduced through siltation and by lowering of the spill level. The spill level was lowered to integrate these tanks in to the irrigation system developed under the Mahaweli Development Project in early Eighties. Raising the spill level and de-silting the tanks are the two options readily available to increase their capacity. Together with this it is necessary to encourage better cultivation practices to reduce soil erosion, maintain reservations and frequently clear the aquatic weeds.

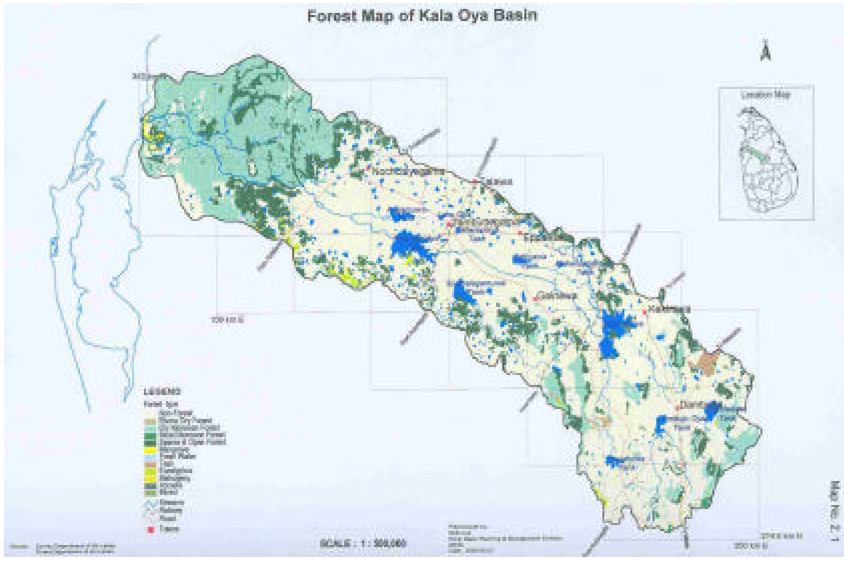
Sri Lanka has two major climatic zones called wet and dry. The wet zone covers about a quarter of the country and receives an annual rainfall of around 2,400 mm from both monsoons - South-West monsoon from April to September and the North-East monsoon from October to March. Nearly the entirety of the remaining area is in the dry zone receiving around 1,450 mm annually, leaving a narrow intermediate zone as a strip between the two main zones. Around 75% of the Kala Oya Basin is in the dry zone and receives only the North-East monsoon rains

## 2.2 Kala Oya Estuary

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

Coastal resources of the Kala Oya basin include varied biotopes such as mangroves, sea grass beds, sand dunes, the lagoon system, Bar Reef Marine Sanctuary, etc. The Bar Reef marine sanctuary (306 $km^2$) with very high biodiversity significance is situated at the sea mouth of the Kala Oya basin. It is of vast ecological and economic importance as the reefs within the sanctuary function as an integral part of the larger economic system adjacent to coastal waters.

Tanks in the basin play a major role in supplying water for the estuary to maintain its fresh water balance and to conserve biodiversity. The tanks prevent large quantities of fresh water rushing in to inundate the estuary during the rainy season. In the dry season, the controlled release of tank water for cultivation purposes is perhaps adequate to meet the fresh water requirements of the estuary.




Source: River Basin Planning and Management Unit, MASL

## 2.3 Wetland Resources and Livelihoods in the Basin

Large number of important wetlands including man-made and natural wetlands is situated in the Kala Oya basin. These wetlands are very important for sustaining the livelihoods of the basin community as they have a role in maintaining water quality, bio-diversity, water quantity regulation, fishery, recreation, tourism, etc., depending on their strategic location in the basin.

As livelihoods in the basin area depends largely on agriculture and its related activities, the demand for irrigation water is very high. A large proportion of regulated water in the lower valley of the basin is used in the irrigation sector. Domestic and Industrial uses are comparatively low quantity-wise as most of the domestic uses are non-consumptive and the industrial demand is negligible. The average annual releases for Kala Oya Basin amount to 1,150 MCM. This figure includes return flows from upper irrigation areas and excludes releases from approximately 600 minor tanks spread over the basin. The tanks which have less than 80 ha of command area outside System H are managed by the Agrarian Services Department (ASD) in association with the relevant farmer organizations. Both MASL and ASD conduct meetings ("Kanna Resweem") prior to each season to inform farmers regarding water availability, expected rainfall, suitable crops for the season and the proper management of water and the irrigation systems.

Around 40 percent of the households living around the tank receive a Samurdhi allowance (government welfare programme for low income groups), and around 18% of households have at least one family-member employed either in a government or a private institution. About 72% of the families are fully engaged in agriculture Only around 7 percent of households are considered as being rich and they possess tractors for agriculture and other vehicles like vans and lorries in addition to agricultural land. Most of these rich households have their own wells and overhead tanks for water storage. If the well water is not hard, these people rarely use the tank for bathing.

Poor people who do not own lands, cultivate on the "*Anda*" system. This is a land tenure mechanism where poor people cultivate paddy lands with assistance from the landlord. The landlord provides fertilizers and agrochemicals, and receives from the tenant an agreed portion of the harvest. All the paddy fields and lands of other field crops are located in such a manner that they all can get water from the canals coming from the tank and thus depend solely on the water of the tank. Though they start cultivation with the rain, the rain water alone is not enough for the entire period of cultivation.

In 1983, new settlements were established and each family received two and half acres of paddy land and half an acre of upland for housing and a home garden. Since all the land in the area, other than reservations, were distributed among the farmers, there was no land available for succeeding generations. Consequently some youth migrated to cities to work in factories or joined the armed forces whose demand for young men and women is high due to the conflict situation prevailing in the 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. When the family is large the 2 ½ acre allotment is inadequate. Hence, some settled illegally in the reservations after they married or stayed with their parents and worked as daily paid labourers in other lands. Since the demand for labour for agriculture is very low and highly seasonal, these families face enormous economic problems. Generally, in these villages, it is the families who do not own cultivable land that are considered poor. It is mostly these people who use the resources of the tank for their living. They engage mainly in fishing full time or collecting lotus flowers and roots.

Very few families (only a family or two in each village) lease out their lands to other villagers (though it is illegal) and work as labourers. According to the categorisation of villagers only these people are considered to be very poor. All the others are not regarded as being poor although they experience difficulties in cultivation due to high prices of fertilizer and chemicals, while the price paid for paddy remains low.

### 2.4 Employment in Major Industries

A major part of the Kala Oya basin is in the Anuradhapura District. More than half the labour force in this district is engaged in Agriculture as a principal occupation while the manufacturing sector only accounts for 6.4%. Although employment in the fishing sector is relatively low (0.7%), it is a significant amount for a land-locked district, and reflects the economic contribution of the tanks (both small & large) in the district. Fresh water fishing also provides nutrition to children and the community in this economically disadvantaged district. The field studies clearly showed that though there are few full time fishermen there are many part timers who fish mainly for their consumption. In addition to the free education and health services in the country, these freely available resources in close proximity contribute to uplift the level of health of the poor.

**Table 2.2 Percentage of employed people by major industry**

| Major Sector | Anuradhapura District |
|---|---|
| Agriculture & Forestry | 54.9 |
| Fishing | 0.7 |
| Manufacturing | 6.4 |
| Other | 38.0 |

Source: Census 2001, Department of Census & Statistics

## 2.5 Major Resources and Services Provided by the Tanks in the Kala Oya Basin

### 2.5.1 Agriculture

Labour constitutes the largest single input accounting for over 50% of the total cost of paddy production (CBSL, 2003). Farmers always resort to family labour for cultivation, and use a minimum of hired labour to reduce expenditure. Paddy cultivation provides a good opportunity for the unemployed family members to earn some money until they gain employment in the industrial or service sectors. Agriculture is not only the main user of the tanks it is also the largest source of employment in the basin. A large number of crops can be cultivated particularly in lands where both irrigated water and subsurface water is available. However, paddy is the major crop under the tank. Other crops such as chilies, onion, bitter gourd etc are also grown in the tank serving area, especially when there is not enough water for paddy cultivation, in the Yala season. Further, homesteads near the tank, with sub surface water and a healthy micro climate, have a rich mixture of perennial and other crops.

### 2.5.2 Lotus Flowers

The lotus flower is accorded a very high position in the writings on Buddhism and it is greatly esteemed by Buddhists. Hence, although lotus flowers are relatively expensive, Buddhists (69% of the population in 1981) prefer to offer lotus flowers at their temples. This is particularly so when worshiping at ancient sacred temples such as the Dalada Maligawa in Kandy, which holds the sacred tooth relic of Lord Buddha, the Kelaniya temple, believed to have been visited by Lord Buddha, and the “Sri Maha Bodhiya” in Anuradhapura, raised from a sapling of the Bo tree under which Lord Buddha attained enlightenment some 2500 years ago in India.. This sacred Bo tree is regarded as the oldest living historic tree on earth. Thousands of people visit these places each year, and customarily offer lotus flowers in worship. Hence, lotus flowers fetch a good price - a “Mal Wattiya”, (a tray of three flowers) sells for as much as Rs. 10. Some flowers sold at Anuradhapura and Kelaniya are known to originate from tanks in the Kala Oya Basin. The preference for lotus flowers is seen at even the village temples and village boys pick and sell these flowers on Full Moon Poya days when many Buddhists visit temples.

Generally, the villagers harvest the flowers and sell their pick to middlemen who come from outside. Sometimes outsiders harvest the flowers themselves. In these instances the villagers in the tank vicinity do not benefit, but all the same there are many who earn a living from lotus flowers.

### 2.5.3 Lotus Roots

Extracting lotus roots and supplying them to the market is a good business in these villages and a great employment opportunity for villagers. Both the wholesale buyers and the extractors are from the village and this resource is able to provide a good income to the surrounding households while providing fibre rich food for the villagers and people elsewhere. An important feature of this resource is that it is available throughout the year. It is of course easier to extract during the dry period when options for income generation are also limited. Extraction calls for certain skills and the extractor has to stay in the mud for a long time to remove a reasonable quantity of roots. In the same operation lotus seeds are also extracted and consumed in the villages.

A silted tank covered with lotus

### 2.5.4 Fishery

Fishing in the tanks is carried out on a small scale for both home consumption and commercial purposes. Fish is an important protein supplement in the local diet. Hence, fishing is an important supplementary source of income and good nutrition for the village families. Apart from the relatively well established farmer organizations for water management there are village organizations for livestock and fisheries development. Fisheries organizations work closely with the Fisheries Officers to develop the fishery resources and activities and promote sustainable practices for their management. Many villagers are engaged in fishing for commercial purposes, on a full time or part time basis, as well as for their own consumption. Though the fisheries organizations are not functioning properly in the study area, for many reasons, government is attempting to develop the sector by assigning a Fisheries Inspector to assist them and by providing fingerlings to enrich the tanks.

### 2.5.5 Livestock

Farmers are not able to sustain their families on cultivation alone, as the extent of land is limited. Therefore many of them engage in several other income generating activities. One of the more important activities is livestock farming. As the land they own is inadequate to rear cattle all livestock farmers resort to using the tank and the reservation area to keep their cattle. The tank and its surroundings provide both water and fodder for the cattle throughout the year.

### 2.5.6 Bathing and Recreation

Since there is rain only for just four months, from October to January, the water level in wells goes down substantially during the dry period. It is the tanks that provide water for bathing and washing clothes. Tank density in North Western Province and North Central Province is one per 1.2 and 2.6 sq km, respectively. Hence, villagers can walk to the nearest tank within 15 to 30 minutes. Most residents prefer to bathe and wash clothes in the tank. They enjoy swimming in the clean water while bathing, and it is common to see the children, mainly boys, playing together in the shallow water while their parents wash clothes and bathe. Even households with wells in their garden prefer to use the tank in the dry season as the water level in the well goes deep down during this period. The villagers regard the tank as a treasure. They do not fail to take their visitors from outside the province, for a tank bath. Of course, they ensure that the visitors are taken to a tank with good quality water.

### 2.5.7 Carbon Sequestration

The Kyoto Protocol opened up a new vista for environmental conservation by encouraging the expansion of forest cover through payments for carbon sinks. The protocol clearly identified the importance of carbon sequestration in arresting the atmospheric build-up of carbon resulting from industries, thermal power generation, transportation etc. In the context of climate change it emphasized the importance of protection and enhancement of sinks and reservoirs for gases, promotion of sustainable forest management practices, afforestation and reforestation, and promotion of sustainable forms of agriculture.

A tank in the Kala Oya basin with a forest cover

As mentioned in the previous chapter a well maintained tank has a dense forest cover in its immediate catchments which provides firewood, medicinal plants, fruits etc for the nearby households. These patches of forest contribute to the carbon sequestration process in the dry zone. The conservation of these forests should be regarded as part and parcel of good tank management. Then, proper management of the tank, motivated on account of its numerous tangible direct services, will automatically conserve the forest cover.

Properly maintained tanks will provide water for cultivation in both seasons. When there is adequate water for both seasons, the cultivations will contribute an additional green cover of up to 80 ha per tank. Moreover, beside a tank, there are a number of homesteads which are rich with perennial crops like coconut, mango, jak and arecanut watered by subsurface seepage from the tank.

The benefits accruing from the forests in the tank catchments and reservations have been undervalued in relation to the issue of landlessness among the poor. Hence, these forest reservations are severely threatened by encroachment.

### 2.5.8 Flood Attenuation

Another major service provided by the tank is flood attenuation. Tanks protect villagers from floods which damage and destroy houses, household equipment, infrastructure, crops, livestock and human lives. Since villagers around these tanks have not experienced flood damage for decades due to the storage capacity of these tanks, they cannot easily comprehend the gravity of floods. The thousands of tanks in the dry zone are able to hold up the rainwater and release it slowly to the next tank in the cascade. This prevents much damage from the heavy rains experienced during the four–month rainy season. In addition, it saves government resources which would otherwise have been required to rehabilitate roads, bridges and public infrastructure damaged by floods.

Mr. S. Arumugam[2] has stated in his article on "The floods of December 1957 and their impact on water conservation works" that "it is well known that the maintenance of these small tanks, which is a responsibility of the cultivator, is conspicuously poor. As such it is no surprise to find the top levels of bunds below designed level and spill tail channels choked with jungle growth" (Ministry of Irrigation and Water Management, 2003). He stressed that due to the lack of proper maintenance these tanks cannot withstand a very high flood and were indeed damaged in the 1957 floods which, was one of unprecedented magnitude.

The economic valuation conducted in Muturajawela Wetland by Emerton in 2003 found that flood attenuation is the largest service (66% of the total value) provided by the wetland among other direct and indirect services such as industrial waste water treatment, agricultural production, support to down stream fisheries, firewood, fishing etc.

### 2.5.9 Other Indirect Services

Evapo-transpiration from the tank helps to maintain local humidity, microclimate and rainfall levels. The cool breeze coming across the water filled tank renders the surrounding area more comfortable. As explained above, during times of heavy rainfall, tanks mitigate the impacts of floods by slowly releasing the water into the system. In these high flow situations tanks help to reduce the erosion of river banks and cultivated lands. The plants in the tank facilitate the deposition of sediments in the water. This deposition helps to remove the toxic substances and nutrients which are held on particles of sediment.

The valuation of the above noted resources and services, may be carried out in three stages i.e. estimation of direct use values, indirect use values and non-use values. Twenty three tanks of the Mahaweli area and non-Mahaweli areas were studied. Their direct use values were estimated, and their indirect uses were identified and assessed qualitatively.

[2] Deputy Director of Irrigation, Presidential Address, Section C, Engineering, Architecture and Surveying, Ceylon Association for the Advancement of Science, 1960

# 3. ECONOMIC VALUATION OF DIRECT USES

In the selected sample in Rajangana - Angamauwa sub catchment, there are around 150 families living in the vicinity of a village tank and they engage in many income generating activities like crop farming, fishing, keeping livestock and extracting lotus flowers and roots etc. from the wetland. Around 10 to 15 percent of the families have two and half acres of paddy fields which, are directly fed from the tank, and the other families have agricultural lands fed from Mahaweli irrigation water. Direct use values of agriculture, livestock, industry, fishery, water plants, sedge and all the domestic uses are estimated in these two sub catchments. Only the services provided by the tank were valued. Paddy cultivation and the other field crops fed directly from the tank were considered. Productivity changes of banana and coconut trees in the home gardens, which are in the tank command area were also estimated. Since data was not available about the depths of water in these tanks, all the estimations were carried out for the services provided per hectare of the water spread of a tank.

## 3.1 Agriculture

Paddy is the main crop cultivated in both the Maha and Yala seasons if tank water is available. Other crops cultivated in the tank command area, including home gardens, with tank water to supplement rains are red onion, chilies, banana, coconut, papaw and vegetables. The quantity of tank water consumed by these crops depends on the season, as they are usually planted in the rainy season. Farmers say that coconut on the tank periphery give higher yields due to the high sub surface water level around the tank.

**Table 3.1 Cultivable area and number of farmers of wetlands in the Kala Oya Basin**

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

Source: Kala Oya River Basin Management Secretariat

### 3.1.1 Paddy

In accordance with government policy to pay a remunerative price for paddy, government organizations purchased paddy at Rs 13.50 per kg. Seasonal differences in rainfall and water availability are reflected in the paddy yields and are 197.6 and 215 bushels/hectare in Yala and Maha, respectively. According to the estimates of the farmers, the Department of Agriculture and the North Western Provincial Council the cost of production of paddy per ha in this region, including imputed labour costs, management costs and land rent, is Rs. 57,866 and Rs. 55,965 in Maha and Yala, respectively. Land value per year was estimated on the basis of the rent paid by the tenants. Usually, tenants pay land rent in kind after harvesting the paddy, and it is around 50 bushels per hectare. Most of the agricultural lands here are still owned by the original recipients under the Mahaweli irrigation project.

**Table 3.2 Economic return in Rs per Hectare of water spread (HWS) for irrigated paddy production**

| Season | Extent cultivated per HWS (ha) | Yield Bushel/ ha | Price (Rs/ kg) | Cost (Rs/ ha) | Economic return per HWS (Rs) |
|---|---|---|---|---|---|
| Maha | 1.98 | 215 | 13.50 | 57,866.00 | 11,875 |
| Yala | 1.49 | 197.6 | 13.50 | 55,965.00 | 4,052 |

Source: Primary survey data collected at Kala Oya Basin 2003

Annual Economic return per Hectare of water spread of the tank for irrigated paddy production was Rs 15,928.

### 3.1.2 Banana

There are small scale banana plantations (less than 0.4 Ha per plot) in the command area and every home garden has around 10 -15 clumps. There are 1000 clumps per hectare and the harvest is around 3000 bunches per hectare per year. The average weight of a bunch is 9 kg and sells at around Rs. 12.00 per kg. Cost of production per hectare including land rent and labour was estimated at Rs. 133,375.00 per year. Costs of individual items (including labour) were estimated using data from the North Central Province Secretariat. Land rent was assumed to be same as for paddy. Annual Economic return per Hectare of water spread of the tank for banana cultivation was Rs. 20717.12 per year.

### 3.1.3 Coconut

Coconut is a valued palm in the villages as its products have many uses. Sri Lankans use coconut milk (a water extract of the kernel) as a medium for cooking most of their curries. “Pol Sambol” is a very popular salad prepared from grated coconut kernel spiced with chilies and salt. Young coconut is used as a sweet beverage. Coconut timber has a good demand in the construction industry while coconut fronds are a cheap thatch for houses, huts, cattle sheds etc. It is therefore not difficult to understand why nearly all home gardens in this region have 5 – 6 coconut trees. The trees growing in the command area of the tank out yield others by around 10 nuts per round. Cost of production does not include here as only the increased income is estimated.

**Table 3.3 Economic return per Hectare of water spread (HWS) for coconut cultivation**

| Area cultivated per HWS (Ha) | Yield per Ha per year (nuts) | Price (Rs/ Nut) | Economic return per HWS (Rs) |
|---|---|---|---|
| 0.26 | 12,000 | 7.00 | 21,433.00 |

Source: Primary survey data collected at Kala Oya Basin 2003

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

### 3.1.4 Other Field Crops

Farmers in the Mahaweli area are often encouraged by the irrigation authorities to cultivate other field crops (OFCs) which give higher incomes and require less water. But farmers prefer paddy, mainly because of their experience in its cultivation and see no reason to experiment especially when tank water is available. Water Officers believe that farmers can be motivated to cultivate OFCs only when there is not enough water for paddy. Otherwise they do not wish to take the risk of cultivating new crops. Hence, land area used for OFCs like chilies, B'oinion, Cucumber and "Kohila" (*Lassia spinosa*), and the number of farmers engaged in their cultivation is small. As the sample available for OFC-related data collection is small, production data was adjusted using data available at the Department of Agriculture. Moreover, only B'onion and Chilies were considered for the valuation as the extent of other crops such as bitter gourd, cucumber and Kohila was not significant.

**Table 3.4 Economic return per Hectare of water spread (HWS) for OFC cultivation**

| Crop | Area cultivated per HWS (ha) | Yield per ha (Kg) | Price (Rs/ Kg) | Cost of production (Rs/ ha) | Economic return per HWS (Rs) |
|---|---|---|---|---|---|
| B'Onion | 0.01673 | 10690 | 20.00 | 76,422 | 2,298 |
| Chillies | 0.01455 | 1482 | 117.50 | 69,012 | 1,529 |

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

Economic return for cultivation of other field crops is Rs. 3,828.00 per hectare of water spread.

### 3.2 Domestic 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 clothes even though they have wells in their gardens. Mahaweli water is released from April 20 to July 15 and November 1 to January 20. The villagers have an opportunity to use this water for at least 80 days, within these two periods, though the release is not continuous. Washing clothes, bathing the children and themselves is a part of women's daily routine in this area. Hundreds of people using the tank is a common sight. Women and children are seen mostly in the afternoon, while men come in the evening on returning from work. Some use their bicycles, motor bicycles or tractors to travel to the tank. The tank provides a venue for recreation and to socialize with friends and neighbours after the day's work. People enjoy bathing at the tank rather than at their own wells if the quality of the water is better. Even the rich (only around 7 percent) who usually bathe at their wells come to the tank when they have visitors, if the water is clean.

Taking all this in to account, an average villager normally uses the tank around 228 days per year for bathing and washing clothes. August to October is very dry in this area and there is hardly any water in the wells and in Mahaweli irrigation channels. Therefore people from nearby villages also use the tank during this period. According to observations made and villagers' estimations, around 600 persons, including the outsiders, use the tank in the dry season and around 350 persons at other times. If the tank was not available, all these people would have to go to another tank, situated approximately 30 minutes walking distance away.

**Table 3.5 Economic return per Hectare of water spread for bathing & washing clothes**

| Period | No. of days | Average No. of people per HWS | Average travel time to the next tank | Value of a labour hour(Rs) | Economic return per HWS (Rs) |
|---|---|---|---|---|---|
| Dry period | 90 | 27.27 | 30 minutes | 31.25 | 76,818 |
| Other period | 138 | 15.9 | 30 minutes | 31.25 | 68,636 |
| Total | | | | | 145,454 |

Source: Primary survey data collected at Kala Oya Basin 2003

### 3.3 Drinking Water

Drinking water is a major issue faced by the people in the basin. Generally, tank water is of poor quality and the wells have hard water 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. Elsewhere, the water in the wells is hard. But there are a few wells, here and there, with fresh water, the reasons for which are not known.

Generally, the 'dead storage' below the sluice gate helps to maintain the water level of the nearby wells. In addition, water controllers always retain a little water in the tank for domestic use and for serving the nearby wells without releasing it for agricultural purposes in the dry season. However, in case their well in the command area of the tank gets dried up, the survey conducted in the area showed that a family can reach a fresh water well within 15 to 25 minutes,

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 have to walk up to half a mile to obtain drinking water, which involves a considerable investment of time and energy for farm women. (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. Men and grown up boys mostly engage in agricultural work or other business work.
Some families boil the water to remove its hardness and make it fit for drinking. But the common practice is when a drinking water well dries up they seek another well with water fit for drinking. However, the opportunity cost of labour for collecting drinking water was not estimated for the study.

## 3.4 Livestock

Most of the villagers keep cattle and goats as an additional income generating activity. Around 258 animals from the village and another 100 from other villages come to the tank to drink water. 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. Mahaweli water is available for the animals for the rest of the year.

Some special breeds of milking cows in the area are not taken out to graze. They are kept in sheds and provided with water and fodder. The labour requirement for feeding these special breeds was estimated on the basis of information collected from the owners.

**Table 3.6 Economic return per Hectare of water spread (HWS) for watering the cattle**

| No of Animals per HWS | 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 saved per Hectare of water spread since the tank provides drinking water to the cattle is Rs. 9,661.95.

Around 86 animals graze in the tank reservation, for 7 to 8 hours per day from July to October, consuming around 9 kg per day. They also graze in the reservation for about 120 days of the Yala season, but consuming only about 2.25 kg per day. In the Maha and part of the Yala they graze on the banks of the channels. A villager has to spend around one hour to collect and carry 7 to 8 kg of grass.

**Table 3.7 Economic return per Hectare of water spread (HWS) for grazing cattle**

| Period | No. of days | Average No. of animals per HWS | 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 HWS (Rs) |
|---|---|---|---|---|---|---|
| Dry period | 116 | 4 | 9 | 7.0 | 31.25 | 18,642.80 |
| Other period | 120 | 4 | 2.25 | 7.0 | 31.25 | 4,821.40 |
| Total | | | | | | 23,464.20 |

Source: Primary survey data collected at Kala Oya Basin 2003

The value of the time saved per Hectare of water spread since the tank provides fodder to the cattle and goats is Rs 23,464.20.

## 3.5 Industrial Use

As nearly all the inhabitants in this rural area are engaged in agriculture or fishing, there is hardly any industry except small scale brick producing centers. Brick production is confined to just three months in the year, in the dry season from July to September. About 5 families are engaged in the industry and they require around 400 litres of water per day for three months.

If water is not available in the village tank, it would have to be transported from another tank situated around two kilometers away. The cost of transport for two barrels of water (400 litres) by a two-wheel tractor is Rs 60.

**Table 3.8 Economic return per Hectare of water spread (HWS) for brick manufacturing**

| No. of litres per day/per ha | No. of days | Cost of transportation per litre (Rs) | Economic return per HWS (Rs) |
|---|---|---|---|
| 90.90 | 90 | 0.15 | 1,227.72 |

Source: Primary survey data collected at Kala Oya Basin 2003

If this tank is not available, industrialists have to spend Rs 1,227.72 per year per ha of water spread to bring water from another tank.

### 3.6 Fishery

Fishing is the main income generating activity supported by the tank. About 25 persons are engaged in fishing in the tank, of which only 10 are full time. The others do part time fishing mainly for their consumption. As the tank is small mechanized boats are not used and only 3 to 3.5 inch nylon fishing nets are used.

**Table 3.9 Economic return per Hectare of water spread for fishing**

| Type and No. of Fishermen per HWS | Catch per person in dry season (Kg) | | No. of days per fishing season | | Price (Rs) | | Income per HWS (Rs) |
|---|---|---|---|---|---|---|---|
| | 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 Kala Oya Basin 2003

Cost of the fishing operations (including labour) is Rs 44,355.00 per hectare of water spread.

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

### 3.7 Lotus Flowers and Roots

Almost all tanks in the Rajangana – Angamuwa sub catchments have lotus and sedges. The density of lotus increases as the depth of the tank decreases due to siltation. The tanks in the Mahaweli area do not dry out completely but the depth decreases dramatically in the dry season which is favourable for the growth of lotus. There is a great demand for lotus flowers among Buddhists for their religious observances. Flowers collected from these tanks are sold in far away places like Kelaniya, near Colombo (see section 2.8.2), and transport costs are a substantial proportion of the selling price. However, the benefits derived from the flowers are not fully reaped by the villagers as, at most times, the vendors who come from outside harvest the flowers themselves.

As for the villagers, they derive a great deal of emotional satisfaction and fulfillment in offering lotus flowers to Lord Buddha at their temples and consider it a blessing to have a ready source of flowers from the tank.

**Table 3.10 Economic return per Hectare of water spread (HWS) for extracting lotus**

| Type | No./ kg per ha per year | Price (Rs) | Cost of collection incl labour/HWS | Value (Rs) |
|---|---|---|---|---|
| Lotus Flowers | 3,849 flowers | 2.50 per flower * | 2,485.64 ** | 7,136.86 |
| Lotus Roots | 1,045.45 kg | 21 per kg | 11,363.64 | 10,590.81 |
| Total | | | | 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

## 3.8 Sedge

Most of the households around the tank do not have to purchase mats. They weave mats for their own use with sedge collected from the tank. However, there is no economic gain as the process is highly labour intensive.

**Table 3.11 Economic return per Hectare of water spread (HWS) for extracting sedge**

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

Source: Primary survey data collected at Kala Oya Basin 2003

Labour cost for weaving a mat = Rs. 250
Annual Economic return of the tank for providing sedge is zero.

**Table 3.12 Total Economic return per hectare of water spread (HWS) of a tank**

| Product | Economic Value per HWS per year (Rs) | Economic value per HWS per year (US $) |
|---|---|---|
| Paddy | 15,928 | 161 |
| Other Field crops | 3,828 | 39 |
| Banana | 20,717 | 209 |
| Coconut | 21,433 | 216 |
| Domestic Use | 145,454 | 1,469 |
| 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 Kala Oya Basin 2003, IUCN

The results of the valuation study of direct uses showed that minor tanks in the Rajanganaya and Angamuwa sub catchments of the Kala Oya basin yield an average value of US $ 2972 per hectare of the inundated surface area of a tank at 2003 prices. The valuation study also showed that these benefits were particularly important for poorer households, for whom alternative sources of income and subsistence were scarce, and who lacked access to water from other sources like wells, pipe borne water etc.

# 4. ASSESSING INDIRECT SERVICES

## 4.1 Understanding the Role of Wetlands – Where Are We

The economic values associated with the direct use of wetland resources are tangible and fairly easy to calculate as shown in the previous chapter. Wetlands also provide indirect benefits through a number of services and functions that are much more difficult to estimate. Valuing these indirect benefits, in economic terms, requires site-specific knowledge of the hydrological conditions and characteristics of the surrounding ecosystem as well as the economic linkages without which, the value of these functions and services would not be realized.

Wetlands have generally been acknowledged as providers of environmental services and goods. Their influence on the water cycle and their role in hydrological functions is recognized and supported by a large number of studies. However, this widely held stereotype perception of wetlands reducing floods, promoting groundwater recharge, retaining nutrients, purifying water, and regulating river flows is now 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, savanna or arable land, and that the 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 that interaction with groundwater therefore is limited

More knowledge on the specific functions and services of a wetland and the its economic linkages are required not only for estimating economic values, but also to successfully and adequately incorporate wetlands in national, regional and international policy formulations on water resource management.

Whether wetlands are beneficial or not, will depend on the specific characteristics of the services provided (eg. flood reduction or flood generation), but even more importantly on who is impacted. People living in flood prone areas will obviously place different values on wetlands that reduce floods and wetlands that generate them. From an ecological standpoint 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.

### 4.2 Identifying and Assessing the Functions and Services of the Selected Tanks

In selecting tanks for this assessment, an important consideration was the availability of previous studies and data in regard to specific functions and services provided by them. After reviewing the available information, and interviewing various experts as well as the local communities it was possible to ascertain the significant functions and services they provided. The functions and services identified by the project for further analysis were:

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

The above functions and services were examined individually and the results set out in the sub sections below. Their importance was assessed mainly on the basis of linkages to agriculture and consumption. Some of these linkages and their values were discussed and estimates presented in the previous chapter dealing with direct values. Specifically, the values associated with ground and sub-surface water availability were dealt with earlier. However, the available data was not adequate to make site-specific calculations of the total value for each of the above-listed services and functions. In the circumstances, a value-range per acre is presented for each function and service as a best estimate. 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. Transferring valuation estimates in this way from another study conducted elsewhere to a project area is perceived by many as an uncertain method. But such benefit transfers 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 In terms of the size, the functions and services provided and the socio-economic characteristics.

### 4.3 Ground and Sub-surface Water Recharge

In Sri Lanka most wetlands are actually ancient water storage tanks created by man many centuries ago, including the ones selected for this study. The main purpose of constructing these tanks was to provide water for agriculture and domestic consumption in the dry seasons. Since these were not natural wetlands in the first place, it is fair to assume that without human intervention they would not exist. 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.

Cooray and Jayawardene (1982) identified the principal source of groundwater recharge 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 negligible, 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 generally the groundwater table in the Kala Oya Basin had risen in areas under the Mahaweli irrigation project after its implementation. The higher groundwater table was shown to affect shallow tube wells in areas close to irrigation channels and leads to water logging in low lying fields.

People living around the selected tanks also reported that they experienced decreasing water levels in their wells after the irrigation project started, especially in the dry season. Clearly, the location of the well has a major influence on the water level. 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 losing their storage capacity due to sedimentation they are under increasing threat of drying out during periods. Furthermore, since the initiation of the Mahaweli irrigation project, demand for tank water has increased. On the other hand, wells adjacent to irrigation channels are more likely to be recharged than wells in the command areas as irrigation channels are provided with adequate water throughout the dry season. Therefore, unless the tank storage capacity is improved, the wells dependent on the tanks for recharge risk losing their value.

### 4.4 Nutrient and Sediment Retention

Many wetlands have the ability to act as natural water filtering stations by storing nutrients, especially nitrogen and phosphorus in their soil and vegetation, and trapping sediments. Of course, each wetland has an upper limit to the nutrient concentration that will not adversely affect its biodiversity. The accumulating nutrients stimulate eutrophication, especially in smaller water bodies where the nutrient carrying capacity is fairly low. Eutrophication is a natural process that could be greatly accelerated by human activities such as agriculture. Increasing the rate at which nutrients and organic substances enter aquatic ecosystems will accelerate the eutrophication process and stimulate algal growth. Excessive growth of algae can hurt the ecosystem in two ways. Firstly, by blocking the entry of sunlight into the water and consequently killing underwater grasses and destroying important underwater habitats of many species, including fish and waterfowl. Secondly, by depleting dissolved oxygen – a life sustaining resource required by other aquatic species - in the decomposition of dead algae. On the other hand, the high levels of nutrients would benefit rice production when the tank water is used for irrigation.

The Mahaweli Authority regards water quality as an important issue in the project area (Mahaweli Authority Interim Report, 2002). The overuse of agro chemicals (fertilizers, pesticides etc.) by farmers is a threat to the quality of water in the tanks. Furthermore, most of the small and medium sized tanks show signs of eutrophication due to the accumulation of nutrients.

Generally, the retention of nutrients in wetlands is seen as a benefit, but it appears that the present nutrient concentrations pose a problem for the smaller tanks. Evidently, there are both benefits and costs associated with the current nutrient status of tank water in Kala Oya. Calculating the net effect of the function would require a detailed analysis of the impacts of water quality on the different uses such as irrigation, consumption, and habitats. Data on the quantum and quality of nutrients stored in the tanks would be essential for such a calculation. Since such data is not presently available it is assumed that the benefits and costs offset each other in the smaller tanks.

### 4.5 Water Quality

MASL conducted a water quality study in collaboration with the University of Colombo at 33 locations along the Kala Oya river. The quality of water and its acceptability for drinking, bathing or irrigation depends upon several factors pertaining to the water, soil, plants and climate. This study identified many measurable factors to assess the quality of water.

In the absence of relevant data pertaining to small tanks, water quality indicators at water intakes and outlets of the Kala Wewa, Rajangana and Angamuwa were considered, in an attempt to assess the services provided by the wetlands in water purification. Ten monthly records of Dissolved Oxygen (DO) ratios, from January to November 2003, were analysed (Table 4.5). The DO ratios were below the required level[3] (should be more than 5 for bathing and recreation) in five out of the ten observations at the intake of Kala Wewa. In the corresponding observations made at the outlet, the DO ratios had increased and were above the required ratio in four observations; data for the fifth was not available. The results at the Rajangana and Angamuwa tanks were similar.

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

**Table 4.5 Dissolved Oxygen Ratio at selected wetlands**

| Location | 2003 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | May | Jun | Jul | Aug | Sep | Oct | Nov |
| Rajanagna Tank (intake) | 7.3 | 3.3 | 7.4 | 5.6 | 4.2 | 6.1 | 5.6 | n.a. | 6.3 | 4.8 |
| Rajangana Tank – Left Bank Canal | 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 | n.a. | 7.0 | 8.6 |

Source: River Basin Planning & Management Division, MASL

Microbiological assays of the surface water, at all 33 locations along the Kala Oya, were carried out using standard sampling procedures. Coliform bacteria were observed only at three locations before the river entered the Kala Wewa. Contamination with Faecal bacteria was recorded at location No. 7 – the Dambulu Oya stream. The water flowing through these locations ultimately collect in the Kalawewa and are used for irrigation. However, other surface water bodies beyond Kalawewa were not contaminated with microbes. The exposure to sunlight in the Kalawewa tank, which has a large surface area would have destroyed the bacteria and this explains the absence of microbes beyond Kalawewa (MASL, University of Colombo).

## 4.6 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. The economic importance of these tanks, as food and income sources, has been established in the previous chapter. Many of these species also comprise a large part of the daily nutritional intake. Moreover, The tanks might even be perceived as having a healing or religious value. In the Kala Oya region, the snakehead (Channa spp.) is believed to be of some significance for pregnant women.

The tanks also benefit neighbouring farmers by providing a habitat for bio-control agents, which consume pests such as insects, crabs and rodents. *Limnonectes limnocharis*, a species of frog, is renowned for it's ability to consume large quantities of insect pests. Many large 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 a habitat for a variety of flora. The most important from a livelihood perspective is the lotus. Lotus flowers are used for religious purposes and the roots are widely harvested for consumption. However, the lotus is being threatened by the water hyacinth which is an alien invasive species of no use to the local community. The water hyacinth has a competitive advantage over the lotus especially in the smaller tanks where nutrient levels are high. Besides competing with the lotus, the water hyacinth also has a negative impact on biodiversity. Its ability to completely cover the water surface is not favoured by many wetland species, especially the aquatic birds and waterfowl.

# 5. CONCLUSION

The small tanks in the dry zone provide a large number of direct and indirect services to the community and nature. The community enjoys different kinds of services and uses the tank for various income generating activities, including non farm activities. However, the community does not take the initiative to collectively maintain this asset located at their doorsteps. They prefer to wait until the local authorities or some other agency attends to the repairs and maintenance of the tank. Government organizations attend to tank rehabilitation and maintenance, from time to time, but the villagers are generally not satisfied with the quality of their work. Although there are farmer organizations in every village they have failed to obtain whole hearted cooperation and enlist the entire community for public work. There are many reasons for this failure. Some villagers are unable to attend meetings and community work as they are engaged in daily paid casual work to earn their daily living. Political differences among the villagers are another reason. Those who do not use water for irrigation are of the view that the farmers who are the main beneficiaries should maintain the tank. And the farmers feel they cannot do it alone and other users and the government also must contribute. Fisheries organizations are not strong enough to engage in tank maintenance although they succeed in maintaining the fish catch among stakeholders.

The community is generally not satisfied with the tank renovations done by government agencies. Their complaint is that these efforts did not increase the tank capacity which was their main expectation. This is not surprising as the funds allocated to government agencies are insufficient and does not stretch beyond repairs to infrastructure like sluice gates or bunds. Funds are not voted for the proper management of tank reservations or for removing silt. It appears that funding authorities are of the view that de-silting is very costly and is not a worthwhile investment to serve just a few hectares of paddy fields. In this context the findings of this study, by IUCN in collaboration with MASL, that investment in tank rehabilitation generates high economic returns, is significant. However, this is not to advocate that government should be held solely responsible for maintaining tanks. What is more feasible and appropriate is to establish a mechanism with a beneficiary participation approach to undertake regular maintenance of the tanks. It must be stressed at this point that unless a proper management system is in place, particularly for the tank reservation, it is not wise to spend money on tank rehabilitation. If not, the services will revert to the previous level within a very short time, and the investment will be wasted.

The treasure of the villagers, which is already under threat, should be conserved to at least support the livelihoods of the poor community living around the tank. One major threat is encroachment. Encroachers and the village people are well aware that this action is illegal, and harmful to the tank, but no effort is made to curb it. Encroaching on the valuable reservation of the tank is no solution for landlessness.

Perhaps, in the past, these harmful activities were not taken seriously as many subscribed to the view, the tank merely stored water for paddy cultivation. This is certainly not the case as shown by the findings presented in this paper. The economic value of the tank, for its contribution to the ecosystem and the community, is very large and far beyond the estimations in this study, when the values of indirect services are also taken into account.

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