Sri Lanka J.Aquat.Sci **2** (1997): 131-140

SHORT COMMUNICATION

Pricing Mangrove Resources and Amenities

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Abstract

Natural habitats such as mangroves could be conserved and sustainably managed only if local communities have economic incentives to do so. Mangrove species, such as *Avicennia* sp., *Rhizophora* sp. and *Bruguiera* sp., provide many direct and indirect benefits to humans.

The cost of replanting mangroves is estimated to be in the order of Rs. 80 per sapling. Since one hectare of healthy mangroves requires about 10,500 saplings, replanting a hectare will cost an estimated Rs. 840,000. Increase in fish catch will be reflected after 1-2 years and if fish are valued at Rs. 75 per kg and assuming that the increase of fish yield is 1000 kg/year, this will generate benefits worth of Rs. 75,000 annually. After 4-5 years, the branches and leaves can be collected for fodder, firewood or brush piles. For fodder, *Avicennia* sp. generates the most benefits at a maximum of 200 kg per plant per year and therefore one hectare of *Avicennia* sp. generates a maximum of Rs. 4 million per year. After 10 years, the forked poles from the mangroves can be harvested for housing construction and assuming 5 branches per sapling at Rs. 200 per pole, a ha of *Rhizophora* sp. will generate Rs. 1 million revenues.

Economic analysis shows that in the long run, the benefits of mangroves to the local community are much greater than the costs of replanting, but these benefits are reaped after 5 years or so. This suggests that poor communities may require assistance to subsidise replanting. Nevertheless if communities are given an understanding of the economic benefits, and the authority to control access to the mangroves, they have enough incentives to sustainably manage the mangroves.

Introduction

Mangrove forests in the North-western coast of Sri Lanka

The North-western coast of Sri Lanka consists of large patches of mangrove forests, which is important for direct and indirect uses. However many of these mangrove areas are threatened (Pemadasa 1996).

(a) *Maha Oya estuary*

A moderate sized mangrove area is found in the Maha Oya estuary which constantly joins the sea and fresh water bodies in Borellasa from Nainamadama to Sindathriya (Fig. 1). The main species present in this mangal are *Nypa* sp., *Rhizophora* sp., *Bruguiera* sp., *Avicennia* sp, and *Sonneratia* sp. The brackish water bodies are productive for harvesting fish, crabs and molluscs. *Nypa* sp. is an endangered species in Sri Lanka, mostly threatened by illicit liquor brewers who extract fuelwood and matured fruits. In addition, *Nypa* sp. is threatened by cutting florescence for toddy tapping (Pemadasa 1996).

(b). *Thalvila lagoon*

Thalvila lagoon is a straight water body with 165 ha of mangrove forest including 10 villages. The sea water enters at Thoduwava and comes down to Thalvila (Fig. 1). This area is called Anankalliya or Gemberandiya and is used for fishing and illicit liquor production. The vegetation is mostly degraded.

(c). *Chilaw Lagoon*

The Chilaw lagoon is fed with sea water through its wide mouth, at Irannavilla. This is a large productive lagoon because of the continuous opening to the sea with 25-30 bordering villages (Fig. 1). It suffers from pressure of intensive fishing and collection of cockles, clams and oysters. Around 1,000 fishing families depend on fishing, mostly using "the log rafts" or canoes. Cultured shrimps are also caught in this area during floods when they escape from shrimp farms due to breakage of bunds of culture ponds. The mangrove forests in this area are very rich in productivity and biodiversity and consists of all true species and associated species. Intensive fuelwood and bivalve collections are other pressures in this area. Propagation of Mangrove is also found to be retarded in this area (Pernadasa 1996).

(d). *Puttalam Lagoon*

Puttalam lagoon is a large ecosystem covering an area of 5,000 ha, with about 100 villages around. It starts from Gangewadiya (off Vanathavillu) in the north and joins Mundel lake at the southern end (Fig. 1). Puttalam lagoon is popular for crab fishery where fishermen use the kraals and traps to harvest them. Fishermen use bamboo and mangrove branches in these catching devices. This lagoon is rich in sea grass beds, providing favourable habitats for dugongs, dolphins, turtles and crocodiles. Dugongs are slaughtered by fishermen for their flesh and fishermen mix the dried and smoked crocodile carcasses with dried shark flesh. In addition, the skin of crocodiles is used in the leather industry. Collection of clams and cockles also takes place in certain areas of Puttalam lagoon (Kithsiri 1996). Extraction of firewood particularly to be sold to bakeries is done in a semi-commercial manner in the Kalpitiya peninsula, because of the high heat generated from mangrove firewood (Amarasinghe 1996).

Economic use of Mangrove Forests

The mangrove ecosystems provide many direct and indirect uses to the communities living around them. The price of goods and services derived from direct uses are undervalued because of market imperfection. Indirect uses are not priced. Direct consumption leads to the destruction of the mangrove forests (Anon. 1997).

(a) *Direct uses*

The coastal inhabitants have sustainably used mangrove products for generations, at subsistence and commercial levels (Anon. 1991). The stems of the mangrove plants specially those of *Rhizophora*, *Bruguiera* and *Avicennia* are very hard and have a low decomposition rate. Therefore, the timber is used for housing construction, fencing and construction of fishing crafts (Anon. 1991). Mangrove forests also play a very important role in supplying timber for firewood and furniture. The mangrove timber of *Rhizophora mucronata* and *Ceriops tagal* has a high tannin content and is used to tan fishing nets and sails of fishing crafts to increase their durability (Anon. 1991). Although timber extraction is restricted by the Forestry ordinance, illegal timber extraction takes place in mangals at an immature stage, causing destruction to these habitats. The illegal

collectors damage the live mangrove plants, allow them to die and then collect for fuelwood and other uses. Timber for construction work is mainly provided by *Rhizophora* sp. and all mangrove plants are collected as fuelwood without discrimination (Samarakoon & Van Zon 1991).

Brush piles which are circular piles of mangrove branches and twigs, are widely used in lagoon fisheries in Sri Lanka. Fishery has clear property rights, with fishermen owning the location from generation to generation (Anon. 1991). The catch is usually high in the brush piles located in the lagoon mouth. Fishermen cut the mangrove branches and transport them in traditional canoes and install them in a circle. The crabs, prawns and small fishes are attracted towards the branches (Amarasinghe 1996).

Tender leaves of *Acrosticum* sp. are used as a vegetable and a beverage is prepared from ripe fruits of *Sonneratia* sp. Extract of mangrove plant are used in indigenous medicine too. Further, species such as *Acrosticum* sp. and *Nypa* sp. are used for thatching roofs (Samarakoon & Van Zon 1991). *Rhizophora* and *Avicennia* are also used as fodder for cattle and goats. Leaves of *Avicennia* are used as manure too. Some
species, specially *Cerebra manghas* are used to make handicrafts (Anon. 1991). Nature based tourism can be strengthened in the coastal areas by incorporating mangrove tree planting in the vicinity of hotels and swimming pools. This is already been done at Ranweli beach hotel at Waikkal.

(b) *Indirect Uses*

The productivity of mangrove forests has been reported to be greater than that of rain forests. The root system of mangroves expands twice as much as ordinary tree forms. On their surface layers, the aerial roots have a thin chlorophyll layer too. Some species consume oxygen produced in their roots without discharging out. The decayed roots and leaves provide nutrients to the lagoon ecosystems and serve as feed to small fish, crabs and shrimps that inhabit these habitats. In addition, mangroves provide breeding sites to these animals. The mangroves also provide a safe habitat protected from predators. Normally the increased fish yield of mangrove rehabilitation is visible after 1-2 years. This benefit will continue only if the fish stock is harvested in a sustainable manner (Amarasinghe 1996).

Mangroves, due to the presence of their prop roots and pneumatophores, are able to consolidate sediment, hence they are able to assist in controlling erosion. This ability of mangrove plants is utilized by the inhabitants around Negombo lagoon, who grow mangrove seedlings (*Rhizophora* sp.) at the periphery of newly reclaimed homesteads in the inter-tidal areas to prevent the filled material being washed away by tidal water. Mangrove tree planting can be carried out to control erosion of the coastal belt (Amarasinghe 1996).

Being located closer to the sea, mangals also act as a wind barrier and provide protection from salt aerosols. The colloidal particles of mangrove sediment such as clay particles and organic matter, are capable of adsorbing some heavy metal ions and therefore are capable of removing certain toxic materials, particularly those contained in industrial effluent, from the water column (Amarasinghe 1996).

The management of mangrove forests includes stopping unsustainable deforestation and promoting afforestation. Mangrove replanting is a popular and simple method used in the management of mangroves. It is necessary to estimate and compare the long term, multiple benefits of mangrove forests with the cost of replanting in order to evaluate the economic feasibility of replanting.

The present investigation was carried out to test the hypothesis that the long term economic benefits of mangrove replanting are more than the replanting cost.

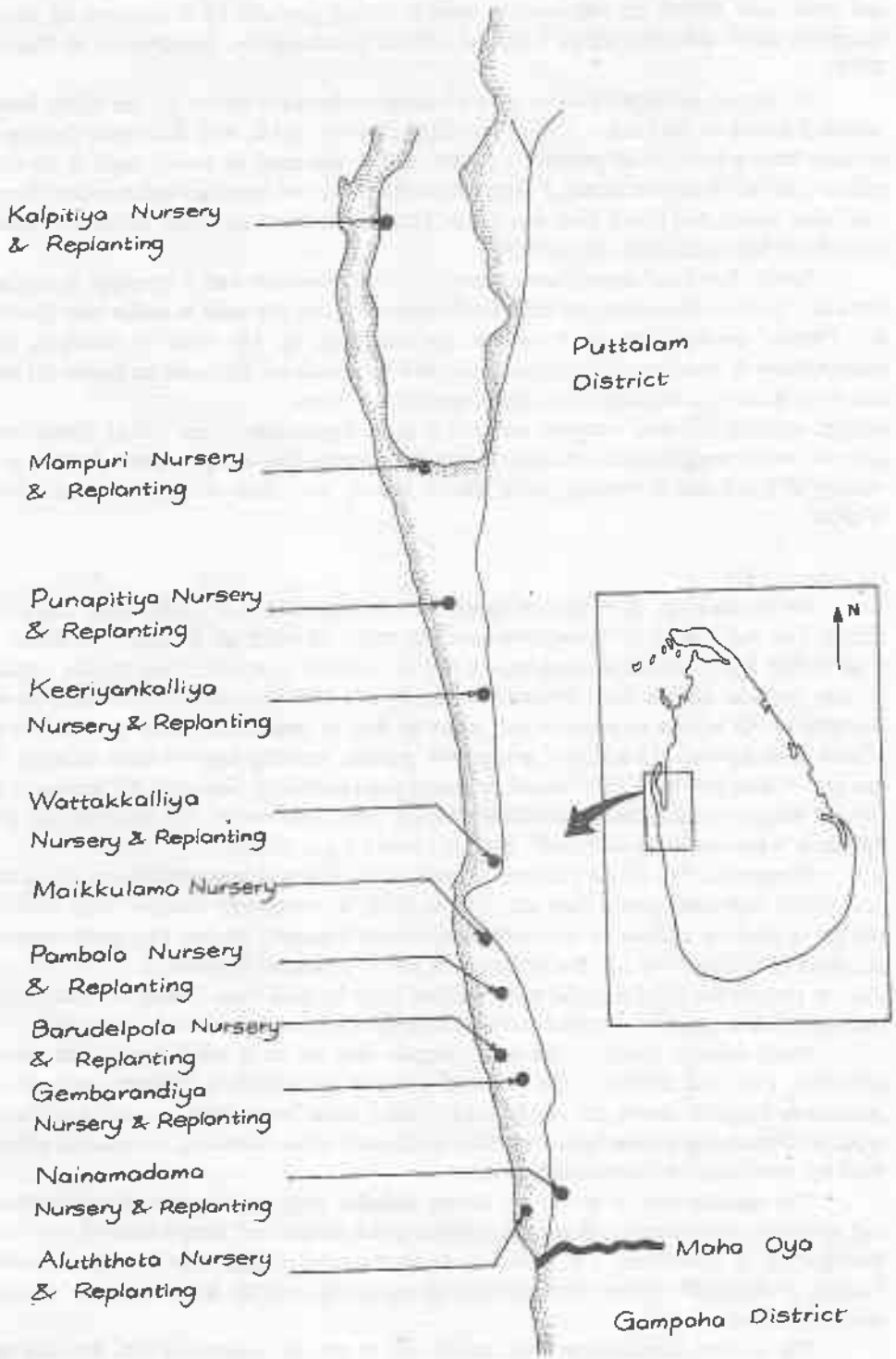

Fig. 1. Mangrove replanted areas on the north-western cost of Sri Lanka.

Materials and Methods

This present study was carried out in the mangrove rehabilitation area at Thalvila in the North-western coastal area of Sri Lanka. Nine household was selected randomly from this village and the distance of these households from the mangal and the benefits they obtain from the mangroves were recorded. The economic value of these benefits were then enumerated. The cost involved in replanting one hectare of mangals was also recorded. The economic benefits from 1 ha of mangals were estimated assuming that there are 10000 plants of mangroves per hectare (Anon. 1996). The survey was carried out only in one village.

Sustainable mangrove rehabilitation is an ongoing process, therefore the project is analysed for 20 years. After 20 years the discounted benefits tend to become very low or zero. The concept of discounting is used to convert the future economic cost and benefits to the present value. The discount rates of 10%, 20% and 30% were assigned for the project to check the economic feasibility in different scenarios. The very high discount rates of 20% and 30% were chosen as poor families who are struggling to survive now, have a very high preference for present benefits rather than future benefits.

The Net present value is the aggregate of discounted net benefits. The Net present value is estimated with different discount rates to define the value of a mangrove rehabilitation project for 1 ha.

Results

Economic Benefits of Mangrove Forest

When used for fodder, *Avicennia* sp. generates the most benefits at a maximum of 200 kg per plant per year, while *Bruguiera* sp. and *Rhizophora* sp. generate about 50 kg per year. Fodder sold in the area costs Rs. 2 per kg and therefore one hectare of *Avicennia* sp. generates a maximum of Rs. 4 million per year. After 10 years, the forked poles from these plants can be harvested for the construction of houses. *Rhizophora* sp., and *Bruguiera* sp. will provide the most benefits at about 5-10 branches per sapling at Rs. 200 per pole and therefore one hectare of *Rhizophora* sp. will generate Rs. 1 million revenues. This is shown in Table 1.

Indirect or functional benefits include, providing nursery, breeding and feeding grounds for fish, assimilating waste and pollutants, coastal flood protection, controlling soil erosion and serving as wind barriers. The immediate visible functional benefits were the increase of lagoon fish within 1-2 years and it is estimated by NARA that 1 ha of mangroves will generate about 750-2,500 kg of fish, prawns, crabs and molluscs per year (Amarasinghe 1996). Valued at Rs. 75 per kg and assuming 1,000 kg of fish are caught benefits of about Rs. 75,000 are generated (Table 1).

Mangroves in this area are also used for medicinal purposes. These are listed in Table 2. This has become very popular mainly because the fishing communities do not have adequate medical facilities. These Medicinal values are not evaluated, because, no clear information is available on the exact medicinal value of these plants.

Study revealed that a mangrove dependent household in the Puttalam Lagoon area use fuelwood worth over Rs. 1,000 per year, brushwood for fisheries worth about Rs. 2,000 per year, and catch crabs worth about Rs. 1,000 per year. In addition, they gained benefits worth of Rs. 10,000 by the increase of small fish in lagoon (Table 3).

The results of the present study also showed that the local community themselves would like to manage the mangroves through police action, strengthening the fisheries co-operative society, more replanting and better community education (Table 3).

Economic Costs of Replanting Mangroves.

The cost of replanting is estimated as Rs. 80 per sapling including the cost of collecting planting material, planting in a polythene bag of muddy soil, land clearing and preparation of nursery, constructing trenches to drain off lagoon water, fencing to get protection from goats and cattle, storage in a village based nursery for 6 - 8 months, planting, and maintenance. According to the Forest Department recommendation, 10,500 healthy plants are needed (including 5% natural mortality rate after planting) to generate 1 ha of healthy mangrove forest (Anon. 1996). Table 4 illustrates the different activities, inputs and costs of mangrove rehabilitation.

The net present value was estimated to be around Rs. 9 million at the normal discount rate of 10% in the year 1997. Higher discount rates of 20% and 30% provides the Net present value of about Rs. 4 million and Rs. 2 million respectively (Table 5).

Table 1. Summary of Direct Benefits of 1 ha healthy Mangrove forest for the Community

Use	**Price**	**Time**	**Amount (kg/year) & Value (Rs./ha/year)**		
			Avicennia	*Bruguiera*	*Rhizophora*
Lagoon fishing	Rs 75/kg	after 1-2 years	1,000 kg Rs. 75,000	1,000 kg Rs. 75,000	1,000 kg Rs 75,000
Fodder for livestock **or**	Rs 2/kg	after 4 years	2 M kg Rs. 4 M **or**	0.5 M kg Rs. 1 M **or**	0.5M. kg Rs. 1 M **or**
Firewood for domestic use **or**	Rs. 2/kg	after 4 years	1,5 M kg Rs. 3 M **or**	1,5 M.kg Rs. 3 M **or**	1,5 M. kg Rs. 3 M **or**
Brushnet for fishing	Rs 75/kg	after 4 years	1,330 kg Rs.0.1 M	1,330 kg Rs 0.1 M	1,330 kg Rs.0.1M
Poles (Straight and forked)	Rs. 200/ poles	after 10 years	—	45,000 poles Rs. 1 M	45,000 poles Rs. 1 M
Bark	not sold	after 4 years	not sold	not sold	not sold
Minor uses (masks, artificial limbs, floats etc.)	not sold	after 4 years	not sold	not sold	not sold
Medicinal value (snake bites, fish attacks, skin disease, etc.)	not sold	after 1 year	not sold	not sold	not sold

Table 2. Medicinal uses of some mangrove species. Source: Perry & Metzger (1980).

Species	Medicinal use
Avicennia sp.	- Juice of root is used for impotency problems - Fruit mixed with butter for bursting chicken pox - Bark used for scabies
Rhizophora sp.	- Bark used to cure fractures - Bark used for diarrhoea - Roots used for haemorrhages - Latex used for Angina disease - Old leave juice used for pain relief
Bruguiera sp.	- Crushed bark is used on minor cuts and for diarrhoea - Latex used to treat burns and pimples
Nypa fruticans	- Juice from pulp used for headache - Lotion used to treat ulcers
Sonneratia sp.	- Fruits used for slight wounds and as worm treatment - Fruit juice used for ulcers and bleeding piles - Leaves used for coughs, haemorrhages and chicken pox
Acanthus sp.	- Seeds are used for coughs - Crust used for inflammations and boils
Xylocarpus sp.	- Root used for cholera - Fruit and seed considered to be anticholeric
Excoecaria agallocha	- Leaves used for fish venom - Burnt leaves used for epilepsy - Latex used for ulcers and wounds - Oil used for rashes, scabies and all skin diseases
Aegiceras corniculatum	- Bark used as a fish poison - Used for menstrual problems.

Table 3. Survey of economic benefits to Mangrove dependent households (HH) in Thalvila, Marawilla. F - Increase in Small Fish Catch, R - Increase Rainfall Precipitation, E - Improvement in local Environment, S - Reduction in Soil Erosion, FW - Collection of Fuelwood, T - Extraction of Timber wood. **BMS** Better Management Systems; PO - Police Action; FS - Strengthening the Fisheries Co-operative society; RP - More replanting; ED - Better community Education.

HH	Distance from mangroves (km)	Benefits	Direct Benefits (Rs./yr)				BMS
			Small Fish	Brush pile	Fuel wood	Fenc -ing	
1	0.5	F, R, E	3,000		600		PO
2	1	F, S, FW, T	16,875				FS
3	0.15	F, R	7,200		480		PO
4	2	F, S, E	30,000		1,440	2,500	FS
5	2	F, S	7,200		1,440		RP
6	1.5	F, R, E	7,200	2,500	1,440		ED
7	1.5	F	6,000				RP
8	1	F. S	12,150	1,500	1,440		PO
9	1	F, S			720		FS, ED
Ave rage	1.18		9,958	2,000	1,080	2,500	

Table 4. Cost of replanting of one hectare of mangals

Activities	Inputs	Cost (Rs.)
Fencing to protect tender vegetation from cattle and goat. Conduction of 4 awareness programmes	*Labour - 40 man days *Fence post, Barb wire, Old Fish nets, Cadjans, Coir ropes	8,000 30,000 –
Land Preparation including removal of stumps of trees	*Labour - 70 man days *Hiring a tractor	14,000 5,000
Drenching - Intake of water	*Labour - 30 man days	6,000
Constructing small shed	*Poles, Coir ropes, Cadjans and labour charges	5,000
Collection of Planting material and planting in nursery	*Labour - 30 man days	6,000
Planting in field	*Labour - 60 man days	12,000
Permanent labourers	*Casual Labourers-4 (96 man months)	384,000
Polythene bags		60,000
Maintaining the Nursery		150,000
Miscellaneous	*Meals, Transport, etc.	120,000
Total		800,000

Table 5. Present Value of Mangrove replanting

Discount Rate (%)	Net Present Value (Rs.)
10	9,036,581
20	4,194,914
30	2,428,535

Discussion

Economic analysis shows that in the long run the benefits of mangroves to the local community are much greater than the costs of replanting, but these benefits can be reaped only after about 5 years. This suggests that poor communities may require outside assistance to subsidise replanting. But if communities are given an understanding of the economic benefits, and the authority to control access to the mangroves, they have enough incentives to manage the mangroves once they are planted.

The Forest department and other government agencies should ensure that local communities are not only involved in replanting mangroves, but they are also given rights to harvest them sustainably. This requires legal mechanisms to be developed as already been done in some forest areas.

NGOs and Fisheries co-operatives must mobilise their members to carry out replanting and to develop institutional mechanisms to protect the mangroves without over exploitation. This may require better co-operation among the members of the community and also between those in neighbouring village.

Acknowledgements

We would like to thank the members of NGO, NATMARCO (National Mangrove and Coastal Habitat Conservation Fund) for providing some data. In addition, we would like to acknowledge the President of Thalvila Fisheries Co-operative Society and its members for assisting in conducting the survey and providing useful information.

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