

# Sustainable aquatic resources management in the 21<sup>st</sup> century: Some important issues

U. Edirisinghe

Department of Animal Science, Faculty of Agriculture, University of Peradeniya, Peradeniya, Sri Lanka

Fax No: 08-388041, E-mail: [udenic@pdn.ac.lk](mailto:udenic@pdn.ac.lk)

Accepted 26th September 2003

## ABSTRACT

Sri Lanka, 'the Paradise of the earth', is blessed under the Law of the Sea to possess 514,000 km<sup>2</sup> of marine resources, in addition to having the highest water bodies: land ratio in the world. Harvesting of resources from deep sea and international waters is hampered by lack of capital as well as technology.

A research survey for the determination of available resources has become essential, especially for the management of coastal and offshore resources. Difficulties associated with the management of open access resources under open market economy with easy entry and denied withdrawal even at economic loss is the rule of the day. This is further aggravated by the multi-gear and multi-species problems inherent to fisheries. Lack of boundaries between coastal and offshore resources have led to political decisions resulting in diminished catches with respect to migratory species and, over exploitation of some of the endemic and indigenous species. Non-availability of data with respect to ecosystem imbalances mainly due to illegal fishing, dynamiting, over-fishing, destruction of natural habitats together with unsuitable modern technology imported without any research have led to irreparable damage of these invaluable resources.

Brackish water resources have been irretrievably damaged due to irrational river-base diversification schemes, which have been planned with little consideration for environmental protection. The conversion of highly productive lagoons to polluted estuaries as a result of these irrigation schemes has badly affected the sustainable life styles of the coastal populations. Unscientific development of shrimp farming in the sensitive areas with the destruction of the mangrove vegetation has damaged the resource beyond easy recovery. The disruption of the riverine ecosystem by damming and the concurrent unplanned agriculture development has not only polluted the aquatic resources but also led to environmental degradation of the coastal resources. The haphazard introduction of exotic fish even by the state has led to ecosystem imbalances due to parasitism and pathogenesis as well. Sustainable development of agriculture, livestock and fisheries through a holistic integrated approach should be the plan for the new millennium.

**Key words:** Marine, brackish water, freshwater, environment

## INTRODUCTION

### Aquatic Resources

According to the FAO statistics (FAO Year Books 1980 - 1990), the fastest growing sector during that decade has been aquaculture (Fig. 1). Though Marine capture fisheries production is well ahead of population growth, it does not show further growth due to over-fishing of most of the stocks throughout the world (FAO, 1997), unlike aquaculture.

The aquatic resource Sri Lanka possesses is around 7.5 times that of the total land area (Fig. 2). The percent contribution to the national GDP (Gross Domestic Product) has always been below 3%. This may be explained as being due to irrational management strategies of Sri Lanka. The policy planning of this country has always been a continuation of the colonial era. This may be either due to possessing of the same objectives or negligence. Due consideration has never been given

to both conservation and exploitation of invaluable open access or common pool resources in a scientific manner.

Total freshwater resources of the country are around 201,832 ha, which is ever increasing due to the construction of large and small reservoirs, mostly in the wet zone of the country in the recent past (Table 1). This is the world's highest land: water bodies ratio (De Silva, 1991), which itself indicates the importance of sustainable harvesting to supply the essential food fish for a balanced diet for the Sri Lankans.

### Cultural Heritage and Nutrition

Sri Lanka is an island with a very rich and diverse cultural heritage. This hydraulic civilization, which dates back to beyond 1500 BC with the construction of enormous number of small and large reservoirs, is unparalleled in the world. Mahawamse stresses the value of smallness to an invisible country like Sri



Fig. 1 - Growth of global population and food production (1980-1990)

Lanka.

The construction of a pagoda near to both small and large reservoirs exemplifies the intelligence and the incredible knowledge in environmental sustainable management, since this has been mainly for the protection of the 'villus' and other low lying areas from the removed soil. The concept of having a temple in the vicinity of the tank was therefore not only for spiritual satisfaction of the people, but also for the conservation of the environment at the same

Table 1 - Important basic data for Sri Lanka.

<sup>a</sup> Land area (excluding inland waters) of Sri Lanka	= 65 610 km <sup>2</sup>
Coast-line	= 1 739.3 km <sup>2</sup>
<sup>a</sup> Continental shelf	= 28 000 km <sup>2</sup>
<sup>a</sup> Territorial waters and contagious zone	= 51 300 km <sup>2</sup>
<sup>a</sup> Exclusive economic zone	= 437 000km <sup>2</sup>
* Extended Exclusive Economic Zone	= 1 750 000 km <sup>2</sup>
<sup>a</sup> Brackish water resources	= 158 016 ha
<sup>a</sup> Fresh water resources	= 201 832 ha
<sup>a</sup> Total population	= 19 043 000
<sup>a</sup> Total fish production (1998)	= 260 100 MT
<sup>a</sup> Total waste production	= 900 000 MT

<sup>a</sup> Approximate Values  
\* To be declared by UN

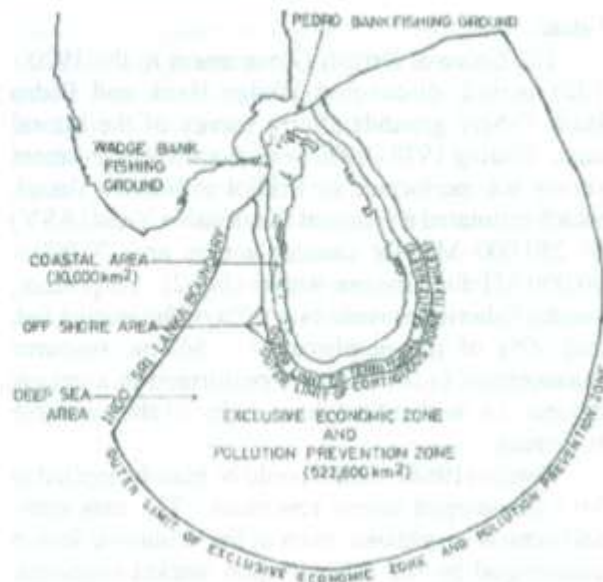


Fig. 2. Map of Sri Lanka with Maritime Boundaries

time protecting the tank by villagers themselves who walk to the temple at different times of the day. These masterly work, unlike Pyramids of Egypt or Taj Mahal of India, have been created solely for the betterment of the masses. These true 'wonders' have been performed by people without any machinery but by relying on the ingenious creativity.

It is pertinent to look at the diet of the people who lived in the past. Today, over 40% of our children are suffering from acute malnutrition (according to our culture where parents eat after feeding their children), and at least over 70% of our elders must be poorly fed.

According to scientific data, fresh quality rice (not insect attacked, low quality rice available in the market) contains proteins and lipids and minerals in addition to carbohydrates. Even today, an average person in a village eats a sizable quantity of rice (a plate full), which make the proteins and lipids significant. The proteins in rice are deficient mainly in lysine and methionine, which are the limiting amino acids in a rice-based diet. Therefore, a small piece of fish becomes the best complementary and supplementary ingredient to balance the protein requirement.

Marine Resources

According to Article 76 of United Nations Convention on the Law of the Sea (UNCLOS), the extent of the Exclusive Economic Zone (EEZ) will depend on the sediment thickness. Therefore, through proper negotiations at the UNCLOS, Sri Lanka would be able to enhance her maritime resources up to 30 times the land resource in the near

future.

The Colonial British Government in the 1920 - 1923 period, discovered Wedge Bank and Pedro Bank fishery grounds after a survey of the littoral zone. During 1978 - 1980 period, a stock assessment survey was performed by Fridjot of Nansen Vessel, which estimated an Annual Sustainable Yield (ASY) of 250,000 MT for coastal waters and 70,000 - 90,000 MT for offshore waters (Fig.2). At present, coastal fisheries provide over 90% of the marine fish and 90% of the employment. Marine resource management in Sri Lanka is performed in a unique manner, i.e. without any knowledge of the available resources.

Hardin (1968), model could be plainly applied to Sri Lankan open access resources. The easy entry and denied withdrawal even at the economic loss is encouraged by the present open market economic policy. This is further aggravated by the inherent management problems of fisheries such as invisibility of the resource, multigear and multi-species in association with the migration of not only fishes but also fishers as well.

The rigid demarcation of boundaries for artisanal fishers in the coastal areas is a rule of the past. Application of a co-management strategy adapted in various countries throughout the world (Feeny et al 1990; McCay and Jentoft 1996; Pomeroy and Berks 1997; van Mulekom 1999), should be suitably developed without any political interference, if this sector is to be redeemed.

The irreparable damage occurring to national assets due to illegal fishing, dynamiting, over-fishing, natural habitat destruction and sedimentation could be easily overcome by adapting a suitably developed co-management methodology, applicable to specific situation (Wilson et al., 1994). The scientific guidance and integrated approach in decision making should be reintroduced. The heavy annual loss from tuna fishery due to political decisions in resource utilization should be analyzed in detail and appropriate action to redeem from the permanent loss must be taken immediately.

The efficiency of fisheries management in Sri Lanka can be judged by referring to the action taken in redeeming the coral reefs in the southern area of the country. Though the effects of destruction is exposed annually by nature, sea erosion gets more and more aggravated after spending money in billions or even trillions, exposing the efficiency of our conservation policy on coastal resources. On the other hand, it is important to note that over 1/3<sup>rd</sup> of the Netherlands is under sea level and the entire land is protected by flood preventing dykes.

## Brackish Water Resources

Brackish water resources (Table 1), which were sustainably harnessed for thousands of years have been irretrievably damaged due to river-base diversion schemes. These schemes have been planned without any consideration on the environmental effects and especially the aquatic resources. The unproductive brackish water resources along the southern coastal area are a direct result of the Uda Walawe scheme. It is incredible to note that even this large-scale damage has not exposed the eyes of the planners and developers. Up to this day, remedial action has not been taken to redeem at least the resources, which can be partially recovered.

The overnight changes from lagoon ecosystems to estuary ecosystems and *vice versa* have led to the complete eradication of many of the flora and fauna, which existed even before the existence of man. The sustainable and contented life styles of the poor coastal populations have been irreparably affected due to no fault of these innocent people (Fig. 3). The inherent humble and ignorant nature of these rural people is perhaps the only reason for them not to agitate and redeem the ecosystem from the ever-increasing environmental destruction.

The utilization of crown land inhabited by mangroves as the inherited properties of the politicians led to the unscientific and unplanned shrimp industry, which is struggling to survive. Major disease problems, *viz.*, Monodon Baculo Virus in 1988- 1990 and Whitespot disease in 1996 have greatly reduced productivity, profitability and sustainability. Even with the exposed calamity of this industry, where thousands have lost their employment prospects with the destruction of mangrove vegetation, up to the present, any positive action has not been taken. The fundamental and natural rule of shrimp production is that it is directly related to the carrying capacity of the area, which in turn is decided upon by the area and density of mangrove vegetation. These principles must be followed to the decimal. Mangroves can be considered as one of the World's inherited heritage possessed only by a few of the nations in the interdependent global village.

## Freshwater Table Fish Industry

The multitude of reservoirs available provide an invaluable resource for the development of the table fish industry. Freshwater fisheries, which was at a subsistence level during the ancient times became a permanent commercial fishery by 1952-1978 period (Edirisinghe, 1997). The inestimable growth in fish

production due to Mossambique tilapia (*Oreochromis mossambicus*) was further increased (De Silva, 1988) due to the subsequent introduction of *O. niloticus* ( Nile tilapia) and *Tilapia rendalli*. The introduction of Chinese -Major Carps in 1975 was not a success due to lack of technology in catching these large fish. The introduction of Indian-major-carps in 1978 and the concurrent development in the infrastructure and extension facilities led to the rapid progress in the freshwater table fish industry (Fig. 3). The sudden decision taken by the then government, not to sponsor inland fisheries due to hitherto unexplained reasons, led to the complete destruction of inland fisheries.

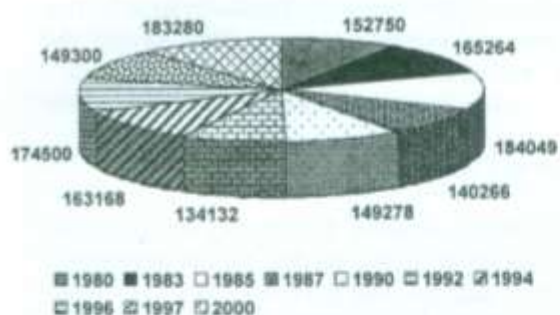


Fig. 3 -Details of Coastal Fish Production in Sri Lanka

According to the available statistics, without the commissioning of most of the freshwater fish breeding and experimental stations in Sri Lanka, freshwater fish production during the past four years has increased tremendously (Fig. 4). Hence, it is important to analyze this trend in detail and determine the factors, which contribute to this erroneous documentation.

It is a fact that programmes are not available to cater to the annual need of billions of fish fingerlings required to be stocked in the available water bodies.

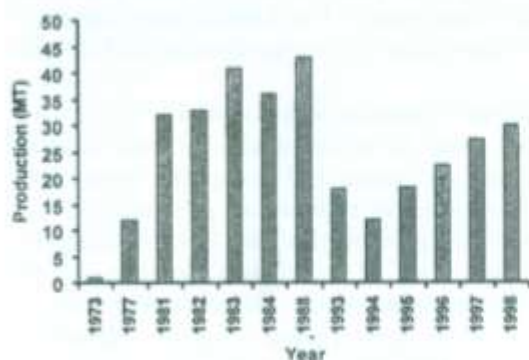


Fig.4. Inland Fish Production in Sri Lanka

Hence, it is essential to develop rice-fish and other suitable integrated farming systems to cater to this need. Development of appropriate co-management strategies (Nathanael & Edirisinghe 2002) would enable the sustainable utilization of vast freshwater aquatic resources of the country.

In order to achieve this goal, integration of inland fisheries with agriculture, livestock, wild life and forestry together with other important line Ministries has become essential. It should be made mandatory to have at least two compost pits in every house/house complexes to compost all the organic wastes. Very high taxes should be levied for those who dispose organic wastes and only polythene and glass (is being recycled at present) should be permitted to be put out of their compounds.

Such legislation not only will recycle the waste while protecting our environment, but also will solve the waste disposal problems faced by the Sri Lankans (Table 1). The current trend in disposing the wastes in low lying areas not only aggravate flooding but also will cause irreparable damage to our endemic fauna and flora, whose completion of life cycles depend on these natural resources.

### Ornamental Fish Industry

Sri Lanka is further blessed in having the ability to 'pick' the necessary climate. This resource availability is of prime importance for the sustainable development of the ornamental fish industry. Today, due to various reasons Sri Lanka does not supply even 1% of the total ornamental fish marketed in the world. However, it is important to note that the export of ornamental fish by quantity and value has increased over the years (Table 2). The potentials for the export of seaweed and aquarium plants are yet to be explored.

The demand for ornamental fish of Sri Lanka is mainly due to the following two reasons.

Some exported fish species are endemic to Sri Lanka and can be obtained only from this country (Edirisinghe, 1999).

Table 2 - Export of Ornamental Fish (1992-1997)

Year	Quantity (kg)	Value ( million Rs)
1992	386 765	159.8
1993	995 138	205.0
1994	743 046	248.3
1995	513 762	273.3
1996	618 559	310.2
1997	963 997	427.9
1998	1 023 401	525.6

Source: Export Development Board (1999)

Most of the fish are cultured in natural environments and therefore they are healthier and more attractive than those exported from other countries.

However, the slow development of this industry can be attributed to the following reasons.

Due to the absence of a coordinating organization for exporters. When an exporter finds it difficult to fulfill the entire requirement (by number and/or species), the importer gets frustrated resulting in cancellation of future orders.

Though Sri Lanka is strategically placed in the world map, the poor infrastructure facilities incur more expenses, while some of the key destinations are inaccessible.

Due to low technological development, always-packing charges are high while survival rates are low.

The difficulties due to regulations cause hardships both to the genuine exporter as well as to the custom officer.

Therefore, it is mandatory to have a coordinating organization with representations from the different fields including research, so as to uplift the aspirations of the resource users. This could be sustainably managed by collecting a reasonable cess from the exports.

### **Agriculture and Aquaculture**

It is disheartening to see that in this country, natural optimum utilization of natural resources is not made. The continuation of the same parliamentary structure, which was devolved upon us by the colonial rulers implies that the objectives of management are the same. In many countries, both developed and developing, Agriculture, Fisheries, Wildlife and Forestry are under one umbrella together with the Environment. The net result of this improper identification of line-ministries is the poor or no management of these invaluable resources.

Sri Lanka being a very small country, the approach towards agriculture and freshwater fisheries should not be similar to that found in United States, United Kingdom or even for that matter in India. The average per capita land availability for agriculture of an average farmer is well below 0.25 ha. Therefore, it is essential to have a political forum to discuss the strategy with respect to the allocation of discipline in to various ministries in Sri Lanka, if there is to be development through sustainable management.

### **Role of Integration**

It is a fact that a colossal quantity of money is spent

for the development of Agriculture as well as Fisheries and other connected Ministries resulted in gradual declining of the quality of life of the farmer. This is the ultimate result of incorrect planning and plan implementation.

When a Sri Lankan farmer is considered, the correct approach should be integration within the farm, within the community and within the country. If this can be practiced, the farming community would easily achieve resilience as well as self-reliance. Farmers should be able to utilize almost all the by-products at least within the community or in the area. Present policies are geared to make Sri Lanka the first in producing wastes as well. Though Sri Lanka has a vast aquatic resource, total annual fish production is only 260 100 MT, while the production of wastes is 900 000 MT (Table 1).

Therefore, development of location specific fish based farming systems in a country having the highest resource can be achieved only through a proper coordination among line ministries.

### **Long Term Planning**

It is essential to observe that during ancient times when kings (both Sinhalese and Tamil) were ruling the country, attempts had not been taken to colonize and cultivate the hill country. Indications for the existence of any kingdom beyond Gampola in the hill country are not present.

The scientific reason for this is that it was known at that time that natural soil is a sponge, which releases the water slowly but surely, so that people in the 'dry zone' (Sri Lanka does not possess any dry land from world standards) have sufficient water throughout the year. It is the colonial and recent rulers of the country, who devastated the hill country with different cultivation.

### **Proper Planning**

It is not too late to make long term (500 Years), medium term (100 Years) and short term plans for the proper development of Sri Lanka. Long term and medium term plans should be devoid of political arguments.

Under such planning, it is essential to convert the catchment areas of rivers gradually with natural forests (not with pines and turpentine trees) and convert unproductive cultivations as sanctuaries or forests depending on the location. Suitable action to prohibit the use of inorganic fertilizers and insecticides and pesticides in the hill country should be taken, while encouraging integrated farming. Sufficient research data are available to use organic

manure even for paddy cultivation.

This necessitates a very strong coordination among the Ministries and hence the creation of "Project Ministries" with very talented, experienced and dedicated Ministers becomes mandatory. Under such a system, table fish industry, ornamental fish industry and shrimp industry could be easily managed with proper utilization of the resources.

The present day concept of co-management of open access resources such as reservoirs, lagoons and estuaries can never be achieved until the Agriculture, Fisheries, Wild Life and Forestry resources are considered as one entity. Such amalgamation will result in optimal utilization of manpower as well as other physical resources with least pollution to the environment. These are essential components in the development plans of the new millennium.

### Suggestions and Conclusions

The continuation of the management strategy handed - over by the colonial rulers possibly with different objectives may be the main reason for the poor development of Sri Lankan fisheries today. A complete reorganization in the portfolio of the Ministries with the objective of sustainable harnessing of resources to the optimum has to be immediately undertaken.

Important environmental issues such as coral reef destruction and unsuitable waste handling must be solved through integrated and co-management strategies. Sri Lanka should be driven towards prosperity by harnessing her resources optimally in a rational manner.

### ACKNOWLEDGMENTS

This paper being a review of the research findings, appreciation is hereby given to the International Foundation for Science, Sweden and the Sri Lanka Council for Agricultural Research Policy for the research funds received. Thanks are given to Dr Shirani Nathanael for assistance in preparing the manuscript.

### REFERENCES

- De Silva SS 1988 Reservoirs of Sri Lanka and their Fisheries. FAO Fisheries Technical Paper 298.  
De Silva KHGM 1991 The predicament of the freshwater Fisheries and aquaculture of Sri Lanka. NAGA, the ICLARM Quarterly, 14: 6-7.

- Edirisinghe U 1996 Effects of poultry litter on the paddy yield and on the growth and recruitment of Nile tilapia (*Oreochromis niloticus*) in a rice-fish integrated system. Sri Lankan Journal of Agricultural Sciences, 33:85-92.  
Edirisinghe U 1997 A case Study on reservoir fisheries management: gill net fisheries in the Victoria Reservoir. Sri Lankan Journal of Agricultural Sciences, 34: 155-165.  
Edirisinghe U 1999 Ornamental fisheries as a livelihood for coastal regions. In: Gunasena HPM, Kotagama HB and Wickramasuriya, HVA (eds.) Coastal Resource management in Sri Lanka. International Development Research Centre, New Delhi, India. pp 63-70.  
EDB. 1999. Export Development Board, Colombo, Sri Lanka.  
FAO Year Books 1980-1990. FAO, Rome.  
FAO. 1997. Technical Guidelines for Responsible Fisheries. No. 4., Rome.  
Fisheries YearBook. 1998. NARA, Colombo, Sri Lanka  
Feeny D, Berks F, McCay BJ and Achason JM 1990 The Tragedy of the commons : twenty-two years later. Human Ecology, 18(1) 1-19.  
Hardin, G. 1968. The tragedy of the commons. Science, 162: 1243-1248.  
McCay BJ and Jentoft S 1996 From the bottom up: Participatory issues in fisheries management. Society and Natural Resources, 9: 237-250.  
Nathanael S and Edirisinghe U 2002 Developing co-management in an artisanal gill-net fishery of a deep hydroelectric reservoir in Sri Lanka. Fisheries Management and Ecology. 9: 267-276.  
Pomeroy RS and Berks F 1997 Two to tango: the role of government in fisheries co-management. Marine Policy, 21(5): 465-480.  
van Mulekom L 1999 An institutional development process in community based coastal resource management: building the capacity and opportunity for community based co-management in a small-scale fisheries community. Ocean and Coastal Management 42: 439-456.  
Wilson JA, Achason JM, Metcalfe M and Kleban P 1994 Chaos, Complexity and Community Management of Fisheries. Marine Policy, 18(4): 291-305.