CHAPTER

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ECONOMIC VALUATION OF MARINE ECOSYSTEM SERVICES

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Introduction

The marine and coastal ecosystem provides a variety of services. Fisheries is an important provisioning service with supplements from supporting and cultural services. The potential services that can be provided by the marine coastal ecosystem includes, sustainable catch, which provides assured income to the fishers, regulates natural phenomena as certain marine fauna acts as bio-filters, provides a rich treasure of marine bio-diversity.

Types of ecosystem: Structure of the Ecosystem

The different types of ecosystem are presented below. (Figure 1)

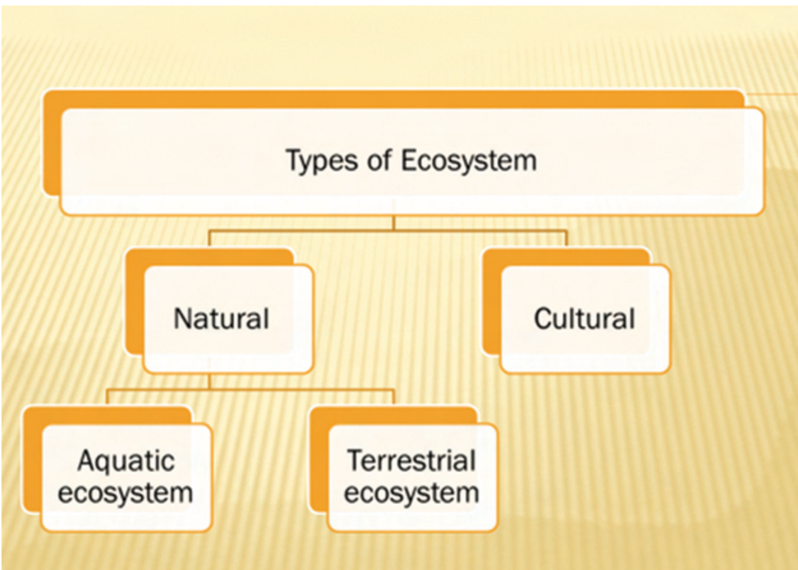

Fig. 1. Types of ecosystem

The marine and coastal ecosystem is coming under the aquatic ecosystem. The coastal ecosystem includes following component like estuaries, salt marshes, rocky/sandy shores, mud-flats, coral reef, mangrove, nesting Grounds/Habitats (Birds, Horse Shoe Crab and Turtle), sea grass, marine parks and sanctuaries, archeological and heritage Sites (Bhatta, 2015).

In general the services provided by the ecosystems include, provisioning, regulatory, supporting and cultural services (MEA, 2005). These services are described for each ecosystems.

Economic valuation of ecosystems

Ecosystem have three distinct characteristics in valuation namely (i) Existence value; (ii) Intrinsic value and (iii) Option value.

Productive use value: It is the value assigned to the products that can be **harvested for exchange in formal market** and is the only value of biological resources that appears in the national income account. Example: Fuel wood, fodder, timber, fish, medicinal plants

Consumptive use value: The value assigned to natural products that are consumed directly *i.e.*, the goods that do not enter normal channels of trade; Example: A variety of Non Timber Forest Products (NTFP)

Intrinsic value: It is the value related primarily with the functions of the ecosystem but sometimes outweigh the consumptive/non-use values like, maintenance of ecological balance, Prevention of soil erosion *etc*.

Types of values

The various types of values that are used in environment and ecological economics parlance are given below (Table 1).

Table 1 Types of values

Value type	Sub type	Example
Use value-Direct	Consumptive Productive	Variety of home consumed forest products Plant breeding
Indirect use value	Non-consumptive	Tourism
Option	Non-consumptive	Ecological process , future values of drugs
Quasi-option	Non-consumptive	Value of being able to ascertain option value
Non-use values	Non-consumptive	Existence value of elephants, turtles

Why economic valuation?

The link between economics and ecology/environment is vital to understand their value. Most of the natural resources that we use have value but not priced and also not traded in the market. eg., Air.

The natural resources (NRS) need valuation because they do not have a regular market for trading, the NRS has various alternatives and alternative uses; there is uncertainty in demand and supply of NRS. The policies for conservation of NRS need to be defined properly and for use in NRS accounting (Kadekodi, 2001). The ultimate out-put namely the green accounting has a significant role to play in the days to come.

Methods for valuing provisional services (Bhatta, 2015)

PROVISIONING SERVICES	METHODOLOGY
Fish	Direct Market Pricing
Fuel wood	Direct Market Pricing
Aquaculture	Direct Market Pricing
Industrial Cooling	Direct Market Pricing
Fresh Water (Desalination Plants)	Direct Market Costs of Production
Ornamental Resources	Direct Market Pricing
Sand Minerals	Direct Market Pricing
Seaweed/Sea-grass Production	Direct Market Pricing
Salt Production	Direct Market Pricing

A case study: Economic valuation of Seasonal Fishing Ban (SFB) on marine ecosystem services

Fishery resources are renewable natural resources but exhaustible if harvested indiscriminately. There are examples wherein certain resources have become extinct due to unsustainable harvest. Hence we have to formulate fishery management policy considering the domestic situations and promote sustainable fishing practices that will not decrease the stock level, but will ensure livelihood security, resource sustainability, economic efficiency and ecosystem integrity.

Seasonal Fishing Ban (SFB) was introduced with the purpose of protecting the spawners during peak spawning season, reducing the fishing effort, giving respite to the sea floor and safety at sea. Since the inception of ban, the marine fisheries sector has undergone immense technological, economic and social changes. However, even after several years of implementation of SFB, there are no specific answers to the following questions: Has the natural capital asset and its value increased? Has the ban improved marine ecosystem services? What is the management cost *vis-a-vis* benefits? How does each maritime state perform? Answers to these questions are needed to arrive at effective management decisions to sustain this sector.

The thematic approach of the present study is to quantify the following potential benefits due to implementation of SFB, which include, increase in catch, which provides high income to fishers; less fuel use and CO_2 emission; impact on biodiversity; and net social benefits.

The Impact of SFB on resource group-wise and sector-wise marine fish landings was assessed for major resources (fish species/ groups) and for different craft types. The craft type (sector) categorization assumes significance as SFB applies to all mechanized boats, which operate trawls and gillnets, but only partially at varying proportions for motorized boats which operate gears like seines. The methodology involved the following two approaches:

(i) Regression approach aims at studying dependence of landings and catch rates (catch per unit craft trip and catch per hour of actual fishing) upon effort (boat trips or actual fishing hours) and an indicator variable signalling the initiation of SFB in respective state.

(ii) The second approach was more general wherein the catch rates were considered a parameter of fishery health/ wealth as well as fisher's success and its compound growth rate in pre SFB and post SFB periods were computed using semi logarithmic model (Power function).

The economic benefit of SFB was assessed by estimating the value of incremental growth attained due to fishing ban. The incremental weight (in tonnes) of each species was multiplied by price/tonne (geometric mean of the last three years at landing centre and retail price level) of respective species and final values were estimated. The impact of SFB on various resource group/species caught including small pelagics, large pelagics, demersal finishes, crustaceans and cephalopods were assessed by their growth rates of catches during pre and post ban period). The annual compound growth rates (ACGR) were estimated for depicting variation in catches/ catch rates over a time period, here pre and post SFB period.

Post fishing ban registered an overall increase in volume of fish catches as well as their species diversity across all states. Stock status also indicates that states with higher level of mechanisation such as Karnataka and Gujarat have higher percentage of exploited stocks that are seriously depleted and require serious attention to rejuvenate stocks compared to states like Andhra Pradesh and Tamil Nadu.The analysis indicated that incremental biomass due to SFB ranged from five to nine per cent in the selected states. This indicated that the SFB has a positive impact on the fish harvest after the ban and need to be recommended for continued implementation as a tool for sustainable marine fisheries management.

The estimated value of the incremental biomass due to SFB ranged from Rs.1,266 lakhs in Andhra Pradesh to Rs.2,809 lakhs in Tamil Nadu at landing centre price level. In Andhra Pradesh, all the resource groups showed a positive trend after the ban while in Tamil Nadu, except crustaceans, all other resource groups exhibited a positive trend after the ban period. The net social benefit was positive in all the States (Kerala-Rs.2,480.86 lakhs, Andhra Pradesh -Rs.1.097.42 lakhs). (Table 3)

Table 3 Incremental economic benefit due to SFB

Parameters	Kerala	Karnataka	Gujarat	Andhra Pradesh	Tamil Nadu
Catch (t) in 45 -60days (if there is no fishing ban)	49,344	35,900	35,523	22,265	67,015
Catch (t) in 45-60 days (if there is fishing ban)	53,785	39,131	38,720	24,046	72,377
Increment in catch during ban period (t)	4,441	3,231	3,197	1,781	5,361
Increment rate (%)	9	9	9	8	8
Value of incremental catch estimated at landing centre price (Rs. in lakhs)*	2,729	1,701	2,129	1,266	2,809
Value of incremental catch estimated at retail market price (Rs. In lakhs)	4,053	3,781	2,897	1,980	4,620

The SFB has led to reduction of carbon emission due to the absence of mechanised and motorized fishing during the period. About 103.6 lakh fishing hours (fishing effort) is reduced due to SFB, which is equivalent to 4.08 lakh tonnes of CO_2 emitted and a savings of 1,565.8 lakh litres of diesel. This indicates that an amount of Rs.82, 988 lakhs is saved (which otherwise would have been spent on diesel) during fishing ban in the year 2014.

The impact of SFB on resource-groups (specie-wise comparison) indicated that across the states, there has been an increase in the post-ban growth rate in the catches of the resource groups. In Andhra Pradesh, all the resource groups showed a positive trend after the ban while in Tamil Nadu, except crustaceans, all the other resource groups exhibited a positive trend after the ban period.

The fishermen in the mechanized sectors were willing to accept an amount for the enforcement of the ban. It varied across the centres and across the duration of ban which was simulated from 30 days to 120 days.

The attitude of the fishermen (motorized and traditional sector) towards willingness to pay (WTP) evinced mixed response in their willingness to pay for the SFB.

The study concluded that the incremental biomass due to SFB ranged from five per cent to nine per cent in the selected states. The SFB has led to reduction of fishing effort and hence carbon emission. There was a positive net social benefit due to SFB. The fishermen in the mechanized sectors were willing to accept an amount for the enforcement of the ban depending on its duration.

The relative performance of the seasonal fishing ban varies across the study States and the ranking will be Gujarat, Tamil Nadu, Kerala, Andhra Pradesh and Karnataka in that order.

But it is important to note that the period of ban in Gujarat and Karnataka are different from that of the remaining three states.

The above findings indicate that the SFB is having predominantly a positive impact on the resources and on the fishers who are dependent on the sector for their livelihood. It was also found that, the net social benefit was positive in all the States (In Kerala Rs.2,480.8 lakhs and in Andhra Pradesh Rs.1.097.4 lakhs). It can be concluded that there is substantial positive net social benefit due to enforcement of Seasonal Fishing Ban in the selected States and hence SFB can be recommended to continue.

Implications and Recommendations of this study

SFB has resulted in a positive net social benefit in the study states. This indicated that the enforcement of SFB can be continued in the study states, which will facilitate sustainability of resources as well as an increase in catch and income to the fishers. SFB can also be considered as a measure to reduce carbon emissions. While it is recommended that the SFB may continue in future, considering the complexities of the economic valuation of SFB, it is recommended that the present analysis may be improved in future by taking into account several externalities which have not been included in the present analysis. It is also recommended that the analysis may be extended to other maritime states not considered in this study.

It has been recognized that SFB alone could not be a complete measure to sustain the fisheries. SFB should be considered as one of the tools in a bundle of several input and output management measures, such as ecosystem approach, Marine Protected Area, No-take zone, regulated entry, catch quotas, certification, minimum legal size at capture *etc*. In a combination of several other measures, SFB will become more effective for sustaining marine fisheries. (Narayana Kumar *et al.,* 2015, 2017)

Payment for ecosystem services (PES)

This is an important aspect that needs to be looked into seriously. The PES includes both demand and supply side. This includes identification of potential buyers (users) of the ecosystem and the payment charged. This also requires to undertake social cost benefit analysis. This is one of the important policy instruments in the field of ecosystem valuation which will ultimately lead to green accounting. The Economics of Ecosystem and Biodiversity (TEEB) has undertaken lots of studies in this aspect across major continents.

Conclusion

In this lecture, an attempt is made to give an insight into the structure, functions and economic valuation of ecosystem services. This can be further expanded to study the different components of ecosystems and incorporate into the green accounting frame work.

It is also important to note that Economics helps to put the things in proper perspective to the policy planners by assigning value to the ecological or environmental services or benefits. However not all services can be brought under valuation as this is a subjective concept. The dynamic nature of the system and the related developments should be considered thoroughly before applying any of these methods to formulate practical policy measures.

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