THE ECONOMIC VALUATION METHODS OF ENVIRONMENT: APPLICATION TO MANGROVE ECOSYSTEM (PRODUCTS) ALONG KARACHI COASTAL AREAS.

Samina Khalil

ABSTRACT

The mangroves of the Indus Delta in the Karachi, Pakistan coastal areas provide a wealth of goods and services to people who live and work among them. However, these products are not sold in established markets. So their economic importance goes unrecognized. As a result, the expansion of regional industry, agriculture and population are permitted to threaten the sustainability of the mangroves ecosystems. This study describes various economic valuation methods of environment and their application to the broad array of goods and services provided by the mangroves and uses market data to estimate the economic value of a few of them. It then argues for the importance of more thorough mangrove valuation studies as a crucial input into policy decisions which will affect the viability of mangrove ecosystems in the future.

INTRODUCTION

This study basically focuses on the Application of Economic Valuation Methods to the Mangroves Ecosystem long the Karachi Coastal Areas. The Mangroves Ecosystem of the coastal zone of the Indus Delta is a vital wetland area in Pakistan and are of great ecological and economic significance.

The location of Mangroves forests of Pakistan being in temperate zone has unique feature as most of the tidal forests of other countries are found in the tropical areas.

The Mangroves of Pakistan occur mainly in the Indus deltas in the Province of Sindh and Baluchistan along the coastline of Arabian Sea. As late as the early 1980s, Mangroves grew all along the 240 km long coastline and occupied an area estimated to be 600,000 acres, approximately 40% of the entire tidal belt and 10% of the Indus Delta fan. (Saifullah. S .M. 1997). They were rated as the fifth or sixth largest Mangrove forests in the world (Sanedkaker 1984) and certainly the largest in arid climate.

The Indus Delta Mangroves are dependent upon forest water discharges from the River Indus as other Mangroves in deltaic regions of the world because they grow better in low salinity water and soft alluvial substrate.

Mangroves ecosystems are complex, diverse and important. The complexity exists not only in the conventionally defined biosphere but in the broader sphere of Human-Mangrove interactions. The diversity also extends to this larger ecosystem as does the importance.

In the traditional economic framework, output is a function of three factors of production; land, labour and capital. Land is broadly defined to include space for building, fields for cultivation, and natural resources such as forests and water bodies. The main emphasis of economic development strategies has been on labour, capital, and the agriculture use of land. The natural resources associated with land are meant, to be used for human benefit with little attention to the sustainability of the use. Moreover, economic growth has been given primary importance, with little attention to its impacts on the environment or the sustainability of the resource base.

The motivation behind this discussion and need of filling the gap in literature

In the traditional economic framework, output is a function of three factors of production; Land, labour and capital. Land is broadly defined to include space for building, fields for cultivation, and natural resources such as forests and water bodies. The main emphasis of economic development strategies has been on labour, capital, and the agricultural use of land. The natural resources associated with land are meant to use for human benefit. However they are treated with little attention to the sustainability to that use. Moreover, economic growth has primary importance, with little attention to its impacts on the environment or the sustainability of the resource base.

In the past, this approach was reasonable. Until the industrial revolution and the associated rapid population growth, human impacts on the environment were negligible. Pollution was localized, and resources were generally adequate to provide food and shelter to those who need them. While life spans were shorter and material well being lower, that was not due to natural resource constraints or environmental problems. In the past two centuries, it has become, increasingly clear that human impacts on the environment may be irreversible and may in time limit our own ability to continue to thrive on earth. Over the past three decades, concern about this problem has grown worldwide. The search is now underway for strategies to minimize our impacts on our surrounding while improving the quality of life of the billions of people living in poverty.

When the environmental movement began gaining strength in the 1960s, it was perceived to present a trade-off between improved standards of living and clean environment. Increasingly, however, both environmentalists and advocates of development are recognizing that to maximize living standards in the long run, we must protect the environment. Improvements in the well being of much of the world's population depend on finding ways to use our resources without destroying them.

The fields of environmental economics and ecological economics are both responses to this challenge. They constitute economist's strategies for ensuring that the decisions of individuals, firms, and governments reflect the economic importance of the environment and that the development paths we choose will be sustainable.

The environment plays four crucial roles in sustaining economic activity:

- Life support
- Supply of raw materials
- Absorption of waste products
- Supply of amenity services

Life support: The environment provides the biological, chemical and physical systems within which human life was created and on which human life depends for its survival. This includes, for example, the air which we breath, the hydrological systems on which we depend for water, and the soil fertility which allows us to grow food. While human populations can rebound from slight degradation of the services, they would not be able to survive without them.

Supply of raw materials: The environment supplies the raw materials and energy necessary for economic production and household activity. Some raw materials, such as forests, are renewable; stocks grow naturally, and humans can expect a content supply if we choose to harvest at sustainable levels. Others, such as minerals and fossil fuels, are nonrenewable; once consumed they cannot be regenerated, so we have to plan for their replacement as we use them up.

Absorption of waste products: The environment acts as a sink, which absorbs the waste products of economic and household activity. Modest quantities of organic waste can easily be absorbed by the environment and derided through natural processes. However, there is a limit to the quantity of effluent which natural systems can handle; beyond a certain level, ecosystems can no longer disperse, dissolve, or degrade the materials dumped into them. Moreover, wastes such as radioactive materials or some toxic chemicals are difficult or impossible to absorb even in small quantities. If history is a guide, the larger the economy gets, the waste will be produced relative to the limited capacity of the environment to absorb it.

Supply of amenity service: The environment provides amenity services, such as scenic beauty, which are enjoyed by humans in their outdoor activity. Although important for psychological well being, these amenities are not indispensable for continued physical existence. Because most people value them, however, they can be a source of revenue, which is sometimes sufficient to make it financially viable to ensure that they are protected; thus they can be of substantial economic importance.

The field of environmental economics exists because the assumptions of the market economy do not always hold where the environment is concerned. Environmental goods and services are often non-rivalrous, nonexclusive, or both making it difficult to force those who use them to pay for them. The difference between the perfect market and the environment constitute the fundamental reason why economic activity leads to environmental degradation. This difference created the need for the field of environmental economics, as well as for public policy intervention to allocate environmental resources through non-market means or to counter the market failures.

Conceptually, what is done when an economic value is put on a particular environmental asset such as a forest, is the identification of each of the individual services which it provides, the valuation of them, and the values to calculate the total value of the forest. Of course using some service of the forest, may preclude using other. For example, if the forest for timber is cut down, then it cannot provide life support to mammals and birds or amenities such as recreation. The total value must be valid for the forest as used for a given set of goods and services which are compatible with each other.

Economists have organized the services of the environment into a standard presentation in developing a framework for valuation. The point of departure is that the aim is to estimate the Total Economic Value (TEV) of an environmental asset. TEV is broken into use values and non-use values.

Use values are clearly identifiable human uses of the environment. This includes direct use of raw materials, both of marketed products such as timber and of non-marketed products such as gathered fuel wood, most water extraction, soil, and so on. It also includes so-called "indirect uses" of the environment, such as waste disposal, amenities like recreation or scenic vistas, flood protection, water filtration by submerged aquatic vegetation, and so on. By and large the indirect uses are not marketed, though access to parks is a notable exception.

Non-use values of the environment capture our willingness to accept (WTA) or willingness to pay (WTP), simply to know the resource will continue to exist, even though we don't expect to use it – or even see it, at any identifiable point in the future. For example, some people are willing to pay to help ensure the existence of the royal Bengal tiger of Sunderbans in Bangladesh. This is called existence of the value. A related form of non-use value is called option value; this would be the WTP for the option to come see the tigers at some undetermined point in the future. Some economists also identify the quasi-option value. This reflects the expectation that the value of the option will increase over time, as the tiger or other environmental good or service becomes more scarce. Yet another non-use value to bequest value; in this example, it would be the willingness to pay to ensure that future generations would be able to see the tigers. Thus: The estimates of the mangrove cover based upon two visual interpretations are shown below in table. On the face of it these two interpretations show a dramatic decline in the mangrove cover in the Indus delta, from about 260,000 ha in 1997 to about 160,000 ha in 1990, a loss of about 38%. This should be viewed with caution however because the land sat imagery has a resolution of only 80m compared to SPOT's resolution of 20m. The earlier image was the first attempt at interpreting mangrove cover in Pakistan and it is probable that there was an overestimate. There are also differences in each visual interpretation of the density of cover. It is also probable that the 1990 interpretation is itself an overestimate since a second interpretation of the northern part of the delta at 1:50,000 shows more blank areas and lower coverage than the 1990 interpretation at 1:250,000.

Character		**1990**		**1997**
	ha	**%**	**ha**	**%**
Dense Mangrove	68100	11.4	62600	9
Medium Mangrove	58500	9.8	NR	-
Normal Mangrove	31900	5.4	NR	-
Spare Mangrove	158500	26.6	263100	44
Mud Flats	382700	64.3	NR	-
No Vegetation	NR	-	137600	22
Sand	29600	409	44500	7
Creek	23600	4.0	162000	27
Salt Pans	1100	0.2	-	-
Total Area	**595200**	**100.0**	**60720**	**100**

The difference, which can be observed in the area, covered by mudflats, sand and creeks, can be largely accounted for by the higher state of the tide by the 1977 image compared to the low tidal state of the 1990 image. At higher tides the mudflats and sandy areas would be covered by the water and would appear more extensive in the 1990 image.

A rough comparison can also be made between the two images to see changes in the shape of the coastline. It would be that the present active delta is beginning to regress and to be eroded as the strong marine processes begin to dominate in the absence of significant revering discharge of sediment. What we beginning to see, is flattening of the bow shape of the delta and a reduction in the coastal granulation.

The implications for the future of the mangrove and its eco-system in the delta are serious and it is probable that the mangroves in the active delta disappeared due to a combination of human pressure and a dramatic change in the oceanographic conditions in these areas Thus although these areas still receives some freshwater and sediment during the flood period, the active reworking of the sediments and erosion by marine processes, makes the creek edges unsuitable for young mangroves to establish themselves. It has already been pointed out that the areas behind the creek edges are higher and drier and too saline for mangrove growth. Once the trees been cut down by human population, (three is no forestry control in these areas, it being under the Central Board of Revenue) they will not be able to re-establish themselves.

Given the present flows to the delta and the timing during the period of July to September, it is probable that any freshwater below Kotri reaches a much smaller area than the original delta. The prevailing current is down the coast from north–west to south-east , so that what water and sediments are discharged will be swept southward towards the Ran of Ketch. Previously when the Indus was in flood, it was reported by one of the earliest British surveys (Burn, 1832) that the contribution of the river to reducing saline conditions across the wider extent of the delta and to promoting mangrove growth would have been most significant.

The question then has to be asked why the mangrove remain in the northern and southern parts of the delta, if they are not receiving freshwater from the river any more? The answer probably lies in the fact that they have become more hydrologically stable over the past 200 years, that are protected from the highest energy marine processes by a series of sand bars which line the front of the creeks in the northern part. They are thus essentially relicts of the wider delta, surviving because erosion has not removed the substrate. There are extensive mudflats in the intertidal level which are regularly inundated and are therefore suitable for mangrove growth and colonization.

There is evidence however, that the salinity in the northern creeks has been increasing. In Korangi creeks for example the salinity rarely now drops below that of seawater (35 ppt) and is often as high as 45 ppt. In earlier years the salinity was apparently as low as 25 ppt. There is no doubt that mangroves can survive in saltines as high as this, and higher, but they will become increasingly stunted. So, whilst the present mature trees will survive for the next 30 years or so, provided that human pressures are controlled, the young trees and seedling taking root will not grow as tall or dense as before. We expect to see significant changes in the cover and biomass productivity, even if the mangroves are not completely lost during this time.

As long as the marine processes is there northern parts of the delta remain relatively excluded, and the mudflats continue to lie within the regularly inundated inter-tidal zone, it is probable that the mangroves will continue to survive under current flow conditions from the river. The productivity of the area will decrease due to stunting is basically a physiological reaction of the tree, which has to expend more energy in counteracting the hyper saline conditions more like the mangrove areas along the Baluchistan coast for example at Sonmiani. These are surviving with little freshwater input, mainly due to the protection from the sea, which the configuration of the coast provides.

MANGROVE ECOSYSTEM : THE ECONOMIC IMPORTANCE

From an economic point of view the characteristics of Mangrove systems are extraordinary important for a variety of reasons. For countries like Pakistan where population and economic pressures on the coastal zone are high, Mangrove forests could be termed as primary natural resource. In fact, Mangrove forests are not only valuable to the economy but coastal environment is also being protected and sustained by these forests.

The Mangrove forests have vital economic importance in sustaining the productivity of inshore and offshore fisheries. They also provide shelter and nurseries for commercial fishery species and some coastal species such as shrims. Pakistan's thriving Shrim fishery, almost entirely depends upon its Mangrove ecosystems and its exports earns to the tune of US $ 100 million annually.

A considerable proportion of fish which contributes towards domestic and foreign consumption is harboured by Mangroves during a part of their life cycle and remain depended on its food webs. This is particularly the case with panarid shrimp, which comprise the most valuable commercial species in Pakistan.

The following Table lists the Direct and Indirect uses of Mangrove products.

TABLE 1

DIRECT PRODUCTS FROM MANGROVE FORESTS

USES	***PRODUCTS***
Fuel	Firewood
	Charcoal
	Alcohol
Construction	Timber for scaffolds
Fishing	Timber for heavy construction (e.g., bridges)
	Railroad ties and house construction.
Agriculture	Fodder
	Green manure
Paper Production	Paper of various kinds
Food, Drugs and Beverages	Sugar
	Alcohol
	Cooking oil
Household Items	Furniture
	Glue
	Hairdressing oil
	Tool handles
	Rice mortar
	Toys
	Matchsticks
	Incense
Textile and Leather Production	Synthetic fibers
	Dye for cloth
	Tannin for leather preservation
Other	Packing boxes

TABLE 2
INDIRECT PRODUCTS FROM MANGROVE FORESTS

SOURCE	PRODUCT
Finish	Food
(many species)	Fertilizers
Crustaceans	Food
(prawns, shrimp, crabs)	
Mollusc	Food
(oysters, mussels, cockles)	
Bees	Honey
	Wax
Birds	Food
	Feathers
	Recreation (watching, hunting)
Mammals	Food
	Fur
	Recreation (watching, hunting)
Reptiles	Skins
	Food
	Recreation
Other Fauna	Food
(e.g, amphibians, insects)	Recreation

These direct and indirect range of Mangrove products form the basis for Mangrove-dependent economic activities vital to many coastal peoples and their countries. The communities living in coastal areas depend on harvesting the fish, shellfish, wood and other products to sustain their lives.

The value of the Mangrove resource in terms of its marketed products can be expressed in economic terms. The difficulty arises when one attempts to value those, which can be termed as free. The free services would cost tremendous amount of money and capital if other sources are utilized for the same. Since this usually gets ignored and does not get account for it results in under estimation of the total value of the Mangrove resources.

FUNCTIONS OF MANGROVE ECOSYSTEM

1. The presence of specie, Avicennia marina along the shoreline ensures the firms and stable form of shoreline and Creeks. A very vital but almost unquantifiable function of the Mangrove ecosystems is the protection of coastline from wind and ocean currents. The location of Port Qasim which is Pakistan's second largest port in the vicinity of Korangi/Phitti Creek system could be attributed as most suitable due to the natural protection it gets from Mangroves.

2. The pollutants and waste discharge due to various industrial activities in and around Karachi City find its way in the natural sink of Mangrove ecosystem. Karachi with its even growing population generate huge amount of domestic effluent which is also being absorbed by the Mangrove ecosystem.

3. The Coastal communities are benefited by a host of products and services of the Mangrove ecosystem. Fishing is the primary source of income for the majority of the fishermen residing in villages along the coast line and these fisheries depend upon mangroves for regeneration.

The Mangrove wood and leaves have multipurpose utilization. It is used as fuelwood, fodder for the livestock like camels, cattle and goats, and sometimes the wood is also useful in building houses and furniture of daily use.

MANGROVE ECOSYSYTEM – DEGRADATION AND DEPLETION

The deforestation and degradation is common among Mangrove ecosystem all over the world, A rise in coastal population, together with rapid economic expansion, has brought about an increase in consumption of forest resources and Mangroves are under pressure to supply wood and other forest products.

Mangrove in Pakistan are facing serious threats which are jeopardizing its sustainability and existence too.

Decreased Indus River Flow

This is probably the most serious problem facing Mangroves of Indus Delta. Mangroves occur preferably in deltaic regions of the world because they grow better in low salinity water and soft alluvial substrate. Their productivity increases proportionately with the availability of freshwater. Therefore, a decrease in freshwater supply means retardation in their growth. There has been a continuous decrease in Indus River discharge ever since the creation of Pakistan some five decades ago. The population of the country was very thin at that time, but has since increased progressively due to continuous migration of people from neighbouring India and fast birth rates. This has called for increased agriculture in the country and as a result a number of dams and barrages were constructed to use the Indus water for irrigation purposes. Consequently, the amount of Indus discharge has decreased gradually over the years and now only a trickle is available to the delta, except during monsoonal floods. Salinity values, therefore, have increased dramatically in the deltaic region, and presently a value of 40 ppt or more is common in some Mangrove areas. There exist no previous records of salinity values in the area past some decades, but it was appreciably lower since rice was once cultivated in Keti Bunder in the vicinity of Mangrove stands (Saifullah, 1982). Due to hypersalinity decline in Mangrove growth is now visible everywhere.

The upstream damming of the Indus River has also stopped the flow of much of the nutrient-rich alluvium. According to one estimate annual alluvial flow has decreased from a figure of 200 million tons in 1955 to a present figure of less than 50 million tons at the Kotri. Lack of sediment also affects the Mangroves negatively.

The solution to the problem requires integrated efforts. The first step is to assess exactly how much damage has been caused to vegetation due to these problems.

The ideal solution to the above mentioned problems will be to restore the normal flow of Indus river to the delta, but this does not seem to be a practical option, especially when one considers the increasing demand for agriculture in the country. Recently, an Indus Water Accord by Government of Pakistan apportioned the use of Indus water between provinces and allowed only a meager amount of 10 MAF to be discharged into the delta. This amount will be less than 35 MAF that is available now and much less than 150 MAF that was available decades ago before the construction of dams (Meynell and Qureshi, 1993). Thus, the situation is likely to worsen with time. The government may prevailed upon to increase the amount to some extent. However, coastal scientists first need to work experimentally and numerically with flow models, the minimum requirement of freshwater for the Mangroves. Only then can one argue the case strongly with the authorities. Such studies would be an obvious undertaking for a coastal management program.

Grazing and Harvesting

Mangroves leaves are eaten by cattle and camels and are considered to be very nutritious. According to an estimate as many as 16,000 camels browse on Mangroves in the Indus Delta and as many as 11,000 cattle feed on them (Qureshi, 1993). The animals seem to have adjusted well to the diet (Saifullah, 1984). Mangroves are also harvested as fuel-wood by local habitants at the rate of cp. 173 kg of wood per month per house hold and 18,000 tons per year for the entire delta areas (Meynell, 1993).

There is the problem of overfishing in the creeks, which is not only affecting resources of the delta but also those of the shelf.

Harvesting of Mangrove parts may be as serious a problem as the hypersalinity, in there decline. In order to manage properly, it is important to assess the damage caused to Mangrove cover annually from this source. IUCN has made a survey in Korangi Creek area about the local consumption of Mangrove wood as fuel (Meynell, 1993) and the Sindh Forest Department surveyed the grazing and stall feeding by camels and cattle respectively in the delta region (Qureshi, 1993). But, none of the organizations have provided quantitative estimates of rate of loss of Mangrove cover by these two activities over a time period. In any case a number of strategies may be suggested to address these problems. Firstly, browsing by camels and stall feeding by cattle can be either completely stopped or allowed only within the sustained yield. Present day revenues collected from sale of Mangrove products are minimal and should be discouraged completely. Strict law enforcement need to be implemented and poachers heavily find. A two months ban on fishing may be reintroduced to prevent decline in fishery.

The ideal solution to the problem is to provide alternate cheap fuel and fodder to the local habitants who use Mangrove parts mainly because they are cheap and easy to obtain. Provision of natural gas, which is cheap and plentiful in Pakistan, may be the best choice. Similarly, if they are encouraged to go into alternative professions, other than fishing, it may improve the situation markedly.

Urbanization

The population and size of the city of Karachi are constantly increasing, estimated to be over 10 million in 1995. Recently, Pakistan's second largest port, Port Qasim, was established in Korangi Creek area at the expense of thousands of acres of Mangrove forests. A nearby steel mill and the port is supported by a new town where people working in the two giant complexes live. Thermal pollution and solid wastes originating from these sources are a direct threat to the Mangroves. Dredging operations in the channels and creeks leading to the port for better navigation has a very detrimental effect on the young seedlings and pneumatophores of Mangroves due to sediments cover and cutting-off of oxygen supply.

An immediate step to prevent further destruction of the Mangrove vegetation must be to regulate coastal development in the area may be regulated and restricted to areas that will do the least harm to Mangroves. Coastal erosion can also be aided by planting selected species of Mangroves on the banks. The dredged material must be disposed off far away from the mangroves. Mangroves experts need to be consulted at every step.

Pollution

According to an estimate there are more than 6,000 industrial units of large and small scale in Karachi area alone, all of which discharge their effluents, directly or indirectly, untreated, into the Indus Delta. The major source of industrial and domestic pollution is the Lyari River, whose spillway lies close to Karachi harbor. The other is Malir River that spills into the Korangi Creek. Industrial pollutants include all types of heavy metals and hazardous chemicals. As many as 170 tanneries have also been established in Korangi, which discharge heavy amounts of chromium in the nearby creeks (Meynell and Qureshi, 1993). In addition, the steel mill is a source of iron pollution in the area. Agricultural pollutants including fertilizers and residues of pesticides and herbicides also make their way into the delta as the river collects these hazardous substance along its source through the country. Fertilizers result in eutrophication and are responsible for abnormal phytoplankton blooms resulting in high fish mortality. The organometallic compounds and chlorinated hydrocarbons are another toxic source of pollutants.

Oil may be the most serious threat to Mangroves. It physically covers the pneumatophores and prevent access of oxygen to the roots, thereby killing the plants by suffocation. Oil pollution in Karachi harbor and Korangi Creek area is very serious and is mostly sourced from the sea. According to one estimate some 20,000 tons of oil find its way to Pakistani beaches, harbors and fishing grounds annually. There are four major sources of this oil, near shore bilge cleaning, leakage from vessels, accidental spills and refinery effluents.

The steel mill, Port Qasim, Korangi Power Plant, West Wharf Power Plant and Sindh Alkalis are also sources of thermal pollution in the area, and may collectively discharge some 1500 million cubic meter of warm water annually.

Pollution in general may not be too serious a problem for Mangroves as they can resist even doses of domestic, industrial and agricultural effluents. There are even suggestions to use them as bio-filters for land-based pollution entering into the sea. Domestic sewage seems to invariably encourage the growth of Mangroves because of its heavy load of nutrients and fresh water.

However, even though the different types of pollutants may not be affecting the mangrove growth, they are certainly toxic to all species of animals living in the ecosystem and therefore, may eventually destroy it. The only way to avoid this catastrophe is to treat the effluents before they enter the area. As yet, there are no treatment facilities for pollutants in the region, though some treatment plants for domestic sewage exist in Karachi area. These are quite inadequate to handle the entire city's load, which is produced at a rate of more than 2000 tons of BOD per day.

An important aspect of combating pollution in the region is the regular monitoring of the levels of pollutants in the substrate and organisms of the area. Marine pollution is an international problem and, therefore, cooperation with international organizations may be sought in fight.

Sea-Level Rise

The response of Mangroves to the threat of sea- level rise depends on the balance between the rate of the rise and the rate of sedimentation or peat accumulation by mangroves. If the former exceeds the latter, then Mangroves will retreat or disappear as on Brmuda. The sea level locally had been rising at a rate of 28 cm/100 years whereas the rate of peat accumulation was only 8.5 to 10.6 cm/100 and as a result the Mangroves perished. If, on the other hand, the rate of rise equals the sediment accumulation, then the Mangroves can continue to flourish.

Recent estimation of sea level rise of 1.1 mm $year^{-1}$ at Karachi during the period 1860-2000 AD, is well below the average global rate. No meaningful estimates of rates of sedimentation in Mangroves of Indus Delta are available. However, due to continuous decrease in sediment loads of the Indus, these rates must be small and it is more likely that Mangrove forests of Indus Delta will be overrun by the rising sea.

Socio-Economic Issues

Poverty, and its associated deprivations, seem to be the source of all socio-economic problems along the coast, including the over-exploitation of Mangrove resources. The local dwellers, if provided with alternatives to fishing and harvesting Mangroves, will tend not to over-exploit the ecosystem. Even if these job opportunities are related to the Mangrove ecosystem itself, it will not only prevent misuse but also guarantee continuous management of Mangroves by people who actually live beside them. Establishment of marine parks, ecotourism and mariculture facilities, and honey-bee farming are some of the alternatives that may be offered to the local people.

Some Mangrove areas in the delta which offer landforms rich in wild life could be treated as marine parks, completely protected from human interference. The objectives of such parks will be:1) protection of the Mangrove ecosystem along with its biodiversity, 2) research areas for scientists and 3) recreation and education for public. The local people should be given priority for jobs in the parks since they live next to them.

However, caution is needed as the excessive and indiscriminate use could overwhelm the Mangrove ecosystem. The best policy is to use only the barren or less-populated areas for this purpose. In Pakistan, a certain proportion of barren areas may be used for pond culture of shrimps. This could be economical and not only cover the management expenses, but also provide job opportunities for the local people.

Apiculture or honey-bee farming is a venture which will have only beneficial effects for the Mangroves as it encourages cross pollination, Mangrove forests are noted for high quality honey production. India and Bangladesh are major producers of Mangrove honey. This profession needs little investment and may be ideal for the local people as a side occupation. The product is a renewable resource and is non-perishable.

Lack of Public Awareness

Lack of public awareness about ecological and environmental issues may be at the heart of the plight of deteriorating coastal ecosystems around the world. In case of economically-important systems as the Mangroves of the Indus Delta, such ignorance is self defeating. Until recently these areas were considered merely as wastelands with nothing to offer to mankind. If their importance had been realized by planners and policy makers at an early stage, perhaps there would not been such a drastic cut in the Indus flow into the delta. Though the educated populace now seems to be better aware of the economic and ecological importance of Mangroves following a number of public fora and articles appearing in press, the Villagers of the delta are not. Even today, they believe that Mangroves would never perish no matter how much they are harvested. They are also ignorant of the relationship between the Mangroves and the fisheries.

NATURAL RESOURCE ACCOUNTING

Natural Resources Accounting (NRA) may be defined as a methodology for the presentation of environmental, resource and economic information. Its aim parallels and extends that of national income accounting, viz: to provide an information framework suitable for analysing the performance of economic-environmental systems. This analysis is facilitated by:

i) Consistency in the presentation of diverse data;

ii) Formation of a basis for a conceptual economic-environmental framework;

iii) Provision of a common basis to facilitate discussion and the interchange of ideas; and

iv) Description of the status quo.

Rationale

The rationale for NRA is usually couched in terms of deficiencies in the System of National Accounts (SNA). National accounting was developed in response to governments' wishes to extend a stronger influence over their own economics through macroeconomic policy. Its deficiencies are well known to economists, and much effort has been spent on improvements. Criticisms of national accounting tend to fall into two categories. Firstly, the SNA uses monetary units exclusively, and so documents only those stocks and flows of goods and services which are openly traded in the marketplace. Elements of the economy for which data are difficult to obtain or which cannot be easily quantified in monetary terms are excluded; e.g. natural resources and environmental services, as well as some aspects of the informal sector. Consequently, the SNA and its indicators do not monitor all activity relevant to economic management. Secondly, neoclassical economics is sometimes construed as placing emphasis on growth, in particular short-term growth of production as reflected in the Gross Domestic Product. Given that economic activity is ultimately dependent on natural resources and that these are inadequately documented in the SNA, the true benefits and costs of economic growth, particularly in the long-term, cannot be indicated. The aim of natural resources accounting is to make the links between economic development and environment can be more accurately estimated. Economics ultimately depend on the environment through the use of resource stocks and environmental services. A more integrated framework for the analysis of both economic and environmental processes, interactions and performance is needed.

NRA Methodologies

There is a diversity of NRA methodologies, which can be broadly grouped into:

i) Those using monetary units;
ii) Those using physical units; and
iii) Those using a mixture of economic and physical units.

Monetary Approaches to NRA

These approaches have concentrated on direct modification of the System of National Accounts. The objectives of these activities have been: to make the use of natural resources and environmental service more explicit within an existing accounting framework; and to adjust certain aggregated economic indicators, generated by the SNA , so that social welfare is more accurately represented. The following have been attempted:

i) Expanding the list of commodity and service flows to include all physical non-market inputs and outputs;
ii) Emphasizing process distinction as the basic criterion of sector definition.
iii) Imputing monetary values to input and output flows that arise when any sector of the economy chooses to employ the services of the environment;
iv) Negative adjustment of Gross National Product (GNP) to reflect the social damage caused by pollution;
v) Adjustment of Net National Product (NNP) by an amount reflecting deterioration in the stock of environmental capital.

An alternative monetary approach which deserves more attention, is the social accounting matrix (SAM – see for example,* Pyatt and Thorbecke, [1976]. This accounting framework may be more amenable to making environmental use more explicit. The monetary approach to NRA has two important advantages: national accounting is firmly entrenched in economic management, and monetary units are familiar to resource managers as well as economic managers. However, the monetisation approach has two problems. First, it depends on our ability to put money values on the losses from resource degradation – e.g. deforestation – and there are formidable problems in valuing such things as the forest's functions in watershed protection and biodiversity. Second, ecological systems are complex and the richness of the interaction may not easily be captured by the monetisation process.

* Pyatt and Thorbecke, 1976, 'Social Accounting Matrix-A Monetory Approach'.

Physical Approaches to NRA

Physical approaches attempt to document stocks and flows in physical units. Their rationale is based on the treatment of 'externalities' by economics, and one inconsistencies between economic theory and certain fundamental laws of physics. Two strands may be identified: materials balance and energy. Materials balance were pioneered in the late 1960s. This approach emphasizes production of residuals and subsequent pollution, by enlarging on the economic view of inputs to and outputs from production processes. It draws largely from the transactions or flow matrix of input-output modeling, whereby the inputs to and outputs from each economic sector are documented. Same criticism can be made of these physical approaches, as was made of the monetary approaches. Some variables are better expressed in monetary terms; e.g., the price or value of physical commodities is as important to managers as its physical quantity, quality energy content. Consequently, such physical accounts will have limited appeal to managers even though they may have a sound basis in a 'global' or physical sense.

Mixed Unit approaches to NRA

The compromise is to develop mixed accounting frameworks. Such structures have been researched in Canada and the USA (e.g.* Repetto [1989]).
These approaches are chracterized by:

i) Modification of the SNA, making monetary flows associated with maintenance of resource stocks and environmental quality explicit;
ii) Design and construction of accounts which describe environmental processes and interactions in physical units; and,
iii) Linkage of the above via quantification, in both monetary and physical units, of flows of goods and services in the economic-environmental interface.

The main constraint to the construction of such expanded accounting frameworks is cost. The benefit to be derived can be enhanced if:

i) A scientifically sound concept of interaction between variables underlies the accounts;
ii) Construction of the accounts is issue-driven and not data – driven, so that they provide information as needed, not data as available;

* Repetto, 1890, 'Wasting Assets: Natural Resources in the National Income Accounts'. World Resource Center.

iii) The accounts focus, on key variables and relationships. Monitoring trends in environmental and economic production functions;

iv) The accounting work is internally consistent;

v) The accounts address specific management and policy issues;

vi) The accounts are capable of interaction with other tools used in decision and policy analysis.

Available information on the various mixed approaches to NRA gives little indication of value of the accounts. The role of the proposed accounts appears to be the precise use as dominated by their being a repository for environmental statistics. The approach developed by the author (see* Gilbert and Hafkamp, [1986]) and discussed below attempts to combine the best elements of the various approaches while addressing the above six points explicitly. The essential characteristics of this approach are as follows: Data are presented in a variety of units, as determined by the information to be communicated and the needs of the user. Users comprise economic, resource and environmental managers, at national and other spatial levels. A variable – e.g. timber – may be presented in more than one unit – number of trees, area felled, volume of timber, cost of extraction, market value, etc. The accounting framework is modularized, and consists of three accounts:

i) Stock Accounts, describing the quantity and quality of natural resource stocks in physical units;

ii) Resource User Accounts, describing the use of these stocks within the environmental-economic interface in a mixture of physical, monetary and other units; and

iii) Socio-Economic Accounts, describing economic activity (in monetary units), as well as demographic elements which bear on the environment (labour force, recreation), and governmental policy for environmental-economic management (e.g. quotas).

The Resource User Accounts provide a bridge or link between the Stock and Socio-Economic Accounts. Each of these accounts consists of sets of sub-accounts based on classifications of resource stocks. Resource users and socio-economic activities. All sub-accounts present information in the form of a 'balance' documenting causes/inputs and effects/outputs of a particular production function. This approach from the input-output components of traditional accounting and input-output modelling. Production functions, particularly in the economic-environmental interface, are generally unknown but their behavior can be monitored via such an approach. This serves to increase our knowledge of economic and environmental interactions.

* Gilbert and Hafkamp (1986), 'Natural Resource Accounting System'.

Use of Natural Resource Accounts

The natural resource accounting framework described briefly above is intended for use in four specific areas.

Database: Disaggregation permits the presentation of more detailed information. Consequently, the accounts comprise an extensive database. The structure of the accounts is 'cause-and-effect' or 'input-output', and so its database is also structured along these lines. This structure facilitates access to data, but also serves to identify links between variables. Since construction of the accounts is intended to be issue-driven and information is presented on identifiable 'key variables', the database consists of relevant data, and is repository for the full range of environmental statistics.

The major constraint to any accounting framework is data, due to: irregular and unsystematic data collection across authorities responsible for data collection; the absence of complete sets of data for any one year (very likely for the Resource User Accounts); collection of data at different spatial levels; the absence of data adequately describing the multi-disciplinary nature of resource and environmental issues; and the absence of data adequately describing cross- sectoral or cross-resource issues. These all complicate the construction of resource accounts.

The accounts should be seen initially as an 'organising concept' rather than a practical tool. Their main role is to present a mixture of information in such a way that economic and environmental linkages cannot be ignored. Data deficiencies will be a less severe constraint with such a perspective. In addition, the accounts will play a major role in identifying which data are unavailable, inadequate and desirable. This in turn indicates priorities in data collection. In addition, construction of the accounts should be evolutionary, responding to specific issues and not available data. For example, the Resource User 'livestock' may be selected, and a preliminary sub-account developed. This activity is related to water availability and to rangelands quality, and so these sub-accounts (of the Stock Accounts) can be partially developed. 'Livestock' has repercussions on economic activities via exports, as well as on subsistence of the rural population. This leads to partial development of the Socio-Economic Accounts. Through this evolutionary approach, the accounts will move towards being a practical tool. It also permits ongoing evaluation of the benefits derived versus the costs of construction.

Monitoring: Resource accounts, as with income accounts, are intended to be constructed on a regular basis. Consequently, the collection of consistent data means that the accounts perform a monitoring function, essential in the identification and evaluation of trends. Specific areas where such a monitoring role is important are:

i) Stock depletion and enhancement;

ii) Rates of resource use and relevant multipliers;

iii) Control of resource characteristics such as age and species, composition, ore grades, sterilization of reserves, etc.;

iv) Locational aspects or resources, such as, which resources should be used first, and where;

v) Temporal aspects such as rates of use over time, optimal turnover or rotation times;

vi) Substitution of resources in both production and consumption;

vii) Conservation and/or recycling of materials and energy;

viii) International trade in natural resources;

ix) Pollution and other environmental impacts at regional, national and international levels; and

x) Effects of fiscal instruments and policies on the natural resource base.

Conflict Identification and Resolution: A product of the monitoring role of resource accounts is the identification of problems and issues. In time, they may also be capable of serving as an early warning system, giving advance notice of potential conflicts. Management, whether of the economy, natural resources, or the environment, is multi-objective and requires resolution of conflicts between competing objectives. Management is also multi-disciplinary, since no single discipline can provide both accurate and comprehensive information. Natural resource accounts, by providing a wide range of information and representing a diversity of disciplines and interest groups, can assist managers in the broader context of multi-objective analysis of resource issues.

A special problem area in natural resource management occurs where, there is competition between different users for one resource, or where use of one resource adversely affects another resource or its user. Resource management is traditionally single use or single resource. Cooperation between managers in such situations requires mutual understanding and communication. A common source of information improves this communication and, if the links between resources and users are specified in this source, both communication and understanding are enhanced. Natural resource accounts attempt to be such a source.

Integration: Economic and environmental management uses a number of different tools. Integration pertains to interactions between accounts and these techniques. At least, two areas of such interaction can be identified. The first is with modelling, whether conceptual or computer. Prediction of future economic or environmental events is based on some understanding of the relevant production functions. However, our knowledge of these functions is only approximate. Resource accounts, by monitoring key elements of these functions, identifying trends and improving this knowledge, may improve our estimations of future events.

Computer modelling takes this interaction even further. Such models make explicit formulation of the productions functions; and so are very dependent on available knowledge and data. Partial validation of models can occur by comparing outputs with historical information contained in the accounts. Finally, models can generate estimates of future accounts and/or their indicators. Model output is then in a familiar format and the results communicable. This greater consistency between data, information, model inputs and outputs encourages more effective communication at various levels of management, and between management and the developers of management tools.

Perspectives

Natural resource accounting aims to encourage a more integrated approach to both economic and environmental planning. The use of the mixture of units is generally considered the most desirable approach – it avoids forcing the expression of data in a single unit, for reasons of consistency, convenience and to serve existing theory, rather than for the purpose of communicating useful and objective information.

Construction of the accounts, in any country, should adopt an evolutionary approach. It should begin with the selection of one or two issues pertinent to national economic management (e.g., livestock and rangelands degradation, agricultural practices and erosion). Aggregated accounts at the national level could then be constructed, and a range of indicators developed. This initial activity would generate three spin of activities. Firstly, interrelationships between the selected issue(s) and other resources, resource users or human activities, not initially envisaged, may be indicated. This may lead to the construction of additional accounts. Secondly, additional or supplementary data collection activities may be needed. The third activity is disaggregation of specific aspects of the accounts; e.g. spatially, or, say, specification of commercial livestock as a subset of the livestock sub-accounts. None of these activities should proceed without careful evaluation of their need and their contribution to the whole.

It is obviously essential that construction of resource accounts involve direct liaison with data collecting authorities, data analysts and data users, perhaps via a national team comprising representatives of relevant government authorities. The work should also be conducted in conjunction with the development of other management tools, such as indicators.

ECONOMIC VALUATION OF MANGROVE ECOSYSTEM PRODUCTS.

As mentioned earlier, Mangroves are a unique type of ecosystem – the combination of land, water, trees, animals and human results in the multiple goods and services that the mangroves provide. They are also fragile ecosystems and the change of one part of the system may have profound effects on other parts. This interdependence of uses and production traditionally has been had to communicate to policy makers and others who see the mangroves as a low value resource to be exploited. It is precisely this multiplicity of uses and interdependencies that a complete economic analysis is imperative to evaluate benefits as well as the costs.

These goods and services may have observable prices as they are marketed and some are non-marketed as they are thought to have little or no value or are difficult to quantify. The first category of goods and services often is referred to as pecuniary goods, that is they can be exchanged and valued using existing market prices. The second category may be environmental materials or resources. These would include the biological production of food that supports Mangrove-dependent plants and animal species and the role of mangroves as spacing or nursery areas for finfish and shellfish. Although these foods and services are not priced, they still are valuable. A major task is the economic valuation of these environmental resources.

The process of economic valuation of the various Mangrove goods and services present many interesting challenges.

The environmental and resource economics literature illustrate a number of techniques that have been used to place values on difficult to measure – effects, for example, that value of Mangroves in preventing storm damage also can be calculated from an analysis of damage with and without the presence of Mangroves. The value of damage prevented by retaining the Mangrove barrier is an implicit valuation of one of the benefits of Mangroves.

In this study however an attempt has been made to value some of the essential Mangrove products which are specific to the coastal village along the Korangi Creek, which lies to the south-east of Karachi.

A good study is to discuss the economic importance of the products identified in table-1 and 2 in terms of their value and share in the Gross Domestic Product. But this study is confined to the valuation of those mangrove products which have no share in the Gross Domestic Product as they are not being accounted in any national financial document albeit these products have economic importance.

To undertake valuation of certain Mangroves products, this study is based on the secondary data available in the "Natural Resource Use Survey", Korangi / Phitti Creek, 1992, Volume I and II, by IUCN Pakistan Programme. The time and resource constraints for this study do not allow a comprehensive natural resources survey of the Mangroves of coastal areas of Pakistan but a rough estimation is done to put value to certain important goods available in the area.

The various valuation methods in the literature require varied information for full and reliable estimations. For instance, for Demand/Supply analysis, the areas must be known to interpret the marginal willingness to pay curve. The total willingness to pay for a certain product is area under the demand curve of the good. Similarly costs can be calculated as the area under the supply curve.

The information and data available in the above mentioned studies of IUCN restrict the valuation of Mangroves to only two Mangrove products i.e. Mangrove wood and fodder. The valuation methods is "Market prices" Method and a simple exercise of multiplying the quantity consumed with the average market prices of the goods is done.
Although the market transactions of these goods takes place but this appear not to be recorded in the accounts.

The Survey methodology adopted in IUCN's Study is, that users of certain Mangrove products like Mangroves wood and Mangrove fodders were interviewed to quantify the consumption level of these goods in the survey area. The respondents were selected at random from 100 houses in the following four coastal villages of Korangi, Creek Area.

		Population 1992	House Holds 1992 Estimated
1)	Ibrahim Hydari	61,442	6,904
2)	Chasma	7,303	769
3)	Rehri	23,612	2,951
4)	Lat Basti	2,898	326
	Total	95255	10950

All the individuals interviewed were users of mangrove products like wood, fodder and fisheries.

Mangrove wood as Fuel

The Mangroves wood is basically and mostly used as fuel in these villages. People either buy it from tal (Shop where wood is sold) or collect it themselves.

The households which buy wood from tal, their average use per day per household = 7.7 kg.

The average price of Mangrove wood is Rs. 1.34 kg.

Hence a rough estimation of consumption of Mangrove wood by 100 households is 770 kg per day and monthly consumption of these households comes around 23100 kg.

The consumption of wood by collection has been estimated on average as 94 kg per visit to Mangrove forest and average visit per month is 4.6, hence the average quantity of Mangrove wood collected by individuals in sample is 432.4 kg. The total value of fuelwood which is used by the community in the sample survey comes around Rs. 579.461 by using market price of Rs. 1.34 per kg.

TABLE – 3
Estimation of the Total Value of Mangrove Wood, Collected and Purchased per month

Total survey Area	Total Consumption Area	Total Sale and Collection per month	Difference
Four Coastal Villages	kg 1395322	kg 996383	kg 398939
Total Value (Average Price Rs 1.34)	Rs 1869731.48	Rs 1335153.22	Rs 534578.26

Table -3 shows the total consumption level and total collection and sale of Mangrove wood per month. The amount of wood consumed per month must be equal to the amount collected by wood cutters and individuals plus the amount sold from the tals. The difference shows that amount of wood sold and collected is under estimated.

Mangroves Leaves as Fodder

The leaves of Mangrove tree Avicennia marina are used for animal fodder. The residents of coastal areas purchase or collect Mangrove leaves to feed the domestic animals such as cattle, goats and sheep. The fodder collectors were interviewed to ascertain the average quantity of fodder collected per month. The area of fodder collection is Korangi, Kadino, Pitiani, Port Qasim and Khuddi. Fodder and mangrove wood is collected from the same areas. The average collection of fodder leaves is 179 kg per visit and visits are made almost every day. The average price of fodders is Rs. 0.62 per kg. Hence the total value of fodder collected by the sample in the survey is Rs. 3329.4 per month.

The individual household users of fodder interviewed in the survey areas for their livestock, termed Mangrove leaves as predominant fodder. The average consumption of fodder is 7 kg per day / household, and can be as much as 40 kg per day/household depending upon the number of animals. The fodder is bought from small individual suppliers at the local jetty or from tals with an average price of Rs. 1.25. The total value of fodder consumed by household who purchase the fodder comes around Rs. 2600 per month per household.

TABLE – 4
Estimation of the Total Value of Mangrove Fodder, Collected and Purchased per month

Total Survey Area	Total Consumption per month	Total Sale and Collection per month	Difference
Four Coastal Villages	Kg 535650	kg 53703	kg 481947
Total Value (Average Price Rs 1.25)	Rs 669562.5	Rs 67128.75	Rs 602433.75

Table-4 shows that amount of fodder consumed by livestock per month in all the coastal areas and total value of this fodder in the area under study. The difference between the total consumption and total sale and collection is because of underestimation of number of fodder collectors.

Mangrove Fishery Resources

The primary source of income and activity for coastal village community is fishing. Fish and fish products accounts for 0.8% of the GDP.
A rough estimates of total quantity of fish products is 250 kg to 1500 kg per trip which is 10 to 12 trips per month. The total value is around Rs. 1440000 as fish is sold with the average, market price of Rs. 80 per kg.

Conclusion

The mangrove wood is the principal energy source and fuelwood supply for the coastal communities in Pakistan. Other products of Mangrove ecosystem like different kinds of fisheries and shirmps have vital economic importance. This study is intended to highlight and help environmentalists and policy makers to understand monetary valuation of few products of the mangrove ecosystem and suggest that this resource is of significant economic importance to the country. The local communities tend to overexploit the mangrove resources for livelihood and other uses. This jeoperdises the sustainability and the very existence of these resources. The approach adopted for valuation of mangrove resources is market prices which reflect the marginal social value of an environmental good or service. The estimated monetary values of Mangrove wood, fodder and fisheries reflect the economic importance of these resources and contribute to making resource management and conservation decisions.

The estimates indicate the need for more research on the actual physical productivity of Mangroves and Mangroves-dependent systems. One particular need is more information on incremental changes in a Mangrove Ecosystem. Use of an appropriate analytical framework and valuation techniques can lead to much better estimates of the values of the various goods and services produced by a Mangrove Ecosystem.

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