ECONOMIC VALUATION OF MANGROVE FORESTS IN HARA PROTECTED AREA

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ABSTRACT

Mangrove forests are among the richest coastal ecosystems which provide a wide range of economic and ecological advantages services. The mangroves are sources of highly valued for developinga commercial products and fishery resources and also as sites burgeoning eco-tourism. Yet despite their ecological and economic importance, the rate and magnitude of mangrove conversion is relatively unknown. These forests can be considered as exceptional wetland ecosystems in southern coastal of Iran which are highly fertile and in terms of biodiversity are among the most important resources. Hara Protected Area with various socio-economic and ecological features includes 8000 ha of these forests. This research was carried out to determine fodder harvest value as one of the direct use values based on data collected from questionnaire and sampling throughout Hara Protected Area during all seasons of 2011 and 2012. The results reveal that the poor pastures and economically undeveloped infrastructures in the region have led the local communities on the coastal areas to supply the livestock's fodder from mangrove leaves. Hence, the household incomes rely considerably on these habitats product, while economic evaluation of the harvested fodder reaches $124686 annually. Recognizing the importance of mangrove forests and their role, protection of this resource must be considered seriously.

Key words: Economic Value, Use Value, Coastal Ecosystems, Mangrove Forests, Hara Protected Area

INTRODUCTION

The environment provides several different types of value to people, use and non-use, and these are defined by the Total Economic Value (TEV) framework (Pearce and Turner, 1990). It has been argued that previous lists of goods and services have not included the less tangible benefits derived from the environment (Brito, 2005). Mangrove forests occur along sheltered inter-tidal coastlines, mudflats, and riverbanks along with the brackish water margin between land and sea in tropical and subtropical areas (Sathirathai, 2000). Mangrove resources are available in approximately 117 countries, covering an area of 190,000 to 240,000 km^2 which support a wide variety of ecosystem services (Barbier, 2007).

Mangroves are extremely important coastal resources, which are vital to our Socio-economic development. The majority of people living in or near

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mangrove areas and most communities depend on local resources for their livelihood (Barnes, 2000; Walters, 2005; Costanza, *et al*., 1997; Barbier, 2007). These forests are one of the most biologically important ecosystems in the coastal areas; they contribute to energy flow between land and sea and provide vital ecosystem services (Blaber, 2007). Nevertheless, mangroves continue to disappear at an alarming rate because of increased coastal development, tourism, and aquaculture (FAO, 2007). Moreover, mangroves provide a direct benefit to humans through the provision of various extraction-based resources such as wood, lumber, honey, tannins, salt, and artisanal fisheries for mussels, crabs, and fish (Alongi, 2002).

The mangrove forests have been shown to sustain more than 70 direct human activities, ranging from fuel-wood collection to fisheries (Lucy, 2006). Although coastal communities and scientists have long realized the value of mangroves policy makers have, until relatively recently, failed to recognize the range of services and products provided by intact mangrove forests (Barbier, 2006; Valiela *et al*., 2001).

Evaluation of mangrove resource primarily means the continuous assessment of the features of a system. Economic analysis aims explicitly to estimate Total Economic Value (TEV) of the mangrove resource which has probably been recorded in more details in economic evaluation process which seems essential for the impartial comparison of all utilization methods. The consumption values of resources and services are usually calculated directly based on vending profits in the market. There is a correlation between the indirect use value of ecological functions and production value change or any protected activity (Bann, 1997; Pearce and Warford, 1993).

The world mangrove forests have been valued at approximately US $181 billion (Costanza, *et al*., 1997). Sivakumar *et al.,* (1997) believes that the direct use of Avicennia species as livestock's fodder has a great value (Sivakumar *et al.,*1997). According to Environmental Information System Newsletter (ENVIS) report, Avicennia leaves are frequently used for feeding cows and camels in Konkan, Goa and Gujarat (ENVIS, 1998). Throughout Eritrea, Avicennia leaves are vastly used for grazing camels, goats and cows and, in this regard, are the best fodder. Furthermore, the annual consumption of Avicennia was estimated to be 10 ton/yr, whereas its production was approximately 20 ton/ha/yr (Tecleab, 2000).

According to the study carried out by Sathirathai and Barbier, the economic direct use of mangrove forests for local communities in southern Thailand was $27264-35921/ha. The mean economic direct use of mangrove forests for local communities was $88/ha/day and for the forest's various goods of direct use value was $632-823/ha (Sathirathai, and Barbier, 2001). While

fishery value comprises 45.5% of direct use of mangrove forests TEV in Gujarat region where the tip cutting and fodder supply contributes 51.6%, fuel value 2.8%, and construction value 0.1% (Hirway and Goswami, 2002). According to Quereshi, (2000), the inhabitants of coastal villages in the states of Sindh and Balochestan supply the livestock's fodder from the twig-cutting of Avicennia marina (Quereshi, 2000). The mean economic value of marine reefs varies from $600000 to $100000/km annually, while the annual value of mangrove forests exceeds $900000/ha. The services value obtained from the mangrove ecosystems of Samoa forests is estimated to reach 50 million dollars/ha and 3.5 million dollars/km in United States and Thailand, respectively (UNEP-WCMC, 2006). Mangroves' annual economic value based on their goods and services ranges from $200000 to $900000/ha (Wells *et al*., 2006). Walton *et al.,* (2006) estimated the direct benefits from fishing, ecotourism and timber obtained from Philippine's mangrove forests, for local communities to be $315/ha annually (Walton *et al.,* 2006).

MATERIALS AND METHODS

The Hara Protected Area (HPA) lies at longitude $55^0$21´-$55^0$52´ east and latitude $26^0$40'-$27^0$40' north between Bandar Khamir and Queshm Island (Fig.1). It is regarded as one of the most strategic marine areas of Iran. The area of mangrove forest in HPA is 8000 hectares which constitutes about 40% of the total mangrove forests of Iran (Danekar, 2006). This zone undertook the protection in 1972 with the extent of 82360 hectares known as Hara Protected Area, Then, extended to 85686 hectares in entitled "National Park" and in the 1975 joined MAB (Man and Biosphere). The zone boasts several estuaries, creeks, a mangrove vegetation cover and an exceptional biodiversity. In addition, a considerable number of inshore and offshore birds migrate to this zone every year. The unique coastal-marine features depict conservation as a tourist's site. Furthermore, there are many settlements, coastlines and mangrove forests in the study area which are mainly dependent on natural ecosystems. The mangrove species found in the southern coasts of Iran include: *Avicennia marina* belonging to the Verbenaceae family and *Rhizophora mucronata,* belonging to the Rhizophoraceae family. Previous studies indicate that only *Avicennia marina* species form the vegetation cover of the HPA (Dehghani, 2007).

The research region has been carried out in an area extending 400000 hectares, including Khamir town and 49 suburbs during 4 seasons-from fall 2011 to summer 2012 collecting data through sampling and questionnaire. Out of 50 settlements in the region, 22 villages along with Khamir city were selected for the study. The studied region was divided into two northern and southern zones, in order to reassure the accuracy of the results, and the necessary data was collected. 7 settlements are located in the north and 15 in the south of HPA. 379 questionnaires were randomly distributed among the households. The questions

were categorized into three groups; *social*, *environmental*, and *economic*. In additional

After removing the unacceptable questionnaires, 343 of them were analyzed using statistical measurements of the SPSS software. Analysis of the result was done with respect to the socio-economic and ecological differences between the areas in the south and north of the HPA. This difference is related to the mount of consumption and fodder value between two areas. Finally, total economic value of mangrove forests was estimated.

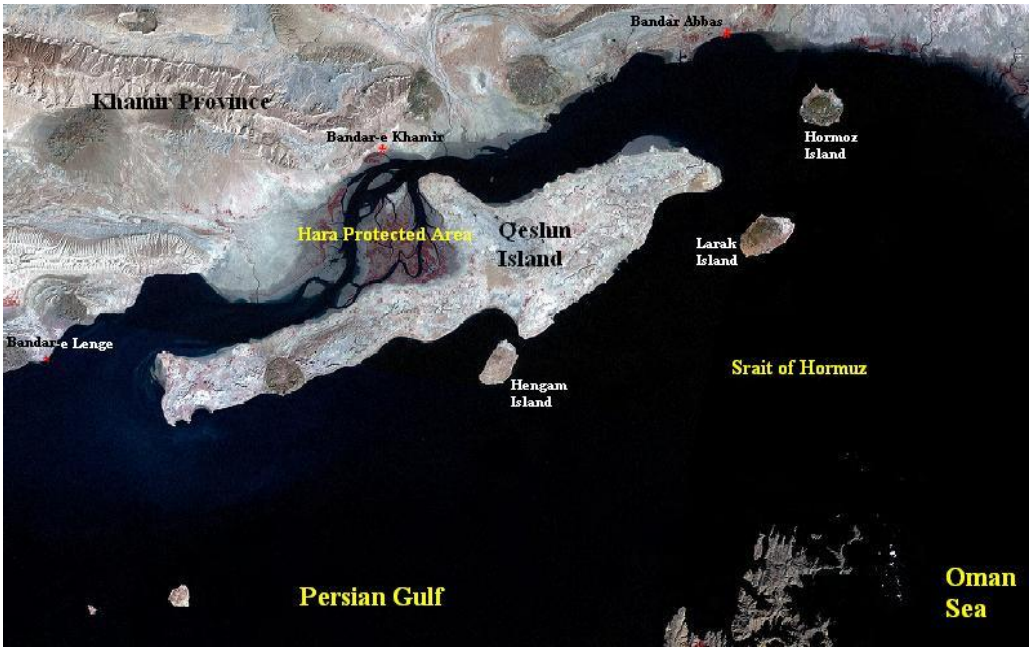

Fig.1. Satellite image (IRS, 2006) of the study area

RESULTS AND DISCUSSION

The total resident population of the study area is 65375 consisting 13941 households out of which 51850 individuals live in the rural area and 13525 individuals live in the urban area (Bandare-Khamir). The resident population of the Mangrove forests border is 34289 (8070 households) and another 28286 individuals in 5871 households live in the settlements far from the Mangrove forests. Totally, 9928 of the whole households keep herd out of which 4868 households live in the border of Mangrove forests. The 46199 unit animal consists of 28903 goats and sheep, 2300 cattle, and 828 camels (Table 2). In the northern of HPA, there are 16378 unit animals (11045 goats and sheep, 417 cattle, and 662 camels) and in the southern part, there are 17858 goats and

sheep, 1883 cattle, and 368 camels (the total of 29821 unit animal). Table 2 shows the population features of the study area.

Table 2. Number of the settlements and their population features (location of the Mangrove forests and HPA)

Location	number of the settlements	population	households	number of unit animal
In the vicinity of forests (northern region)	7	23098	5146	9228
In the vicinity of forests (southern region)	9	13991	2924	13640
Distant from forests (northern region)	9	5616	1077	7150
Distant from forests (southern region)	26	22670	4794	16181
Total	51	65375	13941	46199

According to this study, an average of 41.6 of local communities use Mangrove leaves to feed their herds. This amount reaches 100 percent for some villages of the Mangrove forests border. The results of the analysis show that the leaves of the Mangrove is one of the main resources of cattle fodder used by local communities especially villages of the Mangrove forests border and during the months of low precipitation. Figure 2 displays the position of settlements, mangrove forests and HPA.

In total, the amount of Mangrove harvest in summer, spring, autumn, and winter was recorded as respectively 429228, 355856, 244773 and 58217 kg/month. The average of Mangrove use in the settlements of the Mangrove forests border is 229600 kg per month, while this amount is 42420 kg for the settlements away from the Mangrove forests. In other words, 84.4 percent of the total Mangrove use is in the settlements of the Mangrove forests border. Therefore, in villages near the forests, Mangrove leaves are used extensively. Generally, the exploitation sites of Mangrove forests consist of 11 areas. The main reasons for exploiting these areas are their proximity to the local communities, the density of Mangrove trees and their accessibility. The total amount of harvested fodder estimated to be 3264240 kg/yr (Table 3). The analysis indicates that the largest amount of Mangrove use is 3.9 kg/day and its average in the study area is 0.2 kg/day. In Figure 3, the amount of seasonal harvest of the fodder is demonstrated and Figure 4 showed the total use of Mangrove according to the location in Hara Protected Area.

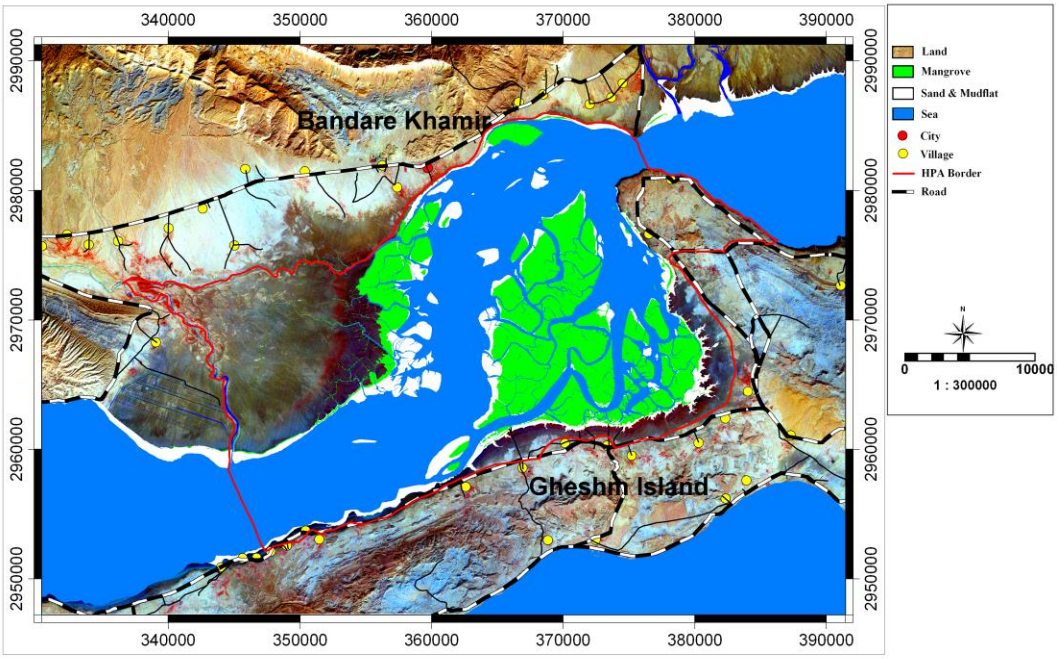

Fig. 2. Settlements, and Mangrove Forests Position in Hara Protected Area

Table 3. The seasonal use of Mangrove in Hara Protected Area

Location	Total harvest (kg/month) ± SD			
	Spring	Summer	Autumn	Winter
Northern region	83084±3021	97318±9954	47142±4530	15529±698
Southern region	272772±65214	331910±71245	197631±57548	42688±3987

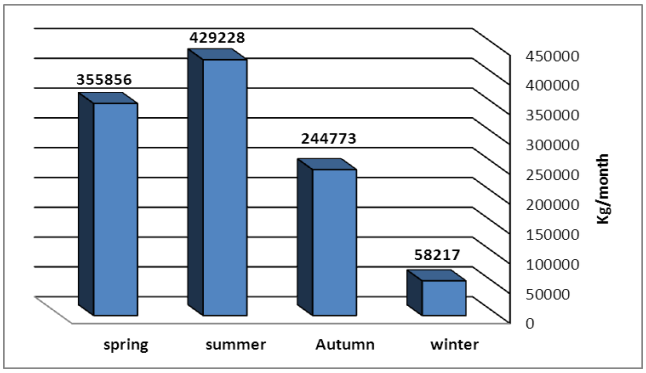

Fig. 3. The total seasonal use of Mangrove in Hara Protected Area

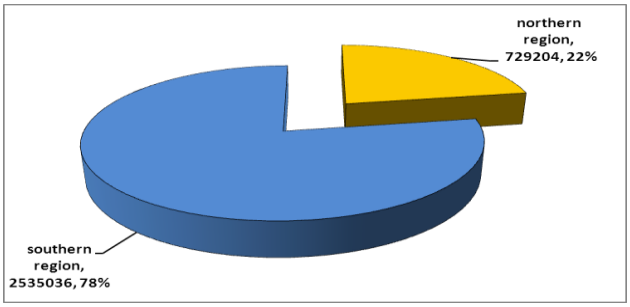

Fig. 4. The total use of Mangrove according to the location in Hara Protected Area

Statistical analysis showed that fodder Mangrove use in the southern region is more than the Northern, and difference between them is significant. Statistical analysis showed that the amount of mangroves in the summer more than compared to other seasons and the difference is significant. In addition, the amount of mangroves in spring and autumn than in winter is a significant difference.

The following formula shows the weight of used mangrove (Formula1):

(1) $$M = \sum m_i * N_i$$

M (Kg/yr) =Total consumption weight

m (Kg/yr) =Average consumption weight for unit animal

N= Number of unit animal

i=Settlement

Economic value of the fodder and exploitation of Mangrove forests has been estimated according to the amount and location of harvest, the regional value of the Mangrove leaves and the value of other kinds of fodders. As explained above, total amount of Mangrove harvest in the study area is 3264240 kg/yr. 729204 kg out of this amount is consumed in the northern of HPA and 2535036 kg in the southern. Economic value of the harvested fodder from the Mangrove trees in the northern and southern parts of the Hara Protected Area is estimated to be 27470 and 97216 per month, respectively and $124686 per month for the whole area (Table 4). Therefore, the supply value of fodder from Mangrove leaves will be $15.6/ha. In fact, 41.5 percent of the whole households of the study area use Mangrove leaves as fodder, while the average income of each household is estimated to be $94 per year. The results of the economic

value of the fodder are presented in table 4. Economic value of Mangrove forests can be estimated through the formula 2:

$$(2)\quad V = \sum (M_j m_j) * P_j$$

M (kg/yr) = Total consumption weight

m (Kg)= Average weight of each package (m)

P (kg/$) = Regional value of each package

j = North or South of HPA

Table 4.The economic value of the fodder in Hara Protected Area

Location	Price$ (Kg)	Package Price ($)	Package Weight (kg/ month)	Consumption average (kg/yr)	Total value ($/yr)
Northern region	377	0.6830	18.13	729204	27470
Southern region	383	0.7340	19.14	2535036	97216
Total value of harvested fodder					124686

In fact, the above estimations are based on the regional prices of the Mangrove leaves. Regarding the fact that a little amount of the harvested Mangrove is traded and the residents do not pay for using the fodder, the real value of the harvested Mangrove should be estimated considering the consuming weight of other types of fodders and their regional prices. Therefore, the real value of the fodder is estimated to be 545347 dollars/yr. Throughout the northern and southern of HPA, this amount is 111349 and 433998 dollars, respectively. Therefore, the real value of the fodder from Mangrove leaves in the study area is $68/hectare/yr.

DISCUSSION

Evaluating different functions of mangrove, especially economic value, the importance of mangrove forests will be established. Evaluation of the total economic value of mangrove forests which contains a wide range of use and non-use values needs extra time and money. Although, in some cases, it is impossible because of the limitations of data and basic information. One of the most important economic values of Mangroves is economic use value of the local area and residence of mangrove-covered forests (Sathirathai and Barbier, 2001). Mangroves forests have some different functions, one of which is using leaves as fodder (Tecleab *et al*., 2000). The value of direct usage contains direct uses or interactions of mangrove sources or services (for example gathering odder,

wood, hunting and fishing) which may include commercial or non-commercial activities. Most of these activities are of great importance for economic life of the local people (Bann, 1997).

Results of this study show that in dry seasons, the use of mangrove increases because of the drought in pastures so that the average using mangrove in summer is 7.4 times more than in winter. On the other hand, the amount of harvest in the southern region of HPA is 3.5 times more than the northern region and the average of mangrove use in forest borders' settlements is 5.5 times more than the average in distant regions. The total amount of fodder from mangroves is 3264240 kg/yr which is equal to 408 acres/yr.

The determination of the harvest area shows that only 446 hectares from the total area of all Mangrove forests are exploited. Therefore, the monthly average of the fodder harvest is 7319 kg/ha. The average harvest in the northern and southern regions of HPA are estimated 6879 Kg/ha and 7682 Kg/ha, respectively (the harvest area in northern region of HPA is 106 hectares and in the southern region is 330 hectares). As a result, the average harvest fodder is 20Kg/ha/day which is equal to 18.8 Kg/ha/day for the northern region and 21 Kg/ha/day for the southern region of the area. Therefore, the comparison between the average of the harvest and production in the forests indicates that the amount of production is higher than consumption; hence, there is no threat for the Mangroves of HPA. The economic value of the fodder in HPA is estimated to be $15.6 ha/yr and the real value is $68 ha/yr. While compared to the fisheries economic value which is $245 ha/year, the mentioned value is lower. In addition, the value of mangrove to use as fodder in Kachch, Jamnagar and Saurashtra areas is estimated 8689 Rupees/yr and in Gulf of Khambhat, this number exceeds 13114 Rupees/acre/yr (Hirway and Goswami, 2002).

The average income of fodder harvest from mangrove in the HPA is about $94/yr for any household. While the studies show that the economic value of fisheries in that area is about $672/yr and this is about 7 times more than the fodder value (Dehghani, 2007).

Despite the rules of the Protected Areas and the prohibition of using the trees and cutting the young sprouts, it's common in the mangrove protected area to use them and there is no control over it. The results show that lack of development in service and industry and mines, severe limitations in agriculture, limitations in business and commerce, the lack of improvement in infrastructures and other economic sections have caused the harvesting fodder, especially for the local people, becomes important in their economic life so that the daily lives of so many of them is dependent on the mangrove.

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