*Int. J. Environ. Res., 1(4): 368-377, Autumn 2007*
*ISSN: 1735-6865*

# Valuing Forests and Rangelands-Ecosystem Services

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Received 15 Feb. 2007; Revised 20 June 2007; Accepted 5 Aug. 2007

**ABSTRACT:** This study is the first effort by Iranian scientists to provide insight to the many benefits and services that forest and rangelands offers to society, and the extent to which the human race is vitally dependent on them. Without a firm understanding of the value of these systems we are unlikely to make many of the hard choices and compromises needed to protect them. In this study the least marginal monetary value of eleven forests and rangelands ecosystem services including gas regulation, plants genetic reverse diversity, pollination, soil formation, biological control, flood control, hydrological current control, water erosion control, wind erosion control, and ecotourism in fivefold vegetative regions of Khazar, Arasbaran, Zagros, Iran-toran and Khalij-e Omani (Oman gulf) with surface area of about 162155626 acres have been estimated at 427528 billion rials annually (47.9 billion dollars/year). This amount equals approximately 43% of GDP and four times of Iran's agricultural added value in 2003. Taking into account the 1.73% share of the market services value of forests and rangelands in GDP, the significance of nonmarket services value of these resources in comparison to market goods will stand out obviously.

**Key words:** Ecosystem Services, Market goods, Monetary Valuing, Marginal

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## INTRODUCTION

Societies often must choose between alternative uses of natural environment. Should a given wetland be preserved, or should the land be drained and converted to agricultural use? Should a particular timberland be maintained in its current state, or should it be opened to forestry or other development? Should a certain park be maintained, or converted to a parking lot? These are difficult questions. The way they are answered has critical importance for the viability of species in the habitats involved as well as the performance of the complex ecosystems of which they are a part.

To make rational choices among alternative uses of a given natural environment, it is important to know both what ecosystem services are provided by that environment and what those services are worth. The first item lies in the realm of fact; the second, the realm of value. Societies cannot escape the value issue: whenever societies choose among alternative uses of nature, they indicate (at least implicitly) which alternative is deemed to be worth more. In many instances, environmentally concerned individuals sense that the wrong decision has been made- that society has imputed insufficient value to nature in its current state and has thereby permitted conversion to take place for the sake of an inferior alternative. Indeed, one may sense that nature routinely is undervalued. No matter how strong suspicions are along these lines, one cannot make a convincing case that nature is undervalued without having a philosophical and empirical framework for assessing nature's values. The philosophical element seeks to identify the ethical or philosophical basis of value, that is, articulate what constitutes the source of value. The empirical element aims to find techniques for the measurement of value, as defined according to a given philosophical notion.

Essentially the philosophical basis of valuation is represented by anthropocentric viewpoints. Element of nature are valuable insofar as they serve human being in one way or another. Utilitarianism, which maintains that natural things have value to the extent that they confer satisfactions to humans. Economists endorse the utilitarian viewpoint; this approach is inherent in benefit – cost analysis. Utilitarianism is able to be sustainable. Utilitarianism includes the direct (for example using the forest's trees) and indirect use values and also nonuse values (Daily, 1997).

It is difficult enough to agree on a philosophical basis for value. Further difficulties arise in attempting to measure nature's value. Environmental economics has developed methods to assessment these services in the last few decades. Considerable progress has been made over the years in developing such methods. But the science is far from perfect. Controversies persist.

Ecosystem services are especially difficult to measure for the same reason that ecosystems themselves are threatened. Many of services provided by ecosystems are positive externalities. The flood control benefits, pollination, gas regulation, water filtration services, pest control and soil fertilization offered by ecosystems are usually external to the parties involved in the market decision as to whether and at what price a given habitat will be sold. As a result, the habitats that support complex ecosystems tend to be sold too cheaply in the absence of public intervention, since important social benefits are not captured in the price.

This study has an especial significance for Iran, since it is accomplished for the first time to assess the marginal nonmarket value of Iran's forests and rangelands. In order to form a precise insight into the various services of the Iran's forests and rangelands on which the existing and next generations are critically depended, and also help us realize the economic value of these services in the life quality and policy-makings. During the few coming years the country will be obliged to make some extremely difficult decisions about the future of several natural resources that unfortunately lots of them are degrading. Destroying the forests and rangelands has awful consequences for everyone because all people are depended on the services of these ecosystems.

Only a few numbers of decision and policy-makers are aware of the importance of these services. Hence, without measurable economic valuation comparable with other economic sections of the country, the awful danger of sacrificing the long living of the forests and rangelands for short-term economic benefits is probable. This note is the main theme of "Ecosystem services Valuation of Forests and Rangelands in Iran". The note which in no way could be ignored, because, ignoring it is the matter of *"To be or not to be"* for life.

## MATERIALS & METHODS

About 136.4 million hectares of Iran's climate is covered by renewable natural resources, approximately 12.4 million hectares forest (7.6% of the country's surface), 90 million hectares rangeland (54.9%), and 34 million hectares desert (20.7%). Other areas with about 27.6 million hectares surface (16.8%) deal with other functions such as agriculture, habitations, installation, etc. Iran's forests and rangelands are located in five vegetative regions of *Khazar* (5724880 hectares), *Arasbaran* (3486226 hectares), *Zagros* (26246130 hectares), *Iran-toran* (107095700 hectares), and *Oman gulf* (22740290 hectares), which totally reckoned at 162155626 hectares (Boom Abad, 2004).

In this study, the necessary data related to type, abundance, and different species volume in the fivefold vegetative regions of Iran was collected, and the major nonmarket services were verified and measured afterward. Available data from different sections of Forests and Rangeland Organization and Ministry of Agriculture, Ministry of Energy, and Management and Planning Organization were used to evaluate the ecosystem services.

The prevailing approach to ascertaining value is benefit cost analysis. As indicated, benefit cost analysis implicitly adopts the utilitarian basis for value. The value of a given living thing is the amount of human satisfaction that thing provides. How could such satisfaction be measured? Nearly every empirical approach assumes that the value of a given natural amenity is revealed by the amount that people would be willing to pay or sacrifice in order to enjoy it. Willingness to pay is thus regarded as the measure of satisfaction. Market behavior often gives evidence of willingness to pay, but in many instances researchers must rely on other, more indirect methods to fathom it. Methods for valuing of nonmarket goods can be divided into(Conventional Market,Implicit Market method,Artificial Market method) three main (conventional market method, implicit market method and artificial market method) categories (Karimzadegan, 2002). Table (1) indicates the valuation methods of each non market service in this study.

**Table 1. Valuing methods and ecosystem services in this study**

| Services | Valuing Methods |
|---|---|
| Gas regulation | Replacement cost |
| Climate regulation | Production function |
| Plants genetic stocks | Production function |
| diversity | Production function |
| Pollination | Production function, |
| pest control | Replacement cost, Averting expenditure |
| Soil fertilization | Production function |
| Hydrological | Production function |
| regulation | Replacement cost, Averting expenditure |
| Water erosion control | |
| Flood control | Replacement cost, Avoided Cost |
| Wind erosion control | Replacement cost |
| Ecotourism | Travel-cost |

## RESULTS & DISCUSSIONS

### *Gas regulation*

Natural ecosystems provide humanity with a wide variety of vital public services whose degradation may seriously threaten civilization. One of services that ecosystems provide is a major influence on the atmospheric composition. Through eons of build up, photosynthesis in bacteria, algae, and plants has provided us with the oxygen in the atmosphere that animals depend on. In addition, oxygen in the stratosphere generates the protective ozone layer. The concentrations of a variety of oxidizing agents such as ozone, OH, and $NO_2$, determine the rate at which reduced compounds (e.g., CO) are converted to oxidized ones that can be more easily removed from the air. In this section the annual potency of forests and rangelands areas for carbon sequestration has been measured (as shown in Table 2) and then, considering that the mean costs of carbon reduction was US$ 100 per ton (IPCC, 2003), the economic value was evaluated in Table 3.

### *Climate regulation*

Natural ecosystems also help to stabilize the climate. The interaction of climate and life is seen through the strength of atmospheric greenhouse effect as a driving force in global climate change. While estimating the value of nonmarket services it is necessary to consider different aspects of this asset. Costanza has assessed the value of forests in climate regulation US$ 141 per hectare (Costanza, 1997). Nordhaus (1992) first estimate the climate damage at 1 percent reduction in GNP based on market sector losses for a central estimate of climate change. This was criticized as too narrow a view of climate as a type of public good since it reflected neither nonmarket values (e.g., species loss) nor climate surprise scenarios. In response, Nordhaus (1994) conducted a survey of conventional economists, environmental economists, atmospheric scientists, and ecologists. Their estimates of loss of gross world product(GWP) resulting from a three degree Celsius warming by 2090 varied between a loss of 0 and 21 percent of GNP with a mean of 1.9 percent. (Nordhaus, 1994).

While it is impossible to estimate credibly a numerical value on all of the ecosystem services provided through climate regulation. We can suppose that, according to Nordhous, damages related to climate change (1percent of GDP), the GDP of Iran in 2002 is equals to136964.625 million dollars (Central Bank, 2002). So the annual value of climate regulation is estimated in this study at 136964.625 million dollars (Karimzadegan *et al.*, 2003).

### *Pollination*

Until recently, the only published economic assessment of pollinator services on a national or global basis have been those managed by European honey bee colonies; even state level estimates of single wild pollinator's value are rarities. Valuing of this asset was determined by considering the role of pollinator insects in

**Table 2. Annual potency of forests and rangeland in carbon sequestration**

| Carbon supply / Vegetative region | Surface (million hectares) | Carbon sequestration (Ton) | | $CO_2$ absorb (Ton) | |
|---|---|---|---|---|---|
| | | Hectares | Total | Hectares | Total |
| 1- Hirkani | 1.92 | 55.5 | 106700000 | 203.7 | 391600000 |
| 2- Zagrosi | 5.05 | 6.9 | 34800000 | 25.3 | 127900000 |
| 3- Iran-torani | 3.20 | 4.1 | 13100000 | 15.1 | 48100000 |
| 4- Oman gulf | 2.10 | 3.3 | 6960000 | 12.1 | 25500000 |
| 5- Arasbarani | 0.15 | 18.6 | 2790000 | 68.3 | 10200000 |
| 6- Foresting | 2.0 | 8 | 16000000 | 29.4 | 58700000 |
| Total | 14.42 | 12.51 | 180350000 | 45.91 | 66200000 |

**Table 3. Valuing gas regulation**

| Vegetative region | Annual value ( million US$) | Annual value of gas regulation per hectare (US$) |
|---|---|---|
| Hirkan | 1408 | 730 |
| Zagros | 82.56 | 150 |
| Iran-toran | 358.78 | 112 |
| Oman gulf | 138.1 | 66 |
| Arasbaran | 49.03 | 33 |
| Foresting | 3.67 | 18 |
| Total | 3078.47 | 212.5 |

**Table 4. Valuing pollinator insects and honeybee in the increase of crops in 2002**

| Crops | Production | Country's average Price(US$) | Crop's value (million US$) | Dependence on pollinator insects | Value of pollinator insects in the increase of crops(mUS$) | Role of honeybee in the increase of crops | Value of honeybee in the increase of Crops(mUS$) |
|---|---|---|---|---|---|---|---|
| Hay | 3256578 | 0.094 | 30856.07 | 1 | 30856.07 | 0.6 | 185.13 |
| Cotton | 411580 | 0.350 | 144119.88 | 0.2 | 28823.97 | 0.8 | 23.05 |
| Bean | 143980 | 0.448 | 64030.03 | 0.1 | 645.30 | 0.5 | 3.22 |
| Onion | 1419297 | 0.072 | 102969.99 | 1 | 102969.99 | 0.9 | 99.67 |
| Cucumber | 1232870 | 0.077 | 95146.74 | 0.9 | 85632.06 | 0.9 | 77.06 |
| Watermelon | 1815746 | 0.054 | 99139.73 | 0.7 | 69397.81 | 0.9 | 62.45 |

producing crops, and other services that pollinators provide (Tables 4 and 5). There are other, noneconomically appraised services that pollinators provide to the biotic communities in which they reside. It may not ever be possible to put a price tag on these services.

***Wind erosion control***

The impact of wind causes more soil erosion rangelands and deforested area than anywhere else. In the current study, in order to valuate the nonmarket asset of wind erosion control, first the costs of the damages related to wind erosion in habitations, major installations, farmlands, interstate roads, and environmental resources had been determined, afterward this asset was valuing by using replacement cost approach (Table 6).

***Biological control of pests***

Natural pest control services maintain the stability of agricultural systems and are crucial for food security, rural household incomes, and national incomes. Monetary value of biological control has been estimated in the below sections, concerning the costs that society is willing to pay to replace the diminishing natural pest control service with synthetic pesticides and other measures such as host plant resistance provide a lower bound estimate of the value of the pest control service.

- Value of service inside the forests and rangelands (Karimzadegan, *et al.*, 2003)
- Value of service in biological control of agricultural systems.
- Value of service in limiting pesticides usage

**Table 5. Estimation of the annual economic value of the pollination asset of forests and rangelands**

| Kind of value | Value (million US$) | Value based on vegetative region (million US$) | | Value per hectare of vegetative region per year (US$) |
|---|---|---|---|---|
| Increase of agricultural products | 1537.63 | Iran-toran | 910.37 | 8.50 |
| | | Zagros | 244.87 | 9.31 |
| | | Khazar | 177.5 | 31.00 |
| | | Oman gulf | 191.87 | 8.43 |
| | | Arasbaran | 13.00 | 37.28 |
| Increase of Garden products | 886.96 | Iran-toran | 567.12 | 5.29 |
| | | Zagros | 196.37 | 7.27 |
| | | Khazar | 83.75 | 14.62 |
| | | Oman gulf | 34.09 | 1.50 |
| | | Arasbaran | 5.58 | 16.13 |
| Increase of livestock products | 316.75 | Iran-toran | 175.37 | 1.63 |
| | | Zagros | 81.12 | 3.08 |
| | | Oman gulf | 224.5 | 9.87 |
| | | Arasbaran & Khazar | 37.62 | 6.19 |
| Increase of nitrogen fixation in rangelands | 10.87 | Iran-toran | - | 0.06 |
| | | Zagros | - | |
| | | Khazar | - | |
| | | Oman gulf | - | |
| | | Arasbaran | - | |
| Total | 2752.21 | Iran-toran | | 15.49 |
| | | Zagros | | 19.94 |
| | | Khazar | | 52.27 |
| | | Oman gulf | | 19.87 |
| | | Arasbaran | | 59.68 |

**Table 6. Valuing wind erosion control of Iran's forests and rangelands in 2002 (Karimzadegan, *et al.*, 2003)**

| Vegetative region | Value (million US$) | Value per hectare of vegetative region (US$) |
|---|---|---|
| Iran-toran | 9.48 | 0.87 |
| Zagros | 0.08 | 0.001 |
| Oman gulf | 2.98 | 0.013 |
| Total | 12.56 | 0.101 |

- Value of service in human and ecosystem health

In 2002, 28194 tons of different kinds of pesticides were used in Iran. Concerning the direct costs of pesticides and their application and indirect costs (human and ecosystem health), the value of the pest control service is estimated at US$ 9694.735 million (2003).

***Flood control***

Flood control service is input to the sustained production of agricultural products. One can place a value on this production input by recognizing what costs or expenditures agricultural producer manage to avoid by virtue of the availability of this input. Damages cost and life losses by considering value of statistical life for Iran are shown in Table 7 (Karimzadegan, *et al.*, 2003).

**Table 7. Estimation of the average of the annual damages costs and life losses of flood in Iran for each vegetative region 2002**

| Vegetative region | Damages cost (million US$) | Life losses (million US$) | Flood damage per hectare of vegetative region (US$) |
|---|---|---|---|
| Arasbaran | 0.00015 | - | 0.0003 |
| Khazar | 1.65 | 0.32 | 0.345 |
| Zagros | 12.32 | 3.46 | 0.600 |
| Oman gulf | 14.39 | 3.68 | 0.794 |
| Iran-toran | 17.45 | 8.04 | 0.242 |
| Total | 45.81 | 16.00 | - |

***Hydrological regulation***

An enormous amount of water is precipitated annually over earth's land surface. This water is soaked up by forest and rangelands soils. Without this service, it would rush off the land in flash floods. Plants and plant residues protect this service. Thus soil interacts with vegetation to play a key regulatory role in the hydrological cycle (Table 8). This service is input for agricultural production and human life. Considering the market price of per cubic meter of water, which is assessed US$ 0.125 based on the estimations of Management and Planning Organization, monetary value of hydrological regulation is shown in Table 9.

***Water erosion control***

Living vegetation is also crucial to the hydrological service of soils. In addition to protecting soil from erosion, plants transpire water from soil back into the atmosphere. Vegetation clearance disrupts this link in the water cycle and leads to potentially dramatic increases in surface runoff, along with nutrient and soil loss (Table 10). Due to the amount of major soil elements losses and overfilling of dams, using replacement cost approach, water erosion control is valued at US$ 279.545 million per year.

***Plants genetic stocks diversity***

All forms of biodiversity are both generated and maintained by natural ecosystems. This section reviews the manifold contribution of biodiversity and its genetic resources to modern agriculture, medicine, and industry. Value of this asset has been estimated at US$ 6561.04 million per year (Karimzadegan, *et al.,* 2003) using production function method.

***Soil fertilization***

Considering the admirable ecological services of soil including major elements' cycle regulation, fertility recovery, eliminating dead organic materials, vegetable foods maintenance and presentation, physical support of plants, and moderation and fixation of the hydrological cycle, the annual soil fertilization value is shown in Table 11. It is based on the minimum hydroponics' costs in Iran which is at US$ 62.5 per hectares.

***Ecotourism***

The travel cost method is used to ascertain some recreational (no consumptive use value) provided by forests. This ecosystem services is estimated at US$ 7700 million per year, based on Table 12.

As Tables (13),(14) and (15) indicates the marginal economic value of ecosystem services(nonmarket services) of forests and rangelands' is US$ 53441 million annually, including soil fertilization (19.2%), biological pests control (18.2%), hydrological regulation (17%), ecotourism (14.4%), plants genetic stocks diversity (12.3%), gas regulation (5.7%), pollination (5.2%), and water erosion control (5.2%).

Even if for some reasons we do not count the value of these services in GDP, it is not useless to compare these values with GDP or the value added of different sections. In other word, adding forests and rangelands' nonmarket services, the GDP value increases from US$ 123175.5 million (Statistics Center of Iran, 1990-2000) to US$ 176541.625 million. We can state that the economic value of forests and rangelands' ecosystem services is 43% of the total value of GDP in 2003.

To compare the role and share of each function in Table (13) with economic series of activity of system of national accounting (SNA), we can identify the advantage takers of these

**Table 8. Role of forests and rangelands in different hydrological regulation in Iran**

| Vegetative region | Percentage of water store in the region | Percentage of water store's share of downfalls | Surface (hectares) | Average rainfall (mm) | Regulating volume in vegetative region (billion cubic meter) | Per hectare regulating water (Cubic meter) |
|---|---|---|---|---|---|---|
| Arasbaran | 98 | 29.4 | 342225 | 350 | 0.352 | 1029.0 |
| Khazar | 98 | 29.4 | 5716500 | 480 | 29.4 | 1411.2 |
| Zagros | 76 | 32.8 | 26070700 | 320 | 22.8 | 729.60 |
| Oman gulf | 38 | 11.4 | 22420650 | 150 | 11.4 | 171.0 |
| Iran-toran | 38 | 8.4 | 106129700 | 245 | 8.4 | 205.8 |
| Total | - | - | 1060679775* | - | 720352 | - |

**Table 9. Estimation of the economic value of hydrological current regulation in Iran 2002**

| Vegetative region | Total value (million US$) | Value per hectare (US$) |
|---|---|---|
| Arasbaran | 44 | 12.86 |
| Khazar | 3675 | 176.4 |
| Zagros | 2850 | 91.2 |
| Oman gulf | 1425 | 21.375 |
| Iran-toran | 1050 | 25.725 |
| Total | 9044 | - |

**Table 10. Amount of major soil elements losses in different functions**

| Function | Average loss of elements (Kilogram in hectare per year) | | |
|---|---|---|---|
| | Nitrogen | Phosphor | Potassium |
| Forests | 0.7 | 0.03 | 3.5 |
| Rangelands | 20.2 | 0.84 | 13.2 |
| Dry farmlands | 7.5 | 1.2 | 0.35 |
| Variance between forests & dry farmlands | 19.5 | 0.81 | 9.7 |
| Variance between rangelands & dry farmlands | 12.7 | - 0.36 | 12.85 |

**Table 11. Economic value of soil fertilization**

| Vegetative regions | Approximate amount of formatted soil (Ton) | Amount of annual generated equivalent fertile field (hectares) | Economic value (million US$) | Value per hectare of vegetative region (US$) |
|---|---|---|---|---|
| Khazar | 4745000 | 1460 | 912.5 | 159.39 |
| Zagros | 12696666 | 3906 | 2441.25 | 929.03 |
| Arasbaran | 197600 | 61 | 38.125 | 109.35 |
| Oman gulf | 7644000 | 2352 | 1470 | 2.14 |
| Iran-toran | 28080000 | 8640 | 5400 | 5042 |
| Total | 53363266 | 16419 | 10261.875 | - |

**Table 12. Annual economic value estimation of ecotourism potential in Iran's forests and rangelands**

| Ecotourism potential in country's forests (people-day per year) | Ecotourism potential in country's forests (people per year) | Amount of generated income through tourism & ecotourism (people- day US$ per year) | Amount of generated income (million US$) | Amount of generated occupations (million US$) |
|---|---|---|---|---|
| 27468760 | 3924108 | 2746876000 | 2700 | 5000 |

**Table 13. Marginal economic value of ecosystem services**

| Service | | | | | | Million US$ | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Gas regulation | Climate regulation | Pollination | Wind erosion control | Biological pests control | Flood control | Hydrological regulation | Water erosion control | Plants genetic stocks diversity | Soil fertilization | Ecotourism |
| 3078.47 | 1369.64 | 2863.40 | 12.81 | 9694.735 | 64.295 | 9044 | 2790.795 | 6561.04 | 10261.87 | 7700 |
| Total | | | | | | | | 53441 | | |

services in series of activity and relate their value to those sections. We can state that farming and gardening section (medium consumptions) and human people (households in consumption area) are both the advantage takers of gas regulation services. Hence, considering that about 60% of GDP consists of households' consumption, based on this ratio, 40% of the value of this function could be related to agriculture section as the medium consumption of farming and gardening section. Also, the climate regulation could be related to agriculture section with the same ratio. Considering the total amount of US$ 2863.375 million value of pollination services to be related to agriculture section is completely reasonable. Value of wind erosion control, despite its low amount, could be divided between value added of agriculture section (70%) and construction section (30%).

Obviously, biological control of pests, water erosion control and plant genetic stocks diversity could be related to agriculture section. Hydrological regulation could also be divided between added values of water, agriculture and industry sections. Value of soil fertilization could be divided between agriculture and construction sections with the ratio of 70% and 30%. Value of ecotourism, whose advantage takers are somehow all sectors, could be divided based on the economic construction of country (Table 14).

According to these findings, the part of ecosystem services, which could be resulted from agriculture section, with about US$ 34848.5 million in 2002, is 2.6 times of value added of agriculture section in 2002 (US$ 13218 million). In other words, if forests and rangelands' ecosystem services had not provided these services, the agriculture section would have had to spend US$ 34750 million as its medium consumption to produce these services. Also, the value added of natural services which is related to construction section is about 0.44 of value added of construction section in 2002. Moreover the advantages of natural functions' services in water section are nearly 1.4 times of value added of water section in 2002.(Table 15).

**Table 14. Value of ecosystem services and their advantage takers and final consumption**

| Service | Value of function's services (million US$) | Advantage-takers of value of services (million US$) | | | | | |
|---|---|---|---|---|---|---|---|
| | | Agriculture | Industry | Construction | Water | Services | Final Consumption |
| Gas regulation | 3078.5 | 1231.37 | - | - | - | - | 1847.125 |
| Climate regulation | 1369.62 | 547.87 | - | - | - | - | 821.75 |
| Pollination | 2863.37 | 2863.37 | - | - | - | - | - |
| Wind erosion control | 12.81 | 6.37 | - | 6.37 | - | - | - |
| Biological control | 9694.75 | 9694.75 | - | - | - | - | - |
| Flood control | 64.25 | 45 | - | 19.25 | - | - | - |
| Hydrological current control | 9044 | 3581.37 | 4847.62 | - | 615 | - | - |
| Water erosion control | 2790.75 | 2790.75 | - | - | - | - | - |
| Plants genetic reserve diversity | 6561 | 6561 | - | - | - | - | - |
| Soil formation | 10261.875 | 7183.37 | - | 3078.5 | - | - | - |
| Ecotourism | 7700 | 343.37 | 1001.25 | 145.125 | - | 1592.5 | 4617.75 |
| **Total** | **53441** | **34848.5** | **5848.8** | **3249** | **615** | **1592.5** | **7286.62** |

**Table 15. Comparison between values added of forests and rangelands' ecosystem Services and system of nation accounts**

| | (1) Normal national accounts (million US$) | (2) Added value of natural functions of forest & rangeland (million US$) | Ratio (2)/(1) |
|---|---|---|---|
| Agriculture | 13218 | 34848.5 | 2.6 |
| Construction | 7310.12 | 3249.25 | 0.44 |
| Water | 449 | 615 | 1.4 |
| Mine & Industry | 38457.75 | 5848.87 | |
| Other sections | 61924.75 | 1592.5 | |

Considering the value of forests and rangelands in support and maintenance of economy and also our life, their degradation should be limited and recovery programs should start as soon as possible. Furthermore, Central Bank and other organizations, which deal with GDP and GNP regulation, are recommended to create an account for forests and rangelands' nonmarket values and every year consider the role of these services in planning.

## CONCLUSION

As nonmarket services of forests and rangelands will become rarer in future, it is expected that their value increases. We should emphasize again that the current study is just the starting point. It implies that we need more researches, and also point to some particular aspects which require more study. Furthermore, this study indicates that relative significance of nonmarket services of forests and rangelands and shows the effects of their destruction on our welfare.

The core analyses presented in this study attempt to value ecosystems and their component species only insofar as they confer benefits, in the form of life support goods and services, to human beings. This focus does not in any way preclude making decisions on the basis of other values as well, such as existence values of nonhuman organisms and their habitats; aesthetic, historical, religious, or other cultural significance; recreational values; etc. Marginal value is summarized in Table 16.

**Table 16. Annual economic value (per hectares) of Iran's forests and rangelands' ecosystem services**

| Nonmarket services | Khazar US$ / ha / yr. | Arasbaran US$ / ha / yr. | Zagros US$ / ha / yr. | Iran-toran US$ / ha / yr. | Oman gulf US$ / ha / yr. | Annual marginal value of all vegetative regions Year/million US$ |
|---|---|---|---|---|---|---|
| Gas regulation (Carbon sequestration) | 730 | 33 | 150 | 112 | 66 | 3078.47 |
| Climate regulation | - | - | - | - | - | 1369.64 |
| Plant genetic stock diversity | 110.29 | 110.29 | 59.52 | 36.46 | 1.06 | 6561.04 |
| Pollination | 52.27 | 59.68 | 19.94 | 15.49 | 19.87 | 2863.40 |
| Biological pest control | - | - | - | - | - | 9694.73 |
| Soil fertilization | 159.39 | 929.03 | 109.35 | 50.42 | 2.14 | 10261.87 |
| Hydrological regulation | 176.4 | 12.86 | 91.2 | 25.72 | 21.37 | 9044 |
| Water erosion control | - | - | - | - | - | 2790.79 |
| Flood control | 0.35 | 0.0003 | 0.62 | 0.25 | 0.82 | 64.29 |
| Wind erosion control | - | - | - | 0.08 | 0.01 | 12.81 |
| Ecotourism | - | - | - | - | - | 7700 |
| | | Total | | | | 53441 |
| Vegetative area's space (hectares) | 5724880 | 348626 | 26246130 | 107095700 | 22740290 | 162155626 |

## ACKNOWLEDGEMENT

The authors would like to thank , Mr. M. Darvish, Dr. Tahmasebi, Dr. H.Arefi, Dr.H.Kia Daliri, Dr. A.Talvari, Dr. Tavasoli, Dr karami, Mrs. S. Saeed Banadaki, who respectively helped us in collecting data of gas regulation, climate regulation, pollination, plants genetic reserve diversity, wind erosion, pests control, flood control, hydrological regulation, water erosion control, soil fertilization and ecotourism sections. Also we appreciate the authorities of Forests and Rangelands Organization and Mr. Shirazi the director of Boom Abad Consulting Engineers and also we thank Mr. Mahdipoor.

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