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An Economic Analysis of Multiple Use of Forests: Belgrade Forest Example

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Abstract: This study is concerned with the management and planning of forest resources in a multiple use context by taking social, economic and environmental considerations into account. In the study three different forest uses, namely timber production, carbon storage and recreation are compared in an oak plantation area of the Belgrade Forest, in Istanbul. In the first option, the forest is allowed to grow untouched for carbon storage without considering recreation and timber value. In the second option, one-third of the forest area is felled in order to enhance the recreational use of the forest. Then the total values of the first and second option are calculated separately. When both results are compared it is suggested that the second option is more beneficial than the first. In other words, felling one-third of the forest area for recreation would provide 53 times more benefit than using the area only for carbon storage.

Keywords: Multiple use, recreation, carbon storage

INTRODUCTION

Forest resources are important for the welfare of people. Forests do not only produce commercial timber but also provide various natural environments where people can pursue different activities.

The various and conflicting demands on the forest have resulted in many controversies between commercial forestry and environmental preservation. Li *et al.,*[4] state that the central problem of what the optimal combination of resource uses from the forestry really is or, to what degree a forestry activity should be concerned with environmental requirements, still remain unsolved. Forestry may give a profit, but also changes the features of a forest landscape and other vegetation cover, and therefore affect the welfare people derive from the forest environment. From an economic point of view, the problem should be solved by maximising the total net benefit both from forestry and the remaining forest environment.

MATERIALS AND METHODS

In this study The Belgrade Forest was chosen as the case study area. The data about timber sales, number of annual visits to the recreation area and entry fee charges were collected from the Bahcekoy Forest Enterprise, which is charged with the management of Belgrade Forests. The Bahcekoy Forest Management Plan was also used to gather information about the identification of the forest uses in the area.

During the calculations, carbon storage and recreation value formulas were applied in order to find the total value of the forest utilities.

Definition and Application of Multiple Use in Forestry: The economics of multiple use forestry have been extensively examined[3,8].

It is not always easy to define the term "multiple use"[5]. In a restricted economic sense, the term simply means that forests and wildlands have more than one use and the typical forestry enterprise produces more than one product[10]. According to Reiske[7], multiple use is defined as the management of various land resources so that they are used in the combination that will best fulfil the needs of people without impairing productivity of soil.

There are two types of multiple use approaches which can be applied to forests. One calls for applying the term only to large areas (a ranger district, a working circle, or even an entire forest holding). Gregory[3], for example, points out that a forest land produces several products, but each specific area is devoted to a single (or at least a primary) use. Under this interpretation, the manager will settle on a primary use for each specific area. Secondary uses would be permitted in the area only if they do not interfere with the primary objective. Timber production, for example, might not be prohibited on a designated recreation area, but would not be permitted to interfere with recreational use. Gregory adds that the alternative approach makes no area subdivision and declares no

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primary uses. Instead, the objective of management is assumed to be the maximisation of social returns, measured in whatever units are deemed appropriate. Following this approach, management should produce the combination of products that would maximise net return to the owners.

Biesterfeldt and Boyce[1] draw to our attention one difficulty which has been the lack of a practical method for coordinating production of multiple benefits. Foresters can, for example, provide wildlife habitat, recreation opportunities, and a high quality of water, while also producing commercial crops of timber. However, they have not known how to harmonise action on a management unit to achieve the most desirable combination of benefits. Most research and management actions deal with primary benefits; secondary benefits are usually ignored or permitted to accrue as they may.

In order to obtain the greatest value from the forest, the dominant use, or primary forest output must first be determined, then the effects of adding various secondary outputs and uses assessed. Therefore, an evaluation method which takes the multiple uses into consideration is needed to identify efficient and beneficial management programs for managing forests.

Introduction of the Study Area:

The Belgrade Forest: The Belgrade Forest lies on the north of the Istanbul peninsula within the region Marmara, between 28°53′25″ - 29°00′55″ eastern longitudes, and 41°09′44″ - 41°14′40″ nothern latitudes with an area of 5 442 hectares. Mainly the Belgrade Forest is divided into two sections called Bentler and Kurtkemeri[9].

The location of the Belgrade Forest is between *Castanetum* and *Fagetum* zones in terms of its silvicultural and climatic features. The Belgrad Forest is a broadleaved deciduous forest formation composed of various oak species mainly *Quercus petraea Lieb., Q. frainetto Ten., Q. robur L., Q. infectoria Oliv., Q. cerris L., Q. robur.* The dominant species in the forest are oaks which cover 75% of the total area although oaks are followed by Oriental beech along with European hornbeam and Spanish chestnut[9].

Belgrade Forest has been inhabited by 71 types of birds, and 18 mammals[9]. Hunting is prohibited within the boundaries of the forest area, and 103 ha of the forest area is reserved for deer breeding and their protection. It is a state forest, and is therefore under multiple use management for timber production, recreation, water collection (for drinking and using), wildlife protection, and finally scientific research.

The forest has been managed to meet the needs of the local public for recreation since 1956. Because there is an increasing demand for recreation, the area allocated for recreation activities has been extended from 55 hectares to 170.5 hectares.

According to the Recreation Master Plan of Istanbul (1988-2010), by 2010 the number of recreation sites will be increased to 11 within the boundaries of the Belgrade Forest. The total recreation area will be extended from 170.5 hectares to 260.0 hectares which is 4.7% of the total area. In the plan, it is stated that 18.6% of the total area (1,012 ha) has great recreational supply capability. Furthermore, the area is suitable for several types of recreation activities in terms of its climatic conditions, space requirements, presence of water on site, slope tolerances, etc.

Evaluation and Comparison of the Multiple Uses in Belgrade Forest: The data in Table 1 used in this case study were taken from the Belgrade Forest Management Plan and relate to the volume and mean annual increment of the oak species (mainly Q. petraea and Q. robur) in the north part of Bentler section of the Belgrade Forest.

The survey area of 29.42 hectares is divided into 7 sections. As has been shown in Table 1, the total standing volume in the total area is 5 560 m^3 and the total increment in total area is 63m^3. These values are expressed in British currency in the following calculations.

As a first option, the forest is allowed to grow untouched for carbon storage without considering recreation and timber value. It is expected that the increment will continue for 100 years. Fankhauser[2] suggests that the moderate carbon value per tonne can be taken as £20. According to research which was carried out by Price and Willis[6], the discount rate is suggested to be 5% and this value is used in this study. The equation shown below can be used in order to calculate the carbon storage value (Vc):

- $I_a \times C \times C_i \times P_c \times D$;

where:

- I_a: actual increment
- C: conversion factor to total biomass (2 for oak)
- Ci: conversion factor volume to carbon mass (0.25 for oak)
- Pc: carbon value per tonne
- D: discount factor for period $\{1/r \times [1 - 1/(1 + r)t]\}$
- when r: discount rate, t is the length of period.

By taking the value of carbon per tonne as £20 and the discount rate as 5%, the carbon increment value (Vc) can be calculated as;

Table 1: Volume and Mean Annual Increment (MAI) of the oak species in Belgrade Forest

	Total Area(ha)	Volume(m^3/ha)	MAI (m^3)	Total Volume (m^3/ha)	Total MAI(m^3)
Area 1					
Section 1	5.16	129	2.48	666	13
Section 2	3.36	154	1.91	520	7
Section 3	4.13	125	1.16	518	4
Area 2					
Section 1	6.45	368	3.37	2 376	22
Section 2	3.10	151	1.74	469	6
Section 3	3.61	155	1.91	559	7
Section 4	3.61	125	1.16	452	4
Total	29.42	1 207	13.73	5 560	63

- V_c = 6 x 2 x 0.25 x 20 x {1/0.05 x [1 - 1/(1 + 0.05)^{30}]}
- V_c = 12 504 £/ha.

The carbon storage value per hectare is £425.

As a second option, suppose that one-third of the forest area is felled for recreation. In this case, one-third of the carbon benefit which is calculated in the first option will be lost. This is £142 per hectare (425/3). Therefore, the carbon storage value will decrease to £283 per hectare. There is also a loss due to decay of existing carbon. If the carbon cost is £20 per tonne the discounted cost of allowing a cubic metre timber to decay will be about £5[6]. For the measured area (29.42 ha) which has a standing volume of 5,560 m3, this value is £315 per hectare.

In order to estimate the timber benefit gained from 1/3 of the area, timber sale values for year 1995 were used in the calculations. Approximately £236 per hectare was obtained from the timber sales.

Data about number of visits and entry fees for the estimation of the recreation value (V_r) were collected from the forest enterprise. In the calculation below entry fee for 1 person and number of annual visits per hectare were taken as 25 pence and 4500 persons. The discounted value of the recreation can be calculated as;

- z x y/r x {1 - [1/(1 + r)t]}

where:

- z: cost per visit
- y: number of visits per hectare per year
- r: discount rate
- t: period of time in years.
- Vr = 0.25 x 4,500/0.05 x {1 - [1/(1 + 0.05)100]}
- Vr = £22,329

By using the results of the second option the total value (TV) can be calculated as;

- TV = value of recreation + value of carbon storage + value of timber production - cost of carbon decay
- TV = 22,329 + 283 + 236 – 315
- TV = £22,533 ha.

It is also useful to indicate how low recreation use could go before the second option is preferred. This can be calculated in terms of either decreasing the number of visits or the amount of the entry fee by equalising the total value of the second option to the first one (the total value of Option 1 = the total value of Option 2). It can be shown as:

- Vc1 = Vc2 - Ccd + Vt + Vr

Where:

- Vc1: carbon storage value of option 1
- Vc2: carbon storage value of option 2
- Ccd: carbon decay cost
- Vt: value of timber
- Vr: Value of recreation

- 425 = 283 - 315 + 236 + {z x y/0.05 x [1 - 1/(1.05)100]}

The second option is viable as long as either the number of visits (y) does not fall below 45 per hectare per year, or when the entry price (z) is not less than 0.25 pence.

RESULTS AND DISCUSSIONS

When the first option's result is compared to the first option's result, it is suggested that the second option is more beneficial than the first one. In other words, felling one-third of the forest area for recreation would allow about 53 (22,533/425) times more benefit than using the area only for carbon storage.

Conclusion: According to the results of this study using the forest for timber production, carbon storage and recreation supplies more benefits than using it only for carbon storage. Increasing the amount of the recreation area will provide short term financial returns to the forest enterprise without waiting for a long harvesting time. However, consideration should also be given to the limited compatibility between timber production and recreation uses. In the short term commercial recreation is desirable so that initial forestry investment costs for timber production can be repaid. However, in the long term, if recreational use is increased in the area timber production and its related revenues will decline. Therefore, this should also be taken into account during forest land planning and forest resource allocation for the multiple uses.

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