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Integrated Assessment and Management of Public Resources

Edited by
Joseph C. Cooper, Federico Perali, Marcella Veronesi

NEW HORIZONS IN ENVIRONMENTAL ECONOMICS

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NEW HORIZONS IN ENVIRONMENTAL ECONOMICS

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DISCLAIMER

We accept full responsibility for the remaining errors and omissions. The views presented here are those of the authors, and do not necessarily represent the views or policies of the Economic Research Service or the United States Department of Agriculture.

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Introduction*

Joseph C. Cooper, Federico Perali and Marcella Veronesi

MOTIVATION

The general objective of this book is to provide a reference work on making integrated environmental policy decisions in managing public goods and natural parks. A public resource such as a natural park has many different functions (for example, production of marketed goods, ecosystem protection, tourism), and its management requires a multidisciplinary approach covering various areas of expertise.

This book is the result of a multidisciplinary effort in which the economics discipline plays a central role. Nonetheless, the proper management of public resources requires the knowledge of the physical, biological and ecological characteristics of the functions supplied by the resource and the value of each function and of the public resource as a whole. The innovative approach proposed in the book consists in the integration of the assessment and management aspects of the policy decision process.

In order to define the most efficient managerial strategy to improve the environmental sustainability and quality of a public resource, information about the natural area and how it interacts with the economy is required. Further, a project representing a consensus over how the public resource is best managed is also sustainable if the project continues to be considered socially desirable by the future generations of tourists or residents.

Considering that conflicts of interests often arise among local actors that result in the perpetuation of the *status quo* rather than in the adoption of a Pareto improving management project, the manager of the natural area can reduce potential conflicts if he or she internalizes the users' preferences in the project proposal. In general, this modern attitude of institutional listening is effectively implemented if the 'voice' of the users is given the importance and attention it deserves within the decision process, thus putting into action the Latin motto 'vox populi, vox dei', i.e. a 'grassroots' approach. After all, the best strategy for harmonizing the natural,

productive, protective and tourist functions of a natural area will not be implemented if it is not accepted by the local community, which is both the most frequent user and the main recipient of the legacy of the project for future generations.

SPECIFIC OBJECTIVES

The empirical case study has been developed from survey information gathered by the Department of Economics of the University of Verona in Italy, on the west side of Garda Lake, in June–October 1997, within a research project financed by the Lombardy region. This survey was part of an integrated analysis on the multi-functionality of the West Garda Regional Forest in order to evaluate the best mix of forest functions and their hypothetical values, to assess the impact of possible policies on the local economy and to define cooperative policies between institutions, local operators and visitors. As this analysis was requested by the regional park authorities, it reflects a real-world application of research of interest to policymakers.

We adopt multi-criteria techniques, thereby permitting us to integrate bio-ecological, territorial and economic information in order to achieve the objective of best coordinating the natural, productive, protective and tourist functions of a public forest or park. Such an analysis can be used to define policies that allow for interactions among institutions, local economic agents and park users while accounting for implications of those policies on the local economy.

METHODOLOGY

Our methodology integrates physical and social sciences in order to consider the forest system as a pool of different elements that interact among themselves and with external systems. In order to define the best combination of functions offered by the area, we use multi-criteria analysis techniques, which consider qualitative indexes of functions, integrating territorial information coming from a geographical information system (GIS) analysis with those related to the preferences of the park's users, estimated using the contingent (CVM) and travel cost (TCM) valuation methods.

The contingent valuation method is a direct (stated preference) method to estimate the value of environmental goods by using 'willingness-to-pay' questions that simulate market mechanisms. The travel cost

method is an indirect (revealed preference) method that estimates the value of the non-market good through the number of recreational trips and the travel cost for visiting the natural area. The number of trips to the area approximates the quantity consumed of the non-market good and the change in the welfare estimates the value of the good. Novel methodologies for CVM and TCM are developed and then used in the empirical case studies.

The results of the environmental valuation exercises and the GIS analysis are integrated into the multi-criteria analysis in order to help the public authority to make those management decisions that maximize a social and environmental goal specific to the natural area. In general, these management decisions have an impact on the local economy whose effects, when measured, may affect the social preference ordering suggested on the basis of the results obtained from the analysis, considering the natural park and its users as an isolated bio-economy.

We evaluate the effects of the decisions about the natural area as an isolated economy within the local economy as a whole as represented by a local social accounting matrix. Traditionally, the information about what is best for the natural area and the local economy is not sufficient for guaranteeing the implementation of the suggested plan because of conflicts of interests among either political parties or interest groups. We incorporate this important aspect of the local political economy by studying game theoretic techniques for conflict resolutions within the context of the natural area of the west side of the Garda Lake.

ORGANIZATION OF THE BOOK

The book is organized as follows. The first two chapters estimate the quantities of the forest's non-market functions using GIS techniques. These chapters define the forest's supply of functions. In the third and fourth chapters we estimate the hypothetical prices of the forest's functions using CVM and TCM techniques. These chapters represent the consumers' demand for the forest's functions. In the fifth chapter we define the best mix of the forest's functions by using multi-criteria analysis, while in the sixth chapter we simulate the impact of each functional alternative on the local economy using a local social accounting matrix. Finally, Chapter 7 specifies the alternative levels of the functions that best satisfy the preferences of institutions, local economic agents and visitors to the forest, using techniques of conflict resolution. The book concludes with environmental policy recommendations. The Appendix describes the survey conducted on the west side of the Garda Lake. The organization

of the book is summarized in the five stages depicted in Figure 0.1. These stages are further grouped within the two assessment and management parts of the research.

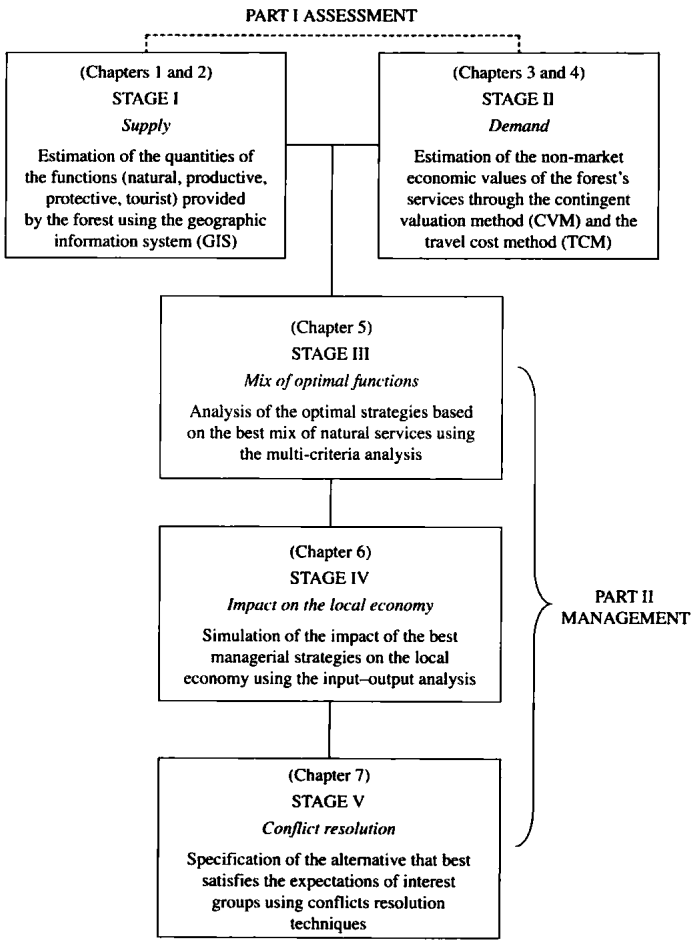

Figure 0.1 Book outline: analysis and chapter linkages

NOTE

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PART I

Assessment

1. Estimating the level of functions supplied by a natural area using GIS information

Michele Carta, Nicola Gallinaro and Massimo Bianchi

1.1 INTRODUCTION

The goal of this research is to define an operative instrument for mapping values of different functions supplied by forest areas. In contrast with a purely economic approach, we tried to map these values by developing for each function a set of indicators, and then aggregating them by a simple cartographic modelling procedure.

This instrument, which is based on the integration of geographic information system (GIS) and multi-criteria analysis (MCA) techniques, could be used in supporting decision making about forest planning strategies. It allows taking into account both monetary and non-monetary values. It can be viewed as a tool capable of considering both the socio-economic opportunities and the environment's carrying capacity in order to make the optimum planning choice.

The instrument has been developed and applied to the West Garda Regional Forest, a sizing about 110 square kilometres and located inside the High Garda Natural Park in eastern Lombardy region.

1.2 METHODOLOGY

It is well acknowledged that forests and other areas featuring a natural environment can be sources of products and services, among which public services play an important role. We may acknowledge that these areas provide some utilities and try to assign a value to them.

The scheme in Table 1.1 even if it is only applied to forest resources, can be easily adapted to the description of natural areas as well.

Functions having a global value, such as the environment function of

Table 1.1 Classification of 'forest products' into homogeneous categories corresponding to different functions

Function	Products	Services
Productive	Timber Food Pasture Resin, tannin Mushrooms Mosses, lichens	
Protective		Protection against: erosion wind avalanches floods
Naturalistic		Conservation of: species ecosystem diversity evolutive processes
Tourist		Landscape quality Tourism and sport Fishing and hunting

carbon dioxide retention of vegetal surfaces, have been excluded from this scheme because their estimation would be too complex. For the same reason we did not consider those functions that have a highly subjective component, such as spiritual and historical–cultural ones.

According to the value each function assumes, the territory can be divided into specific vocational categories:

- *areas with a prevalent function*: areas where one specific function prevails on others;
- *areas with multiple vocations*: areas where two or more functions prevail on others.

The multiple possibilities of combinations and the values functions can assume, determine many different cases.

In this process, we choose not to use predefined 'homogeneous' units, as for example the classic forest stand, but prefer to start from small land parcels according to a grid scheme. This choice is justified by the fact that zones which are 'homogeneous' from a mainly physiographical point of

view, may appear strongly heterogeneous from other perspectives (such as tourism, hydrology, nature conservation, and so on). The identification and mapping of areas showing similar characteristics according to different viewpoints, is the main objective of this study.

The values assigned to each function have been mapped by means of a cartographic evaluation model based on MCA and GIS techniques. Given the practical, operative approach of this work, the parameters considered in the estimation are readily obtainable starting from the available data. Hence, a certain degree of simplification has been accepted.

In order to identify areas showing similar characteristics according to different functions, and represent homogeneous units from a functional point of view, a cluster analysis has finally been carried out.

1.2.1 The Evaluation Model

The evaluation model is intended as a support for operative, practical planning activities. Consequently, being conditioned by data availability and ease of use, its structure is rather simple. Besides a spatial database and a spatial analysis system, the model is based on a wide knowledge base: this gives it the characteristics of a knowledge-based system or 'expert system' (Zimmermann, 1987). The evaluation model is based on MCA concepts and methods. According to Eastman et al. (1993), criteria are elements or attributes of the environment or territory which, individually or in combination with others, can represent phenomena which are not directly measurable in physical units.

Criteria can be subdivided in constraints and factors: the former show just two values (0 = false, 1 = true) and are used to exclude some cells from the calculus (e.g. those above a specified slope threshold); the latter are continuously varying and are estimated through a scale of scores, defined and correlated to the function being evaluated. Thus, a standardization process is needed in order to express all the considered factors according to a common scale. The standardization has been made in a linear way through the following algorithm:

$$x_i = \frac{R_i - R_{\min}}{R_{\max} - R_{\min}} \cdot range,$$

where x_i indicates the score of a standardized scale, R_i the score of the original scale, $R_{\min}$ and $R_{\max}$ respectively the minimum and maximum value of the original scale and *range*, the interval of the standardized scale.

In this study, the value of functions has been evaluated according to a

scale ranging from 1 (minimum value) to 10 (maximum value); however in intermediate steps different scales have been used as well.

Among several multi-criteria evaluation procedures (WLC, OWA, Boolean overlay) we decided to adopt a WLC (weighted linear combination), i.e. an additive model in which, besides a score based on a common scale, each factor has been assigned a weight that increases or reduces its importance of the final analysis.

This study extensively relies on the use of geographic information system (GIS) techniques, which represent the natural instrument while performing complex spatial analysis in wide areas. In general, this technology gives the possibility of handling interrelationships among different information layers, thus providing a powerful tool for turning data into information (Burrough and McDonnell, 1998; Aronoff, 1989).

More specifically, GIS allows the representation of spatial features in a raster (grid) format, made up by a set of square cells. The smaller the cell (or pixel) size, the more precise are the analysis and the mathematical elaboration.

The raster approach has been chosen due to its better performance in carrying out complex spatial analysis at a landscape level. The study area has been represented by a grid of 700 rows by 640 columns, with each cell sizing 50 × 50 m. Data were geo-referenced according to the Italian (Gauss–Boaga) reference system.

1.3 PROJECT STAGES

This project can be subdivided into the following phases:

- input of both cartographic and descriptive data into the GIS;
- database setup;
- analysis: GIS analysis functions together with external computer programs allowed the development of indicators and the definition of the evaluation model;
- output: the final results have been presented through graphics, tables, maps, reports.

The GIS software package used is GRASS, open source free software, formerly developed by the US Army Corps of Engineers Research Laboratory (USACERL, 1993), running in a Linux environment.