Assigning economic value to natural protected areas: an environmental accounting model

Francesco Marangon, Maurizio Spoto and Francesca Visintin

Abstract — The implementation of environmental accounting in Natural Reserves produced some significant results in terms of restrictions. First of all, environmental accounting introduced a limitation in scale, which was inapplicable on a micro scale. A second restriction concerned the physical unit measure that was used instead of a monetary unit measure. Finally, a third limitation was due to the fact that environmental accounting takes into account only costs, not environmental benefits. These three limitations led us to develop an environmental accounting model that considered resources in the Natural Reserve, both consumed and produced. The model applied to Miramare Natural Marine Reserve (Italy) aimed to supplement monetary accounting based on cost and revenue with environmental accounting which reflects not only environmental cost but also environmental revenues, i.e. environmental benefits. Environmental cost took into account anthropic presence, raw materials use, consumption of fuel for motor vehicles and heating fuel, consumption of electricity, water consumption, and administration expenses. Environmental benefits assessed ecosystem functions: gas regulation, nutrient cycling, biological control, food production, recreation, and culture. The difference between costs and benefits, both economic and environmental, represented the value produced or consumed by the Natural Reserve. The model demonstrated that the net benefit for the Reserve was approximately €654,000 covering the amount of public transfer (about €610,000) completely.

Index Terms — Ecosystem functions, environmental accounting, Long Term Financial Plan, natural marine reserve.

1 Introduction

Since 2004 the University of Udine (Italy) and the Italian Association WWF for Nature have collaborated in order to establish an environmental accounting model for the Miramare Natural Marine Reserve (Trieste, Italy) (MNMR). The model aims to investigate what value, and how much, the MNMR had been able to create from the money assigned to it by government and funding bodies.

Environmental accounting issues have been under consideration since the 1990s and in the 2003 the UN, EC, IMF, OECD and the WB [1] undertook a review of the System of National Accounts (SNA) in order to integrate environmental accounting into economic accounting and to analyse the contribution of the environment to the economy and the impact of the economy on the environment in the System for Integrated Environmental and Economic Accounting (SEEA).

Natural Reserves are special subsets of organizations implementing environmental accounting models managing environmental goods and producing environmental services. Their implementation highlighted some issues: each of one required a detailed approach. First of all, the scale limitation. The SEEA models are national accounting sys-

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tems not applicable to micro scale. Natural resource accounting overcomes this limitation, but introduces the second restriction: physical unit measure instead of monetary unit measure. Finally the third limitation is the accounting of environmental costs but not environmental benefits. Without environmental benefits, environmental accounting system takes into account the effects of the resources consumed but not the resources produced by ecosystems (what happens in natural reserves).

In order to overcome these limitations, we developed an accounting framework for local protected areas by adapting the national framework and taking into account both economic and environmental costs and benefits. We tested the application for the MNMR referring to the 2004 [2] and then we improved the model referring to the 2006 on which this paper reports.

2 Methodology

The model adapted the economic asset account. The environmental accounting structure for the MNMR includes a natural capital dimension (natural stock account) and a flow dimension (natural flow account) (Table 1).

TABLE 1

Environmental Accounting Model For The Mnmr

Asset accounts for the MNMR		
Natural stock account	Natural flow account	
Natural stock: Quantity Quality	Costs: monetary (reserve costs) environmental (environmental costs)	Benefits: monetary (reserve revenues) environmental (environmental benefits)

Natural stock accounts should be set up based on a long time series. Data should refer to natural resources quality (species) and quantity (density). Physical data on stocks are usually compiled by biologists, who use different methods to estimate the size of these stocks [1].

Natural flow account assesses physical flows between the biosphere and technosphere and is indicated as “Natural resources asset account” [1]. The study analysed biosphere-technosphere flow, which assessed environmental benefits and economic revenue; technosphere-biosphere flow, which assessed environmental and economic costs. In our model, flows from biosphere to technosphere are represented by ecosystem functions [3], [4], [5], [6], [7], and economic valuation of the MNMR ecosystem functions assessed environmental benefits. The flows from technosphere to biosphere describes how humane activities consume natural resources and are traced back to the management goals of the MNMR: protection and enhancement; dissemination, environmental education and scientific research; sustainable development; management.

3 Results and analysis

3.1 Natural stock account

Natural stock account assessment involves assigning a monetary value to the Reserve’s natural capital (water, flora, fauna and soil). At this stage we have not yet reached an adequate monetary estimate and in order to overcome this lack, a qualitative (species variety) and quantitative (density) accounting method has been adopted. The qualitative aspect is based on the Initial Environmental Analysis (IEA) of the Environmental Management System (EMS), the quantitative aspect, reference was made to the results of a visual census.

3.2 Natural flow account

In order to allocate monetary values to natural flows, a cost-benefit approach has to be adopted.

In this case costs are:

- monetary (costs contained in the profit and loss account),
- environmental (technosphere-biosphere flows),and benefits are:
- monetary (revenues contained in the profit and loss account),
- environmental (biosphere-technosphere flows).

Monetary costs and revenues have been reclassified according to the four goals that came from the income statement for the period ending 31.12.2004. To do this we used the Long Term Financial Plan (LTFP) approach [8].

Environmental costs are related to management goals which benefit from materials and energy flows from the biosphere and cause impacts upon the following: anthropic presence, consumption of raw materials, motor fuel, heating fuel, electricity, water and administration expenses. In order to translate these impacts into environmental costs, the consumption items have been converted into equivalent tonnes of CO_2, and considering a social cost of carbon (SCC) of 33,33 €/tC [9], the monetary value had been calculated.

Factors related to anthropic presence (transport, consumer durables, consumer non-durables) contribute to CO_2 production. The human presence has been transformed into CO_2 emissions and by using a CO_2 production coefficient of kg17,49/inhabitant/day, visits will translate into kg156.818 of CO_2 corresponding to €1.458.

For raw materials use, we considered paper consumption (kg968) converted into equivalent CO_2 quantities, which amounted to €17.

The fuel consumed in the MNMR is used for both motor vehicles and heating. Consumption converted into equivalent CO_2 emissions has been translated into an environmental cost of €164.

Electricity consumption was kWh80.791, which translates into an environmental cost of €530.

Annual water consumption amounted to 248,34m³, which was equivalent to an environmental cost of €1.

Referring to environmental benefits, the continental shelf is the main feature of the MNMR's marine ecosystem, and the following functions have been identified: gas regulation, nutrient cycling, biological control, food production, recreation, and cultural [4].

The gas regulation function measures the carbon content stored by seaweed strata. We assessed that the average yearly primary production of phytoplankton is 130-150 gC/m2 absorbing 1,4 tC/ha and considering the SCC we calculated that the avoided costs are €5.647.

The nutrient cycling function considers the concentrations of phosphorous and nitrogen. Replacement cost is used, i.e. the cost of mechanically removing them. Taking the lowest figure of replacement costs, a value of €777/ha/year is reached. The annual value of its contribution to nutrient cycling can be estimated at €94.049.

Food production takes both fishing and angling into consideration. It has been estimated that professional fishermen catch kg137.690 of fish per year from within the vicinity of the MNMR. By multiplying the total weight of the fish by market value, we obtained an estimate of the monetary value of the food production function of €112.852.

As far as the biological control function is concerned, control exerted by the high trophic levels is at least 30% of the fish catch value. Consequently, taking it results in a figure of €33.856 for the biological control function.

Tourism in the MNMR has been divided into two categories: recreation and culture. Contingent valuation methods have been used to assign a monetary value to the benefits which derive from recreational activities (visitors, scuba divers and snorkellers). The overall benefit is obtained by adding surplus (€71.915) and price (€61.954). Moreover, tourism produces indirect economic effects estimated through the Leontiev multiplier of 1,54 departing from daily tourist spending (accommodation, catering and publications). An overall figure of €258.060 was obtained for revenues produced directly and indirectly in the MNMR. By adding the benefit (incomes plus surplus), the function's value reaches a figure of €329.975.

The cultural function has been divided into scientific and educational. The former regards research activity with an average value/hectare/year of €31, giving a total of €3.744. The second regards educational activity producing revenues of €44.131. The overall cultural function value therefore amounts to €44.877.

Three main figures emerge from the LTFP: revenues amount to €135.496, public funding amounts to €609.512 and third parties amount to €199.425. The grand total amounts to €1.568.687 for monetary and environmental benefits.

In order to conclude the cost analysis, the income statement costs have to be added to the environmental costs which comes to a total of €2.171. Adding environmental and economic costs, passivity amounts to €914.756. It is now possible to obtain a figure for the net benefit in 2006, limited to flows from the biosphere to the technosphere and vice versa. By subtracting costs from benefits, both monetary and environmental, we can see that the MNMR annual net benefit produced is €653.931.

4 Conclusion

From a methodological perspective, the model takes a few steps forward in the accounting framework by adapting macro to micro scale models and allowing not only environmental costs but also environmental benefits to be assessed.

From an analytical perspective, the MNMR environmental accounting shows net benefits of approximately €654.000. How can this result be interpreted? Generally speaking, it can be said that the Reserve's development model is in line with sustainability on the contrary the balance would be negative. The Reserve's natural capital policies fully achieve its objectives regarding sustainable development, protection and enhancement. If we compare the net benefit figure of €654.000 with the public funding we can conclude that public funding is completely covered, producing wealth by a rate of return of 7%.

From a policy perspective, the model developed for the MNMR provides indicators and descriptive statistics to monitor the interaction between the economy and the environment, as well as serving as a tool for strategic planning and policy analysis in order to identify more sustainable development paths.

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