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Exchange rate between scientific currencies. An application to the landuse plan of Natura 2000.

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Abstract

Science is driven by research funds, research funds are associated with decision making, and decision making is attached to valuation. Therefore every scientific paradigm tends to devise its own valuation system. Economists prefer cost benefit analysis where everything can be translated into money. Planners assume values to infinity with lines in a map defining restrictions and enforceable land uses. Ecologists design maps with values for biodiversity. Historians value things according to their age and meaning. And engineers enjoy the mathematical control over multicriteria analysis. Anyway, concerning spatial planning, most of the time there is a line on a map, assumed by politicians and experts and more or less respected by stakeholders. Along this line the total value of alternative uses must be the same. And the total value assumes all the information values provided by economists, ecologists, planners, engineers and historians. Because a line has many points it is possible to estimate the exchange rate function between all these different scientific currencies and derive the total economic value of different land uses.

Introduction

The economic valuation of the environment is already quite structured in compendiums and guidelines and used by many respectable institutions such as the World Band and the United Nations. The main assumptions to use those valuation methods are the following: i) societal welfare is the sum of individual welfare; ii) individual welfare can be measured; and iii) individuals maximise welfare by choosing the best combination of goods and services that yields the maximum net benefit. From this perspective the legitimacy of a policy is guaranteed whenever the interpersonal sum of benefits exceeds costs (Randall, 1987). Therefore, from this perspective, the problem related to any act or policy should be to assess the net benefits estimating the value the beneficiaries would be willing to pay and appraising the costs that the losers are able to accept either to allow voluntarily, or to promote, the implementation the act or policy.

There are many methods to assess the value of changes in the environment associated with different scenarios and policies. In one of the typologies John Dixon (1997,p. 34) classified this methods into six main groups:

i) Approaches that use market values of goods and services such as changes in productivity, cost-of-illness and opportunity-cost. Beyond many applications the opportunity cost method has been used to evaluate the protected areas of Uganda (Howard, 1995), to analyse the value of alternative forestry practices in Nepal (Houghton & Mendelson, 1997), and to help the assessment of the total economic value of Kenya protected areas (Norton Griffths, 1994).

ii) Cost-side approaches that use the value of actual or potential expenditures include cost effectiveness methods, assessing of preventive expenditures, appraisal of replacement costs or relocation costs and implementation costs of shadow-projects. For example the restoration costs of a forest in Croatia are compared with the benefits from tourism, hunting and watershed functions (Pagiola, 1996).

iii) Surrogate - market techniques such as travel-cost methods and market goods as environmental surrogates is another solution. The travel cost method was used to assess the effect of environmental quality on consumer demand in Honduras (Pendleton, 1993). It was also used to appraise the contribution of the Grampians National Park to the regional economy in Australia (Read-Sturgess & Associates,1994).

iv) Another solution is the contingent valuation methods that use bidding games, take-it-or-leave-it experiments, trade-off games, cost-less choice and Delphi techniques. Contingent valuation is used to evaluate the willingness to pay for a protected area in India (Hadker & al., 1997) or the level of water quality in the United States (Wilson and Carpenter,1999).

v) Hedonic methods which look at changes in real-estate values or wage-differential between different places. This methods are often used to evaluate the value or urban environment but can also be used to assess the environmental value of sites close to urban systems (Sozinho, 2001).

vi) And, finally, linear programming models that allow the valuation of environmental goods and services such has water qualtity (Dentinho, 2002), or natural resources accountability.

Because most of the value related to the environment is a non-use value, the advisable valuation method is, according to John Dixon (1997), the Contingent Valuation. Nevertheless the values achieved by this methodology can be quite different and the features of the environment measured by the various studies are often poorly defined. As stressed by Paulo Nunes et al. (2001) some studies assess the value of particular species to humans, others refer goods and services provided by the environment, and some others deal with the value of biodiversity in itself. In the same line of analysis Rudolf de Groot (2002) highlights the lack of a systematic typology to integrate the increasing number of publications that try to value the benefits of natural ecosystems to the human society and, along with other authors (Farber & al,2002; Limburg et al.,2002) identifies three types of valuations:

a) The ecological valuation related to the sustainability of the ecosystem functions.

b) The socio-cultural valuation associated to the crucial role played by ecosystems to ensure a sustainable society (Norton, 1987).

c) The economic valuation which involves direct market valuation, indirect market valuation, contingent valuation and group valuation (de Groot, op.cit.)[1].

What seems to happen is that each scientific paradigm tends to devise its own valuation

[1] Notice that there are economic valuations of assess socio-cultural (Sanz et al., 2003; Bebate et al., (2004) and environmental services (mentioned above). The problem is that, arguably, those studies do not capture all the value of the services provided namely those related to ecosystem and cultural sustainability.

system. Ecologists design maps with environmental values assuming the relevance for the sustainability of the ecosystem. Socio-cultural scientists value things according to their role in the society along space and time. Finally economists, has mentioned above, prefer cost benefit analysis where everything can be translated into money. And the question stays open. How to combine the different disciplinary perspectives in a consistent decision support methodology?

Methodology

The objective of the methodology presented below is to combine different environmental valuation systems in consistent way. The method is based on three assumptions.

- First, the assumption that ecological and socio-cultural values are not considered in the valuation methods based on direct, indirect and induced productivity associated to private and public uses of natural resources. Being so it is possible to add the productive values of each use of the natural resources to the ecological and socio-cultural values associated to each one of those uses. Even if the ecological and socio-cultural values were not expressed in monetary terms, it is possible to make the addition between the various valuations if some “exchange rates” between the various disciplinary currencies can be defined.

- The second assumption takes for granted that the ecological, socio-cultural and economic values can be allocated to some dimensional referential, for instance a spatial grid, even if the effects of those values are felt elsewhere. For example the productive value of some land use can be allocated to a particular spatial grid although its effects are captured along the logistical value chain.

- Finally it is assumed that public decisions are or at least should be consistent so that the trade off between similar values must be the same along all the decision – making space of competences. Therefore in every point of the boundary (f) that limits alternative uses of the environment the total value for one use (Vfa) must be exactly the same as the total value for the alternative use (Vfb).

(1) $$Vfa = Vfb$$

Nevertheless each total value (Vfa, Vfb) results form adding together the economic values (Vfea,Vfeb), the ecological values (Vfba,Vfbb) and the socio-cultural values (Vfca,Vfcb), each one of them multiplied by an Exchange Rate Function. The

Exchange Rate Function (ρ) relates the economic value to the ecological value. The Exchange Rate Function (σ) relates the economic value to the socio-cultural value.

(2) $$Vfa = Vfea + Vfba \times \rho + Vfca \times \sigma$$

(3) $$Vfb = Vfeb + Vfbb \times \rho + Vfcb \times \sigma$$

In the boundary the value associated to alternative uses (a,b) are equal. Therefore:

(4) $$(Vfea-Vfeb) = (Vfba-Vfbb) \times \rho + (Vfca-Vfcb) \times \sigma$$

Notice that the boundary line has many points. Assuming that it is possible to obtain the economic, socio-cultural and ecological values for different alternatives (a,b) then it is also possible to estimate the functions (ρ) and (σ). If these functions are just simple parameters then they can be considered as “Exchange Rates between disciplinary tribes”: between economists and ecologists (ρ), between economists and historians (σ), and also between ecologists and historians (σ/ρ).

Remark that if there is no difference of socio-cultural values for alternative uses then (Vfca-Vfcb) = 0 and

(5) $$\rho = (Vfea - Vfeb) / (Vfba-Vfbb)$$

Application of the concept to Natura 2000 Management Plans

Based on a Geographical Information System, the study area was divided into square parcels of 1 hectare. Each one of these small areas was classified into twelve territorial classes according to the altitude, the slope, the accessibility and the soil. Furthermore for each pair land use/territorial class there is a private economic value related to the employment supported, a public economic value associated with the quantity and quality of water generated, and an ecological value that takes into account the relevance for the preservation of species and habitats of Natura 2000 (Dias et al., 2004).

On the other hand the boundaries of Natura 2000 sites are the result of a discussion between experts and politicians. In each one of the parcels belonging to these boundaries it will be expected that the ecological and economic value associated with the inclusion in a Natura 2000 site, will be exactly the same as the value of being out of that protected area. Therefore taking into consideration the land uses allowed or forbidden on the parcels on the boundary, and based on their respective ecological and economic values (Figure 1 and 2), it is possible obtain various estimates for (ρ) in expression (5).

Figure 1: Ecological Values for the Present Land Use in “Morro Alto” Flores Island

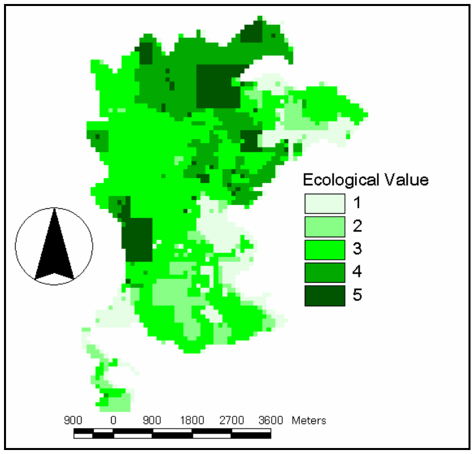
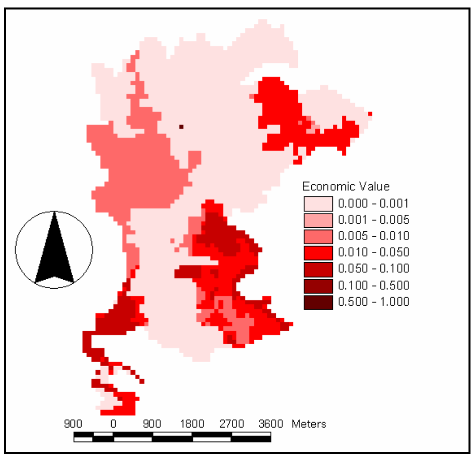


Figure 2: Economic Values for the Present Land Use in “Morro Alto” Flores Island



Notice that the symbol ρ in (5) can be just a coefficient that relates a change in economic value associated with a change in the ecological value. Such coefficient can help planners to design efficient land use plans, at least taking into account the available information on economic, ecological and social-cultural values for alternative land uses.

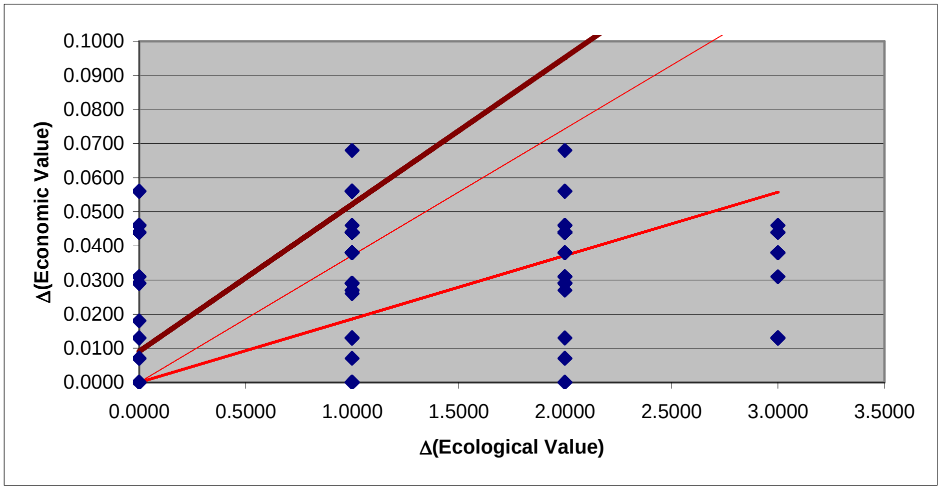
The symbol ρ in (5) can also be a function (6) that somehow highlights the behaviour of regulators.

(6) $$(Vfea\text{-}Vfeb) = \alpha + \delta \times f + (Vfba\text{-}Vfbb) \times \rho$$

Where α = estimated intercept; f = dummy variable associated with the type of soil (0 for bad soil and 1 for good soil); δ = parameter estimated for the dummy; and ρ = the estimated exchange rate between ecological and economic valuations.

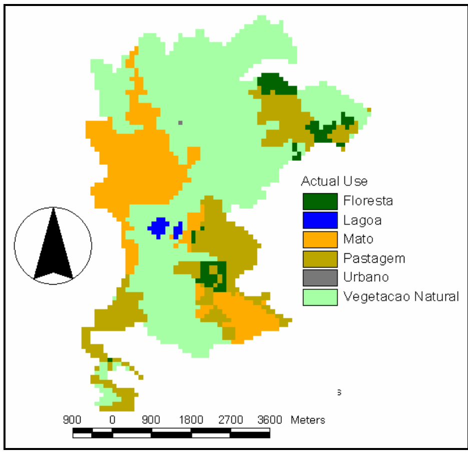
Figure 3 shows the relations between changes in ecological and economic values due to changes in land use for the boundary of "Morro Alto" Natura 2000 site. From the data presented it is possible to estimate the parameters for expression (6) [α = 0.0090(4.79); δ= 0.0431(18.40) and ρ=-0.0020(-2.68); R^2= 59.6%], as well as the value [ρ=-0.018] that minimizes the square error between the line and the points, and its double [ρ=-0.036] designed to define a more conservationist land use plan.

Figure 3: Boundary Trade-Offs between ecological and economic values



Having (ρ), it is then possible to generate various interesting outcomes:

First, it is possible to obtain the best land use map (Figure 4b) and compare it with the present land use (Figure 4a), by choosing for each parcel the land use that leads to the maximum Total Value among all the other alternatives. From the observation of the two maps it is clear that the optimization will lead to an increase in the forest area and a decrease in pastures, natural vegetation and degraded vegetation. In the optimized situation the higher areas and some tourist paths are occupied by natural vegetation whereas most of the other areas will be covered by forest.



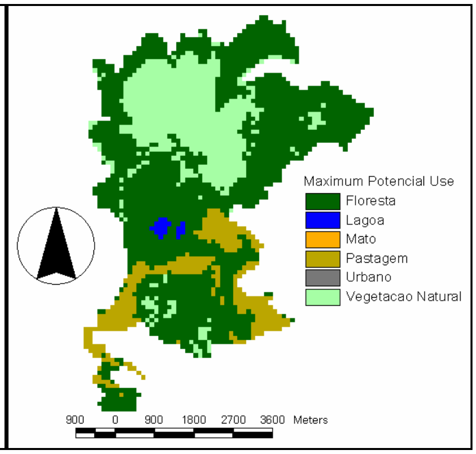


Figure 4a) Actual land use Figure 4b) Optimized land use [ρ=-0.018]

Second, for a higher "exchange rate ρ" it is possible to obtain another consistent land use map that represents a more conservationist solution (Figure 5). In this solution the area of natural vegetation and degraded vegetation will increase. Strangely this solution seems closer to the present situation although a small change from pasture to forest is advocated. Certainly there are good reasons to explain that associated with the lack of representation of the estimate for ρ in Figure 3. Anyway the important message is that a change in this parameter can be linked to major changes in the land use plan.

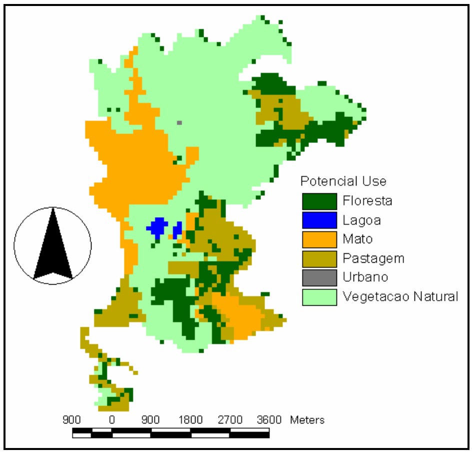


Figure 5: Optimized land use [ρ=-0.036]

Finally, it is possible design the maps of Total Land Use Values for the present situation and for the proposed plan (Figure 6 a and b), having respectably the values of 185 and 228 employments equivalent. Notice the employment indicator can rise some criticism because it is just a proxy variable of the economic value, but that was the data we had to calibrate the economic value linked to each hectare.

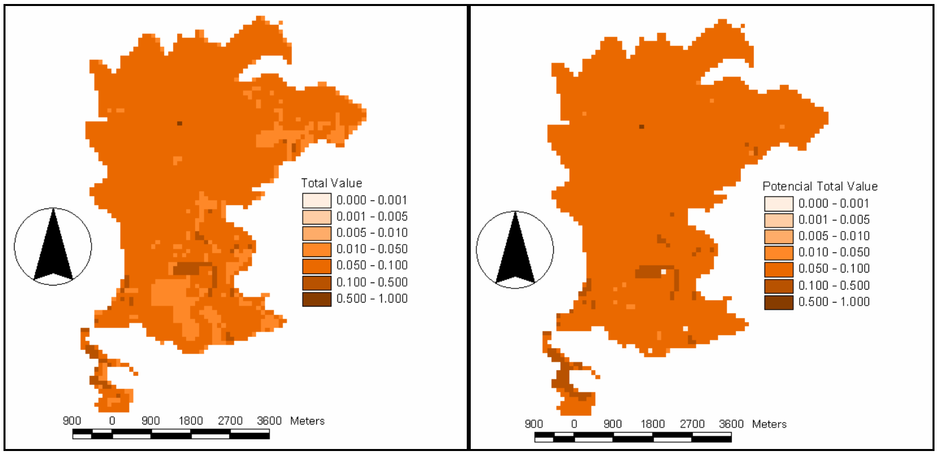


Figure 6a) Actual total value Figure 4b) Optimized total value [ρ=-0.018]

Conclusion

The challenge was to combine the different disciplinary perspectives in a consistent decision support methodology. It was assumed that the economic, ecological and cultural complement each other rather than being substitutes. It was also supposed that each one of this valuations could be allocated to some dimensional referential or map. Finally it was believed that public decisions should be consistent so that the trade off between similar values must be the same along all the decisions. Based on that, the idea of an exchange rate between disciplinary tribes was explained and applied for a Natura 2000 site in the island of Flores (Açores).

The results seem quite interesting. First there is a method to monetarize non-monetary values. Second this method is also suitable to value non-use values without the expensive adoption of the Contingency Valuation. Finally the exchange rate between disciplines can also be used to assess the internal consistency of land use plans or to design different plans according to various exchange rates.

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