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A cartographic and qualitative assessment of economic aspects in Integrated Management Plans

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Introduction

The traditional assessment tools present strong limitations in the determination of the total value of forest services, because they don't consider the non monetary components of the value. On the contrary, these components, in a public evaluation perspective, have to be considered, in order to give correct managerial criteria.

The present article summarises an evaluation method that tries to overcome these limits including some non monetary components in the assessment of forest values.

The method has been set up in the framework of a three years research by the Department of Agricultural, Forestry and Environmental Economics and Engineering of the University of Torino. It deals with a non monetary and ordinal method, fit for the evaluation and the cartographic restitution of the "useful functions" (Giau, 1998, Brun 2002) produced by a forest in a certain geographical area.

Theoretical framework

Economic instruments as toolbox for forest manager

A correct planning should consider the whole amount of services produced by a forest. In fact, in the perspective of social welfare optimisation, typical for the public choices (Merlo 1991), the great benefits offered, not only by market products, but also by numerous services called "externalities[1]"(Dasgupta Pearce, 1995) must be recognised and properly considered.

This is particularly important in ecologically vulnerable areas, like mountain forests, where managing errors can cause larger negative consequences: in these areas more than in others, integrated management plans, taking into consideration manifold services provided by forests and multiple demands requested by the society, are crucial.

Indeed, economic instruments have a significant place in the forest manager toolbox, and must be considered, in the contest of the decision making process, as a step to promote a better knowledge, to enrich the awareness level of all the involved people and to provide feasible solutions.

Multi-function versus Multi-service

From a methodological point of view (Brun, 2002), it is necessary to emphasize that "functions" and "services" are not the same: functions (chemical, physical, biological and so on) are objective, and can be assessed independently from the human context: they are neutral from an economic point of view and related to the life cycle of ecosystems.

Services are the spill–over for the society of functions and, in order for a service to exist, there must be an interaction with man or, at least, man must perceive said function.

Services change in time and space according to the demands of the man. New services arise (recreation in the forest) while others may disappear or become negligible (wood logs, fuel wood); other may remain relatively constant in time (protection in mountain areas).

Therefore, in order to assess the value of a forest we must consider the value that man assigns to its services and, according to the subjective nature of the value, it is possible that the same function produces different services in different time or regions and produces different values.

If those values, not expressed trough the market, are not considered, the services are underestimated and it may not be possible to allocate the proper amount of resources ("institutional failure[2]"), risking for example, to over utilise the forests. In

[1] An external effect occurs each time an activity affect utility of other producers or consumers and the effect is not assessed nor compensated.

[2] Market and Government failure are the most common types of institutional failure. Both can contribute towards forest and environmental degradation. Market failures occur when market is not able to lead choices towards a social optimum, as in the case of the impossibility to emerge and allocate correct prices for environmental and social effect or in the case of failure in the existing markets (monopolies, oligopolies, lack of property rights and so on). Govern-

this case a public intervention with binding regulations is necessary in order to avoid over exploitation of the resources. As a consequence we will have the feeling to suffer the loss of the control of "our" resources.

As an outcome of these considerations, in order to make correct public-choices in forest planning, there is a need to set procedures, at the same time effortless, not expensive and democratic, able to assess and to give a correct weight not only to the wood production but also to all other services produced by forests. In fact, we can correctly manage only when we know the "correct value" for the society.

Furthermore, the design of such procedures, must also reflect a strong understanding of the behavioural responses of individuals, because services depends on people demands. It is straightforward to consider that the best way to assess society need is to fully involve people in the process.

What kind of economics tool should be considered?

Many methods try to assess the total economical value of forest services. Most of them are monetary and focus on estimating a demand curve and on determining the benefit for the consumer, starting from the study of the consumer's preferences. In this way the value people assign to forest services is investigated analysing their actual behaviour or asking their willingness to pay for them.

Generally, these methods are not very effective for forest planning, primarily because they are rather expensive and give a somewhat limited answer, depending on particular conditions that are not repeatable and not comparable with other situations.

Moreover, the most important point is that these methods don't have to provide an absolute truth, but to serve as tools. In other words, it is not strictly necessary to give the exact monetary value to one or to another service, but to help deciders to make correct choices within a range of possible alternatives.

In this perspective the non monetary methods can be more useful in forest planning, especially if they are able to create an ordered list of alternatives and to point out the preferred one.

Furthermore these methods should be more suitable if different process for stakeholder consultation are needed: their workings are generally less complicated and less unfamiliar to those who must comply and can encourage effective participation.

The Economic Quality of Woods

The Economic Quality of Woods or QEB method (from Italian "Qualità economica dei boschi" – Giau, 1998, Brun and Giau, 1998) was set up for the above reasons, to operate as a decision-making tool.

The term "Quality" versus "Value" is intentional, to signal that the assessment doesn't deal with a monetary but with an ordinal estimate. In fact, it is an ordinal and cartographic method of evaluation based on aggregating points of value which are identified in a rational way, based on the main "useful capacities" of the woods of a mountain valley.

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ment failure comes from lack of intervention or wrong intervention.

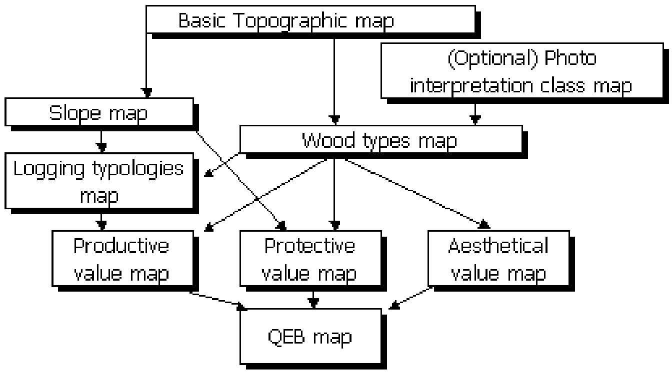
In its current formulation, the QEB method can be used to estimate the economic quality of cartographic units of 200x200m of a typical forest management unit (5'000 – 30'000 ha), by using an additive model that considers the three main services: productive, protective and aesthetic.

The result is a weighted average of the points of values that are assessed on homogeneous types of woods and rendered cartographically using a GIS (Geographical Information System).

Structure of the model

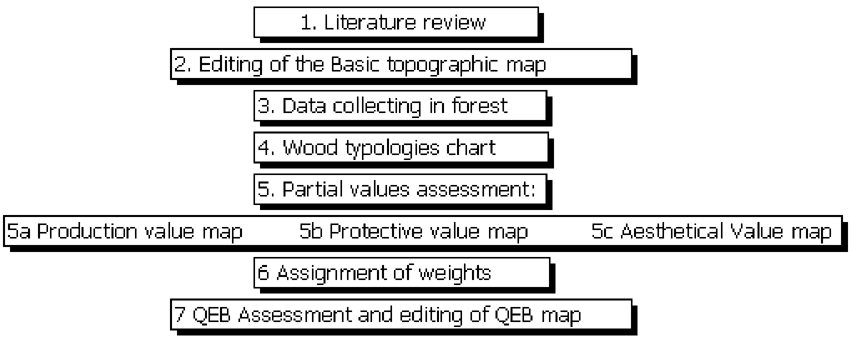
The model of QEB is built on several thematic charts, as it's possible to see in the next picture.

Fig. 1 - The QEB maps



The structure is based on seven main steps, as described in the following scheme (Fig 2).

Fig. 2 - Necessary steps to achieve the QEB map



After a preliminary study of the region, using all available data sources, a **basic topographic map** is edited, with the indispensable information: boundaries, roads, rivers, slides and so on. On this basis a square cartographic network is printed in order to identify the data collection points (1 km network). A second 200 m square network is identified as the printing unit of the results.

Some of the information collected will be used for an automated analysis (using GIS properties) of the territory, for slope map and for routes density as an example, or similar map will be collected in a numerical format if available.

After the collection of data in forest, a second map is edited, using, if necessary, photo interpretation tools: it is the "**type of woods map"**. In Italy there are nowadays several studies that classified woods in typologies, considering main forest species and sylvicultural management characteristics (for example for Piedmont region see Mondino, 1992).

In high Susa Valley, for instance, the management plan defines about 20 main wood types (i.e. larch stands, fir stands, beech stands, reforestation stands and so on) divided into 108 "typologies" (i.e. grazed larch stands, mountain larch stands with spruce, river stand of brushes Salix, eutrophic fir stands, and so on).

The woods-typologies used for the QEB assessment can be different from the current forest stands: in fact they are identified taking into account the potential development of the forest, considering the absence of changes of social-economic variables within a specific period of time. This time is an external datum and is supplied by the commissioner of the estimate (Brun and Giau 1998), based on the duration of the planning that in Italy is usually from 10 up to 20 years.

Anyway, in order to save time and money, where wood typologies maps are present, it is more straightforward to use directly that classification to assess the QEB values.

On the basis of these maps the different values of forest services are assessed and printed, using several other intermediate maps, as the **map of the slopes** that is useful for assess the protection function and the **map of the logging system** that is necessary for the logging cost assessment.

The production value

In a public perspective, the production value of a wood can be represented by the "net social product" that is the new wealth produced by means of the timber exploitation.

Such product is therefore a "value added" and notably the yearly and average value that is gotten by difference between revenues and average costs of the production factors that are totally consumed during the operations of exploitation.

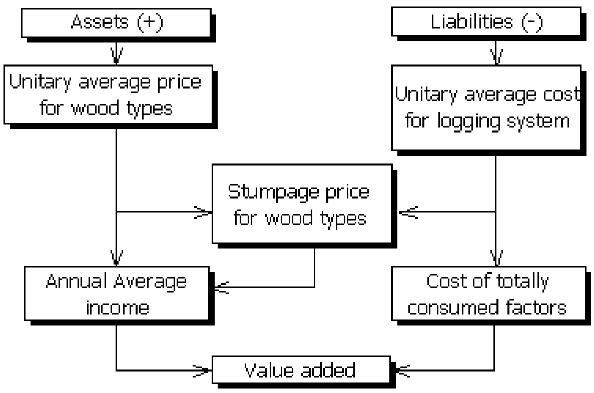
If we identify the production value only with the "value added", we make abstraction of the distribution of incomes among landlords, workers and capitalists, consistently with the public point of view.

But there is an important restriction: the stumpage price (that is the difference between revenues and costs of logging) must be positive. If the stumpage price is negative, for exploiting a certain wood, we should consume more wealth than what is produced. Therefore, from a public point of view, the production value of this wood is nonexistent.

Before estimating the value of production it is therefore necessary to identify the forest areas where the stumpage prices of wood are positive, comparing revenues and logging costs.

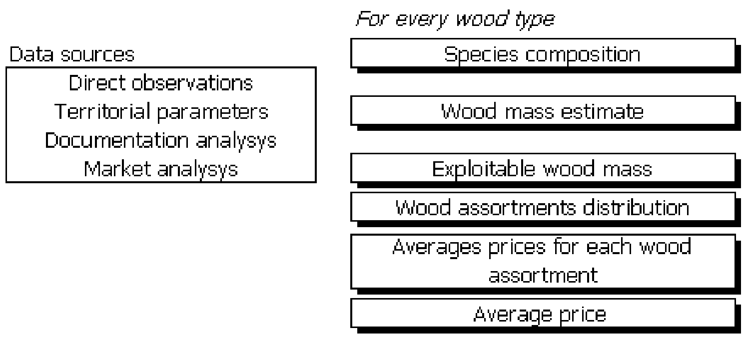
The complete scheme of these phases is represented in the next figure (Fig. 3).

Fig. 3 – Production value estimate



For a successful general assessment of stumpage prices, which will be used for all forest types in the whole territory, it is necessary to adopt strong simplifications. For the active part of estimate (Fig. 4), one must identify, for every wood type, the quantity, the quality and the relevant prices of the exploitable assortments. Several inter linked- information sources can be compared thanks to the geographical computer system and numerous data bases.

Fig. 4 – Scheme of the structure of estimate of active



In the same way, for estimating of unit costs of exploitation, several steps and numerous crossed information are necessary. As a summary the method can be described as following:

1. Analysis of logging systems normally used in the region;
2. Assignment of the likeliest logging typology to every forest surface, according to territory features (notably slope and road density), to logging intensity and to the dimension of exploitable assortments,
3. Determination of the main economic parameters: logging system organization, economical coefficients for different logging phases, labour cost, mechanical costs;
4. Assignment of an average exploitation cost to every logging system.

Subsequently, in those forest areas which present positive stumpage prices, the added value is estimated by subtracting to the average annual revenue the costs of the production factors entirely consumed, obtaining, as it was mentioned, the net social product of the logging operation.

As a final step, these values are classified giving an ordinal score among 0 (no value, i.e. negative stumpage price) and 4 (very high value) and mapped in the production value map.

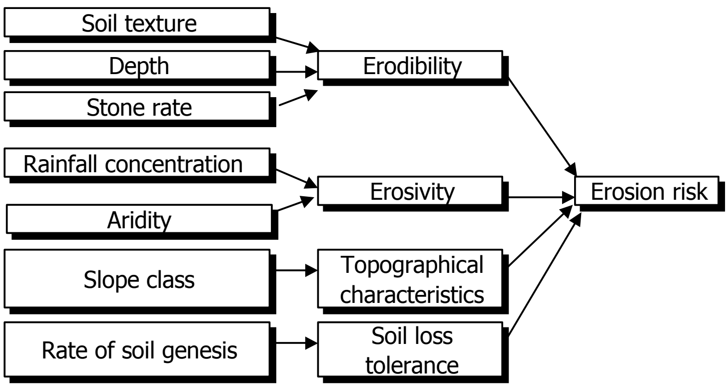
The protection value

The protection value has been defined as the capability of the forest to protect against the soil erosion, and it is derived from a combination of several models present in literature (Brun 1997), respecting the conditions of non expensiveness and simplicity.

The estimate of the protection value has been obtained with a multiplicative model using the product of the "**potential risk of erosion**" and "**the efficiency of the forest cover**."

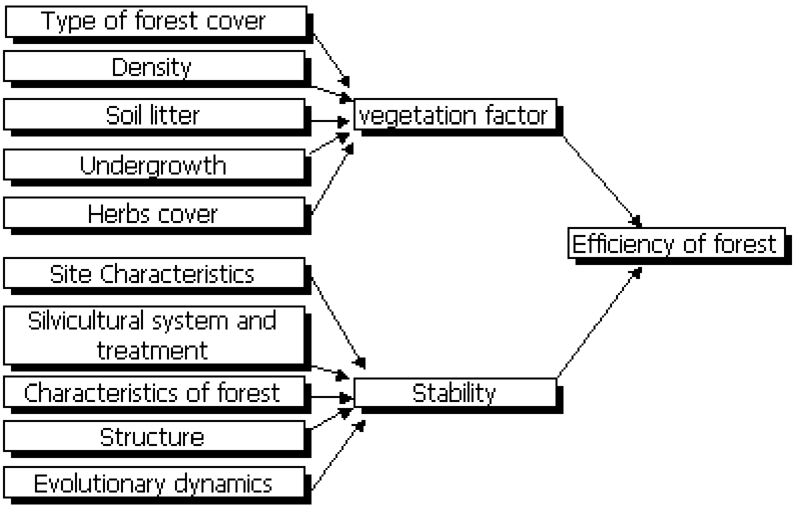
According to CORINE methodology (Briggs et al., 1992) the potential risk of erosion is the result of the product among the soil erodibility, the climate erosivity, a topographic factor and the tolerance to the loss of the soil (Fig. 5).

Fig. 5 The assessment of the risk of erosion



The efficiency of the forest cover has been estimated by a second product. In this case, factors are the "C parameter" of vegetation, contained in the general equation of soil loss of Wischmeier (1975), that expresses the capacity of crowns to develop their protective function, and the forest stability (Langenegger, 1984), that contains a judgment of time preservation of protective function (Fig. 6).

Fig. 6 The assessment of the efficiency of the forest cover



Therefore, according to the model, is easy to understand that a forest placed in a steep slope has a higher protection value than a similar one in a flat soil. Similarly, a forest in a region were rainfall are dangerous (because of their concentration or because of soil fragility) has more value than a forest placed in a region were rainfall are more regular and soil is permeable.

At the same time, in comparable slope, climate and soil conditions (that are the "context variables" not modifiable by the man) a well structured forest, as an uneven aged and dense one, has more protection value than a sparse one.

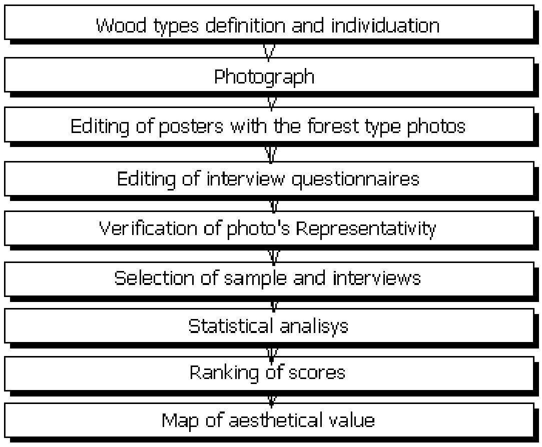
All necessary data were collected with a cluster sampling operated on the knots of a square kilometre grid and the results were applied to the entire surface around each knot, using the GIS.

Subsequently, data were arranged in a classed score system (between 0 – very feeble and 4 – very high) and results were mapped in the protection value map.

The aesthetic value

In order to assess the value of the forest landscape, the visual preferences (Mattalia 1993, Borra and Mattalia, 1994) method was used (Fig. 7).

Fig. 7 – Main steps of the visual preferences method



Synthetically, the visual preferences method requires to define several typologies of forest, which must be clearly identifiable, to photograph them in different conditions and to submit the pictures to the aesthetic judgment of a significant sample of people.

After that, on the basis of the average scores obtained by each typology, in every condition, it's possible to rank the woods using an analysis of variance and to subsequently build the aesthetical value map.

In our case, wood typologies were photographed in four different conditions: inside (considering the leisure service) and outside (considering the aesthetic service) of wood, in summer and in autumn.

Since some aesthetic features, in every typology, remain constant (brightness, trees density, presence of specific brushes), it has been possible to submit the photographs to an expert exam previously to use them for the interviewing. This phase was very useful to assess the correct representative of pictures, according to forest type characteristics. Rejecting those photograms which had not the typical features of the wood type we avoided to falsify the judgment of the interviewees.

The four photos taken from each wood typology were finally submitted to a sample whose dimensions were calculated as a function of the acceptable statistical error:

$$N = d \cdot \frac{p(1-p)}{err^2}$$

where:

N = sample dimension

d = design effect (square standard error of estimate obtained a proportional stratification criterion divided by the square standard error of estimate obtained by a random extraction method)

p = percent of people able to give a different aesthetic value to pictures

err = standard error

Usually the design effect is equal to 1 (Giau, ed. 1998), *err* must be less than 2% and p is calculated after a first sample phase. Considering p=0.9 (90% of interviewed people are able to give different scores) one obtain a minimum sample dimension of 225.

Data were collected in an approx. 500 unit sample, whose composition (for age, sex, geographical origin, instruction level) was chosen according to the main characteristics of the regional population.

The average of the votes calculated for the four photos of each forest typology constitutes the score of the aesthetic value that ranks from 0 – very feeble to 4 very high.

The aggregation of the values

Three partial values, productive, protective and aesthetic, have been assessed as described for each 200x200 m unit of the studied area. These values were codified with a score ranging from 0 to 4, and the score was used to edit a map for each value.

Starting from these values it is possible to appraise the QEB in different ways which imply different aggregation methods of total value; but what it is important to remind is that, consistently with the additive structure of the total value (Randall and Stoll, 1983,Turner et al., 1994, Albani and Romano 1998, Brun, 2002) an additive model must be used.

In our study we used the simplest approach to aggregate values, that is to calculate the arithmetic average of the three partial values. Operating in this way, we have assigned the same weight to the three components of the QEB, considering implicitly a sort of balanced multifunctionality of forest where the three values have the same importance.

Formally, the QEB should be calculated with the following equation (Giau, 1998):

$$QEB = \frac{Vp \cdot Pp + Vd \cdot Pd + Ve \cdot Pe}{Pp + Pd + Pe}$$

where:

Vp, Vd, Ve are, respectively, the productive, the protective and aesthetical values;
Pp, Pd, Pe are their respective weights.

It is indeed possible, and also likely, that services provided by the forests have different importance.

In other words weights must be used to summarised diverse point of view, because tradeoffs may exist between services, due to simultaneous presence of multiple demands that compete with each others (Niemi and Whitelaw, 1999) or the presence of overlapping uses and values related to forests (Buttoud, 1999).

Therefore, in the practical (=not academic) use of the method, it is central to obtain weights whit a transparent and correct way, which reflects the social utility of forest services.

Conclusions

The QEB method was set up with the practical objective to minimizes costs involved in collecting, processing and distributing information, in order to answer to a growing demand of decision-making tools.

It is a rational, non monetary and cartographic method that assumes to be applied on a scale that represents the typical wooded area dimension, i.e. from about 5'000 to 30'000 ha.

As with all non-monetary methods, it cannot be used to directly determine whether economic benefits of a certain programme are sufficient to justify the sustained costs (Brun 2002), but it can be useful for forest manager to order their forest planning choices. At the moment, QEB method represents a first effort which take into consideration only three values related to important services provided by the forest: the productive, the protective and the aesthetical one.

These services were chosen according to their importance in mountain areas and their very different intrinsic structure which permits us to develop a complex model.

The QEB method has an additive structure, which is typical and consistent with the additive structure of total value. Even if this feature may contribute to arise some criticism to the model, because of its simplicity in comparison to multi – criteria methods, it allows, if necessary, to consider other values without any formal change. Furthermore, it also allows to study the effects of different managing choices and investments as the creation of a new road in forest, or a modification of sylvicultural techniques or even the impact of different political interventions.

A central point that must be reminded is the necessity to separate two main phases: on one hand the assessment of services values with a rational and parametric method and on the other hand the weighting of said services, with a "social" decision making method.

In fact only the first phase represents an estimative problem whilst the necessity to give weights is not and it arise when market is not able to give "importance" to services that are public goods.

For these reasons weights of the QEB estimate, which represent the relative importance of services, have to be defined through an external communicative processes, which take into consideration the points of view of different stakeholders, finding a compromising solution between potentially competitive social demands.

It is important to remark that, in this context, economic assessment has an instrumental role and is not able to give "the solution", but "possible solutions" provided that it is inserted in a rigorous procedure. This procedure should be able to involve all stakeholders from the beginning, with an analysis of the situation, through a goal setting phase, in order to end with the definition of concrete actions to be implemented.

In all these steps economics instruments are useful because are **practical** but they are only a (relevant) part of the system which integrate necessarily communicative approaches and democratic decisions.

Different processes for stakeholder consultation may be needed to develop and implement "integrated" management plan: a strong understanding of what these instruments are designed to achieve is necessary to get better results and to avoid confusion in decision making roles.

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