METHODS AND TECHNIQUES FOR QUANTIFYING THE VALUE OF ECOSYSTEM SERVICES

PhD Senior Lecturer Giani GRĂDINARU
Academy of Economic Studies, Bucharest

Abstract

To quantify ecosystem services several methods have been developed, that succeed to address almost the entire range of ecosystems' benefits for human. Using these methods has gained popularity in both developed and developing countries. However, most of studies focus on the U.S., UK and Scandinavian countries (Norway, Sweden, and Finland). In addition, the economic approach to global ecosystem services is poor, the assessment proposed by Costanza et al. (1997), despite the many criticisms of methodological rigor, is still the most important point of reference. For Romania, the assessment of ecosystem services is at the beginning, but we can speak about a growing interest to conduct such studies.

Keywords: statistical tools, Ecosystem services, quantification

Premises harmonization of economic and ecological principles consist in identifying areas of interference and change interaction issues, so the result is a continuous process of self-regulation. One of these is the economic valuation of the environment, where development of ecological processes, that generate ecosystem services, is subject to the "sensors" of economic system

The importance of this area of interference is crucial to progress towards a harmonious relationship, regulated by constructive feed-back. This importance is justified by the environmental integration into the economic system, by transforming it into a factor of influence to manifest either as an offer, or a request, in accordance with objective needs of people and nature. The rationality of this argument is hard to dispute. However, economic valuation of the environment remains a challenge, existing methods and techniques being poorly consolidated and unable to provide the necessary information for the policy in the required pace, volume and quality to ensure effective action, in general, and in the context of budget constraints, increasingly powerful in recent years, in particular.

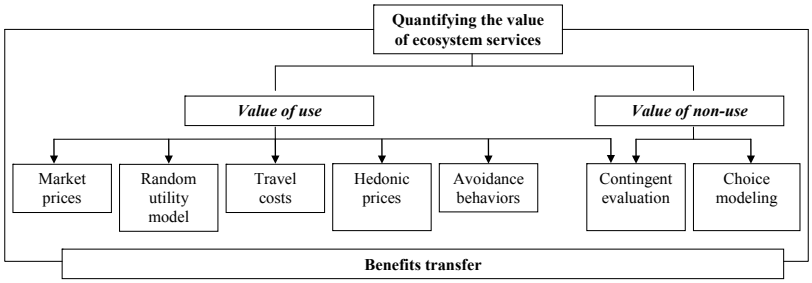
Economic evaluation of environment remains a challenge for many reasons. Most of these can be run up to the temporal and spatial gaps between

causes and effects, amplified by subjective perception and short-term priorities of development. Beyond this, there are a number of sources of ambiguity regarding the methods and techniques developed to date, due to uncertainties in the knowledge of ecological interactions, subjective perceptions, data quality, the insufficient development of monitoring systems, high costs of implementation, limited and questionable transferability of assessments, correlation of techniques with the purpose of evaluation with the ecosystem characteristics and with the evaluated ecosystem services characteristics, incomplete knowledge of the determinants of inconsistency results, obtained by different methods.

Each of the methods and techniques for quantifying ecosystem services has both advantages and disadvantages. Relationship between them can be optimized by proper correlation with the objectives and evaluation subject. The study serves this purpose by providing a critical analysis of each method used for presentation and discussion of conceptual and methodological results of studies. Identified arguments are supported by examples of these methods application under different conditions.

Economic quantification depends on the possibility that ecosystem services are or not traded on the market, depends on the component's value that is measured. One of the most commonly used types of methods and techniques, applicable to quantify ecosystem services.

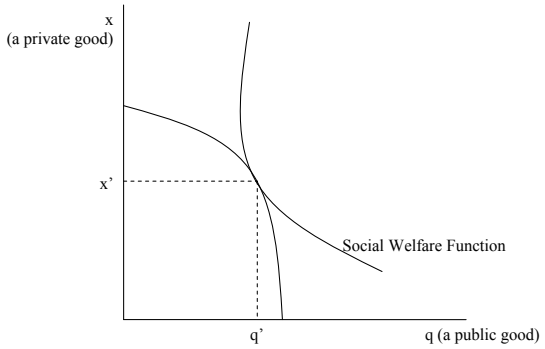
Methods to quantify the value of ecosystem services



Source: adaptated after Nijkamp, P., Vindigni, G., Nunes, P.A.L.D. (2008), Economic valuation of biodiversity: A comparative study, *Ecological economics,* 67

Economic substantiation quantifying ecosystem services derives from welfare economics (normative economics) so that the "optimal" result corresponds to the point of tangency between the social welfare function curve and the production possibility frontier curve.

Optimal production point according to welfare economy



Source: Mitchell, R.C., Carson, R.T. (1989), *Using surveys to value public goods. The contingent valuation method*, Resources for the Future, Washington, D.C.

In addition, the Pareto criterion is also uses, that a policy change is warranted if it brings welfare to a person without causing a disadvantage to any other person.

Cost-benefit analysis (CBA) is the most important method of assessment used to support investment projects and at the same time, the most important user of quantification results for ecosystem services. This method is based on a variant of Pareto criterion, trying to find ways to assign a monetary value to gains and losses of those affected by the provision of public goods in general, or of particular ecosystem service.

Positive economic premises, on which welfare economics is based, are:

- companies, when faced with a choice between two or more possible categories of goods will prefer one of these;
- by its choice, a company tends to maximize its satisfaction, or utility.

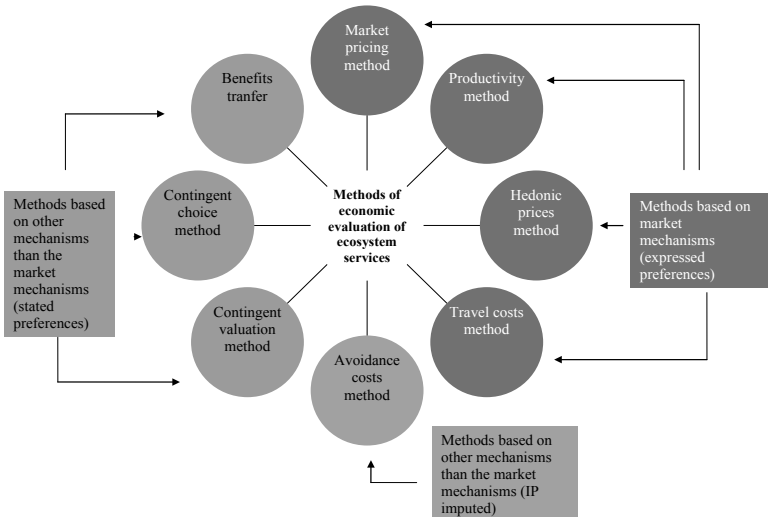
For methods and techniques of quantifying ecosystem services that are not based on the mechanism of the market, these premises have as implications:

- In an economic context, nothing has value for itself;
- Value is either the maximum amount that can be paid for a good by a buyer, or the minimum amount that can be accepted by a seller for the property sold;
- Acceptance of consumer sovereignty - the consumer is in the best position to judge the usefulness of a good for self;

- CBA tends to emphasize economic efficiency compared to distribution problems

Value of ecosystem services that are not traded in the market can be approximated without being a very accurate measurement possible. This approximation is considered that generally leads to an underestimation of being considered a "dilution" of the value of nature to be preserved, regardless of cost conservation (Kuuluvainen, 2002).

Classification of methods and techniques for quantifying the economic value of ecosystem services



Quantifying ecosystem services is achieved by using a variety of techniques, such as travel costs, hedonic prices, avoidance / replacement costs, contingent evaluation, modeling choice, etc. This is complemented by a range of methods and techniques using secondary data such as transfer of value / benefits and meta-analysis techniques. Although, in general, each method is advantageous in a certain context, they developed their typologies. The most common criteria are, at one hand, based on the existence or inexistence of market prices (fig.nr.3) and, on the other hand, on the way the preferences are expressed. Methods based on market mechanisms reveals preferences taken into account, while methods that quantify ecosystem services without market prices are used mainly by stated preferences with respect to a series of scenarios describing a hypothetical market.

Quantifying ecosystem services through methods and techniques based on market mechanisms

Methods and techniques for quantifying ecosystem services based on market mechanisms include: market price method, the productivity method, hedonic price method and travel cost method.

Market Price Method. Market price method is a method which estimates the value of ecosystem services that are bought and sold on the market. The method can be used to assess changes in both the quantity and the quality of a service ecosystem. Using standard economic techniques for measuring the economic benefits of offered services, based on purchased quantities at different prices and on provided quantities at different prices.

Standard method for quantifying the value of use of traded ecosystem service is to estimate consumer surplus and producer surplus using data on prices and quantities. Total net economic benefit is the sum of consumer surplus and producer surplus.

To estimate the demand function is necessary to estimate the consumer surplus, and data needs include: time series of the amount corresponding to different application rates, data on other factors that affect demand (income or other demographic information). Producer surplus estimation requires data on variable production costs and income received from the good's sale.

Productivity Method. Productivity method is used to quantify the ecosystem services that contribute to the production of a good or service that is traded on the market. This method applied to the products or services provided by ecosystems contribute, along with other inputs to the production of a commercial product. For example, water quality influences the effect of irrigation on crop productivity or cost of municipal water treatment. Therefore, the economic benefits of better water quality can be quantified by higher revenues derived from higher agricultural production or lower costs of water supply.

If a service ecosystem is input, changing its quantity or quality will lead to changes in the cost of production and / or productivity of other inputs. Further, it will have an effect on price and / or quantity supplied as finished goods. It can also affect income per unit of input.

For quantification, there are two major types of benefits (or costs). Thus, if the quality or price changes for the consumer, there will be changes in consumer surplus. If productivity or production cost change, will be changes to producer surplus. Therefore, the economic benefits resulting from improved ecosystem services can be estimated using market data changes.

Method involves collecting data on how changes in the quantity and quality of ecosystem services affect: the cost of production of final goods, supply and demand for the final good, supply and demand for other inputs. This information highlights the changing relationship between quantity and quality of ecosystem services and changes occurring in consumer surplus and / or producer surplus, or economic benefit.

Hedonic Price Method – HPM. Hedonic prices assign a value of ecosystem services by estimating the statistical relationship between system attributes evaluated and another good or service for which a market value exists. The value of the land will be influenced by that of neighboring ecosystems. The analysis aims to assess ecosystem services by quantifying the effect they have on the price of land. This is based on the economic concept that the property value is directly related to the present value of the stream of benefits derived from property held (Rojanschi et al., 1997).

Models of property hedonic value assume that individuals perceive housing units as a sum of attributes and to derive different levels of utility from different combinations of these attributes. When performing transactions, individuals compare prices and attributes and decide according to the marginal value of these attributes. To estimate these marginal values, data is collected on property values from the disposal of real estate in a market. The price of a plot or a house is the dependent variable of the structural characteristics of the house, neighborhoods and the insurance features of ecosystem services. Coefficients of attributes allow analysts to recover the marginal value of attributes. It is a method of measurement that is based on revealed preferences as using actual transactions.

Method is necessary for the existence of active markets, to raise awareness on evaluated ecosystem services, the change of supply level to be perceived by population, markets to be unbiased and transactions transparent.

Applying method involves defining and measuring of environmental quality, specifying property price function, achieving multiple regressions and create demand curve to improve ecosystem services that depend on environmental factors.

Travel Cost Method - TCM. Method was proposed in 1947 by Harold Holding for evaluating (estimated value) national parks. It is a method designed to measure in monetary terms the benefits obtained by people visiting recreational areas.

The travel cost is considered an approximation of the price that visitors are willing to pay for ecosystem services. Economic assumption is that the demand is even lower as the price is higher. Total benefit of the resource is given by the area below the demand curve. The total value is, actually, the

consumer surplus and its knowledge allows sizing fees for visitors (Rojanschi et al., 2003).

In TCM estimate is based on the value of goods purchased and have complementary market value. Most analysis identifies two types of methods: individual TCM and zonal TCM.

Individual TCM determines the relationship between the annual number of visits and the cost of travel and other individual variables (age, sex, education, and income) that may influence the decision to travel. It may be applied only if the variation in the number of visits to the visitor to another is significant.

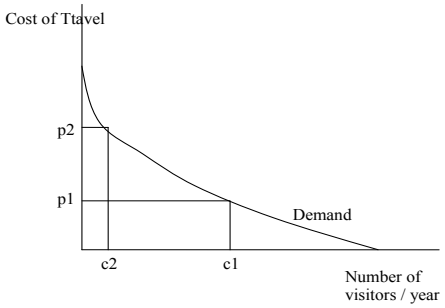
Zonal TCM requires a division of the territory analyzed in several areas considered homogeneous in terms of travel costs to be supported by potential visitors. The dependent variable is the number of visits per thousand inhabitants of resident population per year, according to the formula (1)

$$V_t = [(v_i/n)*N*1000]/p_i \quad (1)$$

v_i – number of visitors from „i" zone /year
n – total number of interviewed visitors
N – total number of visitors / year
p_i – total population from „i" zone

Attendance rate zone is correlated with the average cost of travel, resulting in the first phase of the demand curve. Curve is used to determine the relationship between entry fees and the number of visitors, resulting in the demand curve for recreation analyzed.

Demand curve



Quantifying ecosystem services through methods and techniques based on other economic mechanisms

Avoidance costs are the generic name of the three techniques for quantifying ecosystem services: the cost of *damage avoided*, *replacement* cost and the cost of *replacement*. The estimate is based on the costs of avoiding damage due to the loss of ecosystem services, costs of replacing ecosystem services, and the costs of providing services of placeholders for the ecosystem.

These techniques used to estimate the cost benefits. Therefore, it should be pointed out that it does not provide a measure of economic value. This is obtained using the maximum amount of money a person can give in order to have a common reduced the cost of the asset in question. The cost of avoiding damage or substitution provides realistic estimates of the value of these goods or services. It is based on the assumption that if people incur to avoid damage caused by the loss of ecosystem services or their replacement, these services should be worth at least as much as you paid for it to be replaced. This assumption may or may not be true. However, in some situations it may be reasonable to assume so, and the costs of avoiding damage or replacement are easier to estimate than for certain services ecosystem.

The method is applied when avoiding damage or replacement costs were made. Such cases may be:

- quantification of water quality by measuring the treatment costs;
- quantification of erosion protection for a forest by measuring sediment removal costs;
- evaluation of wastewater treatment in wet lands on the basis of the cost of the treatment of water;
- quantification of protection against storms by measuring the cost of construction of hydraulic protection system.

Contingent Valuation Method - CVM. The method is applied when there is no market for ecosystem services assessed. In such situations, it uses an approximation, asking people if it is willing to pay to get a profit and how claiming to tolerate an expense. The method takes into account the personal evaluations of those who are responsible for the price increases and the quality of services of ecosystem, likely against a hypothetical market. As a result, these reviews give a measure of the option value and existence. The method was proposed by Criacy-Wantrup (1947), and was applied for the first time by Davis in 1963 in order to estimate the benefits of hunting of geese. The popularity grew with the recognition in the 1960s ‘’ the value of non-use, in particular the option and existence values, as important components of the VET.

CVM ecosystem services value based on the stated preferences of potential consumers (most often the visitors). The premise behind this method is that individuals can be persuaded to reveal the inclination to pay (IP) ecosystem services without monetary value through their behavior on a hypothetical market. Hypothetical market can be modeled on the private property market or from the policy.

It is assumed that the probability of negative responses will increase with increasing thereof based on logistic distributions. Outstanding benefits are measured as the IP for the ecosystem and are calculated using the estimated logarithmic parameters. IP environment is calculated using the relationship (2).

$$Pi = 1/(1+e)^{-Z_i} \quad (2)$$

Pi – probability that the i person answers „yes"
e – base of the natural logarithm
$Zi = c_0 + c_iX_i$
X_i – chosen price

The equation defines a bounding a surface equal to the expected value for the IP maximum income household or IP media sample.

Choice Modelling – CM. Choice modeling, also known as the method of quota (Contingent Choice Method – CCM) or experimentation of choice (choice experiment) is a method originally developed for marketing research. In the last two decades has been applied in other areas, its use is relatively recent, and for the evaluation of environmental goods and services. These applications include, according to Rolfe et al. (2004): evaluation of native vegetation, assessment of the quality of attributes, the demand for indoor recreation, forecasting tax for public recreation destinations, estimate the benefits of the conservation of tropical forests, the protection of cultural heritage and of cultural, heritage and monuments. The method allows the quantification of the amount of use and non-use value.

The premise is based on the method refers to the fact that any good can be described by attributes or characteristics and levels recorded. To apply, the respondents were presented a number of alternative options for the use of resources and they are asked to choose your preferred option. The options in each question are known as the *set of choice*. In this set include, and usually without change, corresponding to the existing situation. The choice involves a choice between constant situation and a series of proposed (different). In general, surveys are included between 5 and 8 sets of your choice. Each option

is described using a common set of attributes, which can be found in several sets.

CM is CVM-like. Thus, the theoretical foundation and organization of the survey are similar. The main difference is that the CM looking to communicate the differences using attributes and scenarios, compared with CVM that provides a single value. Both methods provide estimates of consumer surplus, but the CM has the advantage that it can provide such estimates to a broad range of alternative options. CM also has the ability to shape the election process in different ways and to report the compromise between price and an attribute. Other advantages are the flexibility, providing more information, more precisely the limits and increased realism.

Theoretical justification lies in the random utility model (stochastic) which allows the measurement of goods and services which do not have the market. Their value is calculated on the basis of their attributes by applying probabilistic choice models between different combinations of attributes. Making one of these attributes in the prices or costs, estimates of use can turn into monetary estimates for changing attribute level. Utility function Uij, is composed of an observable (indirect utility function), Vij, as a component of unperceivable error (stochastic) Uij, according to relationship.

$$U_{ij} = V_{ij} + \varepsilon_{ij} \quad (3)$$

U_{ij} – utility assigned to the i person for j choice
V_{ij} – deterministic component (observable) of utility assigned to the i person for j choice
ε_{ij} – undeterministic component (unobservable, stochastic) that influence individual choice

Stochastic component makes it difficult to predict the influence of individual preferences. It allows modeling choice options in a probabilistic way, the probability that I person prefers j choice from a set of choices over other options cannot be expressed as a probability that the utility associated with j choice exceeds the utility associated with other options. This relationship can be expressed as .

$$P(i \mid C) = P[V_{ij} + \varepsilon_{ij}) > (V_{in} + \varepsilon_{in}), \text{ all } n \in C] \quad (4)$$

C – complet choice set

Assumptions about the distribution component lead to various forms of stochastic model. For example, if stochastic components are assumed to

be independent and have identical distribution of extreme values, then the probability of choosing j choice is written as a multinomial logit model.

$$Pij = (\exp^{\omega Vij})/\Sigma\exp^{\omega Vin}, n \in C \quad (5)$$

ω - scale parameter that is inversely proportional to the standard deviation of the error and it is generally considered be equal to 1.

Equation can be estimated using multinomial logit regression that assumes that choices are correlated with independence of irrelevant alternatives of property. Property requires that the probability of the chosen choice to be unaffected by the inclusion or omission of other alternative options. If this condition is not met then you can use other types of model (multinomial probit, logit with stochastic parameter).

Meta-analytic Methods

Meta-analysis is the use of quantitative methods to compare and synthesize the results of an empirical investigation set on a common problem. Compared with transfer of benefits, these methods provide a new analysis of comparable data collected for independent empirical studies.

Meta-analytic Techniques

Meta-analysis is performed by using a variety of techniques that Nijkamp et al. (2008) have grouped: statistical techniques and alternative techniques.

Statistical techniques. To compare the results of different studies on similar problems we can use a variety of statistical techniques. Differences between results may be explained by differences in research design, volume and type of data analyzed, the statistical method used and the temporal and geographical features that influenced the analyzed studies.

Using multi-criteria techniques is of great importance when the objective is to compare qualitative synthesis of studies and when study results can be interpreted in relation to a number of criteria. Increasing importance of the studies does not provide similar values for indicators or when tests take into account several indicators.

Alternative techniques. Studies form and synthesis objectives in many areas of social science research are not based solely on empirical experimental phenomena. Therefore a number of alternative techniques were developed, that allow synthesis of results of different studies. Complementary non-statistical techniques and non-parametric statistics used for synthesis can be classified into three categories: unadjusted series analysis, fuzzy series analysis and content analysis. They allow inferences based on quantitative and qualitative results of a collection.

Unadjusted series analysis is a technique that is looking existence of the principle of causality among data sets and tries to eliminate irrelevant information. The technique does not require numerical information if the data are grouped by category. Thus, the technique allows the synthesis of mixed data (quantitative and qualitative) as well as combining results of studies is inconsistent and imprecise. In addition, the technique allows the creation of hierarchies of actions in multi-attribute processes for decision support. The technique is facilitated by the availability of software packages.

Fuzzy sets analysis is applied to synthesize the results when they contain a clear component of linguistic uncertainty in terms of imprecise measurement. The distinction between this technique and unadjusted analysis is quite unclear. The fuzzy analysis uses a continuous classification scale, unlike unadjusted series analysis, using discrete classes. Fuzzy variables can be classified into classes between which boundaries are poorly marked so that variables belong to a certain degree.

Content analysis is a technique which features of text messages are identified in a systematic way in order to be converted into grades that can be then analyzed with quantitative methods. Content analysis can synthesize all kinds of verbal messages and texts by means of quantitative methods, grouping specific words by categories of content.

Benefit Transfer Method – BTM

Application of TCM, CVM, and the HPM is important research efforts whose costs cannot be always covered by available funds and time. Under these conditions, a strong motivation for extending the applicability of the results, obtained in empirical evaluations, conducted for other ecosystems more or less similar, has been developed. Within the literature this technique is known as benefits transfer (Benefit transfer method - BTM) or value transfer.

Choosing appropriate methods to quantify different types of ecosystem services

Given the structure of total economic value (VET), the evaluation is performed only for ecosystem services with direct use value. Ecosystem services with indirect use value helps to keep those in the first category. Therefore direct use value includes the value of other services or indirect use value.

Ecosystem services will be grouped according to the classification proposed by MEA (2003), given the use of this system in many policy initiatives and research. Since the methods have been presented, we will focus on issues that are relevant to the decisions on the choice of methods and

quantification techniques. For support services, necessary for the achievement of all other services, no quantification is done, as they are expressed through indirect use value (Liekens et al., 2010).

Supply services are services that provide ecosystem biomass production by crops. This may have various shapes and harvesting them is generally motivated by the possibility of being traded. Traditionally, natural ecosystems provide wood, fish, and game. The fact that crop products are traded allows the use of market price method. When an ecosystem supports a species whose individuals can be traded (e.g. fish species with commercial value), knowledge of crop value (depending on quantity and price) is an indication of the value of ecosystem services provided respectively. In using the results of these assessments should take into account the fact that the market price is generally lower than IP, or real value of ecosystem services.

Settlement services are benefits obtained by people as a result of regularization processes in ecosystems. Among the most important are climate regulation, flood control, pollination, and water filtration. Because most of these services can be correlated with the production of commercially valuable goods (e.g. agricultural production) it is recommended as a means of quantifying productivity method.

Level of provision of these services determines the attributes or characteristics of properties (e.g. air quality in residential areas). Therefore, the evaluation can be realized using hedonic price method.

Regulating services means reducing the incidence and intensity of natural hazards, thus avoiding the cost method may provide clues regarding the value of such services, taking into account, of course, the limitations of the method in terms of economic substantiation.

Pollination is an important ecosystem service to agriculture. The value of this contribution can be determined using the productivity and replacement costs. For example, crops pollinated by different species of insects in natural ecosystems will adopt productivity method, determining the additional profit generated by these populations. If pollination is accomplished by honeybees, managed by beekeepers populations, it may use the cost method of substitution.

Although cost avoidance is not a correct measure of value, his determination is important because it indicates the net benefit of access to productive inputs provided by ecosystems to the situation where the same input is obtained through an alternative option. Generally, this information provides initial argument for conservation decision ecosystems. For example, when New York Water District was faced with the requirement to maintain water quality in the basin, a study was used, showing that it was much less expensive to make the reconstruction of watershed than constructing a water

treatment system. A very high cost of avoidance determined the decision of maintaining the service of water quality regularization provided by ecosystems (Daily and Ellison, 2002).

Cultural services are the conceptual formula used for proposing expression of ecosystems contribution to the development of man's spiritual dimension. From the perspective of VET, these services expressed both use value and non-use value. Although these services are varied, within the context of quantifying ecosystem, we appreciate their contribution to leisure. In fact, most studies on the value of ecosystem are focused on this utilization, being evaluated, particularly the recreational destinations. The used methods are, mainly, travel cost method, contingent evaluation and contingent choice method.

Conclusions

Although most of methods and techniques have received numerous methodological adjustments and were used to serve the purposes of evaluation in various circumstances, the results succeed only partial to meet information needs for substantiating decisions. This shortcoming is explained by a number of concerns, among the most important considerations are: correlation of value components, of ecosystem services types and of measurement methods; inherent compromises in choosing the method of quantification, and limited ability to generalize, i.e. transferability of results.

The concept of total economic value of ecosystem services was an important contribution to quantify progress. VET components are a useful reporting framework for interpreting the results of quantification. The boundaries between these components are not always clear, and their correspondence with the four categories of ecosystem services is still insufficiently explored.

In general, supply services, some services regulation recreational and cultural services, are considered as generators of direct use value. Support services - soil formation, biogeochemical circulation - are treated as indirect use value, while other cultural services are associated with existence value and testament value.

Relation to the methods of quantification is also an area where there are many overlaps and confusion. Supply services - direct use value - market price method is generally the best combination of acceptability, although it is criticized on the following grounds: the usefulness of a given ecosystem is often best treated with total value provided by the respective ecosystem services, the value determined by the market price is an underestimation of

the value of the good supply, because market prices reflect only a portion of inclination to pay for the respective good.

Another milestone is that indirect use value measurement does not require separate assembly because it would mean twice the same component (Boyd and Banzhaf, 2006).

Non-use value is associated with cultural services, other than recreational. In their case, low trust of economists regarding the contingent valuation method and contingent choice, despite methodological developments, can be mentioned as the most important problem.

Regarding the choice of method, the researcher is forced to accept important compromises. If opting for the robustness of economic methodology, the researcher must give up completeness in relation to ecosystem services. On the other hand, if we insist on quantifying a wider range of services, validity and credibility of the results is economically questionable. This compromise is complicated by the fact that the researcher's discretion is limited. The decision on the type of ecosystem service to be quantified, in most of cases, requires also the method to be used. Further, there are budgetary and time constraints that may influence the outcome either by determining the appropriateness between the methods, used to assess, either by the impact on the rigor of application method.

Another aspect that makes the quantification of ecosystem services difficult is the operational potential of the results. Thus, in most cases they are only valid for the analyzed situation, the possibility of using them in a different context or extending their meaning to higher spatial scale is limited. Need to overcome these limitations has primarily motivated the development of benefit transfer method, without yet reaching general valid and global enforceable procedures (TEEB, 2008).

Quantifying ecosystem services focused the attention of numerous researchers, and its correlation with the development of meta-analytic techniques allows increasing the transferability of results and coverage of evaluations. Accelerate this process depends on the available resources for conducting empirical studies, but also by improving knowledge interactions at the level of ecosystems, and between them and society, to create landmarks improvement methodologies in increasing the validity and reliability of results.

Aknowledgement

This work was supported by CNCSIS-UEFISCDI, project number PN II-RU code TE_336/2010, agreement no. 45/03.08.2010.

Bibliography

- Boyd, J., Banzhaf, S. (2006), *What Are Ecosystem Services? The Need for Standardized Environmental Accounting Units*, Discussion paper, Resources for the future, Washington, DC.

- Costantza, R., d'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R.V., Paruelo, J., Raskin, R.G., Sutton, P., van den Belt, M. (1997), The value of the world's ecosystem services and natural capital, *Nature*, nr.387.

- Daily, G.C., Ellison, K. (2002) *The New Economy of Nature.* Washington, D.C.: Island Press.

- Kuukuvainen, J. (2002), Value of nature conservation: the good or the context, *Journal of Forest Economics*, 8.

- Liekens, I., Schaafsma M., Staes, J., De Nocker, L., Brouwer, R., Meire, P. (2010), Economische waardering van ecosysteemdiensten, een handleiding. Studie in opdracht van LNE, Afdeling Milieu-, Natuur- en Energiebeleid, maart.

- MEA (2003), *Ecosystems and human well-being. Current state and trends*, volume 1, Island Press.

- Mitchell, R.C., Carson, R.T. (1989), *Using Surveys to Value Public Goods*: *The Contingent Valuation Method*. Washington, D.C.: Resources for the Future.

- Nijkamp, P. Vindigni, G., Nunes, P.A.L.D. (2008), Economic valuation of biodiversity: A comparative study, *Ecological economics,* 67.

- Rolfe, J., Alam, K., Windle, J., Whitten, S. (2004), *Designing the Choice Modelling Survey Instrument for Establishing Riparian Buffers in the Fitzroy Basin*, Central Queensland University, Emerald.

- Rojanschi, V., Bran, F., Diaconu, G., Iosif, G.N., Toderoiu, F. (1997), *Economia şi protecţia mediului,* Editura Tribuna economică, Bucureşti.

- Rojanschi, V., Bran, F., Grigore, F., Diaconu, S. (2003), *Abordări economice în protecţia mediului*, Editura ASE, Bucureşti.

- TEEB (2008), *The Economics of Ecosystems and Biodiversity. An interim report.*