Selected Applicable Options for Environmental Assessment

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Abstract

This article is intended to outline possibilities of selected environmental assessment methods. Its aim is to point out an increasing need for a more concerted effort in this integral branch of science also in the Czech Republic.

Keywords: living environment, assessment methods – CEA, CBA, MCA, valuation of environmental goods, decision-making processes

Introduction

Decision-making in private and public sectors

Both private and public sectors are consistent in the fact that decision-making is based on the scarcity of the environmental goods. Environmental goods scarcity is determined by the limitation of given good in the market. If the goods are unlimited, they lack any economic value. Once the good becomes limited (scarce), it has its own value and turns into an economic good. Increasing demand for goods makes the goods scarcer and people are willing to pay more to get them.

From the private sector´s perspective, scarcity and price are driving market-based mechanism, which coordinates continuity of demand for and supply of the goods. However, public sector takes a different point of view on this issue, taking into account also effects arising outside the market. These differences can be observed also in decision-making regarding the projects, which can have both private and public nature.

Engagement of government´s role into economic issues is raising a lot of opinions, e.g. liberals would reduce the role of the state to an absolute minimum and the main economic stream (neoclassical economics) advocates the position of a visible hand of the state, where the government´s role is essential to eliminate market failures. "Both parts – market and government - are essential for healthy, well-performing economy. Driving today´s economy without both of these parts is like trying to clap with one hand" [1].

The environment is a system consisting of natural, artificial, and social components of our material world, that are or might be in constant interaction with the subject concerned. It is everything that creates natural conditions of the existence of organisms, including humans, and it is a precondition of their further development. According to Article 2 of the Act No. 17/1992, Coll. on Environment, its components are mainly the air, water, minerals, soil, organisms, ecosystems and energy [2].

Sustainable development is mostly understood as one of the key EU principles consisting of three main pillars: economic, environmental, and social.

Besides sustainable development principle, the environmental policy area includes and applies especially the principles of prevention and precaution, absorption capacity, responsible management of natural resources, direct liabilities, rehabilitation and restitution.

Various assessments can be performed in the sphere of environment, especially all sorts of indicators and components, measures including their efficiency or several measures in combinations and groups, elaborated in various project designs, incl. evaluation based on the performance (efficiency) - price ratio".

Comprehensive assessment of the environment in the Czech Republic is provided in the Report on the Environment in the Czech Republic.

Every assessment is important; the outcomes can indicate whether planned goals have been met and/or what was the level of effectiveness or financial costs, if applicable.

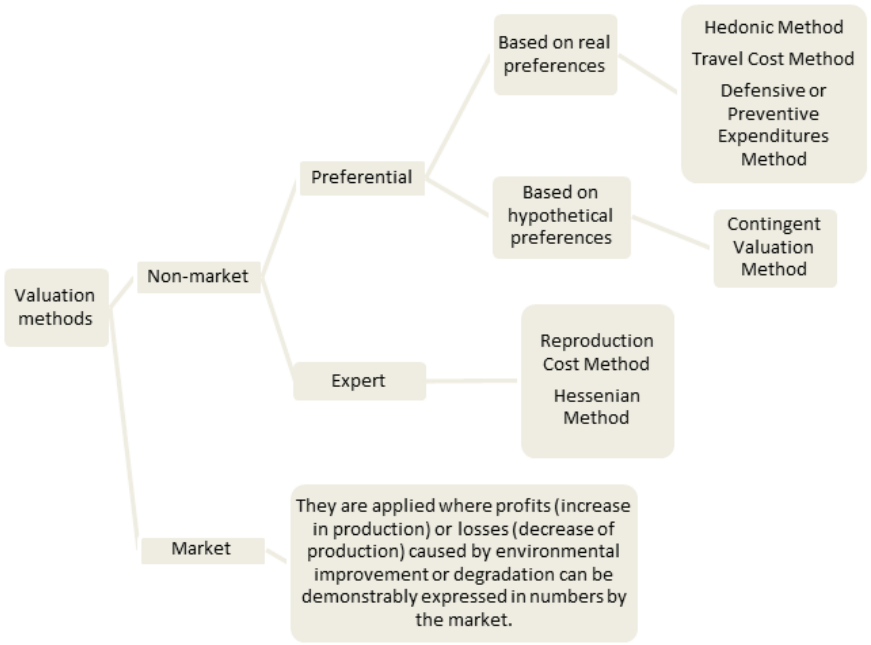
Evaluation Methods in European Union

In European Union, evaluation is recommended to perform and also performed mainly using the following methods: Cost-Effectiveness Analysis (hereinafter referred to as CEA), Cost-Benefit Analysis (hereinafter referred to as CBA), and, where applicable, also with the use of various selected methods of Multi-Criteria Analysis (hereinafter referred to as MCA).

CEA was developed in the 1950s in the United States as a tool for decision-making among the requirements, particularly imposed by the Department of Defense and US Army regarding the armament programs, etc. Originally it was a method for evaluation of solutions of subjects or alternatives. CEA is intended to find out, which project/program or version of the project/program is able to achieve the planned goals with the lowest possible costs. CEA is used for identification of the most cost-effective strategy from a set of possible variants having similar outcomes.

Since the Cost-effectiveness analysis (CEA) is closely related to the Cost-Benefit Analysis (CBA), both methods can be used in combination for project or action program evaluations. This Cost-benefit analysis can be applied in ongoing projects for comparison of various alternatives with similar goals, measuring their efficiency in terms of the costs in-

Fig. 1. Valuation Methods. Source: Valuation method diagram, Environmental Economics, available at http://fzp.ujep.cz
Rys. 1. Metody wyceny. Źródło: Schemat metody wyceny, Environmental Economics, dostępny na stronie http://fzp.ujep.cz



curred. Furthermore, the method can be used in evaluation of expected impacts of alternative measures far earlier before their implementation (ex-ante), or in evaluation of how effective was an already implemented measure (ex-post).

CEA outcomes are often integrated in Multi-Criteria Analysis (MCA), which enables combination of various criteria for decision-making in various formats.

Cost-Benefit Analysis (CBA) is an important method which measures economic efficiency of the potential alternative of the product being assessed, either in private or public sector.

CBA is a tool for enabling comparison of costs and benefits, resulting in analysis that allows to identify, which project alternative is the most advantageous in terms of economic efficiency.

To perform CBA correctly, it must be done according to rigorous logical procedure (methodology). Best known CBA methodologies are for example by A. Boardman [4], and also in recently modified versions in EU guidelines and recommendations [5] [6].

Valuation (appraisal) of benefits in environmental sphere remains problematic. Valuation can be performed only in particular contexts of the territory in question in accordance with the most suitable valuation method. Very important is a move towards nature-based measures [3].

Valuation of Environmental Goods

Environmental goods valuation methods can be divided into:

- Methods of market-based valuation of environmental goods and services – used in goods being already traded in a market (environmental goods value is derived from the price already assigned to a particular good by the market, usually over the course of time)
- Non-market valuation methods – valuation of goods that are not traded in a market and their value must be defined in a different way. One option is to apply preference methods resulting from consumers´ preferences (they derive the environmental goods value from our behaviour that indicates how we appreciate each individual good) and non-preference methods based on expert assessment (they derive the environmental goods value from expert opinions).

Overview of main valuation methods is displayed in Fig. 1.

Multi-criteria analysis is a method applied in decision-making process among multiple alternatives, whilst (as opposed to linear programming) more than one resulting alternative is not accepted; the analysis should always end up with only one alternative. Precondition for multi-criteria analysis is to have more quantifiable criteria that can be included into decision-making process.

This method consists of at least four consecutive steps:

- Identification of alternatives and criteria;
- Valuation (quantification) of criteria;
- Weights assignment (standardisation);
- Calculation of appraisal

Multi-criteria analysis is a tool for evaluation of possible alternatives according to several criteria, whilst an alternative well valued by one criterion is usually not best valued by another. Multi-criteria decision making methods then solve disbalances between conflicting criteria. Aim of the method is to summarise and sort information about variant projects.

Multi-criteria decision making occurs everywhere, where a decision-maker evaluates consequences of his/her choice according to several criteria, such as quantitative criteria, usually expressed in natural numerical scales (we also call it numerical criteria) or qualitative criteria, when a corresponding scale is introduced, such as classification scale or “very high – high – neutral – low – very low” scale, including definition, what scale direction is positive and what negative, i.e. whether best is maximum (”very high”) or minimum (”very low”) value (de-

Tab. 1. Rating system for individual criteria
Tab. 1. System ocen dla poszczególnych kryteriów

Expression of preferences	
Numerical	**Verbal**
1	Criteria are equally important
3	First criterion is a little more important than the second
5	First criterion is more important than the second
7	First criterion is much more important than the second
9	First criterion is absolutely more important than the second

creasing or increasing values). If there is both the list of criteria and list of decision alternatives available, it is necessary to consider, what form should the final decision have.

MCA Methods

Multi-criteria decision-making is always analytic hierarchy process [7]. An important step in evaluating multi-criteria problems is determining the weights (importance of criteria). There is wider range of methods that can be used for their identification. One of possible options is scoring method. Scoring method belongs to the least demanding calculations, but the quality of results obtained through this method is lower. This method is also known as "100-point allocation" [8]. The problem is, that the decision maker must be able to evaluate importance of all criteria quantitatively. However, this is often very difficult due to diversity of observed criteria. For selected scoring scale the decision maker must assign bi value on the scale to i-th criterion. The more important criterion, the higher score. The decision maker need not to choose only from integers on the scale, and the same value can be assigned to more than one criteria. While scoring method requires the decision maker to make a quantitative evaluation of criteria, it allows for more differentiated expression of subjective preferences than e.g. ranking method. Weight calculation is performed according to the formula (1) [8].

$$v_i = \frac{b_i}{\sum_{i=1}^{k} b_i}, i = 1,2,...,k \tag{1}$$

Weights of each criterion are within <0.1> interval, therefore it means that they are weights normalised in one interval (1). This method is affected by high level of subjectivity in respondent´s rating.

Another option which can be used is Saaty´s procedure of binomial assessment. Saaty´s method is based on quantitative pairwise comparison of criteria. Pairwise comparisons S = (sij), i,j = 1,2,…,k are often created using a scale of 1–9. Matrix entries sij are interpreted as estimates of i-th criterion and j-th criterion ratio. Therefore, Saaty´s method is based on assigning weights to each criterion – to determine correlated preferences [8]. In each pair of criteria, the value of correlated preference strength is established and afterwards entered into the matrix. The assessment is based on the use of scoring scale as per table 1 [9].

For more sensitive expression of preferences based on managerial decision making [8] more comparative levels can be used in between (2, 4, 6, 8, 10). Size of preferences related to i-th criterion compared to j-th criterion can be arranged in Saaty´s matrix with entries sij which represent estimates of criteria weight rates (how many times is one criterion more important than the second), according to the relation (2) [8].

$$s_{ji} \approx \frac{v_i}{v_j}, i, j = 1,2,...,n \tag{2}$$

S Matrix is a square matrix of order n x n and the following is valid for its entries [8]:

$$s_{ji} = \frac{1}{v_j}, i, j = 1,2,...,n \tag{3}$$

Matrix is reciprocal in its nature and all the elements on the diagonal are equal to 1. It is due to the fact that each criterion is of equal value itself. For determination of resulting weights of each criterion, normalised geometric mean of Saaty´s matrix rows, relation (4) [8].

$$w_i = \frac{\left[\prod_{j=1}^{n} s_{ij}\right]^{\frac{1}{n}}}{\sum_{k=1}^{n}\left[\prod_{j=1}^{n} s_{kj}\right]^{\frac{1}{n}}} \tag{4}$$

Saaty´s assessment principle is advantageous regarding the fact, that it reduces respondent´s rating to the comparison of two criteria (alternatives).

In solving the adverse extreme phenomena in water management (especially droughts), a set of measures have been proposed, which was subject to various kinds of assessment.

Assessment cannot be performed only in general. For an assessment, already implemented projects to be valued should be available. Valuation (appraisal) of benefits in environmental sphere remains always problematic. Valuation can be performed only in particular contexts in a selected territory according to the applicable valuation methods.

Conclusions and Recommendations

Multi-criteria decision making tools enable to include a wide range of criteria from various categories into an assessment. Each method is to some extent affected by subjective approach of an investigator. This effect can be minimised mainly through Saaty´s method, where there is fixed weight assessment, which the decision maker must build on. Moreover, the scale of descriptors is itself divided by 2-point value, which allows for wider separation of weights. Another advantage might be that the assessment is based on comparison of only two criteria, whilst the rest is ignored.

With respect to the above facts, application of multi-criteria decision making tools combined with CBA (Cost – Benefit Analysis) approach seems to be effective. This outcome is supported by variability of criteria, which can be used for evaluation of environmental issues, but also by the requirements for economic evaluation of measures being implemented. The advantage of combination of both approaches is also the possibility of reassessment, i.e. verification of achieved improvement.

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Wybrane opcje oceny oddziaływania na środowisko

Ten artykuł ma na celu przedstawienie możliwości zastosowania wybranych metod oceny oddziaływania na środowisko. Jego celem jest wskazanie rosnącej potrzeby skoordynowania prac w zakresie ocen oddziaływania w Czechach.

Słowa kluczowe: środowisko życia, metody oceny – CEA, CBA, MCA, wycena dóbr środowiskowych, procesy decyzyjne