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# Methodology and information system for evaluating environmental protection expenditure efficiency at the local level

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**Abstract.** The paper presents a methodology and information system for evaluating the efficiency of current municipal environmental protection expenditures. The methodology and information system were approved by the Ministry of the Environment of the Czech Republic as a voluntary tool for municipal officials. The proposed methodological procedure for evaluating municipal environmental protection expenditures is based on a weighted assessment of multiple criteria. The procedure gives municipalities an instrument for assessing expenditure efficiency and addresses the three pillars of sustainable development: economic development, social development, and environmental protection. The methodology and information system can be used by other countries and municipalities to evaluate the efficiency of public spending at the local level.

**Keywords:** efficiency, environmental protection expenditure, information system, methodology, local level, voluntary tool

## 1 Introduction

Defining and measuring *efficiency* in the process of using resources and transforming them into outputs and outcomes seems to be one of the biggest issues of contemporary economic theory. In 1957, Farrell asked how to measure efficiency and stated its importance for economic policy makers: ‘It is important to know how far a given industry can be expected to increase its output by simply increasing its efficiency, without absorbing further resources’ [6]. Efficiency evaluation and the technology for evaluating efficiency have greatly improved and advanced over the past several decades. However, it remains a conceptual challenge in relation to public expenditures. According to a group of authors at the European Commission [9] this issue is further complicated by the fact that public sector outcomes are often off-market, lacking relevant data, and thus cannot be quantified.

In practice, the ability to effectively manage public expenditures lies in the applicability of the manuals and practices that originated in international organizations. A number of tools have been created for public expenditure management. The handbook by [1] represents an example of a means to effectively manage public expendi-

ture in general. Contemporary society prioritizes the human relationship to nature. Therefore, some handbooks and guides have been created to manage the environment and especially environmental protection costs and expenditures based on experience with the OECD methodology [2-3], [10], [13-15], which is primarily focused on the economic tools of environmental protection (specifically on public expenditure in this area), as well as on the recommendations of the United Nations Organization and World Bank [4].

The aim of the paper is to introduce a new methodological background developing for municipal environmental protection expenditure efficiency evaluating, taking into account three pillars of sustainable development (economic, social and environmental) and efficiency in the sense of 3E methodology. The methodology for the evaluating environmental protection expenditure efficiency at the local level (hereinafter referred to as ‘the methodology’) was created by the authors of this paper [16] and approved as a voluntary tool by the Ministry of the Environment of the Czech Republic. Next goal is to present the developed simple information system for implementing the methodology [18].

## **2 Methodology and information system**

Environmental protection expenditures (EPE) are all the spending on all activities aimed at both preventing and protecting the environment [5]. One of the key criteria is that environmental protection is the primary objective of these activities. Activities that positively affect the environment but do not have protection of the environment as their primary aim are not included. EPE are classified according to funding sources, types of expenditure, and areas of environmental protection. In terms of funding sources, the European Union (EU) statistics divide EPE [5] into the public sector, industrial sector, and environmental specialist manufacturers and producers of environmental services for the private and public sector. EPE are divided into capital (investment) expenditures and current (non-investment) expenditures.

The methodology was designed for the evaluation of current public EPE only. The Classification of Environmental Protection Activities (CEPA 2000) is most frequently used to determine EPE. CEPA 2000 divides EPE into nine areas of environmental protection (EP) [5]:

1. protection of ambient air and climate;
2. wastewater management;
3. waste management;
4. protection and remediation of soil, groundwater and surface water;
5. noise and vibration abatement (excluding external safety);
6. protection of biodiversity and landscapes;
7. protection against radiation;
8. research and development;
9. other environmental protection activities.

The methodology was designed for each area of environmental protection separately. Area 8, research and development, is not included because the municipalities have no such expenditures. The methodology philosophy is:

- *Use the concept of environmental protection, including economic and social aspects* – The methodology is based primarily on the three pillars of sustainable development. Each pillar is evaluated separately. The overall rating is a summary of these three pillars.
- *Use existing methodologies and analysis* – Good practices and satisfactory evaluation indicators of existing methodologies, procedures, and methods were incorporated in the methodology if possible and adapted to the conditions of Czech municipalities.
- *Data availability* – The authors attempt to define indicators for the evaluation that are accessible for regional authorities.
- *Weighted multi-criteria evaluation.*
- *Simplicity and complexity of output* – The methodology result was proposed as an index facilitating the interpretation, publication, and communication of evaluation results.
- *Quality of legislation* – Use of the methodology is strictly limited by the legislation of the country that wants to put this methodology into practice.

## 2.1 Procedure for assessing efficiency

The methodology evaluates current municipal EPE in terms of the “3Es” (economy, effectiveness, efficiency). The suggested assessment process is divided into two main levels: basic and general. The basic assessment is based on a municipal environmental management evaluation and a principle of appropriate budget planning. The general assessment is used for each EPE and proceeds in three (parallel) parts that correspond to the three pillars of sustainable development.

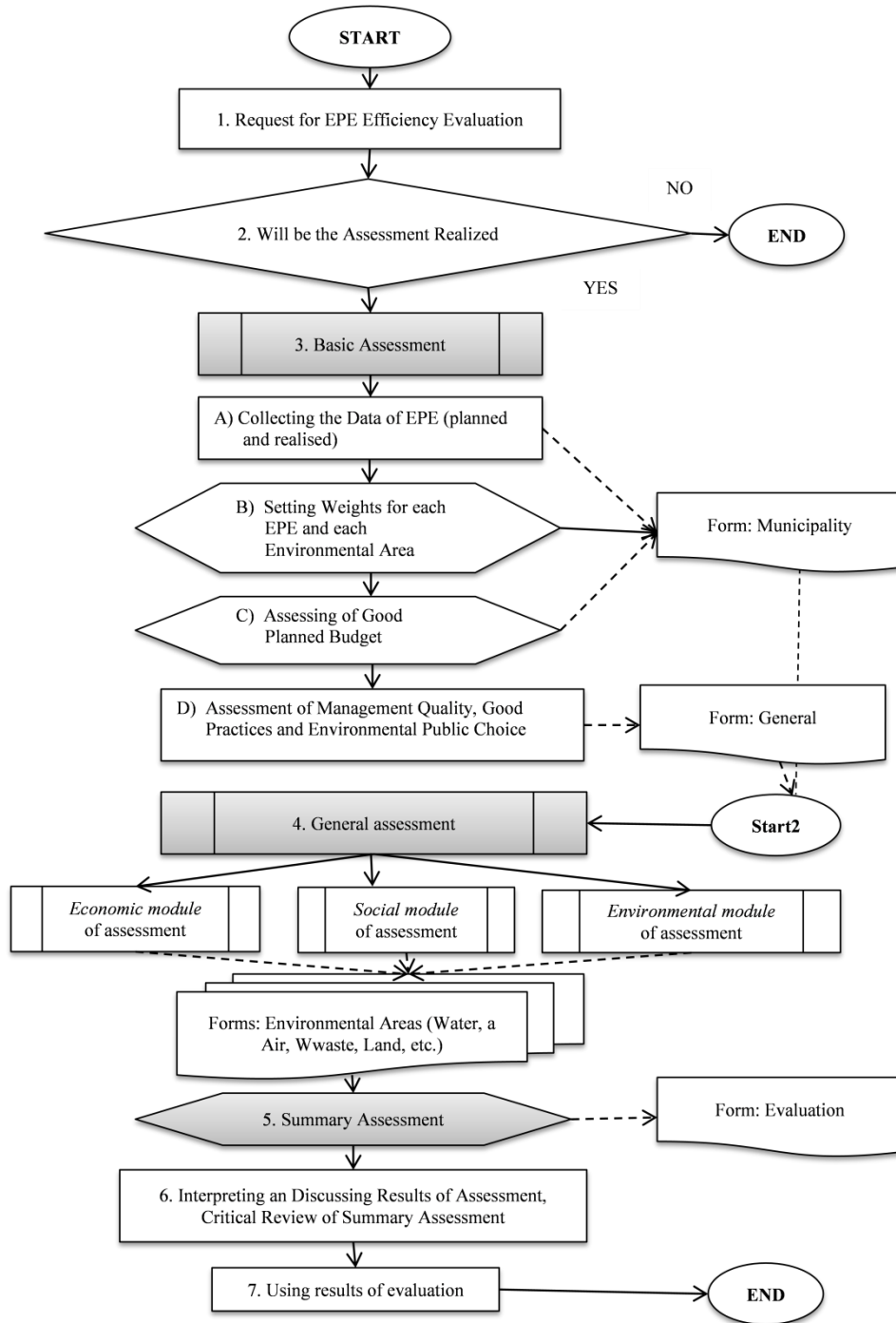
The basic principle of the methodology is structured and easy-to-survey tables, which must be completed in steps. The methodology uses both qualitative and quantitative methods of assessment. The qualitative methods include a simple questionnaire for each EPE. The quantitative methods incorporate weighted multi-criteria analysis techniques. The methodology includes closed and open questions.

Figure 1 shows a simplified schema of the procedure for assessing the effectiveness and design of the methodology as an algorithm.

**Basic assessment.** To keep the evaluation simple, it was appropriate to use existing and available data. Expenditures on selected budget items were divided into eight areas of environmental protection. The areas of EP defined by CEPA 2000 (see above) were changed by the Ministry of the Environment of the Czech Republic<sup>1</sup>.

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<sup>1</sup> Two areas - Noise and vibration abatement protection of biodiversity and landscapes and Protection against radiation were united. New area - Administration in environmental protection was formed by dividing from the area - Other environmental protection activities.



**Fig. 1.** Scheme of the methodology (Source: authors)

Environmental protection expenditures defined according to [2] (items)  $C_{iO}$  ( $i=1 \dots N$ ,  $o=1 \dots M$ ),  $N = 49$ ,  $M = 8$ , are used for a basic assessment, which the first function is setting weights of each EPE and each area of EP. The weights of each EPE are set as follows:

$$w_{iO} = \frac{C_{iO}}{\sum_{i,j=1}^{n,8} C_{iO}} \quad (1)$$

where:

- $w_{iO}$  is the weight of the  $i$ -th EPE in the  $O$ -area of EP ( $i = 1 \dots n$ ,  $O = 1 \dots 8$ );
- $C_{iO}$  is the  $i$ -th EPE in the  $O$ -area of EP;
- $n$  is the number of implemented EPE of the municipality.

The second function of the basic assessment is the evaluation of the budget planning. The difference between the budgeted and actual EPE is analyzed, and the results are entered into the general assessment.

The third function of the basic assessment is the evaluation of management quality, good practices and supporting the elected bodies of the municipality/city. The results of this evaluation are entered into the general assessment.

**General assessment.** When considering efficiency, the general assessment is based on multi-criteria evaluation of efficiency anchored in 3 basic pillars of sustainable development (economic, social and environmental). The evaluation of both economic and social pillars of sustainable development is consistent for all areas of the environment. Questions for the economic pillar are still further divided into the following areas: legality, effectiveness, economy, and efficiency. Questions for the social pillar detect how environmental protection policies create space for the participation of stakeholders, enhance the quality of life, improve of working conditions, and more. Questions for the environmental aspects of the assessment are different in each area of EP and include municipal priorities in the area 7 – Administration in EP.

To simplify the methodology, answers are set and assessed from 0 to 3 points:

- 3 – fully satisfactory;
- 2 – rather satisfactory;
- 1 – rather unsatisfactory;
- 0 – unsatisfactory.

The methodology describes the point system in more detail [16]. The set of questions for each area and each pillar can reach up to 100 points. These points are weighted. The weights were subsequently determined by experts:

- economic pillar – weight 0.35;
- social pillar – weight 0.25 and
- environmental pillar – weight 0.30 and budget planning – weight 0.10.

The point assessment of each EPE is as follows:

$$EC_{iO} = EC_{iO} w_{Ec} + S_{iO} w_S + En_{iO} w_{En} + GPB_{iO} w_{GPB} \quad (2)$$

where

$EC_{iO}$  is the point evaluation of  $i$ -th EPE in the  $O$ -area of EP (0-100 points),

$EC_{iO}$  is the point evaluation of the economic pillar (0-100 points),

$S_{iO}$  is the point evaluation of the social pillar (0-100 points),

$En_{iO}$  is the point evaluation of the environmental pillar (0-100 points),

$GPB_{iO}$  is the point evaluation of the actual budget (0-100 points),

$w_{Ec}$  is the weight of the economic pillar,

$w_S$  is the weight of the social pillar,

$w_{En}$  is the weight of the environmental pillar,

$w_{GPB}$  is the weight of budget planning, where:  $1 = w_{Ec} + w_S + w_{En} + w_{GPB}$

The overall rating is a sum of the weighted sums of the all three pillars of sustainable development and budget planning:

$$E = \sum_{i=1}^n EC_{iO} w_{iO}, \quad (3)$$

where

$E$  is the efficiency of the sum of EPE

$w_{iO}$  is the weight of the  $i$ -th EPE in the  $O$ -area of EP ( $i = 1, \dots, n$ ,  $O = 1, \dots, 8$ ), see above (1)

$GPB_{iO}$  is the point evaluation of the actual budget (0-100 points).

The full result of the methodology was presented in a rating which contains results of each pillar of sustainable development and assessment of actual budget.

## 2.2 Information system for measurement of EPE efficiency

The above text shortly introduced developed methodology for evaluating environmental protection expenditure efficiency at the local level. We used properties of the MS Excel and developed information system (IS EPE) [21] for the integration and simple interconnection of above basic and general assessments into all areas of EP and into summary assessment of EPE efficiency [18]. We used our experience with development of similar information system for waste management expenditure [17], [22-24].

This implemented IS EPE enables the simple option of the chosen set of the input EPEs through the single MS Excel sheet – *List of municipality*, which is interconnected with further MS Excel sheets (IS EPE modules), where are implemented assessment of three pillars of sustainable development:

1. the module *Municipality* of socio-demographic variables and planned and realised EPE variables  $C_{iO}$  of the municipality/city;

2. the module *General* with closed questions relating to the tools of environmental management, good practices, supporting the elected bodies of the municipality/city;
3. the modules *Water / Air/ Waste/ Land/ Biodiversity/ Noise and Radiation / Administration / Others* of environmental protection areas (8). These modules include closed questions to assess the effectiveness of the three pillars of sustainable development;
4. the module *Evaluation* with dynamically calculated results of evaluation. This module contains an evaluation of each EPE, each EP, a sum of EPE, each pillar and budget planning. Based on communication with local authorities, these indexes of efficiency are presented as a percentage of 100% efficiency;
5. the module *Setting* of main communication interface of the methodology, where are setting points for the answers and weights for pillars of sustainable development.

Users of this IS EPE set up planned and realized measurement of EPE. The answer of open questions in the module *Municipality* of IS EPE corresponds to the instructions on the closed question in the module *General* and depending on the allocation of expenditure in the modules of individual areas *Water, Air, Waste, Land*, etc.. Based on its answers IS EPE will evaluate the effectiveness of EPE, EP, all pillars and budget planning of which is shown in the module *Evaluation*.

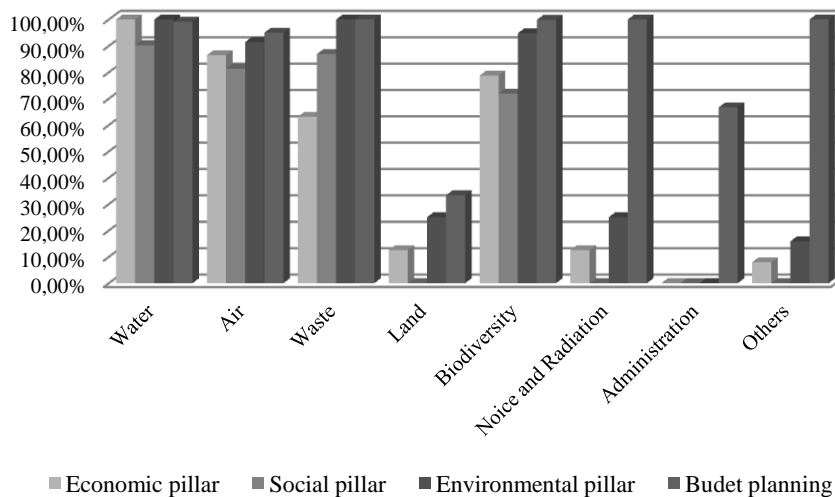
The IS EPE is designed as a simple tool for evaluating the effectiveness of current EPE and is freely accessible to all local authorities and other organizations interested in evaluating the environmental effectiveness of their current expenditure points for the answers and weights for pillars of sustainable development through its web page [21]. The use of IS EPE is possible without the acquisition of licenses.

**Results of IS EPE.** In Table 1 are presented the results of the applied methodology and the IS EPE in Prague, the capital of the Czech Republic in year 2010. Since 2005, the total environmental protection expenditures of Prague have been over 2 billion CZK yearly (in 2010 more than 2.6 billion CZK). Table 1 and Figure 2 present the results of evaluation from the module *Evaluation*.

**Table 1.** Evaluation of EPE of the capital Prague in 2010 (Source: authors)

Set of ratings	Performance
Efficiency of the economic pillar	71,36%
Efficiency of the social pillar	79,02%
Efficiency of the environmental/ecological pillar	96,52%
Budget planning	99,82%
Efficiency of all environmental protection expenditures	86,68%





**Fig. 2.** Efficiency of all pillars of sustainable development and all areas of EP (Source: authors)

The results assessing the effectiveness of each pillar in the relation to each EP provide information within a given area is most efficiently, or how many p are expenditures to which this section or effective compared to other sections. The weights for the individual pillars were determined by an expert, but the methodology makes it possible to set the weights for each pillar in accordance with the priorities of the municipality. Alternatively, the methodology can be based on an evaluation of the sum of all areas and the priorities of the municipality as defined in an assessment.

### 3 Discussion

It is obvious that the methodology provides a wide variety of information unincorporated in other well-known methodologies [2-4], [10], [12-14]. The results present information on:

1. the efficiency of each EPE and each area of EP;
2. an assessment of each pillar of sustainable development and budget planning;
3. a basis for planning, decision making, negotiating, monitoring, and possibly also taking preventive measures;
4. the possibility of monitoring efficiency in real time;
5. the reduction of the likelihood of incorrect or inefficient allocation of resources.

The following factors could present problems:

- lack of appropriate data;
- false interpretation of results, even with proper data;
- the methodology does not address technical efficiency;

- the methodology depends on the management of public spending.

It is necessary to add that the decision-making about EPE with the support of IS EPE also depends on political decisions, which can significantly influence public expenditures regardless of the results of any evaluation [8], [12], [20]. Even the best methodology does not address this problem, but a good methodology could contribute to general awareness for possible approaches to enhance the current situation. The criterion ‘actual budget’ is included in the methodology assessment. The inclusion of this criterion means that municipal officers have the opportunity to adjust the environmental priorities of the municipality and then check whether these priorities are met. The authors are aware that the implementation of this methodology can be complicated, but the case study shows that implementation is possible.

## 4 Conclusion

The Czech government does not currently use indicators for evaluating various areas/activities at the local (municipal) level. Most municipalities do not work systematically with local environmental indicators, including economic and social indicators. Statistical indicators are used only in isolation and unsystematically. The presented methodology and information system were designed in response to the absence of a simple methodology and information technology (IT) tools for the needs of local authorities.

The developed methodology and IS EPE [21] were also created because is not a national level or globally unified conceptual tool for EPE evaluation in the Czech Republic. Although the OECD methodologies [10], [13-15] exist, there are based generally for evaluation economics instruments. OECD methodologies also emphasize and draw attention to the institutional environment over an assessment of economic instruments. The concept of our proposed methodology and its IT implementation is based on a different philosophy than linking the environmental, economic, and social pillars of environmental protection. Methodology and IS EPE use practical experience from previous “good practice” methodology [7], [19] and “good practices” [14] for the management of public expenditure on environmental protection and developed information system for waste management expenditure [17], [23-24].

The methodology results show information for the evaluation of economic, social, and environmental efficiency and budget planning for individual spending areas as well as protection of the total expenditure on environmental protection and is supported by IS EPE. This makes it possible to get an overview of allocated resources EPE in relation to the level of total expenditure in all areas and activities of environmental protection in municipalities of the Czech Republic. Results from IS EPE provide information about all four values which is graphically displayed for all the different areas of environmental protection.

The evaluation of effectiveness and efficiency of public spending with IS EPE should support decision-making in the political process. It provides information on the extent to which the environmental objectives and other objectives of an implemented municipal environmental policy have been achieved, and with which econom-

ic, environmental, and social impacts on all stakeholder were concerned. The results from using IS EPE should include, among other things, the opportunity to compare public spending in relation to other municipalities.

The developed methodology could inspire other Member States of EU and their municipalities to evaluate the effectiveness of public spending at the local level.

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## References

1. Allen, R., Tommasi, D.: Managing public expenditure. A Reference Book for Transition Countries, OECD (2001)
2. Barde, J.P.: Economic instruments in environmental policy: Lessons from the OECD experience and their relevance to developing economies (No. 92). OECD (1994)
3. Burns, A., Yoo, K.Y.: Improving the efficiency and sustainability of public expenditure in the Czech Republic. (No. 328). OECD Publishing, Paris (2002)
4. EIG: Annual Report Results and Performance of the World Bank Group, <http://www.worldbank.org/ieg/rap2010/index.html> (2010)
5. Eurostat: Classification of Environmental Protection Activities and Expenditure (CEPA 2000) with Explanatory Notes, submitted to the United Nations Expert Group on International Economic and Social Classifications – meeting of 18–20 June 2001 in New York, New York (2001)
6. Farrell, M.J.: The measurement of productive efficiency. *J R Stat Soc Ser A-G*, 120, 253–290 (1957)
7. Jílková, J. et al.: Efektivnost veřejných výdajů na ochranu životního prostředí. Závěrečná zpráva (Effectiveness of public expenditure on environmental protection. Final Report). VaV/320/3/03. MŽP, Praha (2004)
8. Malý, I.: Veřejné statky a veřejně poskytované statky (Public goods and public services). *Polit ekon.* 6, 861–868 (1998)
9. Mandl, U., Dierx, A., and Ilzkovitz, F.: The effectiveness and efficiency of public spending (No. 301). Directorate General Economic and Monetary Affairs, European Commission. (2008)
10. Mickwitz, P.: A Framework for Evaluating Environmental Policy Instruments Context and Key Concepts. *Evaluation*, 9, 415–436 (2003)
11. MF.: Vyhláška č. 323/2002 Sb., o rozpočtové skladbě (Notice No. 323/2002 Coll., on the budget structure). Praha, [http://www.mfcr.cz/cps/rde/xchg/mfcr/xsl/vyhlasky\\_32273.htm](http://www.mfcr.cz/cps/rde/xchg/mfcr/xsl/vyhlasky_32273.htm) (2002)
12. Nemeč, J., Ochrana, F., Šumpíková, M.: Czech and Slovak Lessons for Public Administration Performance Evaluation, Management and Finance. *Ekonomický časopis*, 4, 353–369 (2008)
13. OECD: Evaluating the Efficiency and Effectiveness of Economic Instruments in Environmental Policy. OECD Publishing, Paris (1997)
14. OECD: Good Practices of Public Environmental Expenditure Management in Transition Economies. OECD Publishing, Paris (2003)
15. Peszko, G.: Good Practices of Public Environmental Expenditure Management in Transition Economies, <http://www.oecd.org/environment/outreach/2080960.pdf> (2002)

16. Soukopová, J., Bakoš, E., Neshybová, J. Hřebíček, J.: Hodnocení efektivnosti výdajů obcí na životní prostředí (Evaluation of effectiveness of municipal spending on the environment), <http://amr.webnode.cz/metodika-hodnoceni-vydaju-obci/metodika-hodnoceni-efektivnosti-vydaju-obci-na-zp/> (2010)
17. Soukopová, J., Hřebíček, J.: Model of cost and price relationships for municipal waste management of the Czech Republic. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, 59, 371–378 (2011)
18. Soukopová, J., Neshybová, J. Software pro metodiku hodnocení efektivnosti výdajů obcí na ŽP (Software of methodology for evaluating the effectiveness of municipal spending on the environment), <http://amr.webnode.cz/metodika-hodnoceni-vydaju-obci/software-pro-hodnoceni/> (2010)
19. Šauer, P., Kreuz, J., Hadravová, A., Dvořák, A.: Assessment of Environmental Policy Implementation: Two Case Studies from the Czech Republic. *Pol J Environ Stud*, 21, 1383–1391 (2012)
20. Špaček, D.: Apparent Issues of Self-evaluation in Public Administration: The Case of Common Assessment Framework Implementation, *International Journal of Knowledge, Culture and Change Management*. 10, 45–59 (2010)
21. IS EPE, <http://amr.webnode.cz/metodika-hodnoceni-vydaju-obci/software-pro-hodnoceni/>
22. Hejč, M., Hřebíček, J.: Primary Environmental Data Quality Model: Proposal of a Prototype of Model Concept. In: *Proceedings of the iEMSs Fourth Biennial Meeting: International Congress on Environmental Modelling and Software (iEMSs 2008)*. iEMSs, Barcelona, pp. 83–90 (2008)
23. Soukopová, J., Kalina, J.: Mathematical model of economics of municipal waste management. In: *Proceedings of the 30th International Conference Mathematical Methods in Economics*. Silesian University in Opava, Karviná, 823–829 (2012)
24. Hřebíček J., Kalina J., Soukopová J.: Integrated economic model of waste management: Case study for South Moravia region. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, 61, 913-918 (2013)