

Assessing the efficiency of municipal expenditures regarding environmental protection

J. Soukopova, E. Bakos

¹Department of Public Economics, Faculty of Economics and Administration, Masaryk University, Brno, Czech Republic

Abstract

The article deals with efficiency of usual municipal expenditures on environmental protection and suggests a methodology for assessing this efficiency. At first, the paper analyses the concept of efficiency from the view of individual rationality. Authors consider efficiency in the sense of 3E methodology – Economy, Efficiency and Effectiveness and methodology of sustainable development – social, environmental and economic part of sustainable development as well as the role of those who make decisions in environmental politics. A proposal of methodological procedure for assessing municipal expenditure efficiency is presented next. It uses multi-criteria assessment, where a dominant criterion of performance is C/E. This procedure is applied to a file of environmental expenditures data from the representative sample of municipalities in selected areas of environmental protection which were used in a project of the Ministry of Environment of the Czech Republic SP/4i1/54/08 „Analysis of municipal budgets efficiency in relation to the environmental protection“. The data comes from selected municipality budgets and are analyzed for the time range of 2001-2008 because the data has been in an electronic form since then.

Keywords: efficiency, effectiveness, economy, municipal environmental expenditures, sustainable development

1 Introduction

The issue of relation between economic growth and environmental protection becomes increasingly important in recent years. In question are also the effects of environmental policy in individual regions and the influence of environmental policy on economic growth and other basic regional economic indicators such as unemployment, inflation, trade and living standards. The problem of allocation of public expenditures in this field is also related with this. Thus, how much, in what ways and for what purpose should money of taxpayers be spent in relation to environmental protection. This was the reason for Ministry of the Environment (MoE) of the Czech Republic to fund project SP/4i1/54/08 „Analysis of local budgets and their efficiency in relation to environmental protection“. Its main objective is to evaluate efficiency of public expenditures and other financial instruments in the field of environmental protection with focus also on particular regions and optimization of incidence of public subsidies in field of environmental protection on macro and micro-economical level. The important part is identification of factors influencing absorption capacity of individual regions in the Czech Republic and setting of indicators for the evaluation of their efficiency.

2 Analysis of environmental public expenditures

Public expenditures in the field of environmental protection are the important part of total public expenditures and probably even in time of financial crisis their amount will not decrease notably, thanks to the active policy of European Union and expenditures from its structural funds. Figure 1 shows the progression of public expenditures since 1997.

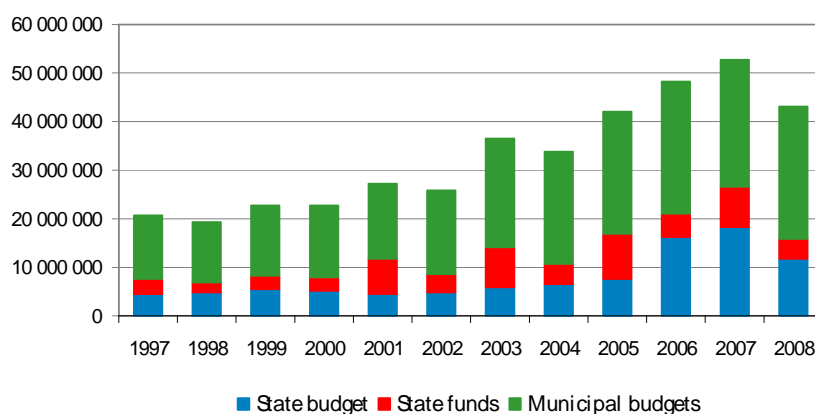


Figure 1: Environmental expenditures of public budgets (in thousands CZK) [11]

In the Figure 1 we can see that municipal expenditures made throughout the time always more than 50 % of total environmental public expenditures.

Environmental expenditures in the budget structure are divided according to the Classification of Environmental Protection Activities and Expenditure (CEPA 2000) which differentiate protection of ambient air and climate, wastewater management, waste management, protection and remediation of soil, groundwater and surface water, noise and vibration abatement, protection of biodiversity and landscapes, protection against radiation, research and development and other environmental protection activities [12]. As shown Figure 2, the biggest parts of environmental municipal expenditures are wastewater management expenditures, waste management expenditures and protection of biodiversity landscapes expenditures.

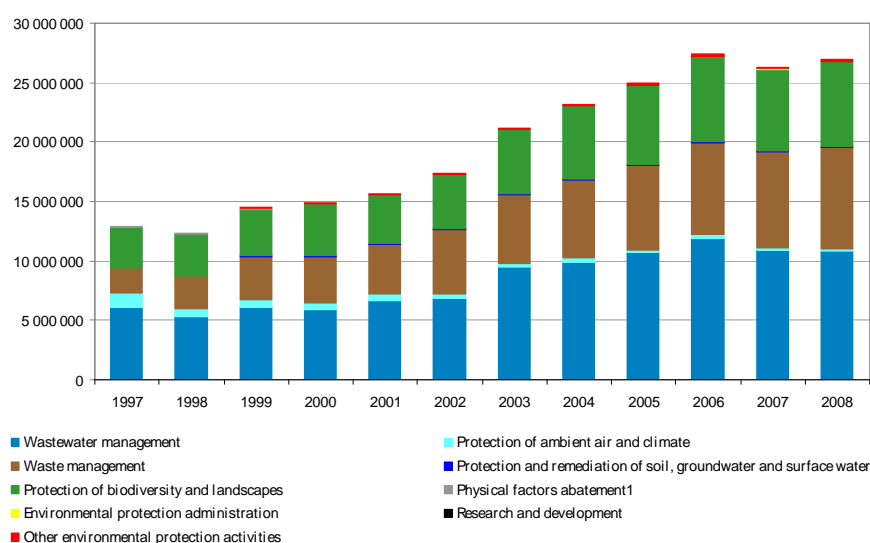


Figure 2: Municipal environmental expenditures according to CEPA 2000 (in thousands CZK) [11]

3 Environmental public expenditures efficiency

One of the biggest problems of contemporary economic theory is the one of defining and measuring the efficiency, or in other words use of resources and their transformation into outputs and outcomes. Already in 1957 Farrell asked the question how to measure efficiency and pointed out [8] 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”[4]. Throughout several decades efficiency evaluation and its technology are greatly improved and advanced. However it still remains conceptual challenge in relation to public expenditures. Given problem is also complicated by the fact that outcomes of public sector are often off-market, lacking relevant data and thus making it cannot be quantified, as

stated by collective of authors at the European Commission [8]. It is the very conceptual frame of inputs, outputs and outcomes that these authors are pointing out. They highlight the difference in comprehension concepts of output and outcome. While they see the efficiency in transformation of inputs to outputs (comparing it to productivity, which they see as a level of product created from input used), which includes also concept of production possibilities frontier (in other words the more output we create from given input or the less input is required for desired output, the more efficient is the activity), they ask for effectiveness in relation between output and outcomes, which they perceive as richness or growth in society and are, besides political decisions, influenced by various other external factors (identified by member states as key factors related to public expenditures were – performance orientation, organizational aspects, human resource management, information technology utilization). Above described problem of expressing difference between concept of inputs, outputs and outcomes and related understanding and measuring of efficiency related also to the public expenditures is concerning besides Mandl et al. [8] many other authors [3, 5, 6, 7 and 9].

To evaluate efficiency of public expenditures (environmental) most of authors use the methodology of 3E – economy, efficiency and effectiveness, which they perceive from theoretical basis like this:

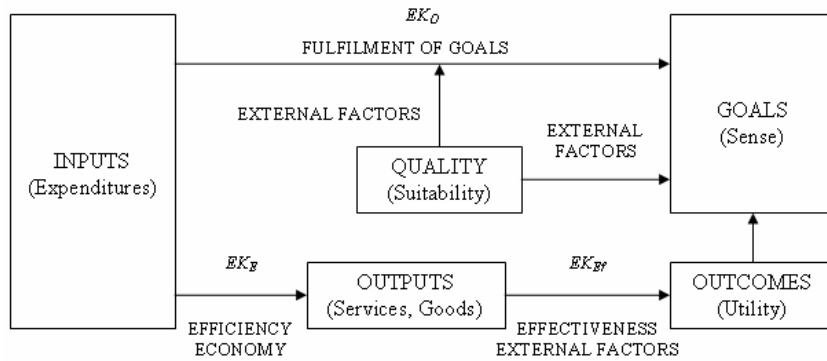
- By economy they understand such use of public expenditures, that leads to provision of given objectives with the least amount of resources spent, while keeping up to the corresponding quality of tasks;
- By efficiency they understand such use of public expenditures that acquires the greatest possible amount, quality and contribution to the given objectives compared to the amount of resources spent in order to fulfil them.

Economy and efficiency are for purposes of quantification and in respect of usage of methods of economic analysis understood as cost efficiency.

- By effectiveness they understand such use of public expenditures that leads to the greatest possible output respecting desired outcome, which are prerequisite for optimal fulfilment of goals set in advance. Therefore effectiveness means how the produced goods or services (for example waste disposal) fulfil utility (for example clean municipal environment without waste).

Besides this classic 3E methodology, the term of quality is sometimes used. Quality means such the use of public expenditures, that provides optimal rate of accomplishment of the „right goals“ while performing given objectives. It means that it is possible to ask about correctness and appropriateness of given goals in, for example, strategic documents or from point of the legitimacy of their fulfilling, or utility set by them. It is important to strongly differentiate between quality and effectiveness, which are sometimes interchanged, for example in the concept of quality, where it comes to optimal fulfilment of goals while carrying out given objectives. In this concept it is not clear enough what process is used set up goals and to what extent these goals are „objectively“ right, or appropriate. Because sometimes it is possible to purposefully (in terms of purpose) fulfil the goals, but not in optimal ways, meaning not taking into account cost amount.

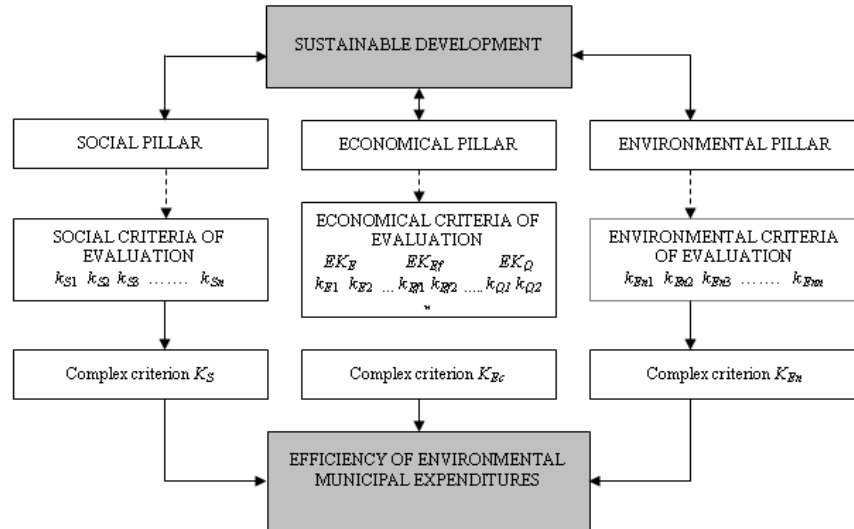
When judging all these criteria (economy, efficiency, effectiveness and quality) we can speak of economical efficiency of public expenditures. For the complex view we need to add, that sometimes we distinguish between terms technical and allocation efficiency. However, this concept's analysis is beyond the scope of this text. Following scheme 1 shows the concept of economical efficiency, from which we move out into further analysis and we use it for the construction of methodology for the evaluation of environmental municipal expenditures.



Scheme 1: Conceptual conception of efficiency of public expenditures

4 Methodology of efficiency evaluation

One of the contemporary problems is how to allocate public expenditures in the field of environment protection more effectively.



Scheme 2: Scheme of environmental public expenditures efficiency evaluation

When considering efficiency, the methodology is based on multi-criteria evaluation of efficiency based on 3 basic pillars of sustainable development. When we designed methodology we came out from the assessment of efficiency in terms of social, environmental and economical points of view (see scheme 2).

4.1 Social aspect of evaluation

Social criteria of evaluation come out from taking the social aspect of existing expenditure into account. The complex criterion for evaluating efficiency from the social point of view K_S could be constructed as follows:

$$K_S = \sum_{i=1}^n w_i k_{Si}, \quad (1)$$

Where k_{Si} is the social efficiency criterion (in percents),

n is the number of criteria,

w_i is the weigh of criterion No. i , and $\sum_{i=1}^n w_i = 1$.

It holds $0 \leq K_S \leq 1$ and if $K_S = 0$ then the expenditure is absolutely inefficient.

Example 1

When it comes to municipal waste management expenditures, suitable criteria for social efficiency evaluation of given expenditures could be the following:

k_{S1}	Willingness to sort municipal waste (in percents)
k_{S2}	Employment – Influence on employment (is given service carried out by local company or external one, and so on) (in percents)
k_{S3}	Living standard of citizens – has the expenditure positive impact on living standard of citizens of municipality (in percents)

When evaluating municipal waste management expenditures in Brno, experts gave these weights to the given criteria $w_1 = 0.4$ $w_2 = 0.3$ $w_3 = 0.3$ and following values:

Criterion	k_{S1}	k_{S2}	k_{S3}
Criterion value	0.58	0.85	0.86

Then $K_S = 0.748$

4.2 Economical aspect of evaluation

Economical criteria of evaluation come out from the concept of efficiency explained above and include the economical evaluation of efficiency and economy EK_E , economical effectiveness EK_{Ef} and economical quality EK_Q , so:

$$K_E = EK_E + EK_{Ef} + EK_Q, \quad (2)$$

Where K_E is the complex criterion of economical efficiency evaluation,

EK_E is the complex criterion of economical efficiency and economy evaluation (cost efficiency evaluation),

EK_{Ef} is the complex criterion of economical effectiveness evaluation,

EK_Q is the complex criterion of economical quality evaluation (quality of environmental goals).

The more detailed explanation of methodology of evaluation according to the given complex criteria follows.

4.2.1 Economy and efficiency evaluation - EK_E

The most commonly used methods for evaluating efficiency of public expenditures (capital and current) are Cost-minimization Analysis, Cost-effectiveness Analysis (CEA), Cost-utility Analysis (CUA) and Cost-benefit Analysis (CBA). These methods are suitable for the evaluation of efficiency of public expenditures for environmental protection. The only exception is Cost-minimization Analysis, which only compares amount of costs (expenditures) in certain investment, therefore we will not consider it further for the evaluation of environmental public budget expenditures. Efficiency evaluation of current expenditures of public budgets, however, encounters several limitations. This is because current expenditures usually consist of expenditures for public services – services of common interest. This makes it quite difficult to evaluate expenses using CBA or CUA. In the case of CBA it is difficult to estimate benefit of these services in terms of money and as for CUA, the situation is even more complicated because there is no suitable methodology for environmental expenditures (however it exists for health-care and others) [1]. Therefore, the most exact appears to be choosing the CEA method [2], when it comes to the evaluation of efficiency, and for the evaluation of C/E choosing efficiency indicator E as a complex criterion created with help of multi-criterial analysis depending on factors influencing expenditures on given environmental service. Let K_E be a set of criteria for the evaluation of quality of environmental public budget expenditures, where $K_E = (k_{E1}, k_{E2}, \dots, k_{En})$, so

$$E = f(k_{E1}, k_{E2}, \dots, k_{En}), \quad (3)$$

Where k_{Ei} is the criterion of cost efficiency and economy evaluation,
 n is the number of outputs for a given environmental expenditure.
 Then the cost efficiency of given expenditure could be expressed as follows:

$$CEA = \frac{C}{E} \geq 0 \rightarrow \min \quad (4)$$

Where C are environmental expenditures,
 E is the indicator of cost efficiency evaluation.

If $CEA \leq 1$, then the expenditure is efficient, if $CEA > 1$, the expenditure is inefficient. Because the criterion is minimizing, it needs to be transformed into maximizing one. Therefore for the construction of EK_E criterion we will use the following formula:

$$EK_E = \frac{1}{CEA} = \frac{E}{C} \geq 0, \quad (5)$$

Where if $EK_E > 1$, then the expenditure is efficient and $EK_E \rightarrow \max$.

Example 2

In 2008 the city of Brno spent in the area of waste management 189,947.87 thousand CZK for municipal waste collection and 176,511.6 thousand CZK for use and disposal of municipal waste, i.e. the total cost of waste management is $C = 366,459.47$ thousand

CZK. The same year city of Brno was producing $Q = 118,662.87$ tons of municipal waste (k_{E1}), the average price for waste treatment was $p = 1,500$ CZK (incinerator) (k_{E2}), the average distance to processing facilities was $v = 20$ kilometres (k_{E3}), and the average size of a mean of transportation for waste was 25 t (k_{E4}), the average rate for transport was 45 CZK / t (k_{E5}) and the average rate for handling was 30 CZK / t (k_{E6}). Then, in the case of collection of municipal waste is the criterion, waste amount, price of waste manipulation, price of waste transport, means of transportation capacity and distance to processing facilities. Costs of collection are the following:

$$E = E_1 + E_2,$$

$$E_1 = N_s = 2 * v * s_d * \frac{Q}{k_d} * m, \quad E_2 = Q * p,$$

Where v is distance from the facility (landfill, incinerator) [km] - (k_{E3})
 s_d is rate for the transportation [CZK/km], considered 45 CZK/km (k_{E5})
 Q is amount of waste [t] (k_{E1})
 k_d is capacity of means of transport for waste [t], considered maximal capacity 25 t. (k_{E4})
 m is price for manipulation [CZK/t]

Then $E_1 = 192,233.85$ CZK, $E_2 = 177,994.305$ CZK and $E = 370,228.155$. It follows: $EK_E = 1.01$.

4.2.2 Evaluation of the effectiveness - EK_{Ef}

Let K_{Ef} be a set of criteria for the evaluation of effectiveness of environmental municipal expenditures, where $K_{Ef} = (k_{Ef1}, k_{Ef2}, \dots, k_{Efn})$, then

$$EK_{Ef} = \sum_{i=1}^n w_i k_{Efi}, \quad (5)$$

Where k_{Efi} is the criterion determining results of given expenditure—percentual fulfilment of the goal No. i (criterion acquires values 0-1),
 n is the amount of outcomes (goals) for given environmental expenditure,

w_i is the weight of i -numbered criterion, which fulfilling $\sum_{i=1}^n w_i = 1$.

It holds $0 \leq EK_{Ef} \leq 1 \rightarrow \max$

Example 3

City of Brno is planning in its Waste management area the following objectives and performance criteria of expenditure effectiveness.

1. Increase material utilization of municipal waste to 50 % by 2010 compared to 2000 - k_{Ef1} ;
2. Material utilization of municipal waste in relation to the whole Czech Republic (ensure the collection subsequent use or disposal of controlled hazardous components of municipal waste (50 % in 2005 and 75 % in 2010)) - k_{Ef2} ;
3. Ensure recycling construction and demolition waste (utilize 50 % of the weight of emerging construction and demolition waste before 31. 12. 2005 and 75 % before 2012) - k_{Ef3} ;
4. Prefer incineration of mixed municipal waste with energy recovery prior to landfill storage - k_{Ef4} ;
5. Reduce the weight ratio of landfilled waste with perspective of further reduction of 20 % in 2010 compared with 2000 - k_{Ef5} ;

6. Decrease the ratio of landfilled waste with energetic utilization potential (35 % in 2010) - k_{Ef6} ;
7. Decrease ratio of landfilled biodegradable municipal waste (75% of what the production was in 1995 to 2010) - k_{Ef7} ;
8. Increase utilization of waste through recycling up to 55 % in 2012 - k_{Ef8} .

For simplicity, all the criteria assigned the same weight $w_i = 0.125$. The expert panel gave each criteria the following values:

Criterion	k_{Ef1}	k_{Ef2}	k_{Ef3}	k_{Ef4}	k_{Ef5}	k_{Ef6}	k_{Ef7}	k_{Ef8}
Criterion value	0.95	1	0.86	1	0.85	0.95	0.65	1

Therefore $EK_{Ef} = 0.9075$

4.2.3 Evaluation of the quality - EK_Q .

Let EK_Q be a set of criteria for the evaluation of the quality of environmental public budget expenditures, where $EK_Q = (k_{Q1}, k_{Q1}, \dots, k_{Qn})$, then

$$EK_Q = \sum_{i=1}^n w_i k_{Qi} \quad (6)$$

Where k_{Qi} is the criterion determining quality – quality of given goal – connection with strategic documents of region or state (in percents) (criterion acquires values 0-1),
 n is the amount of outcomes (goals) for given environmental expenditure,
 w_i is the standardized weight of criterion No. i .

Example 4

The South Moravian Region has in its strategic document – Waste Management Plan (WMP) 25 goals related to waste management. The city of Brno has given in its waste management 8 goals, which are all included in the WMP South Moravian region, therefore, these criteria take value of 1 (100% associated with the strategic documents). Considering the evaluation of quality of expenditures, it is possible to use criteria in Example 3 and build EK_Q , when $EK_Q = 1$.

For the city of Brno the complex criterion for evaluation of economical efficiency comes out as follows:

$$K_E = EK_E + EK_{Ef} + EK_Q = 0.9898 + 0.9075 + 1 = 2.8973$$

4.3 Environmental aspect of evaluation

Environmental criteria of evaluation come out from indicators of sustainable development in selected field of environmental protection. The complex criterion of the evaluation of efficiency could be from the view of environmental K_{En} constructed as follows:

$$K_{En} = \sum_{i=1}^n w_i k_{Eni} \quad (7)$$

Where k_{Eni} is the criterion of environmental efficiency, $k_{Eni} \rightarrow \max$
 n is the amount of criteria,
 w_i is the standardized weight of criterion No. i .

It holds $K_{En} \geq 0$. If $K_{En} = 0$, the expenditure is fully inefficient.

Example 5

Considering waste management expenditures, criterion for evaluation of environmental efficiency could be the following ones, which are maximizing:

- k_{En1} Amount of municipal solid waste per capita in comparison with Czech national average (national average proportion of the municipality value);
- k_{En2} Weight ratio of going to landfills, compared with the Czech average (ratio of Czech average to the actual municipality value);
- k_{En3} Waste management expenditures per capita compared to the Czech average (ratio of Czech average to the actual municipality value);
- k_{En4} Ratio of biodegradable municipal solid waste going to landfills, compared with the Czech average (ratio of Czech average to the actual municipality value);
- k_{En5} Utilization of waste through recycling compared with the Czech average (ratio of Czech average to the actual municipality value).

Experts assigned these criteria by similar weight of $w_i = 0.2$. The expert panel attributed to each criteria the following values:

Criterion	k_{En1}	k_{En2}	k_{En3}	k_{En4}	k_{En5}
Criterion value	1.099	1.541	0.823	1.125	1.02

Then $K_{En} = 1.122$

4.4 Summary of the methodology

The sequence of our suggested methodology for the evaluation of public budget expenditures for environmental protection could be shown in several phases and steps:

1. Phase – evaluation of efficiency from the social view $0 \leq K_s \leq 1 \rightarrow \max$;
2. Phase – the evaluation of the economical efficiency:
 - Step 1 – the evaluation of efficiency and economy of expenditures (whether the given goals are being fulfilled with minimal costs, or if the environmental benefits with given costs are maximized). $EK_E > 1 \rightarrow \max$;
 - Step 2 – the evaluation of effectiveness (how municipal environmental expenditure ensures the setting goal). $0 \leq EK_{Ef} \leq 1 \rightarrow \max$;
 - Step 3 – the evaluation of quality (quality of goals is crucial problem of expenditures, that's why we evaluate it too). $0 \leq EK_Q \leq 1 \rightarrow \max$;
3. Phase – the evaluation of efficiency from environmental view. $K_{En} \geq 0 \rightarrow \max$.

Example 6

If we apply methodology to waste management expenditures of Brno in 2008, then we can use Examples 1 – 5 and the evaluation of efficiency according to our methodology would be following:

Phase 1		Phase 2		Phase 3	Overall evaluation
K_S	EK_E	EK_{Ef}	EK_Q	K_{En}	
0.905	1.01	0.9075	1	1.122	4.9895

When it is compared with the average of municipalities of South-Moravian region, where overall evaluation value is 4.8254, we can say that the efficiency of Brno's waste management expenditures is very good.

5 Conclusion

This paper is one of the results of the project of the Ministry of Environment (MoE) of the Czech Republic SP/4i1/54/08 „Analysis of municipal budgets efficiency in relation to the environmental protection“, where we identified that efficiency evaluation of municipal environmental expenditures is an extraordinary difficult task. Just to determine economy and efficiency from quantifying view with methods of economical analysis is not simple. The greatest problem is to estimate the benefits of public services in value of money. We discussed why the most appropriate way seem to be the Cost-effectiveness Analysis and its application as a part of multi-criteria analysis depending on factors influencing expenditures on given environmental service. Determination of all these factors as shown in the examples in the paper is a prerequisite for establishing an indicator of efficiency.

It is much more complicated when determining efficiency and quality of public expenditures. This opens several questions and tasks, which we are solving in the project No. SP/4i1/54/08 of MoE. What is the extend to which outputs are active in relation to the outcomes? How to determine the success of the objectives? Are the goals set "correctly"? How to identify that? How to assess the quality of the given objectives? Are citizens' views and opinions relevant? Or it can be assumed using previously given objectives in the national and regional documents? For simplicity, we just assess compliance of the objectives set at the local level with the objectives set in national and regional strategic documents. We believe that this is one of the ways to assess the efficiency of public spending on environmental protection. Set of objectives and targets in strategic documents of the Czech Republic and its regions, in our view, in itself reflects the practical effects for improving the environment in the region and this leads to an increase in overall living standard of the population and sustainable development.

At the same time we realize that the described problem in the project No. SP/4i1/54/08 of MoE is much more complicated in practice because the amount of public spending is influenced by a variety of external factors such as orientation to performance, organizational aspects, human resources, the use of information technology, political decisions, interest groups, etc. Some of these factors can not be quantified, they can only be described. International organizations already recognize the complexity of size and efficiency of public expenditures and their management to protect the environment and thus there have been formulated advices referred as "good practices" [10] for the management of public expenditure on the environmental protection. These "good practices", however, are more general and broader access to public spending than the presented methodology for the assessment of public spending efficiency of local budgets for environmental protection in the paper.

6 Acknowledgment

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