

# Some model approaches of natural resources efficiency evaluation

## *Některé modelové přístupy hodnocení efektivnosti přírodních zdrojů*

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**Abstract:** The article deals with problems of sustainable development of agriculture from the viewpoint of efficient use of environmental resources. Environmental resources are factors of creation both usual economic goods and stabilization of environment. Analysis proved that classical indicators of economic performance are necessary to be modified by the ecological threshold of economic activities. However its level is not fixed and follows factors introduced in the paper which arose in frame of solution of the Institutional Research Intention MSM 411100013.

**Key words:** national accounts, environment, environmental resources, ecological threshold of economic activities

**Abstrakt:** Článek se zabývá problematikou trvale udržitelného rozvoje z hlediska efektivního využívání přírodních zdrojů. Přírodní zdroje jsou faktorem tvorby jak běžných ekonomických statků, tak i stability životního prostředí. Analýza ukázala, že klasické makroekonomické ukazatele se projevují v tzv. ekologickém prahu ekonomických činností. Jeho úroveň však není fixní a vyplývá z faktorů uvedených v příspěvku

**Klíčová slova:** národní účty, životní prostředí, přírodní zdroje, ekologický práh ekonomických činností

### INTRODUCTION

The present model of economy arose in different historical connections from viewpoint of economic, social and civilization conditions when an extent of resources and space for unlimited growth appeared to be sufficient, enabling unlimited consumption of resources and unlimited production of waste. However, according to new pieces of knowledge the mankind exceeded the tolerable capacity of the Earth, and the classical economic model is non-sustainable and for maintaining the diversity of life forms and favorable conditions for the mankind it is necessary its modification respecting these limits. Economy is still more often interpreted as non-growth part of the ecosystem and its qualitative development is not forever. It does not mean a return to simple civilization habits, but an efficient management of environmental resources, their pumping which can be regenerated, use of ecologically efficient technolo-

gies, recycling of wastes and reduction of useless consumption.

Sustainable development is unimaginable without a balance in the ecological conception, however, a social and economic balance is important as well. It results from a complex effort to meet people's needs for which the development of society is realized from economic, social and environmental points of view. None of the mentioned aspects can be understood apart from connection with two remaining ones. For the extent of this article, the relation of ecological and economic efficiency will be analyzed further.

### AIMS AND METHODOLOGY

The aim of the contribution is to analyze the efficiency of environmental resources from the viewpoint of measurement of range of their inputs with use of the theory of economic-ecological efficiency.

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The research was realized in the frame of solution of the Institutional Research Intention MSM 411100013.

The working hypothesis stems from following pre-suppositions:

- Classical indicators of economic efficiency do not include environmental effects in full extent
- Objective indicators of economic efficiency supporting the sustainable development have to take into account the state of the environment.
- Efficiency of environmental resources with required economic level is expressed by a quality of the environment.
- Degradation in the efficiency of environmental resources is influenced by the quality of waste management.

In this connection in solution of the above mentioned, the principle of complex expression of national-economic efficiency work out by Samuelson (1985) can be used, which works out besides indicators of a gross domestic and national product, and by their modifications complex indicators of national wealth including a state of environmental resources.

The state of national resources is substantially dependent on waste management. According to Pearce (1978), an assimilation capacity of a natural environment depends on the flexibility of the ecosystem and the character of waste. The natural environment absorbs various kinds of wastes with a different efficiency, nevertheless, pollution reduces the capacity of the natural environment to absorb other pollution.

The used methods were predetermined by problems which were investigated according to the above mentioned structure. However, in all part it was dealt, though in various rate, with qualitative and quantitative analyses, synthesis, comparison, method of analytical judgements, normative method, method of questioning, method of documents processing and so on.

## RESULTS

### Complex measurement of national-economic efficiency

Economic efficiency is expressed by various indicators. For comparison, the most often national accounts (SNA – Systems of National Accounts) are used to measure GNP according to the national standard determined by the UNO. However, the SNA is criticized despite its spread, that it does not consider appropriately secondary effects of economical activities.

Considering that, there are worked out so-called “Green National Accounts”. Their starting conception was formulated by Hicks in 1946 already with delimitation of a real yield, which is the surplus over

all consumed assets, solving numerous weak sides of common national accounts and providing more objective information for a decision making in both economic sphere and the area of environment.

In the System of National Accounts including also unmarketable national resources, the following categories are determined:

$${}_p \text{ GNP} = \text{GNP} + \text{ES} \pm \text{ED}_1 - \text{DE} - \text{IR} \quad (1)$$

$${}_p \text{ NNP} = \text{NNP} + \text{RD} - \text{DEP} - \text{ED}_2 \quad (2)$$

$${}_p \text{ NW} = \text{NFA} + \text{TA}_H + \text{TA}_N \quad (3)$$

Index  $p$  in introduced macroeconomic aggregates expresses their modification regarding changes of the environment of life.

ES = services of the environment to liquidate wastes. Producers and partially also consumers do not pay for them and the price of these services increases profit.

ED<sub>1</sub> = damages (improvements) of the environment – altogether it is dealt with consumed assets of the environment

DE = protection expenditures for the environment expound by households and government. The expenditures of households do not increase a wealth, they only contributes to maintenance of a status quo. The government expenditures can be both protective and increasing the wealth, e.g. waste management

IR = invested rent (an economic profit) from environmental resources, which is expressed by the present value of their reserves remaining after their use.

RD = value of detected environmental resources in the given period

DEP = an inclusion of environmental resources exhaustion is a substantial modification of net product. Resources exhaustion is calculated as losses of their rent (so called method of net price). In case of soil erosion, the environmental resource exhaustion is expressed in the present value of lost production.

ED<sub>2</sub> = is an analogy of ED<sub>1</sub>. Consumption of these assets is expressed by costs necessary for bringing the assets of environment in a state in which they were at the beginning of an accounting period. Another form of an evaluation of deterioration of assets of environment of life is the expound cost for security of their permanent use (not only a maintenance of their state).

NFA = net financial assets which are in the open economy a difference between financial as-

sets and binds, and are either net demands on foreign assets or a net foreign debt

$TA_H$  = tangible assets created in the work process are a substantial part a reproducible capital – machines, buildings, equipment. An investment of the rent from environmental resources in the reproducible capital enables in a certain circumstances the maintenance of flows of consumption in a far future – if the wealth is not increased, it creates a presumption of sustainability.

$TA_N$  = tangible natural assets express market value of resources (mineral resources, energy, forests) and the value of environmental resources providing services of the environment.

### Economic processes and an absorption capacity of the nature

The better are the environmental resources used, the lower is the pollution of nature. However, with given technologies the pollution is directly proportional to an extent of economic activities. The pollution is an unavoidable by-product of the economic activity.

A mathematical model of the relation is following.

$$W = f(x, t) \quad (4)$$

and in an explicit form

$$W = \beta x \quad (5)$$

$W$  = extent of waste

$x$  = extent of economic activities

$t$  = technological-ecological factor

In the equation (5), technological changes are not considered. The parameter  $\beta$  represents a positive slope of the function. Because the function does not contain the parameter of additive constant of pollution, other than from economic activities are not supposed.

The course of the function illustration Figure 1.

Economic activities up to the extent  $x_0$  produce less waste than the absorption capacity of the natural environment is. And its quality does not deteriorate. A change of quality happens when a threshold of absorption capacity is overcome in a point A where  $x_0$  is an ecologic threshold of economic activities. The growth of economic activity above the level  $x_0$  will not prove itself by a linear growth of non-assimilated waste, but its progressive growth, because the pollution reduces progressively – by a growing rate

the absorption capacity of the natural environment (Figure 2). If scope of economic activities should be  $x_1$  it is allowed to produce only  $C$  amount of waste, not  $A$  and not at  $B$ .

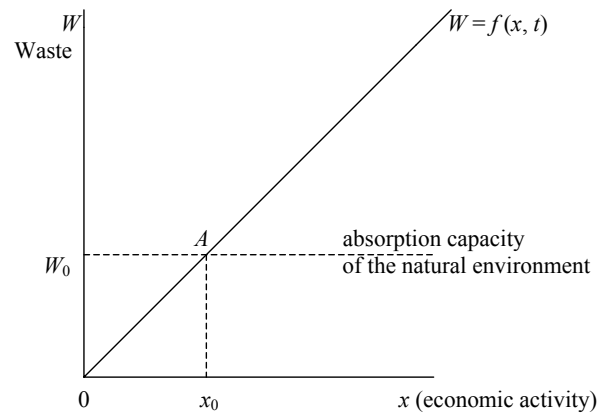


Figure 1. Scope of economic activities not overcoming absorption capacity of natural environment

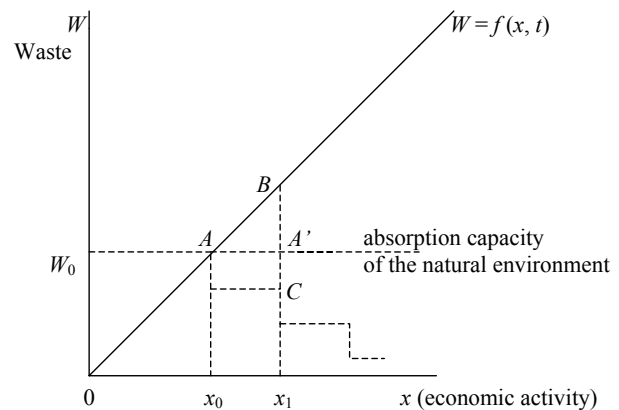


Figure 2. Decrease of absorption capacity if economic activities overcome threshold  $x_0$  with absorption limit  $W_0$

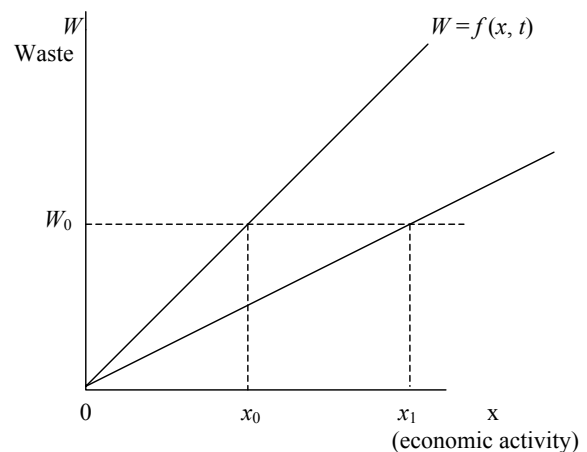


Figure 3. Effect of technological progress enabling expansion of economic activities not decreasing original threshold

A dynamic ecological effect connected with the growth of pollution in an unecological use of environmental resources will prove itself by the decrease of the threshold of ecological loading along the hyperbolic function (in discrete changes according to the step function).

To maintain the original threshold level  $W_0$  a technological progress is necessary, which can be illustrated in the Figure 3.

## DISCUSSION

Security of sustainable development of agriculture demands to measure objectively its real efficiency which can differ considerably from the common macroeconomic indicators.

Above all, the NNP should be maximized in each point of its development trajectory regarding the present value of the future consumption.

A concrete numeration of the mentioned indicators differs despite the effort of the UNO to unify the methodology of national accounts respecting changes in the environment.

From the mentioned, there results a solution of this problem which will not only support a better harmony of accounting and economic processes, but also will contribute to the increase of quality of life.

## CONCLUSION

From the analysis, it is obvious that the evaluation of efficiency of environmental resources demands:

- the objective presenting of all inputs and outputs of the economic activity including ecologic aspects
- use of environmental resources is efficient if the threshold of ecological production extent is not exceeded
- natural environment has a limited capacity to absorb waste – this ability then becomes a rare resource
- a certain amount of estates can be produced without a substantial influence on the environment
- the deterioration of the environment takes effect in non-linear way on the absorption capacity of waste liquidation
- the ecologic threshold of economic activity in environmental resources use can be increased by technological progress

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