FLOOD PROTECTION MEASURES EVALUATION USING CBA APPROACH – CASE STUDY

Eva Vítková, MSc., Ph.D., Assoc. Prof. Vít Hromádka, MSc., Ph.D.,
Brno University of Technology, Faculty of Civil Engineering, Veveří 95, 602 00 Brno,
vitkova.e@fce.vutbr.cz, hromadka.v@fce.vutbr.cz

ABSTRACT

The paper is focused on the presentation of the possibilities of the utilization of Cost-Benefit Analysis approach in economic evaluation of projects in the area of the flood protection measures realization. In the paper there will be identified possible costs and benefits of this kind of projects. Costs and benefits, which are not primarily expressed in monetary units, will be in next steps transferred into cash flow using appropriate approach coming out from the CBA methodology. Results will be presented on the case study.

ОЦЕНКА НА МЕРКИТЕ ЗА ЗАЩИТА ОТ НАВОДНЕНИЯ С ИЗПОЛЗВАНЕТО НА АНАЛИЗ НА РАЗХОДИТЕ И ПОЛЗИТЕ - ПРИМЕР

д-р Ева Виткова, доц. д-р Вит Хромадка,
Технически университет Бърно, Строителен факултет, Veveří 95, 602 00 Brno,
vitkova.e@fce.vutbr.cz, hromadka.v@fce.vutbr.cz

РЕЗЮМЕ

Докладът е фокусиран върху представянето на възможностите за използване на подхода за анализ на разходите и ползите в икономическото оценяване на проекти в сферата на реализиране на мерки за защита от наводнения. В доклада ще бъдат посочени възможни разходи и ползи от този тип проекти. Ползи и разходи, които не са изразени главно в парични единици, в следващата стъпка ще бъдат прехвърлени в

паричен поток чрез използването на подход, произлизащ от методологията на анализа на разходите и ползите. Резултатите ще бъдат показани в примера.

1. Introduction

Floods belong to the most frequent and dangerous nature disasters appearing in the territory of the Czech Republic. To avoid terrible impacts of floods on the society in the form of lost on lives, health and property it is possible to realize some preventive operations in the form of suitable flood protection measures. The realization of the flood protection measure is usually not easy and cheap project, so it is necessary to analyze each case individually. First it is necessary to choose right solution of the flood protection measure from the technical aspect. But each project is connected with some amount of costs, so in the second phase it is good the make an economic analysis of the economic efficiency of the project. Generally we can say, that the project is efficient enough, if it brings more benefits then costs, and it does not matter, if it concerns about benefits and costs expressed in monetary units or not.

2. CBA – basic principle

Cost – Benefit Analysis (CBA) is methodological approach, which solves benefits and costs of relevant subjects – beneficiaries in the frame of the realization of the non-profit investment project. In this way determined impacts are consequently aggregated, transferred into cash-flows and included into the calculation of crucial indexes intended for decision, if the project as a whole is for the society beneficial, or not. In the case of comparing of two or more investments these calculated indexes allow to assess their ranking or to determine the preference of one project. The result efficiency it is possible to calculate using general relation, which it is possible consequently to modify according to the specific needs of valuator and specific form of valuated project.

$$NPV_E = \sum_{i=1}^{n} \frac{B-C}{(1+r)^i}$$

where:

NPVE Economic Net Present Value,

B in monetary units expressed benefits of the project,

C in monetary units expressed costs of the project,

r discount rate,

n lifetime of the project, the duration of the valuated period in years.

The Cost – Benefit Analysis usually consists from following chapters:

- The definition of the essence of the project,
- The determination of the structure of beneficiaries,
- Description of zero and investment option,
- Determination, quantification and classification of all relevant costs and benefits for all phases of the project,
- Specification and separation of non-appreciable costs and benefits and their description,
- The transfer of appreciable costs and benefits into cash-flows,
- The determination of the discount rate,
- The calculation of crucial indexes,
- The sensitivity analysis
- The valuation of the project based on calculated crucial indexes,
- The decision about acceptability and financing of the investment

Detailed information about particular chapters is available in [3].

3. Approaches to impacts´ evaluation

In general it is possible to characterize two basic approaches to evaluation of non-commercial impacts of public investment projects. It concerns about pricing methods and valuation approaches based on the willingness to pay.

3.1 Pricing methods

Pricing methods are represented by simple approaches. They don't come out from the generally defined demand curve, but they set the value of the specific goods or events directly for the specific case. Those methods are not as direct and general as valuation approaches, but for utilization they are easier. It concerns mainly about methods using opportunity costs, costs for alternatives, shadow project costs and the other methods.

The opportunity costs method is based on the finding of the value that it is necessary to sacrifice for increasing of the amount of certain goods or events.

In the case of method based on expenditures for avoiding of losses there are expenditures, which individuals pay for purpose of avoiding negative impacts on environment, considered as a simple expression of monetary value of these impacts.

Shadow project costs method deals mainly with the evaluation of environment and mainly losses on environment caused by realized projects. Principle of the method is based on the assessment of costs connected with the offering of alternative environ-mental goods in other place then it was situated before and later by development project degraded. These costs express the value of environment that enters into costs of development project during its economic efficiency valuation. However by the choice of the shadow project it must be discussed and valuated the adequacy of chosen shadow project in comparison with the rate of devaluation of environment caused by the development project.

The dose - response method is probably the most difficult pricing method, because it requires a lot of statistical information. Basic principle of this method it is the identification of the relation between devaluation of environment (dose) and the rate of its damaging (response) caused by the project realization. However through quite high difficulty the dose - response method is not usually able to take into account all environmental costs caused by the project's realization. Usually it is possible to enumerate only economic losses, thus losses caused on goods appreciable by the market system. [1]

3.2 Valuation approaches

Valuation approaches offer more general way of evaluation of social costs and benefit caused by the investment projects' realization. Particular methods included in valuation

approaches are based on common principles. The main principle of valuation approaches is to assess, what value particular non-profitable goods, events or processes have for the society. The value is in this case characterized as a rate of utility, which individuals (or the society as a whole) feels during the usage of valuated goods or at least in the case of possibility of the choice to use these goods. However the utility is hard to measure and quantify, that is the reason, why for the expression of the utility it is used the magnitude called Willingness to Pay (WTP) for an existence and possibility to use particular non-profitable goods. There exists the presumption that individuals will be able to express the maximal amount of money, which they are willing to sacrifice for possibility to use particular goods. The difference between the willingness to pay (the rate of utility that individuals feel during the utilization of the non-profit goods) and costs connected with the acquisition of these goods (the difference between the sum that the individual is willing to pay and the sum that he must to pay) is called the Consumer Surplus (CS). (Fig. 1)

In the case of decision making about the realization of particular variants of public investment projects it is judged the total change of the consumer surplus for the whole society. [1], [2]

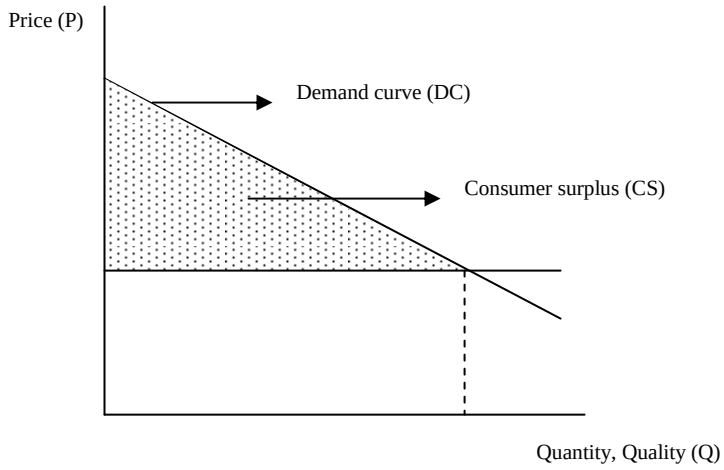

Fig. 1 Construction of Consumer surplus (CS)

4. Impacts of flood protection measures realization

In the frame of the paper is it also suitable to mention basic introduction into the problem of the identification and the structure of costs and benefits caused by the realization

of flood protection measures. As it was mentioned at the beginning of the paper, the economic efficiency of the flood protection measures realization is generally dependent on the difference between the benefits (positive impacts) and costs (negative impacts) brought by selected project. In this paper we will not talk about the ways, how to express benefits and costs in monetary units, we will only focus on the general structure of benefits and costs that the flood protection measures realization projects can cause.

Benefits and costs can arise in the preparation, realization, operation and liquidation phase of the projects and based on the analysis of 29 project intentions (it means approximately 60 individual technical solutions) in the area of flood protection measures realization we can define following areas of the social life, in the frame of that the benefits and costs can arise:

- Impacts on population
- Impacts on air and climate
- Impacts on noise situation
- Impacts on water
- Impacts on soil
- Impacts on natural resources
- Impacts on green, animals and ecosystems
- Impacts on protected parts of the nature
- Impacts on landscape

5. Case study

The case study consists in the simplified economic analysis of the project of the realization of flood protection measures using outputs from previous chapters. The project consists in the realization of following measures:

- the reconstruction and the extension of three existing ponds,
- the realization of new polder.

The technical solution of the flood protection measures is not the subject of the case study and it is necessary to take it only as the technical determination of the solved issue. The reconstruction and extension of ponds consists mainly in the reconstruction and increase of the dam crest and the treatment of slopes. The realization of new polder includes the new road, realization of the dam including installation of specific tubing and stabilization of slopes.

Expected investment costs connected with the realization of flood protection measures are displayed in following table.

Tab. 1 Investment costs of the project

Investment costs	**Pond upper**	**Pond middle**	**Pond bottom**	**Polder**	**Totally**
Basic budgetary costs (1,000 CZK)	1 188	2 244	1 848	1 413	**6 693**
Construction site accessories (1,000 CZK)	12	22	18	14	**66**
Costs totally (1,000 CZK)	1 200	2 266	1 866	1 427	**6 759**

Expected operation costs are 5 % from determined investment costs. To find out the economic efficiency of the project it is necessary to assess the benefits, which will arise with its realization. Benefits will be assessed as losses on property in the territory, which in consequence on the project realization will not arise.

Expected flood has following parameters:

- the duration of the flood 1 day,
- the deepness of water 0,5 m,
- the frequency of the flood 0,1 appearance per a year.

The following table brings information about the property protected by valuated system of flood protection measures, about losses determined using loss curves and about total loss caused on the property in protected territory by the defined flood.

Tab. 2 The loss on the property in protected territory

Name of representative	Damage (%)	Reproduction price (1000 CZK)	Loss totally (1000 CZK)
Apartment buildings till 4 floor	5,26	41 560	2 186
Apartment buildings over 4 floor	do not occur	0	0
family houses	7,67	63 190	4 847
Buildings for health care and services	6,77	7 820	529
Buildings for municipal services and hygiene	do not occur	0	0
Buildings for education and training	6,77	24 420	1 653
Buildings for science, culture and education	do not occur	0	0
Buildings for physical education	6,77	18 110	1 226
Buildings for administration	6,77	16 770	1 135
Buildings for commerce and public catering	6,77	9 480	642
Buildings social care	do not occur	0	0
Buildings manufacturing industry, special	do not occur	0	0
Areas for Physical Education uncovered	8,27	3 350	277
Additional objects	do not occur	0	0
Objects of technical equipment	9,14	980	90
Totally			**12 585**

The last part of the case study is focused on the economic analysis of solved project. For the economic valuation it will be used the index of the net present value. The groundwork for the calculation is displayed in following table. It necessary to remind that during the calculation it is necessary to take into account the frequency of the flood and to this frequency to adapt positive cash-flow of the project in the form of the expected loss, which will be avoided by the project. The valuated period is 20 years, the discount rate is 5 % for the financial analysis and 5,5 % for the economic analysis. The following figures do not include the complex calculation, but only the part including basic essence of the calculation. The financial and the economic analysis were carried out in the SW application eCBA, the complex tool for the Cost-Benefit Analysis elaboration.

The figure 2 displays the basic overview of investment costs, the figure 3 displays the operation costs and revenues.

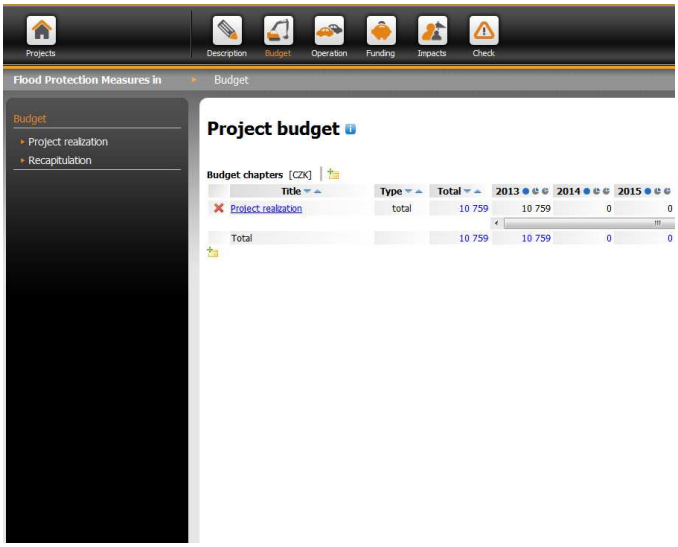

Fig. 2 Investment costs in 1000 CZK

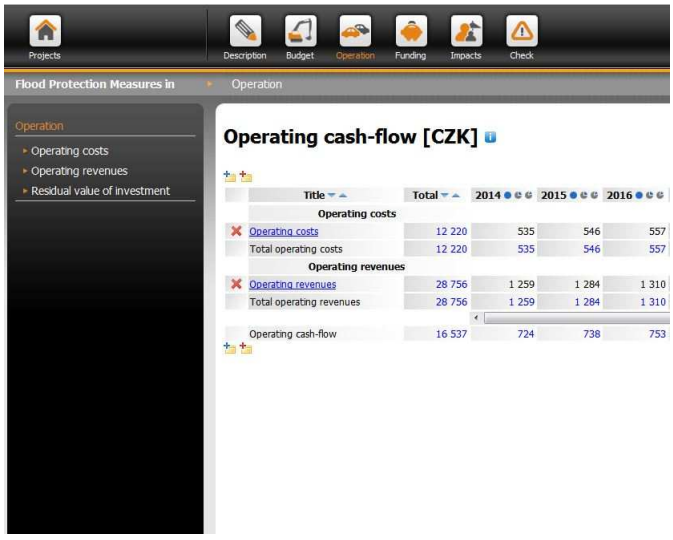

Fig. 3 Operation costs and revenues in 1000 CZK

Figure 4 displays the results of the financial analysis with main indexes (NPV_F = -539 000 CZK, IRR = 4,42 %)

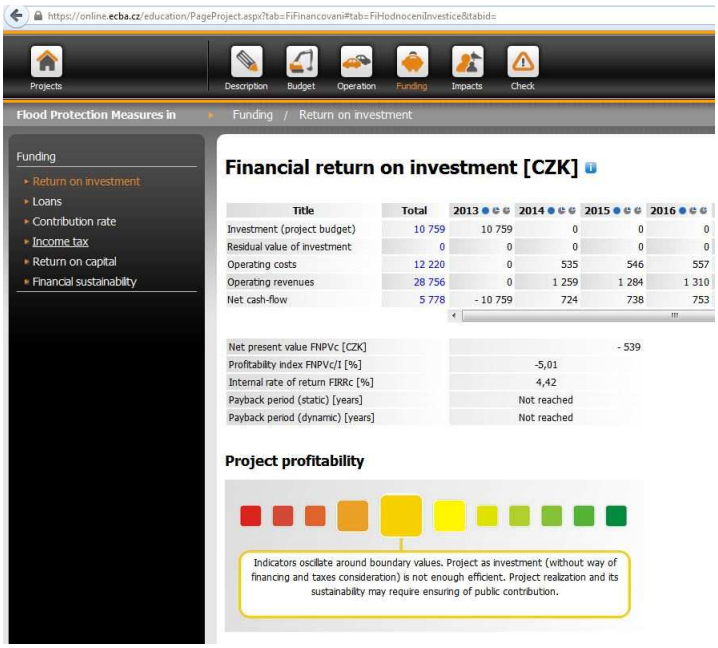

Fig. 4 Results of the financial analysis

The figure 5 identifies the social benefit in the form of the prevention against minor injury (prevention of 2 minor injuries during the flood), the figure 6 displays total results of the economic valuation (NPV_E = 550 000 CZK, IRR = 6,1 %).

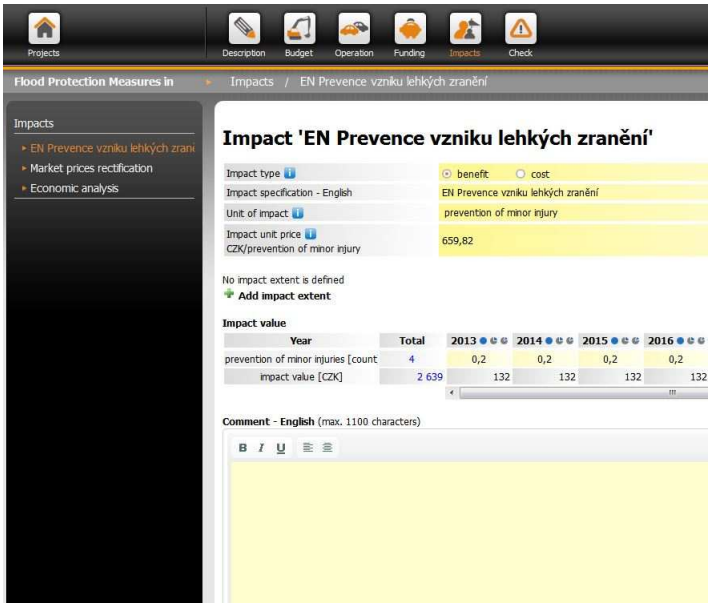

Fig. 5 Identification of social impact – prevention against minor injuries

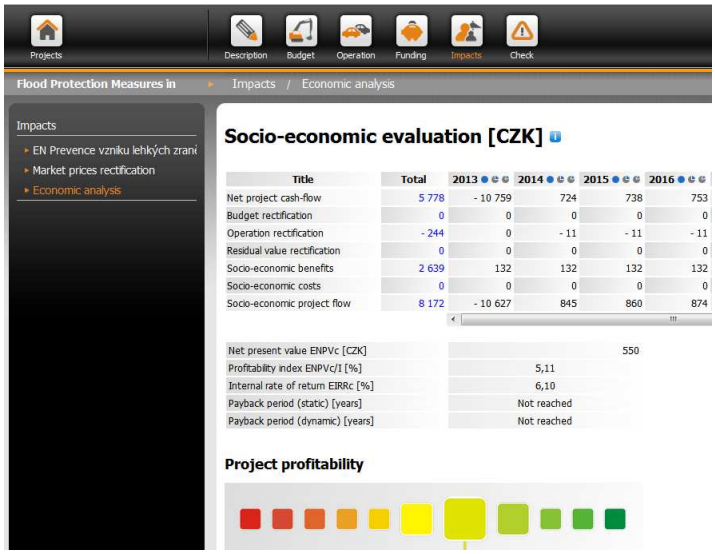

Fig. 6 Results of the economic analysis

In the frame of the case study there was elaborated model example solving the financial and economic analysis of the project of the flood protection measures realization. There were taken into account financial and non-financial benefits and costs and it is possible to deduct the importance of the socio-economic impact connected with these kinds of projects.

6. Conclusions

The main goal of the paper is to describe the issue of valuation public investment projects in the form of the flood protection measures realization using the CBA approach. There are mentioned basic principles of the CBA and possible approaches to evaluation of the socio-economic impacts of these projects. In the second part there is elaborated the case study, which on the model date shows the possibility of the economic efficiency assessment using specific software eCBA used in the Czech conditions.

Acknowledgement

This paper has been written with the support of the specific research of Brno University of Technology, Faculty of Civil Engineering, grant project No. FAST-S-11-61 Economic Aspects of Preparation, Realization and Running of Structural Projects.

R E F E R E N C E S

[1] HROMÁDKA, V. Ekonomická analýza veřejných projektů. Nehnuteľnosti a bývanie [online]. 2006, č. 2/2006. Available on www: http://www.rozvojbyvania.sk. ISSN 1336-9431.

[2] BATEMAN, I.; DAY, B.; LAKE, I.; LOVETT, A. The Effect of Road Traffic on Residential Property Values: A Literature Review and Hedonic Pricing Study. [PDF dokument]. Edinburgh, Scottland, UK. Scottish Executive Development Department. Date of publication: January 2001 [cit. November 2005].
Available on: http://www.scotland.gov.uk/library3/housing/ertpv.pdf.

[3] FLORIO, M. Guide to Cost-Benefit Analysis of Investment Projects. [PDF dokument]. European Commision. Dostupné z: http://www.strukturalni-fondy.cz