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QUANTITATIVE RISK ANALYSIS AND EVALUATING ENVIRONMENTAL PROTECTION PROJECTS

The objective of this study was to identify advantages of the system approach to evaluating environmental protection projects (EPP) and to identify way to get a best result in such areas: Consistent selection more integrated and comprehensive environmental protection strategies which addressed both regulated and non-regulated activities; Development of local capacity to independently environment issues. From methodological point of view the analysis and evaluation of environmental protection projects requires a multidisciplinary approach. Based on technical information (risk analyses), assessments can be made from an economical objectives although effects of aversion and acceptance would also have to be taken into account..

Keywords*: risk analysis, environmental protection projects, decision making, system analysis.*

Introduction

We are facing increasing environmental concerns associated with water, air, and soil pollution as well as climate change induced by human activities. Therefore accurate assessment of the state of the environment is a prerequisite for undertaking any course of action towards improvement [1].

One of the problems is that inflexible limits are set that are technically, but not economically, feasible [2]. This added expenditure can inhibit an industry's ability to develop more advanced and cost-effective pollution-control technologies. Another problem is the lack of uniformity between the various levels of government and regions.

Most regional environmental protection projects suffer from the "megaprojects paradox" [3], the core of which is that more of these projects are being implemented, but such projects typically perform very poorly, often with substantial cost overruns and shortfalls. To be effective we must provide a system for relating large numbers of actions and environmental factors and for placing value judgments on impacts which are difficult to quantify. Additionally, it is necessary the arrangements that the impact of alternative actions is evaluated and considered in project planning.

Environmental protection projects require carefully designed decision making processes. Decision-making process is essentially political in nature. It involves weighing the benefits and costs and making trade-offs among a range of considerations. Often, the views of interested parties are represented directly and decisions are made through an incremental process of negotiation, bargaining and compromise. For major proposals, a number of formal instruments can be used to develop the information necessary for sound decision-making.

Thus, the main focus here is the search for mechanistic decision rules, linked to acceptance regional environmental protection projects.

1. The concept of risk

There is no precise definition, however, of what constitutes an "acceptable risk"; it is basically a subjective notion. In its simplest form, risk denotes the level of uncertainty associated with an individual's given action. The acceptance of risk is generally governed by the degree to which it is considered to be relatively improbable and of limited consequence. We continue study "acceptance of risk" with regard to East Ukrainian region, filled of chemical facilities [4].

In a chemical facility, as in any industrial plant, risk assessment distinguishes between the potential hazards that might be encountered in the absence of any protective measures, and the residual risks that will still remain despite the measures taken. The problem lies in assessing the latter, since there is no way of ensuring that they have been completely eliminated. A number of approaches and methods exist for analyzing risks. We distinguish between two main categories:

a. Statistical methods. Data are available to predict the future performance of the activity or system analyzed. These methods can be based on data extrapolation or probabilistic modeling.

b. System analysis methods. These methods are used to analyze systems where there is a lack of data to accurately predict the future performance of the system. Insights are obtained by decomposing the system into subsystems/components for which more information is available. Overall probabilities and risk are a function of the system's architecture and of the probabilities on the subsystems/component level [5].

2. Statement of the problem

The problem of evaluating environmental protection projects is more complex than their corresponding mathematical model and to compensate this gap, some linguistic explanation occasionally adds to the results obtained through the models. In order to quantify such information, it is possible to apply the uncertainty measure on the basis of existing available data with the additional information from expert knowledge and experience [6].

Thus, the problem of selection more integrated and comprehensive environmental protection projects has such formulation.

Let ℓ_i – is an effect from realization the *i*-th environmental project. Let binary variable x_i is described by the score function:

$$õ_з = \begin{cases} 1, & \text{if EP project i is accepted;} \\ 0, & \text{if EP project i is rejected.} \end{cases}$$

Then problem of selection consists in definition of EP projects led to utility maximization:

$$L(x) = \sum_{i \in Q} \ell_i x_i \qquad (1)$$

in account of restrictions:

$$\sum_{i \in Q} G_{Di} \leq R, \qquad (2)$$

where Q - subset of approved (funded) projects.

3. Procedure of EPP selection

As noted above, for project evaluation best suits system analysis methods [7]. The procedure for selecting the best projects may include the following successive stages

1. The environmental impact analyses
2. The economical analyses
3. Analyses of extra factors
4. Decision procedure
5. Analysis of results

The environmental impact analyses require the definition of two aspects of each action which may have an impact on the environment. The first is the definition of the magnitude of the impact upon specific sectors of the environment. The second is a weighting of the degree of importance of the particular action on the environmental factor in the specific instance under analysis.

Similarly to [8] evaluating the environmental impact of an environmental program can be outlined in the following manner:

a. A statement of the major objective of the proposed project.

b. Analysis of technologic possibilities of achieving the objective.

c. Definition actions for achieving the stated objective.

d. Preparing the report with details the characteristics and conditions of the existing environment prior to the proposed action.

e. For each project the principal engineering proposals must be prepared. Project costs must be estimated.

f. The proposed plan of action, together with the report characterizing the present environment, sets the stage for evaluating the environmental impact of the proposal. If only one proposal is made in the engineering report, it is still necessary to evaluate environmental impacts.

Consequently we obtain two EPP attributes: remaining risk and risk reduction.

Remaining risk is the risk which remains after carrying out protective measures; the remaining tolerable risk in spite of protective measures.

Risk reduction or risk difference is the decrease in risk of a given activity in relation to a control activity.

The economical analysis. Questions on optimum protection measures have always been bound to economic considerations. This involves a comprehensive investigation and analysis of the effect of environment protection measures with an appropriate concept of risk.

By comparing the annual costs for measures and the expected risk reduction, it is possible to make comparisons between measures with a short-term and long-term effect [9-10]. Example of technical and economical analyses results are represented in Table 1.

Table 1

Environment Protection Projects (EPP) Summary

EPP no.	Technical analysis				Economical analysis		
	Remaining Risk		Risk Reduction		Annual costs	Efficiency	
	Objects	Persons	Objects	Persons		Objects	Persons
1	0,14	0,41	0,04	0,02	100	1,4	3,1
2	0,12	0,32	0,01	0,03	150	1,8	-
3	0,23	0,21	0,31	-	200	2,3	2,1
4	-	0,16	0,54	-	500	-	4,3
5	-	0,37	-	0,06	1500	1,6	1,4
6	protect	-	0,23	0,10	1600	2,6	2,3

Analyses of extra factors. Measuring progress toward the project's overall goals of improving the environmental quality to ensure human health and ecological, social, and economic benefits is a long-term process. Nevertheless, participants can point to several environmental and other accomplishments to characterize the project's progress in meeting the previously stated objectives. It can be inclusion of numerical values for the EPP future potential, local group involvement etc. Overall estimates are placed in the Table 2.

Table 2

Overall estimates for the EPP

Indices		EPP No.				
		1	2	3	4	5
Costs	G	100	150	200	500	1500
Environment efficiency	k_1	6	4	10	5	10
Economical efficiency	k_2	1	6	4	5	10
Local group involvement	k_3	1	2	3	2	5
Future potential	k_4	--	--	--	--	10

In this case the effect from realization *i*-th environmental protection project (l_i) represents as an aggregative criterion and can be evaluated as a sum effects with a weight coefficient ω_m for each criterion k_m.

$$\ell_i = \sum_{m=1}^{n} \omega_m k_m \; . \qquad (3)$$

In fact, ω_m correspond to importance of *m*-th criterion k_m and is an expert-specific.

Decision procedure

The analysis embodied in the Tables 1-2 is made with a (1-3) and Table 3. This provides a format for comprehensive review to remind the investigators of the variety of interactions that might be involved.

It helps the decision makers to identify alternatives which might positive impact.

The number of variants listed horizontally in this sample is 5 and the vertical list of environmental characteristics (criteria) contains 6, which give a total of 30 possible interactions. Within such a table, only a few of the projects would be likely to involve impacts of such magnitude and importance that they deserve comprehensive attention.

For example, for

$$l_i = k_1 + 1/2k_2 + 1/2k_3 + 4/5k_4,$$

according to (1-2) for R=500 the set of EPP will include such options: {7, 10, 16}.

The best one is a project No.16 which includes 1, 2 and 3 EPP.

Table 3

Fragment assessment of EPP

	EPP No.					Criteria					
	1	2	3	4	5	G	k_1	k_2	k_3	k_4	*l*
1	+					100	6	1	1	--	7
2		+				150	4	6	2	--	8
3			+			200	10	4	3	--	13,5
4				+		500	5	5	2	--	8,5
5					+	1500	10	10	5	10	25,5
6	+	+				250	10	7	3	--	15
7	+		+			300	16	5	4	--	20,5
8	+			+		600	11	6	3	--	15,5
9	+				+	1600	16	11	6	10	32,5
10		+	+			350	14	10	5	--	21,5
11		+		+		650	9	11	4	--	16,5
12		+			+	1650	14	16	7	10	25,5
13			+	+		700	15	9	5	--	22
14			+		+	1700	20	14	8	10	31
15				+	+	2000	15	15	7	10	26
16	+	+	+			450	20	11	6	--	28,5
17	+	+		+		750	15	12	5	--	23,5

Conclusion

In conclusion, it is worth noting that the final decision is extremely sensitive to the choice of priorities. Due to the fact that we are dealing with an active system, selection criteria and their evaluation performs individual managers, the fact that consideration of the procedures to coordinate the interests of the region and the center are necessary.

From methodological point of view the analysis and evaluation of environmental protection projects requires a multidisciplinary approach. Based on technical information (risk analyses), assessments can be made from an economical objectives although effects of aversion and acceptance would also have to be taken into account.

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КІЛЬКІСНИЙ АНАЛІЗ РИЗИКІВ І ОЦІНКА ПРОЕКТІВ В ГАЛУЗІ ОХОРОНИ НАВКОЛИШНЬОГО СЕРЕДОВИЩА

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Метою даного дослідження було виявлення переваг системного підходу до оцінки природоохоронних проектів (EPP) і визначення способу отримання найкращого результату в наступних областях: вибір найбільш комплексної і всебічної екологічної стратегії захисту, що враховує як регульовані так і нерегульовані види діяльності, розвиток місцевого потенціалу орієнтованого на самостійне вирішення питань оцінки ризиків та охорони навколишнього середовища. Засновані на технічній інформації оцінки можуть бути отримані виходячи з економічних завдань. У статті показані переваги системного підходу при оцінці природоохоронних проектів.

Ключові слова: аналіз ризиків, природоохоронний проект, прийняття рішень, системний аналіз.

КОЛИЧЕСТВЕННЫЙ АНАЛИЗ РИСКОВ И ОЦЕНКА ПРОЕКТОВ В ОБЛАСТИ ОХРАНЫ ОКРУЖАЮЩЕЙ СРЕДЫ

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Целью данного исследования было выявление преимуществ системного подхода к оценке природоохранных проектов (EPP) и определение способа получения наилучшего результата в следующих областях: выбор наиболее комплексной и всесторонней экологической стратегии защиты, учитывающей как регулируемые и нерегулируемые виды деятельности, развитие местного потенциала ориентированного на самостоятельное решение вопросов оценки рисков и охраны окружающей среды. Основанные на технической информации оценки могут быть получены исходя из экономических задач. В статье показаны преимущества системного подхода при оценке природоохранных проектов.

Ключевые слова: анализ рисков, природоохранный проект, принятие решений, системный анализ.

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