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METHODS TO VALUE NATURAL RESOURCES AND ECOSYSTEM SERVICES: EVOLUTIONARY CHANGES

The mess in evaluation approaches to nature and the disparity of evaluation results are the reasons for improving the evaluation process and streamlining the economic valuation methods. The aim of the research is to analyze the existing economic valuation methods of natural resources and ecosystem services and to improve the evaluation process to increase the level of objectivity and comparability of the evaluation results. The research methods are the comparative analysis, comparison, grouping, averaging, analogy method. The studies reveal the stage-wise evolution of the evaluation process in ecological economics and environmental economics, the sequence of the emergence of new methods and the external factors that cause these changes. The latter include: the actualization of economic valuation of ecosystem services due to the appearance of ecosystem approach; the emergence of a new object of evaluation as the natural capital, combining natural resources and ecosystem services; creation of a new valuation model defined by the concept of total economic value, and the transition to market. The evaluation process becomes more complex because of a socio-economic approach to economic valuation, which requires taking into account possible social and environmental consequences that reduce the value of the object of valuation. The paper contains the analysis of the available classifications of economic valuation methods and offers the author's classification, which assumes the usage of four classification criteria, including: the nature of evaluation, the basis of evaluation, the evaluation techniques and the attitude to the market. The qualitative valuation using a point system is considered as an auxiliary stage to the monetary assessment. The identified trends in the change in the methods of economic evaluation and the author's classification of economic valuation methods can help improve the evaluation process and increase the reliability and comparability of evaluation results.

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Introduction

Nature evaluation images interaction between the nature and humans, according to [1], with the characteristic utility/disutility rating. Evaluation, including economic appraisal of natural resources and eco-services, objectively represents evaluation subjects by quantities which define qualities and value of the subjects, i.e., evaluation represents value. The review of evaluation definitions exhibits a two-way approach to it: evaluation is assumed either as a process or as a result of evaluating. Generally, an evaluation is a cognitive activity including the stage of valuation and the stage of obtaining a value. The stage of valuation contains the stage of learning the valuation subject and the stage of using appropriate tools to get the result. The economic evaluation reliability mostly depends on the acceptability of tools (methods) of evaluation and getting the result, for this reason, it is necessary to: (1) review economic evaluation methods with regard to their extended list in the modern reality; (2) generalize existing classifications; (3) develop an authorial classification of economic evaluation methods to order the valuation process and to simplify the choice of methods for economic evaluation of a valuation subject.

Conventional methods of economic evaluation of natural resources

The idea to evaluate natural resources, in particular, land, dates back to the 15th–17th centuries. The evaluation was for the first time ever mentioned in the Engrossment Book which offered three or four category rating of the cropland and forest land toward the tax differentiation. Since 1838, the qualitative evaluation of land was under guidance of the Ministry of National Property, and since 1876 the country councils dealt with that task. The country council's valuations were preceded by comprehensive historical and economic research. The activities degraded greatly afterwards. In the first half of the 20th century, a theoretical framework was developed for the effective concept of mineral deposits on the basis of sound subsoil use by such scientists as S. P. Protodyakonov (1927), N. I. Trushkov (1931), B. N. Pytlyarovsky (1934), E. N. Spektr (1934), F. I. Chaikovsky and others. In the 1950s, the land evaluation, mostly qualitative and using a point system, used the natural characteristics: properties of soil, occurrence conditions of ground water, etc., while the principal criterion of classification was the crop yield. An actual visual display of the qualitative evaluation was the physiographic zoning which embraced almost the whole area of the Soviet Union by the early 1960s. At that time, K. L. Pozharitsky, S. Ya. Rachkovsky, S. A. Pervushin and other Soviet scientists pursued development of an efficient approach to economic appraisal of mineral resources, according to which the evaluation result was NPV over the whole period of exploitation with regard to discounting.

The progress was decelerated because of the lack of the private ownership, the more so as in the mid-1960s S. S. Strumilin's concept model enjoyed a wide spread. According to the model, the price of a natural resource was governed by the value of the expenses connected with the resource production. However, in view of an evident contradiction between the labor worth of proven resources and their value in public production, the concept lacked support as most researchers adhered to the standpoint of N. Fedorenko who considered mineral resources as the source of an economic effect (benefit). As a consequence, the expenditure concept came together with a rental approach to evaluation of natural wealth: land, forests, minerals, etc. A special emphasis should be laid on the studies by N. V. Volodomonov [2], one of the first scrupulous researchers of the problem, who proposed to evaluate a mining rent using the maximum allowable cost related with the cutoff grade. Later on, in the 1970s–80s, the rent concept became popular in the natural

wealth appraisal. The theoretic investigations connected with the rent concept ended with the creation of the Temporal Standard Evaluation Procedure of Mineral Resources (1980) [3]:

$$P = S_{t=1}^{T}(Z_t - З_t) / (1 + E)^t,$$

where P is the economic evaluation of a mineral deposit, RUB; Z_t is the annual product value in terms of the marginal cost in a t-th year, RUB/yr; $З_t$ is the overall capital and operating costs (without amortization) in the t-th year, RUB/yr; T is the base period, years; t is the current period, year; E is the different-time expenses normalization standard, unit fractions.

The necessity of economic evaluation of natural resources in the 1960s was proved by the massive related research. The review of the articles devoted to the economic evaluation in the economic journal *Voprosy Ekonomiki* [4] bespoke on a variety of technical approaches to the evaluation process. The related expenses included: agricultural land withdrawal remuneration; reclamation cost of land disturbed by open pit mineral mining; labor input to convert a disturbed land to a production land and to improve the land quality, etc. The effects included: differential rent; NPV, gross output (cropping capacity in terms of cost) and net profit; net profit and differential rent. Some recommendations advised integrating the cost and effect approaches. Using these methods, the process of evaluation keeps its natural order: cognition of an evaluation subject, evaluation with data generalization and analysis, comparison, grouping, averaging, etc., i.e., computation and obtaining the result represented by a cost estimate of a natural resource.

In the 1970s and then in the 1980s, the rent concept firmed up in economic evaluation of natural resources. This is proved by the writings of such scientists as K. G. Gofman, T. S. Khachaturov, V. V. Varankin, A. A. Minst, as well as such researchers as L. P. Kobakhidze, N. A. Bykhover, I. D. Kogan, M. I. Agoshkov, A. S. Astakhov, T. K. Gatov, B. L. Raikhel, engaged in the evaluation of mineral resources. During those years, the standard measure methods spread, which used the 'duly approved cost indicators or calculation technologies which also included fix rated parameters' [5]. These include taxes and duties related to flora and fauna, forest charges, standard land price, cadastral values of land, etc. A feature of evaluation in this case is the absence of the direct estimation of economic indicators as the ready cost standards are to be used. Those were the first attempts to use a comparative approach when a subject of evaluation was compared with an equivalent for which the cost standard measures were pre-validated.

Among the researchers absorbed with the issues of economic evaluation of natural resources in the 1980s, there were V. I. Gerasimovich and A. A. Golub, N. I. Tsvetkov, A. S. Astakhov, T. Kiselev, E. L. Goldman, S. Ya. Kaganovich, G. Karpenko and others. A signature of that time were the implications of the evaluation procedure subject to many constraints. The necessity of greater care for the social aspects in economic justification of mineral mining projects was illustrated by M. I. Agoshkov, A. S. Astakhov and E. M. Kazakov [6, 7]. Later on, methodological and procedural tools of economic evaluation progressed in the line of refinement of pre-project social and environmental research, and assessment of economic damage due to social and environmental consequences [8]. The requirement of an integrated social and economic evaluation implied that the process of evaluation was getting more sophisticated, both in terms of cognition of an evaluation subject, which involved pre-project investigations, and the evaluation process itself, with calculation of economic criteria with regard to social and environmental consequences, i.e. possible economic disbenefit. The further refinement of economic evaluation meant formation of a geo-eco-socio-economic approach including the environmental factor and disbenefit consequence because of derangement of ecosystem servicing [9, 10].

Methodological tools of economic evaluation in recent period

With economic transition to market relations in the early 1990s, scientists added their traditional research with the market-related methods (some of the methods were even used earlier, in the 1950s, before the advent of the rent approach) and the socio-scientific methods. All in all, the 1990s became a break point in the economic research of the natural wealth given external challenges such as:

- the vivification of economic evaluation of ecosystem services, both in Russia and abroad [11–13], because of an ecosystem approach aimed to consider, evaluate and preserve ecosystem health;
- the appearance of a new subject for evaluation—the natural capital integrating the natural resources and ecosystem services [14, 15], and a new evaluation model within the concept of a total economic value (cost) [16, 17];
- the economic transition of Russia to market relations, which redirected the evaluation survey.

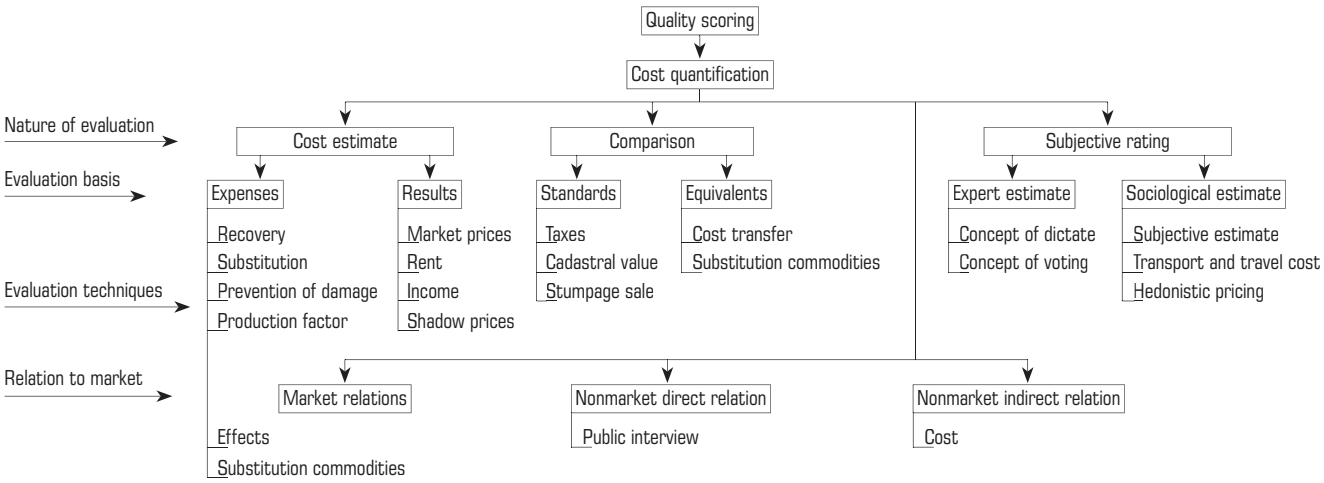
The effect-oriented methods grow in weight: the rent approach; the method of market prices; the factor of income, when the evaluation subject is estimated in terms of the income increment gained outside of the subject (e.g., improvement of water quality thanks to the eco-service connected with water treatment ensures an incremental income in commercial fishery); the methods of shadow artificial prices, when market prices are adjusted with respect to the dooms of the market, transfer of deeds, etc. The new methodical approaches to evaluation of eco-services with indirect profit are reckoned among the sociological methods which evaluate natural resources subjectively. The cost methods are added with the method of production (production function) which correlates the environment quality and the industry. The methods of comparison enjoy wider application—the method of analogies or transfer of value, or the method of substitutional goods. Among the researchers engaged with the economic evaluation in the economy of nature use at that time, and with the evaluation of eco-system services, first of all, it is worthy of mentioning S. N. Bobylev, O. E. Medvedeva, S. V. Solovieva, R. A. Perelet, A. A. Tishkov, A. A. Gusev, G. A. Fomenko, M. A. Fomenko, K. A. Loshadkin and others. The common trends of that time include:

- abortion of combinations (cost-and-effect, score-and-cost, etc.);
- elimination of scoring and standardizing, although taxes and cadastral evaluation remain being used;
- more often application of the total economic evaluation of cost (value);
- inclusion of the sociological evaluation methods, for the first turn, for the economic evaluation of eco-services.

The recent period features the economic evaluation of natural capital and its components using different methods [18–23].

Based on the studies [21], within the framework of the general economic evaluation of cost (value), the value of eco-system services and natural resources has been evaluated as a case-study of the Khanty-Mansi Autonomous Okrug as of 15 March 2022 (1 USD, 115.20 RUB, **Table**). The evaluation of mineral resources involved the analysis of investment efficiency in mineral mining (deposits of Tolya, Otorya, Yana-Turya, Zapad, Upper Tolya, Ust-Mansa) with regard to available subsoil resources and projected years of operation).

It follows from the data in the Table that the direct use value is 5 times less than the indirect use value. All ecosystem services in KMAO's



Classification of methods for economic evaluation of natural resources

Berezovo district have the value of 132494.81 MRUB, including the indirect eco-services of 109890.72 MRUB. The value of the moderate climate forests makes 66.37% of the cost of all ecosystem services (87943.25 MRUB), the swamps, lakes and rivers—26.12% (34612.52 MRUB) and the ecosystem of mountains—7.51% (9939.03 MRUB).

Classification of economic evaluation methods

The analysis and generalization of the existing classifications has allowed the authors to offer their variant using four criteria (**Figure**), with the latter criterion including three groups of methods recommended by UNO [24]. According to the proposed classification, the quality (scoring) evaluation precedes the quantity (cost) evaluation and is supplementary. The first criterion is the nature of evaluation, including the cost estimate, comparison and the subject categories, which differ by the procedure of evaluation. In the first case, the evaluation procedure is traditional, when a valuator perceives the subject of evaluation and carries out the procedure of evaluation; in the second case, at the first stage of the subject cognition, the subject is compared with an equivalent and with a subject with the determined cost standards or economic evaluations; in the third case, there is no process, and valuators use subjective estimates of an evaluation subject from the expert or public interviews.

The second criterion defines the basis for the economic evaluation. This may be the expenses connected with the creation of an evaluation subject. The use of the cost approach is most often governed by the impossible evaluation of the effect of the evaluation subject use. The effect approach based on the rent or income is the most popular method in economic evaluation of natural resources. It displays the result of the direct use of a subject and is assumed as the most reliable representation the subject value.

The comparative assessment rests upon the effective standards concerned with the fauna species, with the costs of development of land newly withdrawn from agricultural use, etc., as well as upon the known economic estimates of natural resources or ecosystem services. In the latter case, the emphasis is on the analogs of a subject being evaluated. When using standards and analogs, it is crucial to carefully reveal the consistency between a subject being evaluated and an analog, for which the economic evaluation has already been performed, or a subject, for which the cost standards are already approved. In the latter case, given the subjective nature of evaluation, the basis is the estimates obtained in the course of an expert or public interview.

Value of direct and indirect use of Berezovo district, KMAO

Ecosystem	Natural resources	Direct use value kRUB	Indirect use value, kRUB	
			Environmental value—regulatory eco-services	Socio-cultural values—cultural eco-services
Forests of moderate climate (boreal climate)	Minerals	20160306.60	0.00	–
	Land	11.39	2487896.73	–
	Water	497486.49	207360.81	–
	Biological	58241.25	64503392.31	–
	Ecosystem in aggregate	–	–	28559.16
Total per forest ecosystem		**20716045.73**	**67198649.84**	**28559.16**
Mountains	Minerals	0.00	0.00	–
	Land	0.00	61295.06	–
	Water	15236.00	4606.48	–
	Biological	42998.56	9475609.66	–
	Ecosystem in aggregate	–	–	339287.06
Total per mountain ecosystem		**58234.56**	**9541511.20**	**339287.06**
Swamps, lakes, rivers	Minerals	0	0	–
	Land	48.59	15981905.15	–
	Water	815409.50	351381.62	–
	Biological	1014348.60	16375801.71	–
	Ecosystem in aggregate	–	–	73624.45
Total per ecosystem of swamps, lakes and rivers		**1829806.70**	**32709088.49**	**73624.45447**
TOTAL		**22604086.98**	**109449249.53**	**441470.68**

A critical criterion of classification is the evaluation techniques. Actually, these are methods applied within the framework of a methodical approach. For instance, in the cost evaluation, the techniques use the costs of the evaluation subject recovery, or substitution, prevention of loss because of withdrawal of an evaluation subject, or the production function. According to the latter criterion, all these belong in the group of nonmarket or indirect techniques. In the effect-oriented evaluation, these are the effects (income) of using the market prices, the rent as a part of income due to specific natural conditions; the income produced outside

the natural resource being evaluated or beyond the influence zone of eco-services, and, finally, the effect (income) from using shadow prices. By the UNO's classification, these techniques (methods) are the market methods supported by the appropriate markets of natural resources. Given the standard-based evaluation, the evaluation methods use taxes, stumpage sale, cadastral values of cropland, grassland, etc. The analogy-based evaluation uses the transfer of value on a subject being evaluated, or the price of substitution commodities possessing the sales markets. In case of subjective evaluation based on the public interviews, the methods and techniques are the subjective estimates, the estimates of transport and travel costs, and hedonic pricing. The UNO's classification unites all these methods and techniques into the group of nonmarket and direct methods lacking a real-life market but pretending to have a hypothetical market. The expert approaches, such as the transfer of cost, do not belong in this classification, while the proposed classification of the economic evaluation methods includes these techniques as they find application in Russia.

Conclusions

The analysis shows that evolution of methods of economic evaluation of natural resources results in extension of the list of the evaluation methods and in the process complication because of the environmental and social constraints. The key causes for the essential modification in the evaluation procedure are:

• the actualization of economic evaluation of ecosystem services in view of advancing ecosystem approach;

• the appearance of a new subject of evaluation—the natural capital, and a new evaluation model within the concept of total economic value (cost);

• the transition to market economy.

On the whole, the changes in economic evaluation of natural resources concern: the subject of evaluation (from natural wealth to natural capital and its components), the model of evaluation (from the direct evaluation of nature components to the general economic appraisal of value and cost), the methods (from cost estimates to the subjective assessment and comparison). The proposed classification of the economic evaluation methods aims at their ordering and correlation with the foreign classification, promotes improvement of the evaluation procedure and upgrades the objectivity and comparability of the evaluation results. The use of the economic evaluation of natural resources and ecosystem services in the modern business environment can help form an effective policy of nature potential management (with regard to the quality and quantity of eco-services provided by the ecosystems in a region), as well as enables efficient preservation of the natural environment. Furthermore, the research findings can be a key factor of an evidence framework for the arrangement of international environmental disputes.

References

1. Kunitsin L. F., Muhina L. I., Preobrazhenskiy V. S. Some general issues of technological evaluation of natural systems in territorial engineering. Moscow : Nauka, 1969. No. 1. pp. 38–49.
2. Volodomonov N. V. Mining rent and mineral appraisal concept. Moscow : Metallurgizdat, 1959. 80 p.
3. Temporal standard procedure of economic evaluation of mineral deposits. Moscow : Preyskurantizdat, 1980. 30 p.
4. Economic evaluation of natural resources. Review of accepted articles. *Voprosy Ekonomiki*. 1969. No. 1. pp. 75–110.
5. Tishkova A. A. Economics of biodiversity, handbook. Moscow : Proekt GEF Sohranenie bioraznoobraziya RF, 2002. 604 p.
6. Astahova A. S., Tota M. Social and economic issues of effective management of mineral resources. Moscow : Nedra, 1985, 272 p.
7. Kozakov E. M., Economic justification of mining and processing projects. Moscow : Nedra, 1987. 208 p.
8. Kozakov E. M., Pahomov V. P., Ignatyeva M. N. Social and economic justification of mineral mining. Yekaterinburg : UrO RAN, 1992. 112 p.
9. Tatarkina A. I., Ignatyeva M. N., Dushin A. V. Development of a system conception in nature potential management in the underexplored northern areas. Yekaterinburg : IE UrO RAN, 2015. 317 p.
10. Dushin A. V., Ignatyeva M. N., Yurak V. V. et al. Economic evaluation of environmental impact of mining: ecosystem approach. *Eurasian Mining*. 2020. No. 1. pp. 30–36.
11. Arias-Arévalo P., Gomez-Baggethun E., Martin-Lopez B. et al. Widening the evaluative space for ecosystem services: A taxonomy of plural values and valuation methods. *Environmental Values*. 2018. Vol. 27, No. 1. pp. 29–53.
12. Costanza R. Valuing natural capital and ecosystem services toward the goals of efficiency, fairness, and sustainability. *Ecosystem Services*. 2020. Vol. 43. 101096.
13. Schaub S., Finger R., Leiber F., Probst S., Kreuzer M. et al. Reply to: Results from a biodiversity experiment fail to represent economic performance of semi-natural grasslands. *Nature Communications*. 2021. Vol. 12. 2124.
14. Ignatyeva M., Yurak V., Logvinenko O. A new look at the natural capital concept: Approaches, structure, and evaluation procedure. *Sustainability*. 2020. Vol. 12, No. 21. pp. 1–21.
15. Badeeb R. A., Lean H. H., Clark J. The evolution of the natural resource curse thesis: A critical literature survey. *Resources Policy*. 2017. Vol. 51. pp. 123–134.
16. Laporta L., Domingos T., Marta-Pedroso C. It's a keeper: Valuing the carbon storage service of Agroforestry ecosystems in the context of CAP Eco-Schemes. *Land Use Policy*. 2021. Vol. 109. 105712.
17. Qiao H., Wang C., Chen M., Su C. J., Tsai C. K. et al. Hedonic price analysis for high-end rural homestay room rates. *Journal of Hospitality and Tourism Management*. 2021. Vol. 49. pp. 1–11.
18. Bobylev S. N., Goryacheva A. A. Identification and assessment of ecosystem services: the international context. *International Organisations Research Journal*. 2019. Vol. 14, No. 1. pp. 225–236.
19. Tikhonova T. V. Environmental and economic assessment of water regulation function of rural territories in the Republic of Komi. *Economic and Social Changes: Facts, Trends, Forecast*. 2017. Vol. 10, No. 3. pp. 209–226.
20. Tsibulnikova M. R. Inclusion and evaluation of natural capital in territorial administration. Tomsk : TPU, 2018. 164 p.
21. Yurak V. V. Theoretical and methodical approach to evaluation of social value of natural resources: Synopsys Cand. Econ. Sci. Dissertation. Yekaterinburg : Mining University 2017. 258 p.
22. Artemenkov A. I., Medvedeva O. E. Cost estimation of water resources of Russia by water rent. *Imuschestvenniye otnosheniya v RF*. 2017. No. 8(191). pp. 62–73.
23. Fomenko G. A., Fomenko M. A., Loshadkin K. A. et al. Accounting and assessment of ecosystem services of Novokuznetsk coal-mining area (Kemerovo oblast). *Izvestiya Rossiiskoi Akademii Nauk. Seriya Geograficheskaya*. 2019. No. 3. pp. 88–97.
24. Fomenko G. A., Fomenko M. A., Loshadkin K. A. et al. Money value of natural resources, subjects of nature and ecosystem services in biodiversity preservation and management : Regional experience. Textbook for practitioners. Yaroslavl : KADASTR, 2002. 80 p. EM