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RESOURCE EFFICIENCY ASSESSMENT IN MINERAL RESOURCES MANAGEMENT

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Abstract

2030 Environmental development policy of the Russian Federation is focused on solving socio-economic problems that enforce the right of every person for satisfactory and healthy environment. Concurrently, quality of life of the population in coal mining regions in 2018 remained at a level below average for Russia. Contradictions of the stated goals and results of regional development, regularly identified violations of subsoil legislation became factors that determining the goal of this study: development of system of indicators for assessing resource efficiency of mineral resources management taking into account sustainability of the coal business. The main materials for the study were taken from sources in Russian and English, published mainly in 2017–2019 and dedicated to the problems of resource efficiency, sustainability of territorial development, violation of subsoil legislation. The main research methods are system approach, comparative analysis, generalization and synthesis of results, economic and statistical data processing methods. The study results show that in regard of coal business sustainability, resource efficiency of mineral resource management should be understood as level of indicators of ratio of coal mining enterprise production results and economic operation and costs of three components balancing: economic, social and environmental, forming consistent system developed by the authors. The study supports conclusion that in addition to economic aspects of operation, observance of international social and environmental requirements can ensure long term sustainability of coal business, attracting investment and increasing its competitiveness.

Keywords: Resource efficiency, coal, sustainable development.

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1. Introduction

In conditions of dynamic change of global community operation and development in the 21st century, global climate change, depletion of natural resources, transformation of human potential, development of information economy, issues of efficient use of all types of resources are becoming particularly relevant. Global agenda for the planet sustainable development, studied by Russian (Bolshakov & Shamaeva, 2017; Chernikova & Baranov, 2018; Chernikova, Zlatitskaya, & Klimashina, 2019; Marinchenko, 2019) and international scientists (Choi, Thangamani, & Kissock, 2019; Corsi, Pagani, Kovaleski, & Luiz, 2020; Hernandez, Paoli, & Cullen, 2017; Knuth, 2018; Li, Chiu, & Lin, 2019; Li, Stoeckl, King, 2019; Liu, Guo, & Nie, 2020; Pan, Pan, Hu, Tu, & Zheng, 2019; Qian, Wang, Wang, & Chen, 2019; Ruan, Yan, & Wang, 2020; Wang, Xu, & Ren, 2019), suggests integration of three components: economic, social and environmental one, whereas resource efficiency assessment maintaining balance between them is seen as a key component.

2030 Environmental development policy of the Russian Federation is focused on solving socio-economic problems that ensure low-carbon sustainable development, preserving satisfactory and healthy environment, biological diversity and natural resources, enforcing the right of every person for satisfactory and healthy environment. Whereas, coal business sustainability implies its ability of long term operation, taking into account stated goals and required level of profitability. In 2018, compared to 2014, growth of coal production in Russia amounted to 22.6 %, and share of mineral resources in GDP has increased by 45.6 %. At the same time, a number of Kuzbass coal mining enterprises went on strike in December 2019 because of wage debt, which exceeded 220 million rubles. It is obvious that coal mining growth increases well-being of coal-mining regions on the one hand, but on the other hand, it increases environmental burden, reduces life quality and do not always ensure a decent standard of living for mining regions population (see in Table 01).

Table 01. The main types of mining impact on biosphere and its results

Biosphere component	Impact	Impact Results
Water basin	Water intake, drainage and transfer of water reservoirs and streams, polluted water discharge	Water basin pollution and reduction of its reserves, violation of hydrogeological and hydrological regimes
Air basin	Point-source and fugitive emissions of dust and gases into the atmosphere	Dusting and gas pollution of the atmosphere
Soil landscape	Mining and construction of buildings, structures and communications, construction of dumps	Earth surface deformations, disturbance and deterioration of soil, reduction of productive land areas, erosion processes
Flora and fauna	Construction of buildings, deforestation, disturbance of soil, pollution of water and atmosphere, noise	Deterioration of living environment, reduction of wild animals number, oppressing and reduction in number of wild plants species, reduction of crop yields and livestock farming productivity
Mineral resources	Mining operation, extraction of mineral resources, drainage of deposits	Change in rock mass stress-strain state, subsoil pollution, induced earthquakes
Society	Air, water, soil pollution, industrial disasters	Increase in morbidity, decrease in life expectancy and worsening of living conditions, industrial disasters mortality

According to the study results, the main atmosphere pollutants are coal and brown coal mines (62 % of total emissions), area of disturbed lands in the Kemerovo region amounts to more than 100 thousand ha, of which 94 % are disturbed by mining. In order to reduce technogenic load on the territory, enterprises has fallen under administrative and economic actions at state level that can reduce sustainability of coal business. In 2019, 10 mining enterprises in Kuzbass were subjected to various types of liability for violations, including fines, license revocation, restriction of operation, unscheduled inspections. Despite this, 686.7 hectares of agricultural land in Prokopyevsky, Belovsky, Leninsk-Kuznetsky, Kemerovo and Novokuznetsky districts were subsidiary transferred for coal mining in 2019. Therefore, society faces important task of finding a compromise between technological development and protection of environment and society.

2. Problem Statement

To ensure sustainable development of national economy and society, it is necessary to solve social and environmental problems: low-carbon development provision, preservation of satisfactory and healthy environment, biodiversity and natural resources for future generations. Coal mining enterprises place a significant burden on host regions ecosystems. In this regard, effective decisions of mines and open pits management requires a system of indicators, providing information about results and costs of mineral resources use taking into account economic, social and environmental aspects, enabling resource efficiency evaluation.

3. Research Questions

The subject of study is indicators for resource efficiency assessment in mineral resources management, distinguishing levels of achievement of economic, social and environmental results of coal mining enterprises operation within sustainable development strategy.

4. Purpose of the Study

The study is aimed at development of a system of indicators for resource efficiency assessment in mineral resources management in regard to coal business sustainability.

5. Research Methods

When setting goals and defining tasks, the authors used empirical method of study and analysis of coal mining industry impact on economic, social and environmental aspects of society life. For comprehensive study of the problem, system approach was applied, based on study of academic research listed in the reference list.

The following methods were used in study of mining enterprises impact on environment and society: statistical method with analysis of actual data on violations of subsoil legislation, comparative analysis of types and results of mining impact on biosphere.

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At stage of designing a system of indicators for resource efficiency assessment, method of statistical generalization and synthesis of processes of complex impact of coal mining on economic efficiency of the enterprise, environment and society was applied.

6. Findings

In regard to sustainable coal business, resource efficiency in mineral resources management is understood as level of correlation of production results and economic operation of coal mining enterprise and costs of three components balancing: economic, social and environmental, which form consistent system of indicators designed by the authors (Table 02).

Table 02. System of resource efficiency indicators in mineral resources management

Name of resource efficiency index in mineral resource management	Calculation Method
Resource efficiency in mineral resource management	$RE = ER + RT + E$
Economic resource efficiency (ER)	$ER = ME + LR + FR + IR + TR$
1 Material resource efficiency (ME)	$ME = RA + MP + WCT + CE$
1.1 Return on assets index (RA)	$RA = \frac{\text{Return on assets, ex post}}{\text{Return on assets in base period}}$
1.2 Material productivity index (MP)	$MP = \frac{\text{Ex post material productivity}}{\text{Material productivity in base period}}$
1.3 Working capital turnover index (WCT)	$WCT = \frac{\text{Turnover ratio, ex post}}{\text{Turnover ratio in base period}}$
1.4 Coal extraction index (CE)	$CE = \frac{\text{Coal extraction ratio, ex post}}{\text{Coal extraction ratio in base period}}$
2 Labor resource efficiency (LR)	$LR = WP + RTW$
2.1 Worker productivity index (WP)	$WP = \frac{\text{Ex post worker productivity}}{\text{Worker productiviti in base period}}$
2.2 Index of return on total wages(RTW)	$RTW = \frac{\text{Ex post return on total wages}}{\text{Returne on total wages in base period}}$
3 Financial resource efficiency (FR)	$FR = P + RS + RI + DS$
3.1 Product Profitability Index (P)	$P = \frac{\text{Ex post product profitability}}{\text{Product profitability in base period}}$
3.2 Return on sales index (RS)	$RS = \frac{\text{Returne on sales, ex post}}{\text{Returne on sales in base period}}$
3.3 Return on investment index (RI)	$RI = \frac{\text{Returne on investments, ex post}}{\text{Returne on sales in base period}}$
3.4 Debt settlement index (DS)	$DS = \frac{\text{Debt settlement ratio, ex post}}{\text{Debt settlement ratio in base period}}$
4 Information Resource Efficiency (IR)	$IR = PC + PSR + WCS + C + RT$
4.1 Production Cycle Index (PC)	$PC = \frac{\text{Production cycle duration in base period}}{\text{Ex post production cycle duration}}$
4.2 Product Sales Revenue Index (PSR)	$PSR = \frac{\text{Ex post sales revenue}}{\text{Sales revenue in base period}}$
4.3 Index of working capital in in reserves (WCS)	$WCS = \frac{\text{Working capital in in reserves in base period}}{\text{Ex post working capital in in reserves}}$
4.4 Production cost index (C)	$C = \frac{\text{Coal production costs in base period}}{\text{Ex post coal production costs}}$
4.5 Receivables turnover ratio (RT)	$RT = \frac{\text{Receivables turnover in base period}}{\text{Receivables turnover, ex post}}$
5 Time Resource Efficiency (TR)	$TR = CPP + PDP + SPI$
5.1 Coal Production Plan Implementation Index (CPP)	$CPP = \frac{\text{Coal production, ex post}}{\text{Coal production, planed}}$
5.2 Index of Production Development Plan Implementation (PDP)	$PDP = \frac{\text{Development workings length (volume of overburden rocks) ex post}}{\text{Development workings length (volume of overburden rocks) planned}}$

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Name of resource efficiency index in mineral resource management	Calculation Method
5.3 Sales Plan Implementation Index (SPI)	$\mathrm{SPI} = \frac{\text{Actual sales quantity}}{\text{Planned sales quantity}}$
Social Resource Efficiency (SRE)	$\mathrm{SRE} = \mathrm{EI} + \mathrm{FA} + \mathrm{IA} + \mathrm{EV} + \mathrm{F} + AW + \mathrm{PD}$
1 Enterprise Injury Index (EI)	$\mathrm{EI} = \frac{\text{Workers injury in base period}}{\text{Workers injury, ex post}}$
2 Fatal Accident Index (FA)	$\mathrm{FA} = \frac{\text{Number of fatal accidents in base period}}{\text{Number of fatal accidents ex post}}$
3 Industrial Accident Index (IA)	$\mathrm{IA} = \frac{\text{Number of industial accidents in base period}}{\text{Number of industial accidents, ex post}}$
4 Index of number of employees held liable for industrial safety requirements violation (EV)	$\mathrm{EV} = \frac{\text{Number of employees held liable for industrial safety requirements violation in base period}}{\text{Number of employees held liable for industrial safety requirements violation, ex post}}$
5 Index of total fines paid by an enterprise for violation of industrial safety requirements (F)	$\mathrm{F} = \frac{\text{Total fines paid by an enterprise for violation of industrial safety requirements in base period}}{\text{Total fines paid by an enterprise for violation of industrial safety requirements ex post}}$
6 Index of wage to an average wage in the region (AW)	$\mathrm{AW} = \frac{\text{Workers average wage}}{\text{Average wage in the region}}$
7 Index of payroll payments delay in coal mining enterprises (PD)	$\mathrm{PD} = \frac{\text{Payroll debts ex post}}{\text{Payroll accounting, ex post}}$
Environmental resource efficiency (E)	$\mathrm{E} = \mathrm{LE} + \mathrm{M} + \mathrm{DL} + \mathrm{RL} + \mathrm{PE} + \mathrm{WWD} + \mathrm{ESF}$
1 Life expectancy index in the region where the enterprise is located (LE)	$\mathrm{LE} = \frac{\text{Ex post life expectancy}}{\text{Life expectancy in base period}}$
2 Morbidity rate in the region where the enterprise is located (M)	$\mathrm{M} = \frac{\text{Regional morbidity rate in base period}}{\text{Regional morbidity rate, ex post}}$
3 Index of disturbed land area (DL)	$\mathrm{DL} = \frac{\text{Disturbed land area in base period}}{\text{Ex post disturbed land area}}$
4 Index of recovered land area (RL)	$\mathrm{RL} = \frac{\text{Ex post recovered land area}}{\text{Recovered land area in base period}}$
5 Pollutant emission index (PE)	$\mathrm{PE} = \frac{\text{Pollutant emission in base period}}{\text{Ex post polutant emission}}$
6 Waste water discharge index (WWD)	$\mathrm{WWD} = \frac{\text{Waste water discharge in base period}}{\text{Ex post waste water discharge}}$
7 Environmental Safety Funding Index (ESF)	$\mathrm{ESF} = \frac{\text{Total environmental safety sunding ex post}}{\text{Total environmental safety funding in base period}}$

7. Conclusion

Thus, a complete and reliable assessment of the financial independence of municipalities, the study of conditions for ensuring and eliminating deficiencies in the municipal finance management system are important areas of sustainable socio-economic development of municipalities with the aim of ensuring a decent quality of life for the population based on the implementation of the fiscal budget by local authorities politicians.

In order to solve the problems of increasing budget independence, it is necessary to increase the budget's filling with revenues, carry out systematic work to reduce the amount of arrears in payments to the municipal (local) budget, strengthen the control by the administration of revenues and their revenues, and carry out a set of measures aimed at increasing the efficiency of using the municipal property.

The solution of social problems of the municipal (local) budget depends on the fulfillment of existing expenditure obligations, the prevention of the adoption of new expenditure obligations not secured by revenue sources, and the improvement of social support measures for citizens and the quality of financial management.

Achieving the budgetary independence of the city of Irkutsk and the advisability of maintaining a sufficient level of budgetary centralization pose new challenges in the field of regional finance management. Negative facts include increased aid from budgets of higher levels. The basis of the financial policy of municipal authorities is the principle of independence of local budgets in combination with state financial support.

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