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Developmental features of non-urban areas using local peat resources in a sustainable way

Alexander N. Semin[1)], Nikolay V. Grevtsev[2)], Natalya Yu. Antoninova[3)]

[1)] Russian Academy of Sciences, Ural State Mining University, Faculty of Economics, Department of Strategic and Industrial Management, ul. Kuybysheva, 30, Yekaterinburg, Sverdlovsk Oblast, 620144, Russia

[2)] Ural State Mining University, Faculty of Engineering and Economics, Department of Environmental Engineering and Water Management, Yekaterinburg, Russia

[3)] Institute of Mining, Ural Branch of the Russian Academy of Sciences, Laboratory of Ecology of Mining, Yekaterinburg, Russia

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Abstract: The article discusses the spatial development of non-urban areas based on the use of local peat resources. Creating a methodology for the advanced spatial development of non-urban areas has peat resources based on multi-criteria optimisation of production and social infrastructures. The industrial and social infrastructure of the non-urban areas having reserves of peat, associated mineral, and industrial raw materials. Regularities, trends, and features of formation and functioning of the productive and social infrastructure of the natural and man-made complex in the development of peat reserves, associated mineral, and industrial raw materials. To achieve this goal, it is necessary to conduct interdisciplinary research and solve the following specific objectives: (1) the scientific justification of new technological processes and equipment for peat and mineral raw materials processing for obtaining new composite materials for multiple purposes; (2) the feature analysis of the use of local peat resources to provide the development of non-urban areas based on a set of scientific approaches; (3) the development of the methodology for project management of the natural and man-made complex to ensure multi-criteria optimisation of productive and social infrastructure. The example of the Khanty-Mansiysk Autonomous Okrug – Yugra development selected results of confronting the existing "big grand" and national challenges through the mechanisms of rational use of local peat resources non-urban areas are illustrated. The results indicated that by 2030 there would be a 3.8-fold increase in mineral extraction and a 5.9-fold increase in processing industries.

Keywords: non-urban area, peat, spatial development, strategic planning

INTRODUCTION

The relevance of the research is determined by the lack of a holistic methodology for the rational use and renewal of peat, agricultural and bioenergetic resources, the imperfection of the organisational and economic mechanism for the development of digital technologies in the manufacturing sector and regional agro-industrial complex, as well as mechanisms and tools for effective solutions to problems and challenges associated with the optimisation of the productive and social infrastructure.

The widespread distribution of peat fields and their territorial proximity to man-made formations make it possible to solve the problem of recycling industrial and agricultural production wastes by their joint processing. Additionally, providing the territories with cheap and effective types of fuel, fertilisers, construction materials, and other peat composite products [Mikhailov *et al.* 2019].

Peat is a natural resource that can be renewed under appropriate conditions. The annual growth of peat reserves in Russia's peat bogs is estimated to be $250 \cdot 10^6$ Mg (at a moisture content of 40%).

Energy reserves of peat representing $68.3 \cdot 10^9$ Mg of reference fuel exceed oil and gas reserves and are second only to coal. However, natural gas and oil reserves are limited, and today there is a trend of the instability of prices for these energy resources.

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The trend of the economy and economic science development includes the processes of digitalisation of industrial sectors and economic operators, spatial, scientific, and technological development of Russia, strategic planning, and project management, as demonstrated in papers by [Kislitskiy 2018; Semin 2019] and the project of the draft concept [Minekonomrazvitiya Rossii 2016] as well as in the strategy [Martynov *et al.* 2020; Okrepilov *et al.* 2020; Seliverstov *et al.* 2019].

The state's economic and social policy makes it possible to confront new "Big Grand Challenges", including human pressure on the natural environment, recent demographic and epidemiological transitions, social stratification, migration, and regional conflicts, as well as other challenges.

The "Big Grand Challenges" are complemented by national challenges to the Russian Federation's spatial development. These include an unprecedented centripetal vector (gradient), the unfavourable geopolitical situation in the world, the insufficient infrastructure of the country, extraordinary unification of norms and rules of the country's spatial organisation, and inadequate elaboration of the spatial package of the Federal legislation.

There are major shifts in the spatial structure of Russia's entire settlement system, which are characterised by increased polarisation and spatial non-uniformity of the settlement.

The inertial development of the settlement system is unacceptable because the consequences of the inertial forecast implementation may become critical for Russia's sustainable socio-economic development, leading to the country's large-scale demographic "desertification".

MATERIALS AND METHODS

The following methods were applied as general scientific ones in the current study: monographic, economic-statistical, and abstract-logic methods.

One of the key research methods was the method of complex scientific and methodical assessment of socio-economic relations in developing management solutions, described in the paper by Kislitskiy [2018].

Monograph is one of the methods used in the in-depth method to study limited communities. In monographs, small and limited communities are studied comprehensively. On the other hand, a monograph is a deep and comprehensive description of a family or a tribe. For example, in a monograph, ten social, economic, demographic and cultural conditions, institutions, norms and in general, all the details of rural life are examined [Kislitskiy 2018].

The economic and statistical method is based on calculating the probability of occurrence of a risk event. Statistical indicators, such as: coefficient of variation, the average expected value (mathematical expectation), variance, and standard deviation are performed.

The complexity of applying scientific approaches determined the place of research: the Khanty-Mansiysk Autonomous Okrug – Yugra, which has many peat deposits and unique natural systems.

RESULTS AND DISCUSSION

Responses to challenges and threats are developed and introduced based on strategic planning documents. In the considered Khanty-Mansiysk Autonomous Okrug – Yugra, as a geographical and administrative-territorial object, the concept of cluster development is used in strategic planning according to papers by Moseiko *et al.* [2015], Raymond *et al.* [2017], Ridey and Tolochko [2017] and local strategy (Kudrin and Mizina [2016], Dmitriev *et al.* [2020], Milchakova and Nemchenko [2020]).

Many researchers, including the famous American economist Michael Porter, the founder of the cluster theory 1990, believe that clusters are very effective and can implement various innovative projects and scientific and technological achievements in a shorter time. We also share their positions.

A cluster (according to Porter) is a group of geographically localised companies, suppliers of equipment, components, specialised services, infrastructure, research institutes, universities, and other organisations that complement each other and enhance the competitive advantages of individual companies and the cluster as a whole, as is proven in Porter's monograph [Porter 2008].

The cluster generation can be divided into five models, according to the paper by Postalyuk [2013]: Italian with a large number of small enterprises united in various associations to improve their competitiveness; Japanese with a leading firm with a large scale production; Finnish with a high level of innovation, supported by strong research and development sector and a well-developed educational system; North American with strong competition between enterprises; and Indian-Chinese with a key role played by the state.

In the Russian Federation, clusters incorporate the features of many models. Still, mainly Russian clusters are closer to the Japanese and Finnish models, i.e., there is a development around a large company (an anchor company) and participation in a cluster of technological parks and scientific and educational centres.

The strategic focus of the Khanty-Mansiysk Autonomous Okrug (KhMAO) – Yugra on the development of cluster economy made it possible to create a series of territorial sector-based clusters, according to papers by Wilson [2001], Islamutdinov [2016], Girsh and Davidenko [2017], Sevastianov *et al.* [2017], Kislykhina [2018], Sevastianov *et al.* [2018], and Kuznetsova [2019]. At the moment, the timber and gas processing clusters are operating successfully. As part of the strategy, the agro-industrial and mining clusters will be further developed. Medical and scientific-innovative clusters are being formed.

The timber and gas processing clusters' priorities aim to modernise and expand production using innovative technologies. An industrial park is being formed in the gas processing cluster.

The technological structure of the agro-industrial cluster of the Berezovsky district developed in the region is aimed at developing agriculture [Ogryzek *et al.* 2019], fishing industry and fish farming, wild crops collecting and hunting (Fig. 1). The creation of small meat and dairy farms and experimental farms for breeding valuable fish species in the village of Saranpaul is of great promise. The agro-industrial cluster aims to develop receiving and processing points for wild crops, create small enterprises for the production of meat and dairy products, fish processing, create small enterprises for processing of fur, and the sewing of fur products. Consumers and distribution channels have been specified.

The practicality of local fuel resources development in the Berezovsky district and the necessity of energy infrastructure

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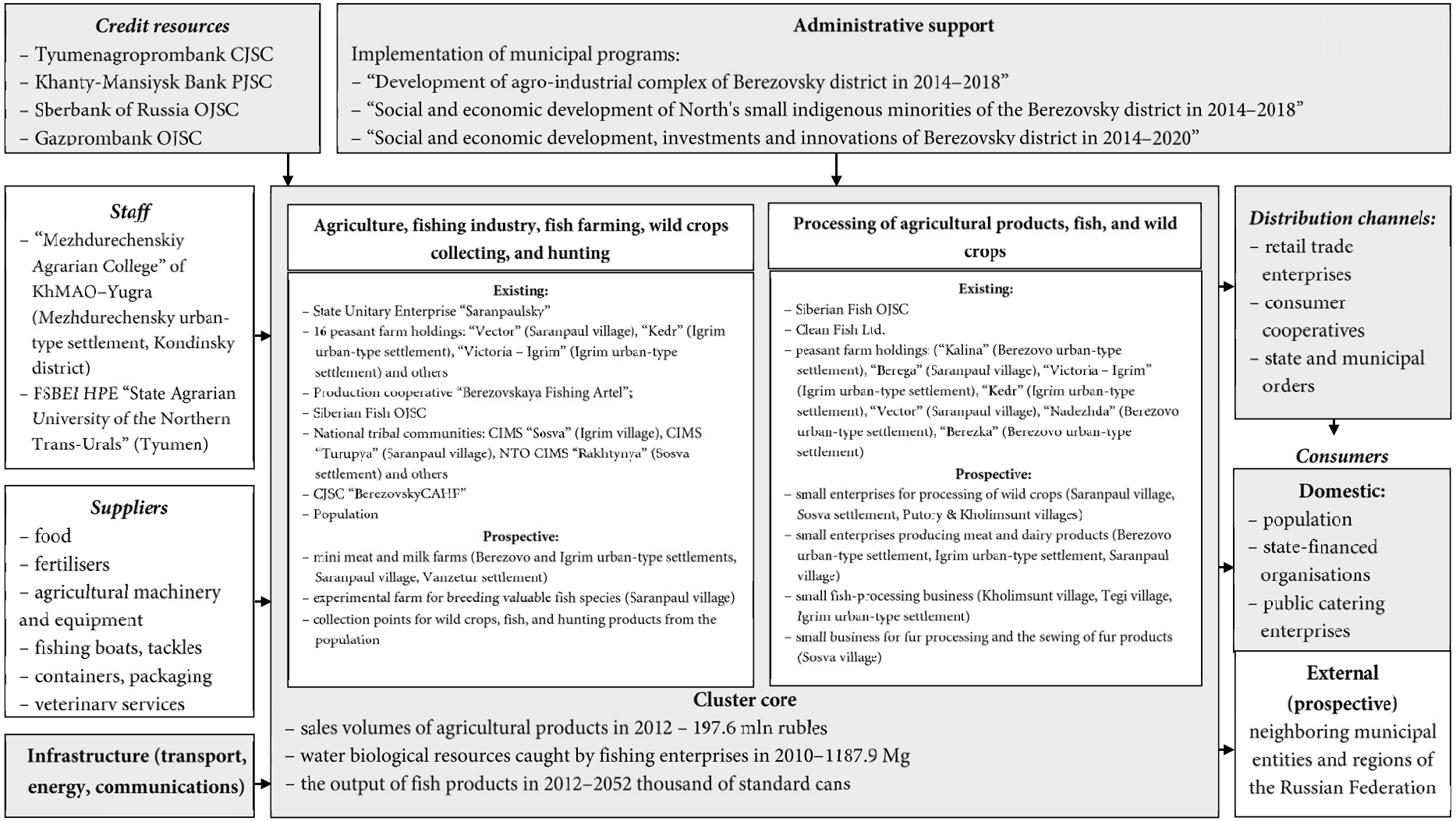

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development on the principles of small-scale municipal power engineering are confirmed by the results of work of local executive authorities and the Development Fund of the Khanty-Mansiysk Autonomous Okrug – Yugra, as well as by research conducted by scientists of the Ural State Mining University.

With the participation of Yugra professionals, the Ural Mining University scientists have developed the "Concept of using local fuels such as brown coal and peat of the Berezovsky District of the Khanty-Mansiysk Autonomous Okrug – Yugra to provide heat and power generation".

The concept of lean manufacturing, project management, application of information and communication technologies will become the mechanisms ensuring the introduction of innovative approaches into the Berezovsky district's economy. The region's strategy includes establishing a Priority Social and Economic Development Area (PSEDA) in the Berezovsky district [Semin 2019].

During the development of the concept, three independent projects were considered: 1) a project for the construction of a small multiple-unit thermal power plant (TPP), operating with the use of modern combustion technologies for local fuels; 2) a project for the development of fuel reserves based on the brown coalfield of the Borisov area of the Lyulinsky field with the placement of the small TPP on the open-pit site or in the village of Saranpaul; 3) a project for the development of fuel reserves based on the peat fields of the Berezovsky district with the extraction of milled or sod peat with the placement of the small TPP in the village of Saranpaul.

The necessary calculations for comparative analysis have been carried out (Tab. 1).

Table 1. Basic technical and economic indicators of peat fuel (milled and sod peat) and brown coal extraction options, according to the previous research

Parameter	Peat fuel		Brown coal	
	milled peat	sod peat	to the open-pit side	to the settlement
Extraction amount (10^3 Mg)	56.4	43.3	30.0	30.0
Breakeven production amount (10^3 Mg)	37.7	26.9	11.0	10.7
Breakeven production volume (thous. RUB)	28,386.0	33,339.5	40,071.4	41,336.4
Funding (thous. RUB)	392,891.5	400,462.0	588,060.0	538,060.0
Investment costs	76,891.5	84,462.0	92,060.0	92,060.0
Planning horizon (year)	10	10	20	20
Reaching the project capacity (year)	2	2	3	3
Credit payment period (year)	4	4	7	6
Discounting rate (%)	7.7	7.7	7.7	7.7
Total net present value (thous. RUB)	517,035.41	169,931.77	155,961.35	167,924.83
Discounted payback period (year)	3.06	3.16	6.74	5.02
Net present value of returns	1.65	1.5	1.36	1.34
Internal rate of return (%)	28.89	24.73	12.85	12.76
Output profitability (%)	110.4	70.38	29.11	23.86
Profitability of sales (%)	46.0	37.10	21.49	18.18
Return on average assets (%)	150.7	106.68	117.28	94.35
Asset turnover	3.26	2.85	5.3	5.02
Overall liquidity	4.86	4.08	3.47	3.13
Instant liquidity	3.18	2.5	1.94	1.63
VAT accrued over the period payable to the budget (thous. RUB)	157,323.8	145,739.8	235,771.3	206,652.6
Social security contributions accrued over the period (thous. RUB)	46,094.95	53,572.7	116,744.7	116,744.7
Property tax accrued over the period (thous. RUB)	7,393.83	8,638.8	10,820.3	10,820.3
Corporate income tax accrued over the period (thous. RUB)	97,264.86	78,397.0	73,858.6	62,728.8
Budgetary income at all levels over the period, (thous. RUB)	308,077.42	286,348.3	437,194.8	396,946.4
Budgetary discounted income at all levels over the period (thous. RUB)	226,403.2	210,510.0	221,718.4	202,684.5

Source: own study.

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Table 2. Characteristics of the use of local peat resources in the development of non-urban areas based on a combination of scientific approaches

Approaches	Characteristics
Adaptive	The regional energy supply system is an adaptive one, the capacity of which at each current moment should meet the needs not only of the region as a whole but also of each separate settlement or enterprise.
Administrative and territorial	The construction of large unit capacity power facilities will not be able to solve the problems of energy supply and heat supply in the Far North regions because construction of expensive long electrical power transmission lines will be required to deliver energy to consumers.
Logistic	The simplicity of transport schemes and short distances for peat removal.
Legal	In June 2016, amendments were made to the Federal Law "On Energy" concerning the implementation of measures to support electricity production using peat as fuel, which is important for the development of small-scale power generation in non-urban areas.
Resource	Reduced non-renewable fuel and energy resources; relatively low labor and energy intensity of fuel peat extraction.
Economic	Prices of peat as an energy raw material are sufficiently stable instead of constantly changing oil and gas fuel prices.
Environmental	Reducing the environmental impact of the fuel and energy complex activities because peat is characterised by low content of sulfur and ash, which provides a low level of harmful emissions during its burning.
Export	Marketing research shows that the export potential of soil-forming fertilisers based on deep processing is quite high. The main threat to agriculture in the Middle East and North Africa countries is the increasing desertification of fertile lands every year. Besides, soil erosion caused by overexploitation of the land due to intensive agriculture is actively developing in many countries of this region. In this regard, away back in the 80s of the last century, the UN, at last, approved a special program to combat this phenomenon. An important factor is an availability in most countries of these regions of quite large disposable monetary resources from oil and gas exports. The leadership of these countries is ready to invest in the development of agricultural infrastructure and landscape architecture.
Energetic	The milled peat is local energy fuel. Peat briquettes and sod peat are traditionally used as public utility fuel by households and utility companies. For today, Russian scientists have developed the effective schemes that allow for the essential expansion of peat fuel use perspectives. There is a long-term industrial Russian and foreign experience in generating heat and electric energy from peat and industrial raw materials.

Source: own study.

The results of calculations presented in the table demonstrate that the variant of organisation of milled peat fuel extraction [Turbiak *et al*. 2017] is distinguished by the lowest investment costs and the payback period of 3.06 years. The net present value of returns in realising this variant is 1.65, and the internal norm of return is 28.89%. These are the maximal parameters among the considered variants. Also, it should be noted that the variant of extraction of the milled peat fuel generates the maximum budgetary income in the considered period; after taking into account discounting, this income will be equal to 226,403.2 thous. RUB.

From summarising the research results, it can be concluded that the sustainable use of local peat resources could ensure the sustainable development of non-urban areas and increase the country's economic development. Features of the use of local peat resources in ensuring the development of non-urban areas are presented in Table 2.

The data in Table 2 demonstrates the key directions for the development of competitive advantages of the local peat resources use and areas for implementation of the concept of sustainable use of natural resources wealth of the municipal economy. Technical and economic studies on the forecast of peat product development demonstrate significant efficiency of products obtained as a result of deep peat processing. Thus, the ratio of prices for new types of products to the price of peat for composting (per-yield-unit) for molasses is 1:35; for fodder yeast is 1:200, for biostimulants is 1:300, for activated carbons is 1:350, and for wax is 1:350. Also, it should be noted that the forecast analyses indicate that by 2030 there will be a 3.8-fold increase in mineral extraction and a 5.9-fold increase in processing industries.

The shipping volume for production and distribution of electricity, gas, and water will increase by 3.5 times by 2030. The turnover of small enterprises and medium businesses will increase by 2.7 times. Fixed capital expenditure will increase by 3.9 times. The average monthly money income per inhabitant will increase by 2.5 times.

CONCLUSIONS

Application of strategic planning, project management, and development of the cluster economy in the territory of the Khanty-Mansiysk Autonomous Okrug–Yugra are effective tools and mechanisms for further sustainable development of this unique region of the Russian Federation.

Implementation of the Concept of using local fuels such as brown coal and peat developed by scientists of Ural State Mining University and the implementable projects presented in the concept will contribute to strengthening the competitive positions of both separate territories of the Okrug (Berezovsky district) as well as its other territories.

The development of small-scale municipal power generation will increase the economic strength of the country's northern

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territories. At the same time, this will provide the additional accelerated growth of GDP, the creation of new workplaces in remote areas, the growth of incomes and revival of the local economy, additional local taxes, as well as the improvement of the environmental situation in regions.

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