Environmental Problems Of The Russian Oil Industry And Their Modeling

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Abstract. **Background**: Many researchers consider topical issues of ecological development of the oil industry because of a variety of reasons. The oil prices are unstable, as well as exchange rates. The instability is contributed by the exhaustion of old fields and the high cost of new realization. The oil industry of Russia significantly influences the balance of payments, budget revenues, support of the ruble, and currency receipts. **Objectives**: The tasks of decision-making by management are considered in conjunction with issues of human health and viability of the oil business in conditions of uncertainty and multiplicity of criteria, as well as significant risks in the industry. **Methods**: methods of system analysis and synthesis, mathematical modeling, classification, scaling, ranking of events, and problematic methods (metabolic responses to pollution, verification) were used. The systems analysis methods used make it possible to investigate the problems of ecosystem self-organization. Private methods are defined flexibly, are adaptive, and agree with the considered task of the oil industry. **Results**: The following results were obtained: a) systematized the tasks of a systematic analysis of environmental problems in the oil industry; b) the target criterion of environmental hazard of the industry is formulated; c) proposed an approach to the formation of a digital environmental profile of the enterprise; d) the model of oil production taking into account its environmental costs is proposed. **Discussion**: Many Russian oil production regions are located in zones of pollution risk to decrease the potential of environmental restoration. At the same time, in the Russian ecological standards are very strict. The criteria and models considered in work can be useful at researching various strategies of the evolution of the oil industry. The results of the work will allow for solving practical problems of improving competitiveness in the oil market, reforming mechanisms of the oil industry, improvement of the domestic market of power and logistic services, etc. **Conclusions**: It is possible not only to predict environmental risks but also to avoid them. Further development can be conducted through information and entropy risk assessment and neuro procedures approach. The offered procedures and models are technological and flexible, do not assume difficult monitoring.

Keywords: oil, environmental problems, modeling, safety.

Introduction

The oil industry is the leading industry for the Russian economy (Zhukov, Korovin, 2020). The significant evolutionary potential of the oil industry also provides significant macroeconomic indicators. For example, in 2022, the oil industry received more than 17% GDP in Russia, 25% of tax and customs duties and 30% of foreign currency revenues to the budget (Nazarova, Lyshko and Goryunov, 2022). For 2022 and 2023, oil and gas annual revenues are expected to be about 7 trillion. rubles. (more than 5% of GDP). This is also confirmed by monitoring studies (Arkhipova, 2018).

Russian oil and gas enterprises produce more than 10 million barrels of oil every day. For example, Rosneft, Lukoil, Surgutneftegas, Gazprom-Neft, Tatneft, and Bashneft, respectively, produced almost 171, 76, 39, 38, 28, and 14 million tons of oil in 2021 (Germanova, Plyushchikov, Sambros, et al., 2022).

Russia has the second position in oil exports, the average annual production exceeded 550 million tons. The strategic development of the oil industry largely determines the socio-economic development, production, and environmental

policy of state development. Environmental issues are key in the research of Russian oil and gas specialists (for example, Sotnikova, Fedyaev, Grigoriadi, et al., 2021).
This article discusses environmental problems and features of the modern development of the Russian oil industry. The work carried out a systematic analysis of the risks and policies of ensuring the environmental safety of the oil industry, its public and private support.
The purpose of the article was to build a method for forming a digital environmental profile of an oil enterprise and to study a mathematical model of oil production taking into account environmental costs. In this article, industry oil analytics is used to develop procedures and models for finding control parameters, and functionalities of the system self-organization in order to increase its stability and viability. A systematic analysis of the risks and policy of ensuring the environmental safety of the oil industry, mechanisms and models for forecasting the development of the oil industry was also carried out.

1. Theoretical basis

Environmental problems have become relevant in connection with the transition to various renewable energy sources, decarbonization and the transition to lean production. Many desire carbon neutrality and energy independence by 2050. But oil is still in force, largely due to the frosty winter (Andreeva, Ivanenko, Siliverstov and Sudakova, 2016) and the "towing" of universal transition to electric cars. The purchase and sale of oil is going on actively. The sales leaders are Saudi Arabia, USA, Norway, Russia, Venezuela, Mexico and other countries. The purchasepure leaders were China, Germany, Japan, Korea, the Netherlands and other countries.
Oil production and refining have a negative impact on the environment (flora, fauna, production, consumption, etc.): from the global greenhouse effect to saving energy in the house.
The number of accidents at their facilities is growing with the development of oil production, refining, and transportation systems. In particular, risks are common:
1) pollution of nearby areas and regions;
2) negative impact on the recreation of the environment;
3) complication of geological development;
4) increase in production costs;
5) human factor (incompetence, inattention, etc.);
6) criminal, fraudulent actions, for example, tie-ins into the pipeline for transporting petroleum products.

Other crisis scenarios are the tasks of the risk management of the oil industry of our time (Solomonov, 2015). For example, oil and oil products are drained during theft, despite heavy fines (up to 200 thousand rubles) or imprisonment (up to 4 years).
Oil and petroleum products in relation to soil can cause erosion, heaving, desertification, and other forms of damage that interfere with soil restoration. The most dangerous are chloride salt, hydrogen sulfide, petroleum fines, organic chlorides, resins, paraffin compounds, etc. For example, according to (Kovaleva, Kudinova, Levichev, et al. 2021), the following table can be compiled:

Table 1. Range of Oil Pollution Factors in the Russian Federation

N	Factor	Max (%)	Min (%)
1	Light contaminant	18.2	11.9
2	Paraffin	1.9	0.5
3	Resin	27.0	19.5
4	Sulfur	2.05	1.55
5	Density (kg/m3)	907	896

The information profile of soil contamination is obtained using bioindicators or living organisms, from which it is possible to determine the level of pollution using metabolic responses to effects (bacteria, algae, etc.).
The goals and resources of the oil industry of Russia connect its economy with the global economy, goals and systemic challenges of globalization. At the same time, the decline in oil production cannot be considered a systemic factor in the loss of its position in the energy processes of the world economy, because, as noted by many researchers, oil is the energy dominant in the world.
According to oil market researchers (for example, Novak, 2021), the key factors in the country's environmental and economic security are:
1) structure and dynamics of supply and demand for oil and petroleum products;
2) structure and volume of investments in the industry;
3) the structure and pace of digitalization, intellectualization of industry management;
4) the degree of relevance and efficiency of forecasting, accounting, and leveling of environmental impact risks;
5) verification of price and geopolitical strategies;
6) the depth of processing of raw materials (especially with an increase in oil export risks);
7) reducing the cost of production, processing and logistics, including depreciation of funds.

When making economic crisis decisions, it is necessary to rely on digitalization, taking into account pandemic and climate threats and uncertainty in the world, as well as jumps in prices and oil production. Producing, processing and consuming countries and companies use various strategies and procedures for optimizing price solutions, accumulating "oil potential." Oil will retain its role as the leading energy resource until 2045-2050. For example, in 2023, the daily world consumption of 102 million barrels is predicted.

2. Methods

Our work is mainly systematic, theoretical, devoted to the model of oil production. But to test our system conclusions and mathematical model, we used the results of some experimental works, mainly devoted to semi-experimental dependencies of assessing environmental pollution risks. These works were carried out in 2016-2022. The search period for similar works was from 2015 to 2023.

Structural factors affect the tectonics, topography, geological structure, and composition of the oil bed. For example, mineralization changes, soil vulnerability, environmental safety decreases. The soil also reflects the negative of geodynamic processes. Scientists investigate processes using remote methods as well: topographic, geophysical and satellite observations.

The methods of predicting safety in the oil-bearing layer and oil-bearing areas make it possible to build safety maps and increase the stress (depression) of the earth layer. For example, it has become possible to monitor erosion and stress dynamics and implement effective safety measures.

Geodynamics of oil companies "areas of activity may be accompanied by weakening of the earth's crust, non-equilibrium physicochemical soil processes, instability, uncertainties and risks of increased danger. Contamination of the territory adjacent to the areas of oil production, transportation or processing is dangerous for both the biosphere and humans. More than 4,000 specific and different pollution factors in oil activities pose a threat to human health.

We note the following main works used by us in terms of our methodology (Alaberdeev, Gaponenko, 2020; Gorodnova, Samara, and Skipin, 2019; Shafiquzzaman, Alharbi, Haider et al., 2020; Liang, Xiao, Liu and Shi, 2020; Kaziev, Kaieva and Gedgafova, 2018).

It is important to consider individual and potential risks. Single contamination parameters, such as accidental oil spills determine individual risks. They are found by experimental dependencies, for example, according to (Tafeeva, Ivanov, Titova, Petrov, 2016):

$R_i = 1 - exp(ln(0.84 \div 0.05)(C/PK_z)^b t),$

where C is the average daily concentration, P is the maximum pollutant value, K_z is the recovery potential of the medium itself, b is the empirical hazard class coefficient (2.40, 1.31, 1.00 or 0.86); t - exposure time (for example, average life expectancy, 76 years).

This study was conducted in the Scopus, WoS, Google Patentes databases and RSCI libraries. The keywords or terms used in the search were "oil", "environmental problems", "modeling", "risk". The logical operators used in the search were AND, OR. In addition, the search used terms individually.

As the main hypotheses in this study, we selected the following hypotheses:

1) budget revenues are generated by oil exports;
2) prices for oil and petroleum products multiplicatively affect the development of other sectors of the Russian economy;
3) prices are calculated for the base oil price of $43.3-45.0 per barrel;
4) the Russian oil industry has a positive trend of planned growth (taking into account OPEC + agreements to reduce oil production);
5) oil production and refining and in unstable times function steadily, and fluctuations in the supply-demand pair have a strong impact on the price of oil;
6) the state provides support to enterprises of the oil industry and controls projects, especially their environmental aspects, approaches to environmental management.

As the main methodological apparatus, methods of system analysis, modeling, classification and decision-making are used.

The refinery uses various technologies, with different environmental risks of refining and transporting oil and petroleum products. The goals and consumers of oil processing are different: fuel for transport, raw materials for the chemical industry, construction, etc. This also reflects the analysis of the structure of the oil industry in Russia (Kurakin, Abramchikova, 2021).

Taxation in the oil industry also introduces dynamic chaos, for example, with various methods (regional, additional, product sections, financial results, offshore, small deposits, etc.). There are also opportunities for tax maneuvers. All this strengthens the risks and their diversity, the need to attract new tools, and modeling.

In addition to "vertical" problems, there are also "horizontal" problems or problems of independent oil groups and companies. They often lack the ability to offset their losses with tax maneuvers like "vertical" structures. There are also problems with the transition to the requirements of the EURO-5 standard.

The tax policy of Russia, its support by companies in the context of growing crises and risks, and uncertainty in the oil market has become the necessary condition for the long-term profitability of business in the oil industry.

Our work is more theoretical (systemic), so special laboratory studies, monitoring was not required. But small test computer experiments were carried out in order to test our models. They were held in Excel and were held from December 2022 to February 2023. Further development of the article involves the use of Big Data, Data Mining (Big Data in Computational Social Sciences, 2018) and the preparation of a special article.

3. Results and Discussion

3.1. Results

3.1.1. Systematic Analysis of Environmental Features and Environmental Pollutants in the Oil Industry

The efficiency of Russian oil production and refining is ensured and accompanied by environmental efficiency, corresponding to digital ecosystems and multi-criteria decision-making in the context of risks.
The future of oil companies is connected with the creation of "Digital Industrial Ecosystems" to manage the oil industry and production at its enterprises. As a result of the creation and development of the "digital oil ecosystem," the centralization of operational management, the use of technologies and systems of artificial intelligence, the use of innovative tools Big Data, Data Mining and others increases.
Environmental safety of the region is based on forecasting and modeling of the risk situation and unacceptable level of environmental pollution. In Russia, we observe a stable balance in the oil industry, this is its strategic advantage in the implementation of economic and environmental safety.
The development of oil industry projects is implemented by new technologies, innovative surveys and is often accompanied by a complication of processes, always accompanied by an increase in the role of environmental efficiency of enterprises and forecasting results. Modeling allows you to adaptively take into account key processes and mechanisms in the industry, follow the norms and rules in the industry.
The digital economy and Industry 4.0 need digital systems. They help to increase the environmental potential and lead to sustainable equilibrium states environmental processes. To manage the oil industry, it is necessary to track the reimbursement of "environmental debt" (restoration, recreational work or "simple" compensation for damage from pollution with fines). Fines are determined by regional policy, legal and environmental economic norms, and taking into account environmental assessments (according to Pareto) (Deryabin, Ungureanu, Buzinov, 2019). For example, they were considering the doses of major contaminants, which may be a thousand (Figure 1).

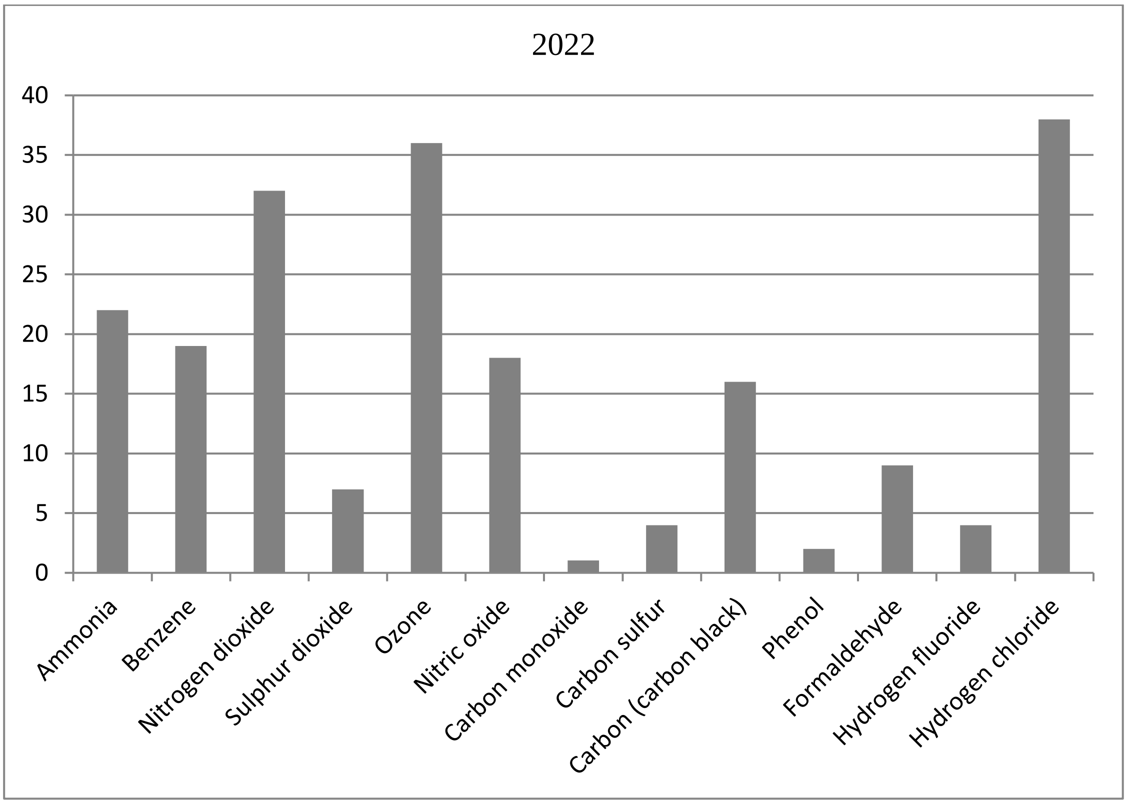

Figure 1. Concentrations in the Russian Federation, mg/m³

In our opinion, Russia has a systemic problem: there is no unified technological infrastructure, an adaptive environment that "on the fly" responds to vulnerabilities and damage from hazards. We will indicate the following reasons for the risks:
1) insufficiently controlled development of structures and forms of subsoil use;
2) complication of deposits and geodynamic activity, for example, deepening production, synergistic effects.

The latter circumstance is especially updated in our work. Digitalization, systematization, and intellectualization allow you to switch to a qualitatively new, systematic level of consideration of projects in the oil industry. Optimization or rationalization of oil fields helps to preserve natural resources from pollution and people from diseases. Many companies apply biotechnology, and lean production effectively train staff.

For example, when implementing expert environmental systems, it is proposed to use the brainstorming in the *i*-th tested situation (hypothetical scenario) belonging to a particular hazard group using the target criterion:

$$A_i = \sum_{j=1}^{n} \frac{A_{ij} a_j}{A_{jmax}} ,$$

where A_{ij} is the number of correct answers to the *j*-th question according to the scenario, a_j is the weight or importance of the j-th question according to the i-th scenario, A_{jmax} is the maximum (regulatory or criterion) for all experts who correctly answered the questionnaire question.

The integral risk of oil production is considered multiplicative. Risk factors and mechanisms of their impact on the environment also take into account disorders of body functions associated with oil pollution (Zaitseva, Onishchenko, May and Shur, 2022)

For example, the assessment of integral health risks should also take into account the additional risks of $R_j, j = 1,2, \ldots, J$ with the scales q_j, in particular, those associated with the adverse impact on the environment of economic factors at time t.

The reduced health risk $\bar{R}_t$ in such cases, we propose to evaluate the corresponding weighted formula:

$$\bar{R}_t = \frac{R_t - \sum_{j=1}^{J} q_j R_{jt}}{1 - \sum_{j=1}^{J} q_j R_{jt}}.$$

This risk characterizes the likelihood of damage to the effects of environmental factors as exposure increases (the horizon for planning health measures).

All risks determined by "white noise" (Gaussian noise) are integrally taken into account by the normal distribution:

$$R_z = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{P_t} e^{-t^2/2}\, dt ,$$

where P_t is determined, for example, statistically, by linear regression.

The total (population) risk of the i-th effect of the j-th factor can be found by the formula:

$R_p = R_{ij} N,$

where R_{ij} is the individual risk, N is the population at risk.

Then the total damage to health in the zone can be determined in a multiplicative way:

$$U = \sum_{i=1}^{N} a_i \sum_{j=1}^{M} R_{ij} \sum_{k=1}^{K} N_{ijk} ,$$

where a_i is the weight ("price") of damage to the i-th unit impact, k is the point number of the evolutionary trajectory of the ecosystem.

In a polluted ecosystem, both flora and fauna are under stress. A systemic sign of the environmental acceptability of production and restoration of the environment is its stability and self-regulation.

For example, the impact of oil production on the sanitary and epidemiological situation near production is manifested in a multi-critical way.

3.1.2. Adoption of environmental and economic situational decisions in the context of digital transformations in the oil industry

In the context of the evolution of the oil industry, it is impossible to do without appropriate analytics, intellectual support for environmental and economic solutions, and forecasting based on modeling. Dynamic adjustment for environmental parameters of oil production is required. For example, to get a result close to the expected result. The integration will be required for the economics, ecology, health care, and education processes.

If we consider the process of oil production or oil refining at the information and logical level, we can emphasize the digital profile of the object of such a process.

Let the set $I = \{i_1, i_2, \ldots, i_n\}$ $(N = |I|)$ be an object (process) for which it is necessary to quickly make an environmentally sound decision. Let I_i present to i-y a resource, and i_j - the corresponding j-y element specified by S standard reference information. Then during some ecological period of $T = \langle t_1, t_2, \ldots, t_k \rangle$ Occurs ecological self-recovery (recreation, neutralization of pollutant, restoration of pastures, etc.).

The frequency of accounting for such information in the process of oil production, processing or transportation is $f_i(i_j)$.

To calculate the limits f_{max} such frequencies, you can use:

$f_{max} = \max_T \left(f_{t_1}(i_j),\ f_{t_2}(i_j), \ldots, f_{t_m}(i_j)\right),$

$t_i \in T,\ l = 1,2, \ldots, k.$

Frequency ranking can be performed by a formalized index:

$$g_k = \frac{f_k}{f_{max}}.$$

If you define the environmental scale $G_k = \{g_{k_i}\}$, then you can divide elements and objects into classes, for example, into three classes: high-frequency, medium-frequency and low-frequency environmental hazard. With their help, you can:

1) reduce the complexity of structuring data, and objects;
2) connect new objects directly to a similar object class;
3) reduce fragmentation in multiple objects, their elements, as well as processes;
4) increase the integration of objects, processes, and data using an associative approach to forming environmental rules, connections.

Associative rules and relationships allow you to integrate and classify environmental relationships, profiles (models), and data structures. For example, as in index references, providing information using tables. The professionalism of the subject analyst-ecologist determines everything. The system analyst determines the level of detail of the data and the relevance of the classification.

The tasks of expert analysts in the oil industry include the following key points:

1) setting priorities, resources, tactics and strategies for achieving goals;
2) collection and analysis of primary information (production data);
3) effective teamwork;
4) process intelligence (automation) situational modeling and expertise, etc.

The analytical expert heuristic procedure includes checking the compliance of the situation with environmental specifications.

The evolving digital economy requires a self-organizing ecosystem (Figure 1).

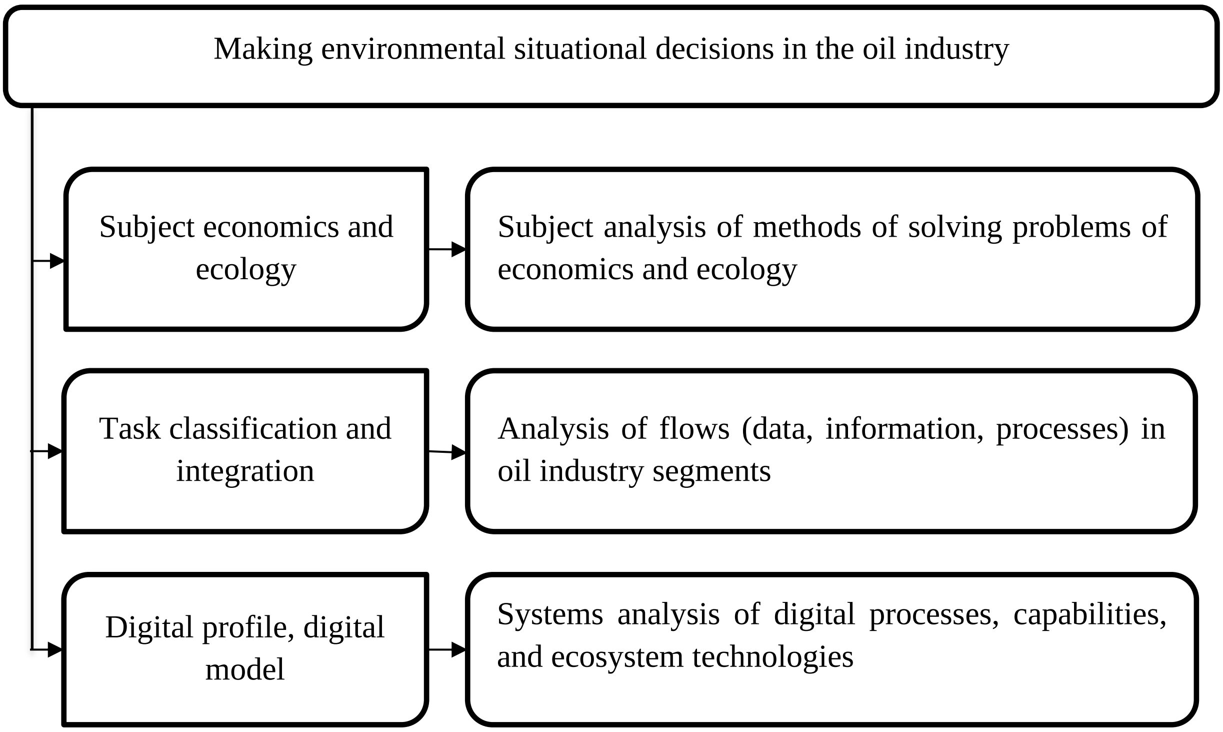

Figure 2. Structure of evolution and self-organization of processes in the ecosystem

Let $x(t)$ - production volume, $p(t)$ - specific environmental costs of a "non-digital" (traditional) oil enterprise, $q(t)$ - specific environmental costs of digital production, $K(\tau)$ - costs of transition from traditional production to digital production in the oil industry, τ - the period of their payback.

Then the innovative effect of digitalization of processes in the oil industry can be determined by the formula:

$$E(\tau) = -K(\tau) + \int_0^{\tau} \big(p(t) - q(t)\big)x(t)dt.$$

The indicator of digitalization efficiency at $q(t) < p(t)$ can be the profitability of the transition to innovation:

$$R = \frac{E(\tau)}{K(\tau)}.$$

Innovative strategy and infrastructure should be adapted to strategic objectives, for example, by effectively applying the potential of ecosystem infrastructure. Especially intellectual potential, and personnel training opportunities (Shchelkunova, Metlin, and Bykova, 2021).

Decision-making processes are influenced by both processes and management, which coordinates and controls goals and processes at different levels (Figure 3).

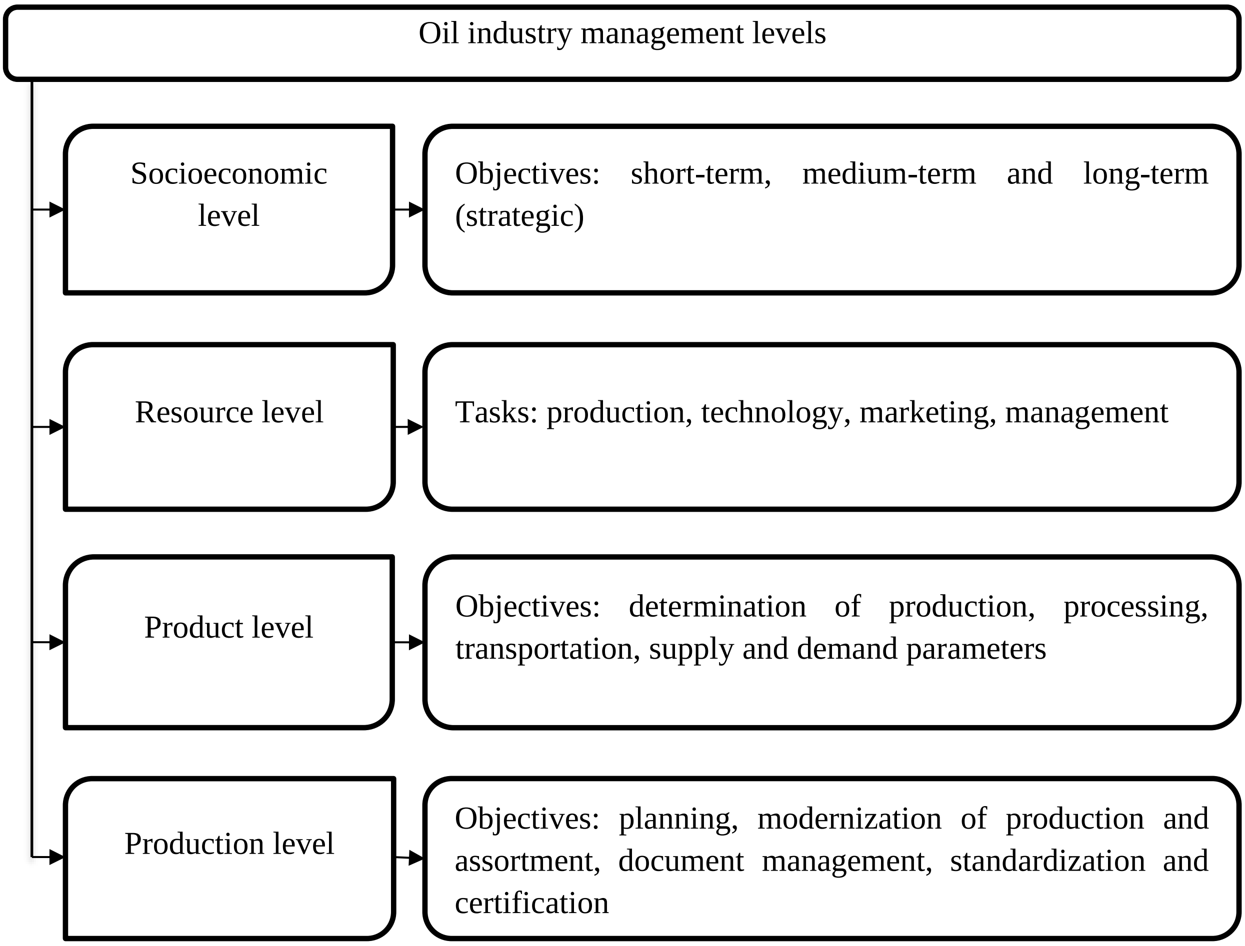

Figure 3. Oil industry management levels and objectives

In the digital ecosystem of the oil industry, the first place will be digital innovations, IT infrastructure that increase the potential of the ecosystem. It also defines the bifurcation points of the system.

3.2. Discussion

The impact of pollutants on the environment presents a multifactorial problem, associated with uncertainties. About 12% of the world's oil is produced in Russia. Many northern and marine territories are located in areas of risk of extraction and pollution, reducing the potential for self-restoration of the ecological niche.

Improving the environmental environment near the territory of oil production is a systemic problem solved by the state and large businesses of Russia. Our analysis makes it possible to note the following areas of the systematic approach to environmental support of the oil industry:

1) creation of unified environmental programs of enterprises, businesses, and the state;
2) ensuring free cooperation of stakeholders and creating a relevant comfortable environment for this;
3) taking into account the peculiarities of oil exports in modern conditions, taking into account the forecasting of trade prospects and trade liberalization;
4) providing logistics flows and transit opportunities, expanding the market niche;
5) ensuring environmental safety both during oil production, processing, and transportation, and corporate safety;
6) organized monitoring of the environment and correct ecological and mathematical, situational modeling.

In the Russian Federation, models of risk situations in the oil industry are being actively studied, because Russian environmental standards are very strict. These regulations exclude the risks of contaminants entering the environment adjacent to the enterprise. Failure to comply leads to business costs and environmental damage.

The adoption of environmental decisions takes place under the integral impact of economic, environmental, social and educational processes. When modeling environmental processes, it is important to consider uncertainties, ambiguities, risks and vulnerabilities.
The results obtained in the work will allow solving practical problems, for example:
1) forecast the decline and increase in oil production at fields, in particular, with high production;
2) increasing competitiveness in the global oil market;
3) reform of mechanisms and optimization of oil industry taxation, etc.
4) forecast of changes in environmental and socio-economic indicators of the industry;
5) improving the domestic market for service services, especially digital energy and logistics services, etc.

The analysis, criteria, and models discussed herein may be useful in investigating the self-organization of environmental systems and the evolution strategy of the petroleum industry.
Oil prices are unstable, as are exchange rates, geopolitical processes. The depletion of old deposits and the high cost of new ones contribute to instability. The Russian oil industry significantly affects the balance of payments, budget revenues, ruble's support and foreign exchange receipts.
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4. Conclusions
As a result of our research, we can conclude that environmental risks can avoided. The applied analysis can be the basis for forecasting production, and economic and environmental processes in the oil sector. The future lies with smart oil production and processing.
Further development can be carried out both with the help of an information and entropy approach to risk assessment and with the help of fuzzy and neural network procedures. For example, if the entropy in the system is large, then pollution is observed. With the growth of entropy, the system can cross the self-regulation threshold (cleaning from pollution).
The work investigated the levels and tasks of the management of the oil company, which will help organize practical management. The proposed procedures, and models are technological and flexible, do not involve complex monitoring.

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References
1. Andreeva E.E., Ivanenko A.V., Siliverstov V.A., Sudakova E.V. Application of methodology for the assessment of risk for public health from harmful environmental factors in the practice activity of the Office of Service for Supervision of Consumer Rights Protection and Human Welfare in the City of Moscow // Gigiena i sanitariya, 2016, vol.95, no.2, pp.219–222. DOI:10.18821/0016-9900-2016-95-2-219-222.
2. Alaberdeev, R.R., Gaponenko, V.F. (2020) Strategic Directions for Ensuring the Economic Security of the Russian Oil and Gas Complex. -M.: First economic publishing house –380 p. DOI:10.18334/9785912923180
3. Arkhipova, Z.V. (2018) The Concept of Information System for Monitoring Digital Economy Development Level // Baikal Research Journal, vol.9, no.3. DOI:10.17150/2411-6262.2018.9(3).8.
4. Big Data in Computational Social Sciences & Humanities (2018) // Big Data in Computational Social Science and Humanities, pp.1-25. DOI:10.1007/978-3-319-95465-3_1
5. Deryabin A.N., Ungureanu T.N., Buzinov R.V. Public health risk associated with exposure of soil chemicals // Health risk analysis. 2019, No.3. p.18-25. DOI:10.21668/health.risk/201
6. Germanova SE, Plyushchikov VG, Sambros N.B., et al. The problem of pollution of agricultural land with petroleum products and its modeling//International Agricultural Journal. 2022. T.65. №1(385). p.12-15. DOI:10.55186/25876740_2022_65_1_12
7. Gorodnova, N.V., Samara, N.A., Skipin, D.L. (2019) Improving the efficiency of training management personnel of large Russian companies // Leadership and management, vol.6, no.3, pp.303-322. DOI:10.18334/lim.6.3.40895.
8. Kaziev, V.M., Kazieva, B.V., Gedgafofa, I.J. (2018) Modelling of investment attractiveness and Economic stability of region // SCTCMG 2018 International Scientific Conference «Social and Cultural Transformations in the Context of Modern Globalism», DOI:10.15405/epsbs.2019.03.02.288
9. Kurakin, V.I., Abramchikova N.V. (2021) Analysis of the peculiarities of the formation of the structure of the oil and gas industry in Russia // Economic sciences, no.195, pp.101-108. DOI:10.14451/1.195.101
10. Liang Y., Xiao H., Liu X., Shi H. (2020) The risk and phytotoxicity of metal(loid)s in the sediment, floodplain soil, and hygrophilous grasses along Le'an River, International Journal of Environmental Science and Technology, 17, p.1963–1974. DOI:10.1007/s13762-019-02592-0.
11. Nazarova, Yu.A., Lyshko, A.A. Goryunov, I.O. (2022) The current state prospects of the development of the oil and gas industry in the context of ensuring economic security // RGGU Bulletin (Ser. "Economics. Management. Law"), no.3, pp.75-87, DOI: 10.28995/2073-6304-2022-3-75-87.
12. Novak, A. (2021) The future of Russian oil in the era of energy transition // Energy policy, no.12(166), pp.4-13. DOI 10.46920/2409-5516_2021_12166_4

13. Zaitseva, N.V., Onishchenko, G.G., May, I.V., Shur, P.Z. Developing the methodology for health risk assessment within public management of sanitary-epidemiological welfare of the population. Health Risk Analysis, 2022, no. 3, pp. 4–20. DOI: 10.21668/health.risk/2022.3.01.eng
14. Zhukov, I.F., Korovin, E.V. (2020) The current state of the Russian oil and gas complex // Economic vector, no.1(20), pp.51–57. DOI:10.36807/2411-7269-2020-1-20-51-57
15. Kovaleva I., Kudinova M., Levichev V., et al. (2021) Development of rural territories of the agro-oriented region in the conditions of self-sufficient food supply // IOP Conference Series: Earth and Environmental Science, Krasnoyarsk / Krasnoyarsk Science and Technology City Hall of the Russian Union of Scientific and Engineering. Vol.839. – Krasnoyarsk: IOP Publishing Ltd, p. 22019. DOI 10.1088/1755- 1315/839/2/022019.
16. Solomonov, A.P. (2015) Features of state regulation of modernization of oil refineries capacities and foreign trade of petroleum products in Russia // SCIENCE, Vol.7. DOI:10.15862/48EVN615
17. Sotnikova, Yu.M., Fedyaev, V.V., Grigoriadi, A.S., et al. (2021) Assessment of the agricultural plants' phytoremediation potential under oil pollution of the soil. // University proceedings. Volga region. Natural sciences. No.3. p.99–109. DOI:10.21685/2307- 9150-2021-3-9
18. Shafiquzzaman M., Alharbi S., Haider H. et al. (2020) Development and evaluation of treatment options for recycling ablution greywater, International Journal of Environmental Science and Technology, 17, 1225–1238. DOI:10.1007/s13762-019-02537-7.
19. Shchelkunova, S.A., Metlin, S.V., Bykova M.S. (2021) New approaches to personnel training // Moscow Economic Journal, no.1, pp.472-480. DOI:10.24412/2413-046Kh-2021-10043
20. Tafeeva, E.A., Ivanov, A.V., Titova, A.A., Petrov, I.V. (2016) The content of heavy metals and oil products in the soil on the territory of the oil-producing regions of the Republic of Tatarstan // Hygiene and sanitation. No.10. p.939–941. DOI:10.18821/0016-9900-2016-95-10-939-941