Environmental engineering as a tool to reduce the risks of industrial production in the region

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Abstract. This article proves that one of the main conditions of overcoming technological inferiority and improving the competitiveness of the territory is a balanced socio-economic development of the region which should be planned with consideration of reducing the negative impact of industry on the environment on the basis of industrial areas rational placement, the use of resource-saving technologies and alternative energy sources. This article presents a SWOT analysis of the investment project of the industrial enterprise for the production of floor coverings from polyvinylchloride (PVC) being implemented in the Orel region. The authors of the study identified the environmental risks of launching this production. It has been discovered that it will have a negative impact on the environment. One of the effective tools to reduce environmental risks and to ensure environmental safety in the industrial enterprise is environmental engineering. Some specific measures for the industrial enterprise environmental audit for the production of floor coverings from polyvinylchloride (PVC) in the Orel region have been proposed.

1. Introduction
The intensive growth of economic activity, the continuous processes of globalization, the focus of the economy on the innovative path of development on the one hand put into prospective new opportunities for the regions, and on the other hand - new problems of achieving long-term dynamic development and a high level of quality of life of the population. Under these circumstances, one of the most important strategic tasks is to ensure the sustainable development of its regions.

Problems of sustainable development of territories are the area of interest for many modern scientists [1; 2; 3; 4]. The sustainability of the socio-economic system (territory) means not only its safety and reliability, but also the ability to develop [5]. Solving the problems of sustainable and stable economic growth and development of territories, improving the welfare of the population are very important for Russia. However, achieving social and economic sustainability should not be detrimental to the environment and should include the rational use of natural resources.

The process of human interaction with nature is the content of any production. Economics is essentially the art of rational and effective management of this process, otherwise, as the world and domestic experience of environmental management reveals, economic and environmental crises are
inevitable. The processes in the system "economy-ecology" are inseparable, closely interconnected and stipulate each other.

The current environmental situation shows that the human impact on the environment has reached such a level that its further growth under the previous conditions can lead to irreversible changes which threaten the normal functioning of society.

The desire to achieve the growth of gross domestic product at any cost which is not based on new technologies and care for the environment often causes a serious crisis when the nature is no longer able to meet the growing unlimited needs of mankind.

Ensuring sustainable regional development requires more than just investments in the environment or some new technologies. The policy of sustainable development of the region should be aimed at reducing the negative impact of industry on the environment, the rational siting of industrial areas, the development and implementation of resource-saving technologies, the development of alternative energy sources, the formation of a balanced interregional infrastructure, balanced socio-economic development, increasing investment activity and competitiveness of the territory [5; 6].

2. Research methods

Environmental engineering (ecoengineering) is a set of targeted actions implemented in certain organizational and legal forms, resulting in the creation of new production facilities designed to minimize the damage in the field of environmental protection and the use of natural resources, characterized by the mandatory participation of the state and the presence of special entities: the organization-polluter of the environment (customer) and specialized engineering organizations performing the project, production and supply of technical systems for its protection (contractor).

In fact, environmental engineering makes it possible to realize the idea of sustainable development of any industrial enterprise that can simultaneously reduce the negative impact on the environment and improve the efficiency of technological processes.

Environmental engineering is a priority for the development of the country in the context of environmental activities in the Russian Federation.

There are many documents regulating the economic, organizational and regulatory relations of environmental engineering in the Russian Federation. The main document is the Constitution of the Russian Federation (Art. 42), where it is determined that “everyone has the right to a favorable environment, reliable information about its condition and compensation for damage caused to its health or property by an environmental violation. Everyone is obliged to preserve nature and the environment, to take care of the natural resources that are the basis of sustainable development, life and activities of the peoples living in Russia.”

At the same time, ensuring sustainable development, full employment, a high level and quality of life of the population is impossible without the development of industry, the agricultural sector and other industries, based on the rational and efficient use of natural, demographic, economic, historical and cultural potential. Thus, in the Concept of the long-term socio-economic development of the Russian Federation for the period up to 2020 [7], it is emphasized that the solution of socio-economic development problems should be carried out taking into account the preservation of a favorable environment and natural resource potential in order to meet the needs of current and future generations.

The sustainable development of the Russian Federation, the high quality of life and health of its people, as well as national security can be ensured only if the natural systems are preserved and the environmental quality is maintained, as it is emphasized in Ecological Doctrine of the Russian Federation [8].

The Decree of the President of the Russian Federation “About the Strategy of the National Security of the Russian Federation for the period up to 2020” defined the priorities for sustainable development:
Ecology of living systems and rational environmental management, the maintenance of which is achieved through balanced consumption;

Development of advanced technologies;

Rational reproduction of the country's natural resource potential [9].

Thus, the state acts as an active participant in the process of regulating environmental activities and environmental safety, creating the necessary legal framework, introducing economic sanctions and incentives, carrying out control functions. Therefore, in matters of engineering activity in ecology, organizational, legal, managerial, economic, and scientific and technical aspects are organically intertwined.

One of the directions of ecoengineering is a pre-investment environmental assessment of project proposals, which is very important for new investment projects. Ecoengineering can be used as a tool to reduce the environmental risks of industrial production.

3. Results of the research

The economy of the Oryol region is represented by all types of economic activity, the leading ones of which are agriculture, manufacturing, construction, transport and communications and trade. The region has a sufficient industrial and economic potential of agrarian and industrial orientation for solving intraregional problems, as well as for normal interaction at the interregional level in accordance with the established division of labor.

Industrial production accounts for the largest share in the gross regional product (GRP) at the beginning of 2019 - 19.9%. Agricultural production in farms of all categories is 16.7%. The share of trade and public catering accounts for 15.7%, transport and communications - 11.4%, construction - 7.4% of the total GRP.

Thus, the industry is a basic component of the economy of the Oryol region. There are more than a thousand industrial enterprises in the industrial complex of the region, of which about 200 are large and medium-sized organizations. 50.4 thousand people are employed in industry, which is about 25% of the total number of people employed in the economy. The main part of industrial production in the region is concentrated in three industrial centers of the region - Orel, Mtsensk and Livny.

In the Oryol region, investment project for the construction of a PVC flooring plant «the International Vynil Company-East LLC» has been developed and is being prepared for implementation. As it follows from the project of the sanitary protection zone (SPZ) and the official expert opinion on it, the construction of large-scale production associated with the processing and storage of large volumes of bulk and liquid polymeric raw materials, as well as other chemical materials — more than 43 thousand tons per year (only PVC and plasticizer) — with several stages of thermal processing, as well as bulk transportation is expected within the city of Orel.

The authors have developed a SWOT analysis of this investment project, which is presented in table 1.

**Table 1.** SWOT-analysis of the investment project *International Vynil Company-East LLC.*

| S   | Strengths                                      | W          | Weaknesses                                      |
|-----|-----------------------------------------------|------------|------------------------------------------------|
|     | - favorable economic and geographical position; | - production specifics |                                           |
|     | - low competition;                            | - discontent of local residents |                                           |
|     | - developed infrastructure                     |            |                                              |
| O   | Opportunities                                  | T          | Threats                                        |
|     | - support from the authorities;                | - high environmental risks;  |                                           |
|     | - creation of new jobs;                       | - significant capital investments in |                                           |
|     | - unsatisfied demand from consumers,          | technological re-equipment of |                                           |
|     | - potential for the development of small and medium businesses | - financial risks |                                           |
SWOT analysis shows that the production of PVC flooring is a serious factor that adversely affects the environment and has a whole range of possible environmental risks that cause dissatisfaction of local residents.

The main threat is the risk of serious pollution. In terms of gross emissions of harmful substances into the atmosphere, wastewater discharges into natural surface water bodies and the volume of waste generated, the chemical complex occupies one of the leading places in the global industry [10]. Waste disposal is hampered by the lack of profitable recycling technologies. Also for the enterprises of the chemical complex, there is a high probability of technogenic accidents and significant environmental damage.

The main raw materials for the production of polymer films are polyolefins and polyvinyl chloride. Polyvinyl chloride (PVC) is a thermoplastic polymer obtained by polymerization of vinyl chloride (VC) \((\text{CH}_2 = \text{CHCl})\) obtained by various methods from acetylene and hydrogen chloride. Due to its high chlorine content, it does not ignite and does not burn. At 130-170 °C is the decomposition of polyvinyl chloride, accompanied by the release of hydrogen chloride.

The main raw material for the production of PVC is chlorine (57%), which is present in unlimited quantities all over the world in the form of salt, and only 43% is obtained from refined products. In the production of PVC, its processing into products, the operation of products and the combustion of hydrocarbons, toxic compounds hazardous to human health are released.

The elimination of the consequences of the negative impact on the environment will require additional costs, leading to a reduction in funds for the development of enterprises in the chemical complex of the region, as well as reducing the investment attractiveness of the industry.

People whose activities are associated with increased danger to others are obliged to compensate for the damage caused by the source of increased danger, if they do not prove that the damage was caused by force majeure or the intent of the victim. In this case, the obligation to compensate for harm is imposed on a legal entity that owns a source of increased danger on the right of ownership, the right of economic management or the right of operational management, or on any other legal basis.

Production of PVC flooring belongs to the 3rd class of hazard production. This is the average degree of the impact of hazardous waste on the environment when the ecological system is disturbed, and its recovery period is at least 10 years after the reduction of the harmful effects from an existing source [11]. According to the legislation, the enterprise must have its own sanitary protection zone (SPZ) [12]. Since the construction of the enterprise is carried out within the city, it is necessary to change the type of industrial zone: transfer land from the fourth danger zone to the third. This circumstance entails additional costs, increasing the value of the investment project. Moreover, such changes require mandatory coordination with the deputies of the city, as well as holding public hearings. The public, as a rule, negatively relates to the construction of non-environmentally friendly production within the city, which can lead to a long and protracted confrontation with the residents of the territory, which entails a shift in the timing of the investment project, additional legal costs and, as a result, direct and indirect costs ("loss of profit") the costs of the not yet created enterprise.

All of the above suggests that a correct assessment of the future activities of a future enterprise regarding environmental safety is impossible without a comprehensive environmental audit, which is one of the areas of environmental engineering.

Environmental audit, in our opinion, should include the following aspects:

- Verification of the activities of the enterprise regarding compliance with standards and requirements in the field of environmental protection;
- Assessment of the general characteristics of hazardous production facilities (areas of activity, location, climatic characteristics, characteristics of hazardous substances, etc.) [13];
- Economic assessment of environmental risks and analysis of environmental safety (possible scenarios for the development of accidents, the amount of hazardous substances released into
the environment, the size of the likely areas of impact of damaging factors, possible environmental damage);
• Drawing up recommendations on environmental protection activities;
• Independent assessment of environmental costs;
• Exercising control over resources (financial, technical, personnel) allocated for the protection of the environment;
• Creating environmental performance transparency for management
• Argumentation for making informed decisions in the field of environmental activities;
• Reduction of administrative expenses, prevention of fines from government bodies;
• Optimization of environmental payments;
• Rapid adjustment to changes, including legislation on environmental protection and related areas.

Environmental audit in the creation of new industries, first of all, should focus on assessing the likelihood (probability) of an oncoming of the environmental risks on industrial enterprises which occur due to omissions in environment and environmental issue that they might overlook, taking industry-specific specifications into account.

The most frequently occurring environmental risks at manufacturing enterprises are industrial accidents, violations of the procedure for assessing the impact on the environment and a lack of public participation [14].

Ecological problems cannot be fully resolved, since considerable funds are needed for this. In the future, the improvement of the environment will be promoted by the transition to environmentally friendly technologies in the creation of new industries or further investment into environmental protection in general.

4. Conclusions and prospects of development of this direction of researches
Modern society is becoming increasingly aware of the fact that its further development is impossible without the establishment of strict control over potentially hazardous industries and industries in general. Issues of environmental safety have come to the fore. Virtually no investment project in the field of industrial production has a chance to be implemented without a strict environmental impact assessment, including an assessment of environmental risks, and taking into account public opinion.

One of the effective tools for reducing environmental risks and ensuring environmental safety at an industrial enterprise is environmental engineering, the purpose of which is a feasibility study of a set of measures for the ecological modernization of production with preliminary technological studies on pilot equipment (for example, cleaning), if necessary. The goal of ecoengineering can be pre-investment environmental assessment of project proposals. In the course of such an assessment, the analysis of the impact of the objects that are being designed on the environment is carried out, or environmental justification of investment projects and environmental risk assessment are provided as part of the design of organizational financing schemes.

An investment project for the construction of a PVC flooring plant is being implemented in the Oryol Region, which caused a considerable public outcry due to the residents’ concern about the environmental safety of the project. Based on the assessment of the general characteristics of the production and the SWOT analysis of the investment project, the authors identified its possible environmental risks and justified the need for individual areas of environmental engineering, namely, a comprehensive environmental audit. Properly conducted environmental audit will allow to calculate the likelihood of negative environmental impacts of the enterprise and to prepare proposals for the development of measures aimed at reducing environmental risks and improving the environmental safety of production.

In terms of specific measures for the environmental audit of a PVC flooring plant, it is necessary:
1. Competent authorities are to get acquainted in full with the project of the sanitary protection zone and the official expert opinion on the project of the PVC flooring plant, in order to fully represent the degree of responsibility when considering the issue of changing the status of the industrial zone.

2. Since the project is not provided with a full-fledged environmental impact assessment and thorough sanitary-epidemiological research, it is necessary to involve external experts, in particular, from the Russian Academy of Sciences and leading universities of the country. It is well known that in the production of PVC coatings, harmful chlorine compounds are formed, which act on the central nervous system and cause the risk of cancers, and in recent years, the number of cancer patients has increased by one third in the Oryol region. The position and geographical location of the plant is aggravated by the proximity of underground freshwater sources, from which drinking water is taken for most of the region. In addition, a detailed analysis of the environmental situation around the already functioning PVC flooring plant in Kameshkovo, Vladimir region is extremely important.

3. Considering the technological complexity, scope and risks of the project, it is also necessary to involve in the discussion the representatives responsible for civil defense and emergency situations (on the issue of the safety of the location of the enterprise in the city and the availability in the region of preparedness to neutralize man-made accidents in large polymer production) authorized bodies responsible for the environmental situation in the region (including on the lack of information about the background level of pollution in the Oryol region).

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