



CONVERGENCE OF CRITICAL TECHNOLOGIES AND ENVIRONMENTAL MANAGEMENT IN REGIONS BASED ON SUSTAINABLE AND INCLUSIVE DEVELOPMENT

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Introduction

Regions, as systems, are represented by economic, social and environmental subsystems. In the context of sustainable development, the environmental subsystem is necessary to ensure the functioning and improvement of economic and social subsystems. Environmental subsystem is based on the convergence of critical technologies and environmental management in regions.

Critical technologies (key technologies, innovative technologies) are high technologies that have fundamental importance for maintaining national security or economic growth. They also need conservation and development. In general, there are three priority areas of critical technologies:

- a) technologies of life support for the population (medicine, food and consumer goods, energy, ecology);
- b) advanced dual-use technologies (transport, materials, mechanical engineering technologies, computer sciences and communications);
- c) special-purpose technologies (in particular, the defense industry) [1-3].

In view of this, the environmental subsystem (of a specific region) can be considered as a springboard for the introduction of critical technologies. Thus, it "ensures the sustainable development of other - economic and social - systems" [4, p. 86-88]. At the same time, the uneven regional development and the heterogeneity of its environmental problems actualize the issue of regional aspects of inclusivity. This applies in particular to ensuring the convergence of critical technologies and environmental management in regions. This is indicated by the following thesis: "the concept of inclusive development assumes that each economic entity is important, unique, valuable to society and has the capacity to meet its needs. In a generalized sense, inclusive development is the need to strengthen the involvement of all segments of the population, as well as territories, in any matters that contribute to the actual development» [5].



5.1. Critical technologies in the context of relationship between the concepts of "sustainable development" and "inclusive development"

According to the United Nations Development Program, it is stated that "inclusive development is the type of development that complements human development and includes a wide range of changes – from environmental resilience development (that is, climate change, pollution, lack of energy resources) and natural disasters to the development of rural communities, citizens' incomes, health care costs, education and recreation" [6].

This interpretation of the concept of "inclusive development" allows us to ascertain:

- the importance and need to ensure human development in all its areas (employment, access to public services, including environmental, etc.);

- the need to respect human rights (for example, political (right to participate in governance), economic (right for microfinancing), social (right for the healthcare), environmental (right to have a safe environment)), in the context of which the idea of inclusiveness has been developed;

- the close relationship between the concepts of "sustainable development" and "inclusive development" at all levels of the respective developments. It is proven by, for example, this thesis: "Sustainable development of territories is a harmonious, social, economic and environmental development of urban and rural settlements, aimed at creating living conditions for current and subsequent generations on the basis of balanced use of resources" [7, p. 4].

Sustainable development as well as the concept of inclusive growth involve three-vector progress (development): economic, social and environmental. An additional proof of the relationship between the concepts of "sustainable development" and "inclusive development" is such a thesis: "comprehensive implementation of sustainable development ideas turned out to be extremely difficult, sometimes even impossible. It led to the gradual spread of compromise approaches, one of which stood out in the concept of inclusive development. The poorest and most vulnerable segments of the population were in the focus of its' main attention" [8].

The increase of both sustainable and inclusive development requires profound substantive and functional changes in environmental management. Appropriate changes can be implemented through the introduction of critical technologies to strengthen environmentalisation, the use of new methods of management, the



accumulation of efforts and the state, the public, and entrepreneurial structures in the course of constructive interaction. The leading role in the process of environmental management is assigned to the state. The state, through the implementation of environmental policy (taking into account the provisions of the concept of sustainable development, the concept of inclusive development, etc.), including policy towards the regions, determines the conditions for the implementation of natural resource and environmental activities and forms institutional support for this matter.

The state should also be the main subject of the implementation of critical technologies in the environmental protection field. Within the framework of three groups of indicators that form the index of inclusive development, a separate group, which is referred to as "Intergenerational Equity & Sustainability" is also commonly distinguished. Environmental pollution is the key indicator in this group.

5.2. Regional environmentalisation as a factor for critical technologies development

In the scientific work [9] it is stated that "environmentalisation is defined as the process of penetration of ideas, knowledge, laws of ecology, environmental thinking in other areas of science, production, as well as in the livelihoods of society and the state. In other words, it refers to the penetration of environmental aspects into all spheres of human activity and management. Environmentalisation aims to form a new system of thinking and perception of objective reality in the field of nature management and economic security".

The above interpretation of the concept of "environmentalisation" shows that it should function as an end-to-end process of strengthening the ecological content of the activities of institutions (state, society, entrepreneurship, etc.), each of which has its own functional load. For example, the state should increase the effectiveness of managerial influence and environmental regulation through state bodies and local governments; the public should take part in solving environmental issues (through environmental impact assessment, waste sorting, etc.); entrepreneurs should reduce the energy and material intensity of production.

Today it is undeniable that there is a high chance and risk of an environmental crisis. It is due to a number of reasons (irrational deployment of productive forces on the territory of our state; exhaustion of natural resources and deterioration of their



quality; increasing amount of generated waste, especially as a result of war and damage to infrastructure and production facilities; ineffective environmental management at different levels; low level of ecological culture of a significant number of the population and managers of enterprises, etc.). With that being said, we can assume that the environmental sphere as a system, which is designed to create and maintain conditions for the life support of the population of Ukraine and its regions and territorial communities, is currently incapable of this. Under such critical conditions, there is a dilemma of using technologies that, initially working with the "environmental crisis" will allow, as a result, to obtain "an appropriate, environmentally friendly" resource.

Solving environmental problems at the regional level requires the convergence of critical technologies and the greening of management as tools for establishing regional aspects of inclusiveness. The state, entrepreneurs, the public and market infrastructure institutions should be the main subjects of such management.

Therefore, in the context of the issue of identifying the environmental problems of the region as an imperative for the convergence of critical technologies and the environmentalisation of management in the regions, we will consider specifically the Ternopil region (Ukraine). Through thorough analysis, we can identify environmental problems and conduct research on the state of its environment as a result of air pollution and waste disposal in the environment. There are no indicators for us to assess the state of environmental pollution in the studied region for 2022-2023. This is due to the Law of Ukraine "On Protection of the Interests of Reporting Entities and Other Documents during the Period of Martial Law or the State of War". According to this law, "statistical and financial statements may be submitted by respondents to the state statistics bodies within three months after the termination or abolition of martial law or the state of war for the entire non-reporting period" [10].

The dynamics of emissions into the atmosphere of the Ternopil region during 2016-2021 is given in Table 1.

Gross regional product (GRP) is an important indicator of the development of the regional economy, which shows the result of the activities of resident economic units in the field of material production and in the service sector. Any production activity is accompanied by environmental pollution. Therefore, the volume of emissions

Table 1 – Dynamics of emissions into the atmosphere of the Ternopil region during 2016-2021, thousand tons



Years	Emissions into the air of the region, thousand tons			Emission density per 1 square km, kg	Emissions per 1 person, kg	Emissions per unit of GRP, thousand tons/1 billion UAH
	Total amounts of emissions	Emissions by stationary sources	Emissions by movable sources			
2016	45,2	9,0	36,2	3270	42,5	1,5
2017	45,3	10,6	34,7	3277	42,9	1,1
2018	42,9	10,2	32,7	3104	40,9	0,9
2019	42,0	9,4	32,6	3037	40,2	0,7
2020	41,6	9,5	32,1*	3005	40,2*	**
2021	**	**	**	**	**	**

* preliminary data on emissions from mobile sources

** according to the Main Department of Statistics in the Ternopil region, the actual data is not available, in accordance to the Law of Ukraine "On Protection of the Interests of Reporting Entities and Other Documents during the Period of Martial Law or the State of War". According to this law, statistical and financial statements may be submitted by respondents to the state statistics bodies within three months after the termination or abolition of martial law or the state of war for the entire non-reporting period.

Source: [10-11]

(thousand tons), which falls on the unit of GRP, shows what anthropogenic pressure in the form of emissions into the atmosphere is carried out when receiving 1 billion UAH of GRP.

Ideally, with the effectiveness of the environmental policy tools (permits, norms, etc.) and the introduction by economic entities of environmental protection activities (non-exceeding of established limits, updating of equipment and equipment, etc.), the indicator of emissions per unit of GRP should be reduced.

The dynamics of pollutant emissions per unit of GRP of the Ternopil region during 2016-2020 is illustrated in Table 2.

From the Table 2 we can see, that the indicator of the volume of emissions of the Ternopil region during 2016-2020, in general, had a downward trend, while the same indicator per unit of GRP remained at the same level. At the same time, the volume of produced GRP increased over the same period.

Table 2 – The dynamics of pollutant emissions per unit of GRP of the Ternopil region during 2016-2020



Years	GRP volume, million UAH	Emissions from stationary and movable sources (total amount), thousand tons	Emissions per unit of GRP, thousand tons/1 billion UAH
2016	31072	45,2	1,5
2017	40715	45,3	1,1
2018	49127	42,9	0,9
2019	57140	42,0	0,7
2020	62661	41,6	0,7

Source: [10-11]

The decrease in emissions by stationary sources during 2016-2020 was largely caused by smaller amounts of emissions by agricultural enterprises (a decrease in the volume of cultivation of farm animals (pigs)), the processing industry (a decrease in the volume of processing of sugar raw materials), the gas industry (a decrease in the volume of gas transportation). The volume of emissions generated into the atmosphere by mobile sources also decreased. In general, this transformed into a decrease in the total volume of emissions of pollutants into the air of the region by 0.4 thousand tons (from 42 thousand tons in 2019 to 41.6 thousand tons in 2020).

Speaking about the GRP produced during 2016-2020, although its volume grew, in 2020 there was a decline in the GRP formed by 3.2% compared to 2019.

Conclusions

In view of this, the relevance of the issue of environmental management in regions is undeniable. Such environmentalisation is revealed through:

- professionalization of the personnel of state bodies and local authorities in order to effectively fulfill their environmental functional load;
- establishment of a multi-level system for monitoring the effectiveness of environmental management, as well as the results of the introduction of environmental projects and the financial resources used for them;
- reduction of anthropogenic pressure on the environment together with the risk of emergencies;
- increase of the level of environmental culture of all subjects of environmental management;
- creation of a comprehensive infrastructure for protecting and improving the



environment (legal, information and communication, material and technical, financial, etc.), its systems (atmosphere, water and land resources, etc.);

- development of environmental management, which will indicate conscious and internally motivated activities of business entities. The results of such activities are increasing the competitiveness of enterprises in the domestic and foreign markets, the possibility of developing new markets, improving the image, attracting investors, establishing in the minds of consumers as a socially responsible environmentally oriented enterprise.

In this context, the expansion of the use of critical technologies as environmental tools (stimulation: production of batteries for electric vehicles; automobile and bicycle electric revolution; regional environmental partnership; creation of ecological provinces, etc.) [12-13] is the matter of particular importance for the case ensuring the environmentalisation of regional management. According to the analysts from Deloitte, "the increase in the use of urban bicycles can cause significant social changes, such as reducing of traffic, nature pollution and the load of the public transport system, as well as the health conditions improvement" [14].

Therefore, the convergence of critical technologies and the environmentalisation of governance should become a springboard that will contribute the consistency in the introduction of vital environmental functions, which can ensure both environmental and national sustainability. Such changes will mark a new stage in the development of security approaches, during which the activities of state bodies, the population, the private sector of the economy and other subjects will be synchronized in order to ensure the environmental security of the state, regions, and territorial communities.