

# An algorithm of adaptive stimulation of ecological and socio-economic development of a cross-border region

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**Abstract.** Ecological, social, and economic development of a cross-border region is determined by regulated and unregulated factors, some of which are formed outside the region and even countries. Environmental pollution cannot be limited to territorial boundaries, and this requires taking into account this fact when developing programs and activities aimed at the regional ecological and socio-economic development.

## 1. Introduction

The Orenburg region is one of the subjects of the Russian Federation. It is located on the border with the Republic of Kazakhstan, having the longest part of the Russian-Kazakhstan border. The Orenburg region belongs to the mining regions, with a rather complex environmental situation and a high level of mortality and morbidity from environmentally related diseases. There are problems associated with the development of natural resource potential, despite the existing advantages of cross-border cooperation with Kazakhstan [1]. Ecological and socio-economic development of the Russian region and territories of Kazakhstan adjacent to the Orenburg region is influenced by a variety of internal and external, exogenous (controllable) and endogenous (uncontrollable, formed within the region as a system) factors. For this reason, environmental and socio-economic development should be stimulated, taking into account not only internal factors and changes, but also looking into the situation in neighboring regions and countries. To make effective management decisions, we need to adapt not only to the existing state of ecological, social, and economic development, but it is necessary to also take into account its prospects [12; 13]. In this connection, the development of an algorithm to adaptively select a number of tools to stimulate the ecological and socio-economic development of a cross-border region is relevant.

## 2. Materials and Methods

S. L. Vasenev, Kh. B. Badarchi, D. S. Gordeeva, D. F. Dabiev, V. V. Borodkina, and others devoted their research to the assessment of the ecological-social and economic development of regions [2-5]. These researchers use on a system of indicators that characterize the ecological and socio-economic state of regions in modern conditions. The pressure-state-response model was taken as the basis in our study. The model is based on the thesis that human activity exerts “pressure” on the environment, forcing the government to react, and changing social agents’ behavioral patterns [6]. We have developed a methodology for monitoring and forecasting (in short-term) the regional ecological and socio-economic development. The methodology outcome is a set of strictly limited indicators of environmental and socio-economic forecasting, taking values from 0 to 1 [7]. The results are used in our proposed roadmap [8]. The roadmap structure for environmental and socio-economic development includes the time axis

(short, long, and super long-term perspectives) and the road map layers (global, in-country, and intra-regional challenges). Choosing incentive instruments and their priorities adaptively changes, depending on the levels achieved and the scenarios implemented. The transition from one scenario to another occurs due to correctly selecting and implementing incentive tools.

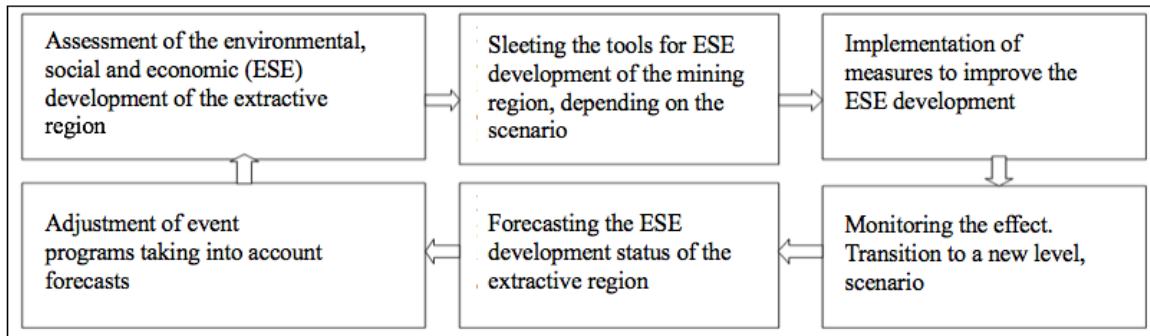
### 3. Results

Let's consider a number of scenarios describing the ecological and socio-economic development of the Orenburg region:

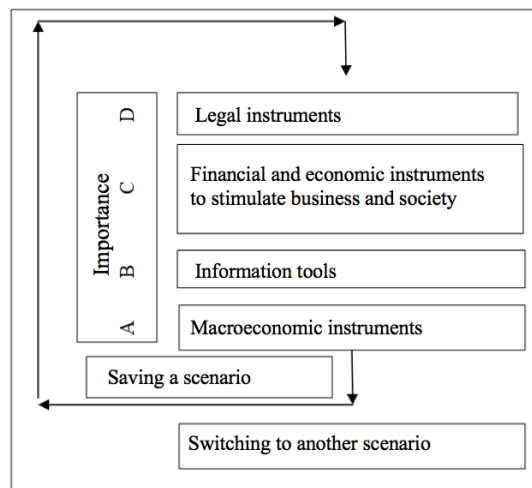
1. "A mining resource-dependent depressed region." Such a scenario is negative. In the long term (15 years or more), the dominant type of economic activity ("mining and quarrying," having a high proportion in GRP) is preserved and strengthened. At the same time, the contribution of this type of activity to the "Pressure" indicator block remains unchanged or increases. Indicators of the block "State" and "Reaction" are in a negative trend. Interaction with Kazakhstan within the framework of changes in "Pressure" and "Reaction" indicators is minimal or absent.
2. "A multi-industry moderately developed region (economic diversification)." In the long run, the role of other types of economic activity increases, without any predominance. Mineral mining continues, but with a tendency to reduce and completely eliminate this type of activity. Improving indicators for all "Pressure-state-response" blocks are observed. A really working mechanism for reducing pressure on the environment is being established with Kazakhstan.
3. "An agrarian region with a green economy (moderate growth)." In this region, the role of agriculture with an increasing share of the population engaged in this type of economic activity increases. Innovative methods are being introduced; they are effective for those areas with risky agriculture. Transition to such a scenario in WTO conditions is possible, as the region belongs to the zone of risky farming (thus, it is subjected to drought). Accordingly, requirements for reducing and canceling state support do not apply to the region. At the same time, transition to the agrarian specialization of a competitive level is possible only with significant government support [9]. Mining continues, but it has a tendency to reduce and completely eliminate this type of activity. Food security is ensured. Positive changes are observed in all "Pressure-state-reaction" blocks. A really working mechanism for reducing pressure on the environment is being established with Kazakhstan.
4. "Innovative development (optimistic variant)." The region is reorienting to new high-yielding economic activities that are not typical for the region's economy at present, developing existing economic activities and ensuring food and economic security. The impact of both internal and external pressure factors on the environment can be leveled out or reduced to a minimum in the region, by achieving the same results in neighboring regions and in Kazakhstan.

A management scheme of the region's ecological and socio-economic development is demonstrated in Figure 1. It begins with assessing the region's state. As shown in Figure 1, the presented scheme suggests an iterative solution to the issue of managing the region's ecological and socio-economic development. Also, it is based on the scenarios and methods for monitoring and forecasting the ecological and socio-economic development within the framework of our roadmap.

Without describing the tools used in detail (which can be found in the works of Yashalova [10] and IDegtyareva [11]), we move on to our proposed adaptive algorithm for stimulating the region's ecological, social, and economic development (Figure 1). Ranking tools in order of importance is required in advance, and this is done on an expert basis. At the same time, in the conditions of a cross-border region, experts from the Orenburg region and Kazakhstan should be involved. Each degree of importance of these tools is conditionally denoted by the following letters: A, B, C, D, etc. The degree of different instruments' importance may coincide, and their list may vary depending on the scenario being implemented. When switching to another scenario, the corresponding importance degree is reviewed. The effect is estimated on the basis of monitoring and forecasting the region's ecological and socio-economic development.



**Figure 1.** A management scheme of the region's ecological and socio-economic development. Source: Developed by authors.



**Figure 2.** An algorithm for choosing a tool to stimulate the region's ecological and socio-economic development. Source: Developed by authors.

Adaptation of the algorithm implies recalculating the importance of tools, as well as their composition depending on the implementation of a particular scenario.

#### 4. Discussion

The adaptive nature of the choosing instruments for stimulating the ecological and socio-economic development of a cross-border region is also determined by the fact that shifts in the weight of control levers to the regional level are observed [1]. Close cooperation in the field of environmental protection between Kazakhstan and the Orenburg region is initiated at the regional level. The solution of such major tasks as the transition to a "green" economy is possible only in the long term with an integrated approach that takes into account many factors of a controlled and uncontrolled nature.

The proposed approach requires clarification of incentive tools. The selected incentive tools will be projected through programs and activities to improve environmental and socio-economic development. In the future, the development of projects of specific programs is planned with defining the program life cycle, costs of implementing program's activities, as well as effectiveness of its implementation.

#### 5. Conclusion

Thus, the cross-border region's ecological and socio-economic development depends not only on internal factors, but it is also determined by the external "pressure." To improve the whole situation, the Orenburg region should adopt measures aimed at addressing the causes of environmental pollution. In

our opinion, it is also necessary to work closer with Kazakhstan on such issues, including reaching bilateral treaties and establishing common monitoring mechanisms.

Within this research, we present a roadmap for ecological and socio-economic development, which is based on a system of indicators within the framework of the “Pressure-state-reaction” model. More than that, an adaptive incentive algorithm is described in the paper, which would allow the region to move to a new level of development that meets the concept of sustainable development.

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