

# *Cluster Approach in Environmental Management: Experience, Problems and Prospects for Further Development*

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**Abstract**—The paper considers various approaches of domestic and foreign researchers to the interpretation of the “cluster” concept. It studies the main stages of formation and development of clusters. Possibilities of cluster approach in environmental management for the development of new hi-tech and ecologically safe directions are discussed based on foreign and Russian clustering experience. Strengths (fertile chernozem soils, diversity of climatic, geomorphological, landscape conditions, etc.) and weaknesses (insufficient activity and initiative of business communities regarding generation of independent projects, unexpressed public involvement, etc.) of environmental management clustering in the conditions of the Russian economy are revealed and its importance is stated. The analysis of structural logic diagrams of interregional clusters recommended for the development in the northeast Caucasus confirms a variety of opportunities to increase innovativeness and competitiveness of local production, services sector and multiplicative effect of formed systems of environmental management by strengthening vertical and horizontal interactions between public authorities, local government, business and research communication centers.

**Keywords**—*interregional clustering; principles and models; systems of environmental management; balanced development*

## I. INTRODUCTION

The priority of cluster policy is highlighted in the Concept of long-term social and economic development of the Russian Federation until 2020, which emphasizes the importance of interregional clusters in electric power industry, agriculture, processing of mineral resources, transportation, etc. This new approach is caused by the need to increase the economic growth and diversify the domestic economy due to various

potential opportunities of improving competitiveness of nature users, ecologization of enterprises, suppliers of equipment, accessories, specialized products and services, research and educational organizations involved in territorial and production clusters [3]. In the light of increasing geopolitical collisions (sanctions and other restrictions), this circumstance highlights the importance of clustering for Russian regions to ensure national environmental and economic stability.

The **purpose** of the study is to give theoretical and methodological justification of clustering of environmental management. The **object** of the study covers regions of the Northeast Caucasus.

## II. METHODS AND MATERIALS

The methodology includes the system of principles (principle of interaction, complementarity, relativity, optimality, preservation and development) and methods of scientific knowledge (visualization, abstraction, analysis and synthesis, modeling, etc.).

## III. SOURCES AND FOREIGN EXPERIENCE OF CLUSTERING

In the theory and practice of world economy the “cluster” concept gained its widespread use. For the first time the cluster approach was put into practice in the US industry. In 1960s-1970s of the 20<sup>th</sup> century along with traditional directions of industry the cluster approach strengthened its positions in high-tech industries (Silicon Valley, California). Nevertheless, there is no unanimity of views regarding the interpretation of the “cluster” concept. The founders of cluster approach are A. Marshall and B.S. Yastremsky [1]. The use of clusters to improve the competitiveness of regional economy

belongs to the Harvard Business School. According to M. Porter [5], let us highlight some main characteristics: geographical proximity of the “theatre” of activity of participants, joint production, services under the competitive climate; existence of a system of vertical and horizontal communication, synergetic effect.

According to M. Porter and others, the degree of cluster development is determined by deep and specialized bases of suppliers, a variety of related and auxiliary organizations. The interrelation between the formation of clusters and development of the region are studied by many domestic and foreign scientists [4, 9, 13, 23]. Considering the variety of existing approaches to a cluster, all of them indicate high degree of territorial concentration of participants, synergetic effect of their interaction, balance between competition and cooperation of participants, high level of their innovative activity aimed at the development of market advantages in comparison with external competitors. At the same time not all production associations may be considered clusters, but only those capable of improvement and self-development [1, 17].

The experience of developed countries confirms that the creation of modern computer technologies and digital economy shall be based on multipurpose integration, in particular, by means of cluster development. This prospect is also relevant for countries with transition economies, developing states seeking to become technological empires [14]. Over the last two centuries, the clusters in developed foreign countries and regions were formed ever more rapidly. So far, the clustering captured about 50% of economies of advanced countries [2]. In total, there are approximately 900 industrial and agro-industrial, transport and other clusters in the world: 380 – in the USA; 240 – in Europe; 80 – in China; 30 – in Asia; 50 – in other countries [7]. The geography of cluster approach confirms its efficiency and forms a strong basis for more effective interaction of representatives of a business sector, the state, trade associations, research and educational institutions in the innovative process of transition to digital technologies.

In many countries, the cluster approach to development became firmly established as a primary approach at the state level. Such countries as the USA, Canada, China, Finland and Germany are among the most advanced countries there clustering is established in the sphere of environmental management [3]. Over 60% of industrial and agricultural products in the USA are manufactured within cluster associations. At the same time American universities take the key role in promoting innovations to the regional economy. Danish, Finnish, Norwegian and Swedish industry and economy are completely covered by clustering with the engagement of academic institutes and higher educational institutions. In developed countries, the innovative sector [7] ensures 75-90% of GDP growth, while in Russia this indicator makes about 10%.

Let us identify several approaches to the formation of foreign clusters:

a) top-down approach, when authorities define the development strategy, allocate resources and establish coordination council;

b) bottom-up approach, if certain economic entities uniting separate projects and programs take the initiative;

c) mixed approach combining both options [2]. The majority of developed countries are characterized by the tendency of using the first two approaches in order to identify and develop especially significant innovative zones, territories, business parks, technoparks, etc.

Analyzing the approaches to foreign cluster policy let us pay attention to two directions: liberal and dirigiste. The first implies the use of clustering as a market mechanism at the minimum state regulation. This model is typical for the USA, Great Britain and Australia. In Scandinavia, Japan, South Korea, France and some other countries the dirigiste role of the state is quite important at all stages, authorities even participate in choosing the priority directions of environmental management development and their financing. For example, the government of Canada supports forestry, fishing and other clusters at the federal level by investing into perspective scientific studies, contributing to the design of educational programs, protecting intellectual property, etc. The government of China, South Korea and Japan promoted clustering of sea environmental management through the creation of special economic zones and simplification of taxation of efficient agro-industrial clusters. The typical fishery cluster in Japan consists of one large parent enterprise and two or three levels of subcontracting firms. Instead of rigid vertical integration the independent subcontractors of the first level are connected with each other and with the parent enterprise by contracts, similar relations are established between suppliers of the subsequent levels [7].

In the past decade, the majority of clusters specialized in production of consumer goods to enhance the competitiveness of certain regions. The industrial clusters appeared at the turn of the 21<sup>st</sup> century [29]. Their innovative orientation gradually increased and today it serves the major characteristic defining competitiveness of foreign cluster formations.

The information and communicative clusters breaking new IT grounds within production, science and education are the most successful. In some countries the cluster approach is used to improve the quality of ecosystem and biomedical services [7, 21]. The leading scientific schools, which inter alia ensure training of highly qualified specialists, act as a core of the innovative cluster. Educational clusters unite scientific schools, higher educational institutions, colleges and manufacturing enterprises [6, 16, 25, 27].

#### IV. FIRST ATTEMPTS OF CLUSTERING IN RUSSIA

In the majority of Russian regions the following are considered as prerequisites for efficient clustering in environmental management: advantageous geographical location, developed transportation infrastructure, competitive enterprises and research centers, high population density, human resources, etc. [10]. In 2005-2006, some Russian regions started to create innovative clusters. Their state

support implies the following: budgetary subsidizing of regions in order to develop pilot territorial clusters, involvement of government institutions and business communities to joint regional development programs, comprehensive stimulation of innovative development projects.

Nevertheless, the efforts in the sphere of innovative clustering still have not received a due scope. Perhaps, it is mainly caused by the fact that the structures called innovative clusters do not fully correspond to their foreign analogs and rather belong to “quasiclusters” [10]. In reality, instead of real innovative clusters the structures corresponding to protocusters or territorial and production complexes, which earlier existed in our country, are formed. In the conditions of the Russian economy, the monopolized associations prevail, in which horizontal communications are limited to domination of the state over business and science, and as a result, blocking the forward stroke of innovative processes. The role of the state regulation is critical in the development of support mechanisms for the most perspective clusters. However, in market conditions and in the conditions of developed competition the authoritative actions are especially inappropriate.

About  $\frac{1}{4}$  of the population in Russia (as of 01.01.2018) live in rural areas. Fertile chernozem soils (over 40% of the world reserves), a variety of climatic, geomorphological, landscape conditions predetermine the paramount importance of highly efficient agro-industrial clusters in our country [18, 28] with further transformation of existing types of environmental management into knowledge-intensive and hi-tech productions [11]. Their efficiency may increase manyfold if combined with agroecotourism and other types of recreational environmental management [22]. It is difficult to overestimate the role of clusters for the development of rural territories [19, 26]. The capacity of a tourist flow is usually higher for companies joining a cluster than for companies working beyond it [15, 20, 24].

Clusters have a variety of forms and types depending on motivation and initiative of technological potential and other factors [13]. In environmental management the clusters characterized by natural self-organization assume special forms. Dynamism, variability of means, technologies, etc. are typical for them. From geocological and social and economic perspectives the formation of clusters in environmental management implies balanced use, preservation and reproduction of natural resources potential and human capital as well as active search of ways to decrease environmental risks and financial costs.

Some authors [9] believe that the nature-aligned clusters shall be created on the basis of scientifically valid area zoning with identification of zones suitable for recreation, environmentally friendly agricultural production, protective zones with adjustable recreation, transport and communication, etc. It is noted that the cluster structure in the sphere of environmental management is formed due to production forces, production relations of enterprises and organizations, various organizational and economic forms of activity using natural resources potential, which is territorially

tied to certain administrative structures and is structured by types of environmental and economic activity [8].

Geographical areas of a cluster can be hypothetically defined in quite wide scales – from a city or a region to cross-border space. In Russia they are most often formed at regional and interregional levels. Interregional clusters will ensure steadier social, economic and ecologically safe regional development. One of the major tasks is to create a favorable investment climate in the republics of the Northeast Caucasus. For this purpose organizational, financial and administrative legal support of balanced development of manufacturing sectors of republican economies. The introduction of innovative and knowledge-intensive products (economic and environmentally safe) with high added value into production will ensure the development of perspective and basic types of environmental management. Such transformations are only possible in the following cases: increase of credibility and transparency of relations of authorities with potential investors, increase of efficiency of federal and regional public authorities ensuring the inflow of investments, control over their target use, etc.

#### V. PROSPECTS OF CLUSTERING IN NORTHEAST CAUCASUS

At present, clusters of agrarian, tourist and recreational and nature protection clusters are formed in the regions of the Northeast Caucasus. The agrarian cluster is one of the forms of horizontally vertical integration of agricultural, processing, transportation and commercial productions. Its advantage is the innovative nature (the cluster also unites research institutes and agricultural universities). The state support is provided by regional and municipal executive authorities. One of the main principles of a cluster is the compliance with equal conditions of integration of its subjects. The difficulty of organization is the fact that the cluster is designed to unite and interconnect the interests of various parties involved in voluntary association, to stimulate the development taking into account controversial private interests of cluster participants. Therefore at different levels of authority the cluster policy shall flexibly coordinate actions and find compromise solutions.

The main focus is placed by authors on clustering of innovative activity in agrarian environmental management. The structure of interregional agro-industrial cluster, the core of which is presented by agroholdings LLC Sady Chechni (Gardens of Chechnya) and LLC Sad Gigant-Ingushetiya (Giant Garden) may serve an example [12]. The first apple garden in Chechnya was put in 2009 on the area of 400 hectares, and in Ingushetia – in 2013 on the area of 250 hectares. Apple varieties are chosen with the account of climatic features of regions in the zone of flat chernozems. In the next years it is planned to increase the areas up to 1000 hectares in each enterprise. The Gardens of Chechnya produce virus-free landing material of fruit and berry crops, the plantations of intensive type including a full cycle of works – from systematic analysis of changes of chemical composition of soils to basic and drop irrigation systems are also established here. About 60 hectares belong to pilot seed-trial grounds.

The products of the Gardens of Chechnya are already delivered to the Gudermes agroplant making over 50 varieties of juice, drinks, canned food. The Tsentoroyevsky agroplant produces the best-selling soft drinks and aseptic semi-finished products. Innovative developments play an important role at research institutes and higher educational institutions, which train highly qualified personnel: agronomists, land surveyors, managers for operating enterprises. The development of a “self-sustaining” cluster implies financial cooperation against public-private partnership agreements. The system of drop irrigation with supply of mineral fertilizers is applied in Ingush agroholding. Besides cultivation (according to Italian technology) of over 15 immune varieties of apples the products are also stored here (up to 6.5 thousand tons).

Agroholdings of Chechnya and Ingushetia deliver environmentally friendly products to St. Petersburg and other large cities of Russia. The coordination council consisting of representatives of all stakeholders shall take the major part in clustering of agro-industrial production to ensure dialogue and coordination of interests between producers of agricultural products, processors, education and research centers, investors and participants of other allied industries of economy. Taking into account the interests of small-scale producers of agricultural products the agro-industrial clusters will also boost the employment in many mountainous areas of the Northeast Caucasus.

In many respects the efficiency of clusters will depend on concurrence of actions of its actors at local, regional and federal levels, as well as at the level of certain enterprises, education and research centers. A special structure representing some kind of the operating program shall serve its regional coordinator. Such mechanism is implied by the state program of cluster development, but it is obviously not enough. The successful implementation requires the market of management companies [10].

Prerequisites for the formation of interregional tourist and recreation and nature protection clusters are quite favorable. In comparison with production, agro-industrial and service clusters the specifics of tourist and recreation activity is bound to its territorial organization. In the Northeast Caucasus the tourist and recreation cluster can be established on the basis of the Kezenoy-Am Lake (1869 m A.S.L.) in the zone of Alpine meadows on the border of Chechnya and Dagestan (Fig. 1). Together with the adjacent territory the lake is quite interesting from educational and informative, medical and tourist perspective. The bulltrout, which is included into the republican and all-Russian Red Book can be found here. According to Ramsar Convention the lake is also included into the list of wetlands. It is of key importance for preservation of rare and endangered species of Egyptian vulture eagle, griffon vulture, etc.

However, there is a need to consider the risk of avalanching and mudslides from mountain slopes and thus this requires the corresponding engineering and ecological study. Due to the increasing flow of tourists to the Kezenoy-Am Lake it is necessary to estimate the admissible capacity of the geocosystem. At present, the Kezenoy-Am tourist and recreation center functions as public-private partnership, it has

a sports and health center, 12-storey Pyramid Hotel, luxury cottages, boating station, and other facilities. The center is connected to the capital of Chechnya by the asphalted road. The settlements near the lake are gasified. The recreation complex is also developing on the Dagestan coast of the lake.

The model of the proposed interregional cluster implies the correlation of science, business and production. The Kezenoy-Am cluster can become basic for successful development of domestic and incoming tourism considering climatic, historical, cultural and ethnocultural features of two regions of the Northeast Caucasus. The most probable cluster participants are enterprises and organizations of Chechnya and Dagestan involved in recreation activity, educational institutions and the population. In the neighborhood of the lake local shepherds already sell their dairy products. However, original symbiosis between recreation and nature protection is only possible in case of a common understanding of advantages and benefits of cooperation among the participants. The balance of momentary and perspective interests between the participants of the Kezenoy-Am cluster shall be anticipatory and long-term. The French-Russian investment construction project of the year-round Veduchi ski resort is implemented in the mountain Itum-Kalinsky district of Chechnya. It is planned to commission the first 10-kilometer trail in 2020.

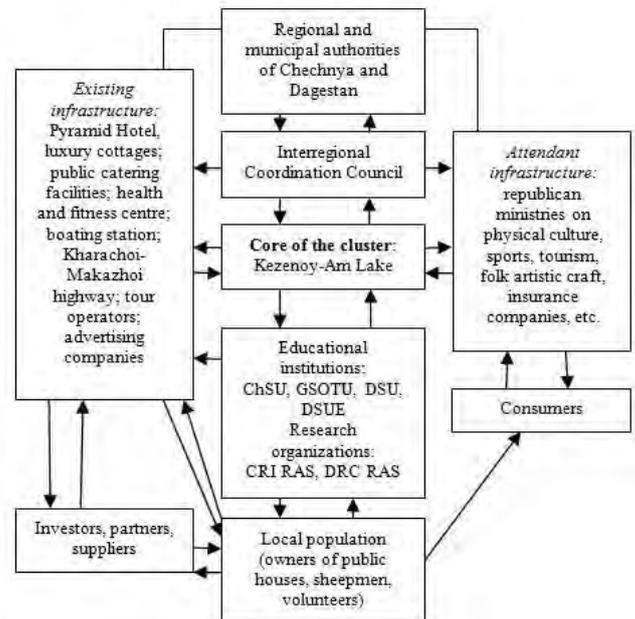


Fig. 1. Conceptual model of interregional Kezenoy-Am tourist and recreation cluster [12]

The nature protection mountain cluster on the basis of the Erzi reserve and natural wildlife areas of Ingushetia, Chechnya and Dagestan is exclusively perspective. For this purpose first of all it is necessary to establish the interregional coordination council with the involvement of scientific, administrative and nature protection organizations of these republics. The main objective of clustering of especially protected natural territories is ecological education of youth in secondary and higher educational institutions. The general awareness of its importance for recent and future generations can serve the

guarantee for successful implementation of such large-scale nature protection and educational cluster. The UNESCO Cross-border Biosphere Reserve shall also contribute to this matter.

## VI. CONCLUSION

The experience of environmental management clustering in developed and developing countries confirms the fact that modern competitive production on the basis of natural resources potential can only be successful through horizontal, interregional and vertical integration. The environmental management clustering is one of the ways to develop models of competitive, investment attractive and ecologically safe types of exploitation of natural resources thus ensuring higher level and quality of life of the population, involvement of not only large producers (users of natural resources), but also small and medium business into balanced environmental management. The cluster approach at the interregional level is the most efficient for regions of the Northeast Caucasus, which are still underdeveloped and depressive. To some extent it is caused by business insufficiency regarding generation of independent ideas and implementation of initiative projects, weak involvement of the population into the dialogue with business and authorities. However, the harmonious development of business initiatives and more efficient development of natural resources potential requires the resolute shift of a social thought to the quality of life and the human capital [12].

Nevertheless there are some favorable prerequisites in the Northeast Caucasus for the development of agrarian, tourist and recreation, nature protection, and other clusters implying interregional voluntary merging of enterprises, organizations and institutions being territorially close and functioning in the spheres of production and sale of goods and services. The cluster can only function as a form of mutually beneficial economic cooperation based on long-term contractual relations of nature users with belief and hope that their projects will be successful in market conditions and demanded by both current and future consumers of goods and services. The optimization of environmental management and social and economic development of the studied regions on the basis of clustering will allow modernizing the existing infrastructure and increasing the qualification of staff: managers, land surveyors, marketing specialists and others, which are able to implement interregional cluster projects.

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