Natural Factors of Sustainable Development of the Central-Black-Earth District

A E Krupko¹, R E Rogozina¹, Yu M Fetisov¹, M V Derevyagina¹, L N Shentseva²

¹Voronezh State University, Universitetskaya pl. 1, Voronezh, Russia, 394018
²Voronezh branch of FSBEI VR “Plekhanov Russian University of Economics”, Karl Marx St., 67A, Voronezh, Russia, 394030

E-mail: glomer-a@mail.ru, rrogozina@bk.ru, m_derevyagina@mail.ru, lorashentseva@yandex.ru

Abstract. The article discusses the issues of sustainable development of the region by the example of one of the old-developed economic regions of Russia - Central Black Earth, gives an analysis of the state of natural resources subjected to the active anthropogenic impact, reveals the factors and problems of using the main types of resources, shows the directions for their conservation and possible optimization.

1. Introduction and Discussion

Currently, the concept of sustainable development is one of the leading paradigms of social-economic-ecological development of the region. Having appeared at the turn of two centuries, this category remains one of the decisive factors in solving environmental management problems, which are the result of the anthropogenic impact on the environment. In the third decade, especially since 1992, the United Nations has been dealing with this issue, thereby expanding international cooperation to make the world a better place to live. [1] The UN structures are still debating whether it is worth adhering to a previously formulated concept or it must be brought into line with the current level of the development of the productive forces. The work of John Pisey, done at the request of the World Bank, provided a summary of more than 60 definitions of sustainable development, published by the end of the 1980s, by different authors. Multiple definitions are based on the need to save and maintain natural-resource life-support systems and the quality of the environment in the condition that would provide the favourable conditions for life and productive activity for not only living but also for future generations. Sometimes the existing concept of “sustainable development” is already an independent subject of the research and is revealed by modern scientists in different ways but at the same time it is considered more comprehensively in foreign science.

Szopik-Depczyńska, K.; K edzierska-Szczepaniak, A.; Szczepaniak, K.; Cheba, K.; Gajda, W.; Ioppolo, G. believe that the term sustainable development is used in many areas and spheres of life and acts as a modern phenomenon that determines the direction of the development of any society. It implies the continuous economic development taking into account the environmental principles and focuses on overcoming the conflicts between the economy and the environment [2]. Due to the continuous development of the society, there is a threat of depletion of scarce natural resources. Therefore, the research in the field of sustainable development can improve the environmental literacy of people and society in general, so that they can really assess the consequences of their impact on the environment [3].

From the point of view of Schmid, G., the goal of sustainable development is achieved through a dynamic process of improving the equipment and technologies, the growth of public welfare and the quality of life of the population, while not neglecting the need to protect the environment, as well as saving resources for future generations [4].

These formulations reflect the versatility of the term “sustainable development”. In most of them there are the most relevant features and directions of social-economic development, which is quite understandable in the face of changing the social structure and the economy. At present, in our opinion,
it is necessary to return to the classical version of the understanding of this category, that is, to such a development of the region that makes the maximum use of the possibilities of fully preserving and the improving of its natural environment.

One of the regions of the Russian Federation, the sustainable development of which is very important for the whole country, is the Central Black Earth Region (CCR). It is distinguished by a high degree of the development, population, and transport security: railway and automobile highways of the federal significance, power lines, and gas pipelines pass through its territory. It has enormous iron ore resources and arrays of chernozems, which determines the modern areas of nature management. Despite the fact that the region accounts for about one percent of the territory and 8.8% of Russia's arable lands, its natural resources play an important role in ensuring the country's food security. Currently, the CCR is not only an important agricultural region of the country (about 15% of the agricultural production of the Russian Federation and 3/5 of the Central Federal District) with a wide development of agricultural production processing but it is also characterized by a significant development of heavy industry sectors. In the material sphere of the economy of the Russian Federation, the CCR is distinguished, in addition to the food industry, by the development of ferrous metallurgy and mechanical engineering, nuclear energy and chemical industry. The region belongs to the territories where the natural environment has been subjected to the significant changes, where there are practically no natural landscapes preserved in their original form.

The most difficult situation in the environmental management of the region is determined not only by modern anthropogenesis. In the second half of the 19th century, the high density of the rural population contributed to the formation of an ultra-high share of arable lands in the land use structure (about 80% of the total area of CCR) due to the deforestation, the reduction of hayfields and pastures, and water protection zones. The forested area in the Black Earth Region during the years of the development of the territory decreased more than three times (from 5 million hectares to 1.5 million hectares) and is 8.7%. The deforestation caused a nearly two-fold reduction in the length of small rivers and significant soil erosion, which is characteristic of over 1/3 of its territory. The area is characterized by a high anthropogenic and, moreover, often the irrational load on natural ecosystems, which causes a constant deterioration of the ecological situation. All the main components of the natural environment of the CCR experience excessive pressure, structural deterioration and territorial decrease (medium and strong). The significant degradation of nature led to the crisis and almost catastrophic state of many natural objects, which requires the transition to an expanded reproduction of natural resources - mere nature conservation is no longer enough. Therefore, it seems relevant to us to assess the level of anthropogenic use and degradation of the main natural components - soils, waters, forests of the region.

2. Results

Currently, the anthropogenic pressure increases global environmental risks and represents the most important driver of the planet change [5]. Agriculture is the largest engine of the global environmental change [6]. Therefore, it is necessary to continue the sustainable intensification of agriculture for the prosperity of the mankind and the global sustainability [7]. The UN for the period up to 2030 has put forward as the priorities and global goals of the sustainable development: eradicating hunger, maintaining food security, ensuring the sustainability of agriculture and managing natural resources [8]. In order to meet the future needs of the world in the field of food security and sustainable development, food production should increase significantly, while the environmental impact of agriculture should be sharply reduced [9].

At the regional level, the priority tasks of the sustainable development are designed to solve the territories that have the appropriate resources for this. In Russia, due to the natural features, there are not many such regions, and one of them is the CCR. The land use, as a rule, is regarded as a local environmental problem, but it becomes a force of the global significance [10]. The land structure of the Central Black Earth Region has the characteristic features of the active agricultural use. The share of agricultural lands in the total land area of the district (16.79 million ha) reaches 79.5%, and the share of arable lands - 61.5% (see table 1).
Plowing of agricultural lands in 2017 reached 77.5%. The total area of crops at the same time amounted to more than half of all lands and about 2/3 of agricultural lands in the CCR. The share of arable lands in these lands of the administrative districts of the region is quite homogeneous: it ranges from 74.5% in the Voronezh region to 79.7% in the Kursk region. In all rural municipalities of the region, excessively high plowing of the territory is also preserved - 20-25% higher than optimal for maintaining soil quality. In the structure of the land use of the municipal regions (MR) of the Black Earth Region, the share of agricultural lands varies significantly: in some of them it exceeds 90% of all lands, and in some MRs its indicator is two times lower. In a number of areas, located on the Oka-Don plain, there is a situation close to an ecological disaster: arable lands in agricultural lands exceed 8/10 of their total area. At the same time, in the areas of the Middle Russian Upland, arable lands account for about half of the area of agricultural lands. This characterizes the significant territorial heterogeneity of the CCR at the municipal level and requires an appropriate approach to studying the ecological state of natural systems. Despite the fact that in the region more than 80% of the soils are represented by chernozems, and the most productive of them occupies 28% of the total land area, the CCR is characterized by extremely low humus content in soils (on average 5%). The content of the main organic matter in chernozems in the context of the municipal regions of the CCR varies from 4% in the Gryvoron MR of the Belgorod region to 7.3% in the Paninsky region of the Voronezh region, which is 1.5 - 2 times lower than normal. Such indicators are inherent in less productive soils of dry steppes, and not chernozems. Typical chernozems before intensive plowing had a minimum of 8-10% of humus. Currently, they are almost completely plowed. To achieve a steady state, the maximum share of plowing on chernozems should be 60-65% of agricultural lands, and the minimum forest cover is 15-20% of the territory. Over the past five years, there has been a decrease in the content of humus in soils by 0.1% and almost 1.4 million hectares of land have been abandoned from agricultural use. For many years, the balance of nutrients in soils was sharply negative - the loss of humus was many times greater than its accumulation. Even in the Belgorod region, where 8.4 t / ha of organic fertilizers were introduced in 2017, the share of arable lands, on which organic farming was carried out, amounted to only 1/8 of the total area of these lands. In the 90s, a third of the lands was not used, and half of the cultivated arable land was not given with mineral and organic fertilizers.

Soil degradation is intensified due to the irrational land use [11]. In the region, grains and sunflowers account for 3/4 of all crops, and in farms 90% of the cultivated products are grains. During the market time there has been a significant reduction in the area of perennial and annual grasses. In 1990, feed crops occupied 3 million hectares, or 30% of the crops of the CCR, and in 2017 their areas decreased to 30.6 thousand hectares, which corresponds to a share of 8.3%. Relatively high proportion of feed crops in the crops of the Belgorod and Voronezh regions - over 12%, the Lipetsk and Kursk - 2 times less, and in the Tambov region their share is noticeably lower - 3.5%. The size of the areas under these crops completely does not meet the criteria of the ecological-landscape farming system, which is used by some agricultural organizations of the Belgorod and Voronezh regions, as well as the crop rotation system that existed in the Soviet years. In the Liskinsky region (the leader of the CCR for livestock

| Distribution of agricultural lands by regions of the CCR on January 1, 2017, % [1] |
|--------------------------------|----------------|-------------|-------------|-------------|---------------|-------------|
|                                | Totallands | Agricultura| Arablelan| Hayfields | Pastures | Perennialpl |
| Belgorod                        | 100.0     | 78.8       | 60.7      | 2.1       | 14.7     | 1.25        |
| Voronezh                        | 100.0     | 78.0       | 58.4      | 3.0       | 14.9     | 0.99        |
| Kursk                           | 100.0     | 81.4       | 64.8      | 3.3       | 12.3     | 0.94        |
| Lipetsk                         | 100.0     | 81.3       | 64.6      | 3.5       | 11.7     | 1.48        |
| Tambov                          | 100.0     | 79.0       | 61.7      | 4.8       | 11.3     | 0.94        |
| CCR                             | 100.0     | 79.5       | 61.5      | 3.4       | 13.2     | 1.08        |
development), the share of feed crops exceeds 1/3 in the crop structure. In other municipal areas, the sown area of these crops varies from 3 to 20% (the minimum is observed in the Petrovsky MR of the Tambov region - 0.9%), which is far from the characteristics of rational nature management. The decrease in the sown area of feed crops is due to the reduction in the number of cattle (cattle) in all regions, except the Voronezh. Over the past decades, there has been a transition to monocultural agriculture - to the cultivation of grains and sunflowers, so in the CCR it is necessary and urgent to develop the agriculture, which would preserve the natural environment: "biological", "green", ecological farming. Ecological-landscape (adaptive) or landscape-ecological farming system is based on the soil-protection contour-reclamation organization of landscapes, taking into account the natural features of the structural elements of the territory [5]. Adaptive farming involves significant crops of forage grasses, which requires an increase in the number of cattle. To maintain soil fertility, at least, a minimal balance between livestock and crop production is needed (2.5-3 ha of arable lands or 3-3.5 million heads of cattle are required per cattle head). In 2018, there were only about 1.1 million heads of cattle in the district, which is 4.5 times less than in the Soviet period. To ensure an increase in the content of humus in the soils of the region, the number of cattle should be increased five times, which is currently unrealistic. A necessary direction for improving the environmental situation in the coming years is the processing of pig manure and bird droppings into organic fertilizers, a significant part of which is not used and pollutes the environment. At the beginning of 2018, the number of pigs in the CCR was about nine thousand heads, of which almost half (4362.8 thousand heads) was in the Belgorod region. In 2017, the total amount of organic fertilizers applied to the CCR was 24.3 million tons, of which almost half was brought in the Belgorod, about 1/3 - in the Voronezh, about 1/8 - in the Lipetsk regions. Organic fertilizers are almost never used in the Kursk and Tambov regions (less than 1 million tons and less than 0.5 million tons, respectively). At the same time, in the Tambov region only 8 of the largest enterprises produce organic waste of almost 5 million tons per year (3 t / ha), and the actual application of organic fertilizers is 0.2 t / ha. Further non-rational use of chernozems, with existing development trends, will lead to the death of most of them in the next 15-20 years.

Thus, how to achieve high agricultural sustainability while reducing the negative impact on the environment and ensuring ecological balance - this problem is relevant for people around the world [12]. The situation in the CCR with water resources is no less acute. The most universal indicator of environmental quality is the state of water and water resources, which indirectly also show the state of air and soil [10]. On the one hand, the low availability of water, which amounts to 100 thousand m³ / km² per year, which is 2.5 times less than the average for the Russian Federation, remains a negative factor for sustainable nature management in the region. On average for the Black Earth region, the annual runoff layer is 127 thousand m³ / km² of area, and the total amount of water resources does not exceed 20 km³ / year. Despite the fact that there are 941 rivers in the region with a total length of over 27 thousand km, the total river runoff of the CCR, formed in the local channel system, makes up about 0.4% of the total runoff of Russia. The water supply of the population in the CCR (642 m³ / person) is lower than the national average, and in the southern part - in the Voronezh region, and even less - 374 m³ / person. The total surface of water area is 352.8 thousand ha or 2.1% of the area, which is located in the transitional climate zone. The average annual runoff in the region decreases from the northwest to the southeast by more than 4 times. The largest runoff layer is characteristic of the basins of Tim, Ksheni, Olym, and KrasivayaMecha (from 170 mm), and the smallest - for the rivers of the southeast: ChernayaKalitva, Bityug, Elan, Savala, Kriusha, where it is 60-40 mm. Among the administrative regions of the CCR, the highest flow rates are in the Kursk and Lipetsk regions (128 mm and 113 mm, respectively). Average water availability is observed in the Tambov region, and low - in the Belgorod and, especially, in the Voronezh region (see table 2). It is in these southern regions that the problems with the conservation of water resources are the most urgent, and the need for them is higher.

On the other hand, the rivers were greatly degraded: the bottom is covered with silt, the banks are eroded intensively, water protection zones are involved in economic use. Except rivers, flowing through the reserves (at the outlet they usually have the second class of water quality “low pollution”), all other rivers are characterized by low classes: 3 “a” (polluted), 3 “b”, (very polluted) and 4 "A" (dirty). Therefore, such water can hardly be used for domestic and most household purposes. In general, the development trends of the water basin are extremely negative. So, in 2016, in the once clean, navigable and beautiful river Tsna, the water quality in the Tambov-Morshansk section reached the 4th quality
class - “dirty”, which characterizes the transition to an aggravation of the environmental crisis in its basin.

Table 2

| Districts | Long-term average runoff (mm/year) | Long-term average runoff (km³) | Water resources (average annual) |
|-----------|-----------------------------------|-------------------------------|---------------------------------|
|           |                                   |                               | (km³) | m³/person |
| Belgorod  | 99                                | 2.33                          | 0.62  | 477       |
| Voronezh  | 76                                | 3.65                          | 0.86  | 374       |
| Kursk     | 128                               | 3.62                          | 0.99  | 660       |
| Lipetsk   | 113                               | 2.99                          | 0.91  | 758       |
| Tambov    | 103                               | 3.41                          | 1.05  | 700       |
| CCR       | 108                               | 16.0                          | 5.43  | 642       |

The level of water consumption (over 1 km³/year) and dirty water discharge (325 million m³ in 2017) in most regions already exceeds the possible local maximum. The degradation of the river systems of the CCR made its significant territories waterless. With a relatively uniform average density of the river system for the region of 0.23 km / km², an excess of this indicator is typical for the Tambov (0.27 km / km²) and the Kursk (0.26 km / km²) and full compliance with it for the Lipetsk region. In the Voronezh (0.21 km / km²), in the Belgorod (0.14 km / km²) the density of the river system is lower than the average for the CCR. In a number of municipal districts of the Black Earth region there were no rivers at all, and only old dry channels remained. In this regard, the presence of lakes, the creation of ponds and reservoirs are necessary for the normal functioning of localities. Artificial reservoirs of the region (compared to lakes) play a much more important role for optimizing nature management. They store 4% of the runoff, their amount is 0.45 km³, and the water area exceeds 27 thousand ha. Most of these surface water bodies are also in critical or crisis condition. Practically almost all of them are silty, and in some places even boggy. New large ponds and reservoirs are currently under construction, and many ponds need major repairs, landscaping, which requires tens of billions of rubles of investments in the CCR. The overhaul of the hydropower facilities of 6 ponds in the Belgorod region in 2016 cost 35 million rubles (near the villages of Red October, Zhukovo, Kiselevo, hut. Church, the village of Komsomolsky, st. Solovey). In the same year, cleansing and environmental rehabilitation of the Zhigalka river in Tambov, r. Psel in the city of Oboyan and other rivers. Residents received magnificent recreational areas, and the rivers themselves became more full-flowing, but the costs amounted to several million rubles per 1 km of the channel. The optimization of water use in New York has shown that water treatment is the most cost-effective way to improve the quality of groundwater and surface water. The widespread treatment of wastewater, especially storm water, which is underdeveloped in the area, is urgently needed. It is no coincidence that in most water bodies of the CCR, the main pollutants are suspended solids (dry residue is hundreds of thousands tons per year) and the chemical oxygen consumption [13].

It is currently impossible to use the water of most reservoirs because of its low quality, therefore, groundwater is mainly used, but in the future, with modern trends in water use, a decrease in quality and groundwater can be expected.

The state of forest resources in the CCR also does not allow to achieve a stable state of the environment, and the conservation of water and soil resources. It is deforestation in the area that causes too short spring floods, pollution and shallowing of rivers. Forest lands, as already noted, in 2018 occupied about 9% of the total area of the region, and the estimated minimum required should be one sixth of the territory, i.e. about 3 million hectares. The optimal amount of forest cover for conservation
of soil and water resources, improvement, reduction of the imbalance in the formation of carbon dioxide and oxygen in the CCR should reach 20-25%. About the same value, according to our calculations, should be the forest cover of the CCR in order to achieve a stable state of all types of locality in the region. Currently, forests, woody-shrubby vegetation, perennial plantations are occupied as a whole it is only about 12% of the total central area [14]. In this regard, a crisis situation is observed in the administrative areas of the region, and, as in most municipal districts and rural settlements, the ecological situation is close to catastrophic (see table 3).

### Table 3

|                | Catastrophic situation | Crisis situation | Critical situation | Conflict situation | Satisfactory situation |
|----------------|------------------------|-----------------|--------------------|-------------------|------------------------|
| Belgorod       | 4                      | 6.1-12.0        | 12.1-18.0          | 18.1-24.0         | over 24%               |
| Voronezh       | 4                      | 16              | 7                  | 3                 | 1                      |
| Kursk          | 10                     | 14              | 3                  | 1                 | -                      |
| Lipetsk        | 12                     | 2               | 3                  | 1                 | -                      |
| Tambov         | 12                     | 3               | 5                  | 2                 | 1                      |
| CCR            | 42                     | 44              | 21                 | 9                 | 2                      |

Only in the Shebekinsky district of the Belgorod region (33.17%), the Morshansky district of the Tambov region (29.4%) and the Ramonsky district of the Voronezh region (24%), as well as in the Voronezh (31%) and Starooskolsky districts (25.6%), is a satisfactory situation, and in nine MR of the regions - conflict. But even in these territories, in many rural settlements, the share of forest lands does not exceed 6%, and in general, over 4/5 of all municipalities are characterized by such indicators in the CCR (in MR the forest cover is higher due to the separate large forest areas). So, in the Ramonsky district, the forest cover of the eastern part exceeds 50%, and in the western part of the district it is ten times lower. The situation is complicated by the fact that large areas of the so-called collective farm forests and forest belts are ownerless, fall into the hands of unscrupulous developers and degrade. The region is characterized by an extremely low level of reforestation - 4.6 thousand ha in 2017, which is almost 4 times lower than the level of the Kostroma region alone. Forest restoration costs are not that big. So, to compensate for carbon dioxide emissions of the Novolipetsk Steel (NLMK), a landing of 0.8-1.2 million ha is required. The cost of such planting and tree care for 5 years is about 40-50 billion rubles, that is, only 4% of the annual profit of the enterprise. It should be noted that, as a whole, reforestation is intensifying in the CFD (with the exception of the CCR and the Oryol region), without which it is impossible to improve the environmental situation.

### 3. Conclusion and offer

Currently, in the administrative fields of the region, environmental problems are increasing due to the degradation of soils, water and forest resources, and environmental pollution. Not well-ordered in urban areas, and in the villages of the district, water supply, sewage, and other engineering infrastructure are generally poorly developed. In agrarian territories, monocultural agriculture predominates, with disturbance of crop rotation, with a growing chemicalization of agriculture, and irrational cattle grazing is observed. The problems are the almost complete absence of separate collection of garbage, household, industrial waste and its insufficient processing (a significant part of production waste and almost 9/10 solid municipal waste in the area are not recycled). The use of water resources, soils and forests by the population and enterprises of the CCR can often be attributed to the criminal nature management. Outdated production process technologies make a low level of greening of the industry of the region,
which requires a radical modernization of the production, the reduction of waste and the improved water treatment. A significant reduction in stationary air emissions (by 20% by 2024) in the CCR can be achieved, first of all, by the replacing traditional blast production technologies of iron in Lipetsk with the innovative blast furnaces (such as «Rossiyanka»). It is necessary to increase taxes and fines for air emissions many times over, as well as to create an economic mechanism for combating carbon dioxide emissions, in which enterprises and vehicle owners must provide the necessary amount of forest planting to utilize the carbon dioxide they produce. It should be noted that in recent years NLMK has managed to reduce specific emissions into the atmosphere, but still blast furnaces of the plant remain the absolute main pollutant of the air environment in the region, and in the Lipetsk region this enterprise accounts for more than 2/3 of atmospheric air pollution. To restore soils and water resources, it is necessary to expand afforestation with unproductive agricultural lands. To improve the quality of water resources, it is necessary to replace and modernize obsolete wastewater treatment plants, the widespread introduction of modern technologies, including denitrification and dephosphatization. A positive tendency is the increase in the number of small modern biological treatment plants, but their number in the CCR is several dozen, and several hundred with different degrees of purification and post-treatment of water at wastewater treatment plants are needed.

In general, the Central Black Earth Region is characterized by the threshold of the complete ecological disaster, which is confirmed by the decrease in the number of species and the diversity of the fauna and flora. The prohibitive level of environmental degradation and oppression in the CCR requires an exceptionally powerful universal restoration of the region’s natural resources and the attraction of appropriate financial investments, which leads to a radical change in the nature management strategy. The creation of a new branch of the economy — the restoration of nature with the appropriate infrastructure and funding amounting to tens of billions of rubles annually, is relevant. Only in this case it will be possible to achieve a radical change and improve the nature management in the water, forest and agricultural sectors.

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