Accessibility of protected natural areas of regional significance: a case study from Samara Oblast, Russia

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Abstract. A significant role is assigned to the preservation of natural areas in the paradigm of sustainable development both in the international and regional aspects. Protected natural areas of regional importance make it possible to solve the problem of the preservation of natural ecosystems. The aim of the research is to establish for the municipal districts of Samara Oblast: dynamics, formation features and provision of PAs of regional significance. In the course of the study, on the basis of analysis, logical presentation, and statistical research, the authors established: the dynamics, features of the formation and provision of the municipal districts of Samara Oblast with specially protected natural areas of regional significance. The authors show a significant variability in areas, specific value and provision of the local population with specially protected natural areas, the relationship of individual parameters. The authors also built a rating and compiled a classification of municipal districts according to the given indicators. The authors identified the categories of municipal districts with a high, medium and low share of specially protected natural areas in the total area of the subregional area and the provision of the population with protected areas. The authors studied various options or models of compensatory benefits and environmental costs of municipal areas, taking into account specially protected natural areas of federal significance and the influence of the urban environment. The results of the analysis make it possible to use the obtained materials for making current managerial decisions in the interaction of regional environmental authorities with the administrations of municipal districts, for correcting the prospective scheme for the development of specially protected natural areas of regional significance, and for modernizing the development strategies of territories.

1. Introduction.
The history of the creation of protected areas (PAs) is based on the dramatic events of the irrational development of natural resources, when, in pursuit of an increase in the collection, extraction and production of products, the natural component of ecosystems was increasingly reduced, the natural environment was increasingly polluted, and biological diversity became poorer. Especially great damage to the natural environment was caused by the grandiose industrial and transport development, large-scale urbanization, the unreasonable spread of various types of reclamation, an increase in cultivated areas, and so on. The sphere of regulation of relations in the system of organization, protection and use of protected areas is spelled out by the Federal Law "On Specially Protected
Natural Areas (as amended on July 26, 2019)" dated March 14, 1995 No. 33-FZ, which indicates the goals of their creation, categories, authority powers, citizen participation, etc. [1].

The preservation of natural areas is assigned a significant role in the paradigm of sustainable development in the international and regional aspects [2, 3]. Using a new global biodiversity database with unprecedented geographical and taxonomic coverage, scientists have found that species richness is 10.6% higher and the abundance is 14.5% higher in protected areas compared to the unprotected ones [4]. In the article [5], the authors propose tools for assessing the representativeness, sustainability and efficiency of protected natural areas. Territorial conservation measures are the most important aspects for the sustainable use of biodiversity in the global concept of “living in harmony with nature” for the period up to 2050. [6].

The existence of PAs is determined by the presence of natural objects and complexes for the purposes of their preservation, the size of the territory sufficient to fulfill the assigned mission, intended for various purposes, including the environmental tourism.

A special system, created over several decades, serves as the foundation for the preservation of natural objects and complexes in Samara Oblast. It includes, first of all, an object of international importance, the Middle Volga Complex Biosphere Reserve, three objects of federal importance: Zhiguli Nature Reserve and two National Parks (Samarskaya Luka National Park and Buzuluksky Bor National Park), which together occupy 201,631 hectares, making up the lion's share (about 70%) of the area. In addition, there are 211 PAs of regional significance, key bird areas: 7 of international and 8 of federal significance, wildlife reserves and more. The area of all PAs in the total area of the region, according to [7], is 5.5%.

PAs of regional significance have a special place in the system of protected areas, primarily due to their relative abundance, geographic, ecological, biological and other unique features [8, 9, 10, 11, 12, 13, 14]. However, the development of PAs of regional significance, as a rule, is considered on a regional scale, or at specific objects and complexes [15], and to a lesser extent is studied at the municipal level. The need to preserve natural diversity at the municipal level (about 30% by the area of PAs in Samara Oblast) under regional regulation is increasing in the context of strengthening legislative requirements and regulations, as well as empowering local administrations with powers in environmental activities, the growing demand for ecological tourism, which is reflected in strategic documents for the development of territories, for education and training of the population in the ideology of sustainable development.

The aim of the research is to establish for the municipal districts of Samara Oblast: dynamics, formation features and provision of PAs of regional significance.

2. Materials and Methods
The materials of the article are based on the analysis of available data. The authors conducted a statistical study based on a summary and grouping of observation materials, absolute and relative values, a number of dynamic changes; methods of description, classification, comparison, including the use of the rating method, were used.

As factual material, the authors used data from the official publications of the Federal State Statistics Service (Samara regional office - Samarastat) [16], the Cadastre of PAs of regional significance of Samara Oblast [17], and annual reports of the Ministry of Forestry, Environmental Protection and Nature Management of Samara Oblast [18]. The main calculations were carried out as of January 1, 2019 in view of the maximum variety of the estimated indicators.

3. Results and Discussion
The official registration of natural monuments as PAs of regional significance in the administrative districts of Samara Oblast began in 1967 with the aim of preserving 25 unique natural objects and complexes located in 13 districts and on a relatively small total area of 10 342.18 hectares. Their importance has increased over the years (table 1).
Table 1 The first PAs of regional significance in the municipal districts of Samara Oblast (1967)

| №  | PAs                                     | Area (ha) | Municipal District              |
|----|-----------------------------------------|-----------|---------------------------------|
| 1. | Kolok «Duboven'kij»                      | 234.04    | Bolsheglushitsky                |
| 2. | Part of Tchipakovo-Kovyl'naya virgin steppe | 931.95    | Bolshechernigovsky              |
| 3. | Natural birch stand                      | 229.89    | Volzhsky                        |
| 4. | Genkovskaya forest belt, sq. 28-32      | 550.50    | Volzhsky                        |
| 5. | Genkovskie forest belts, sq. 25 - 26    | 267.05    | Volzhsky                        |
| 6. | Natural oak tree                         | 430.21    | Volzhsky                        |
| 7. | Lake Yaitskoe                            | 194.44    | Volzhsky                        |
| 8. | Oak tree stand                           | 225.04    | Isaklinsky                      |
| 9. | Linden tree stand                        | 61.15     | Isaklinsky                      |
| 10.| Natural pine stand                       | 10.20     | Isaklinsky                      |
| 11.| Maple-woodruff oak grove                 | 533.96    | Kamyshlinsky                    |
| 12.| Aspen and aspen-linden stands            | 1737.84   | Kamyshlinsky                    |
| 13.| Stone valley                             | 42.68     | Kinel'sky                       |
| 14.| Remnants of the pine forest              | 245.17    | Klyavlinsky                     |
| 15.| Pine stand                               | 78.86     | Klyavlinsky                     |
| 16.| Oak stand                                | 150.87    | Krasnoyarsky                    |
| 17.| Oak stand mixed with linden and maple     | 73.53     | Krasnoyarsky                    |
| 18.| Blue Lake                                | 6.07      | Sergievsky                      |
| 19.| Mountain High                            | 168.49    | Sergievsky                      |
| 20.| Oil ravine                               | 53.40     | Sergievsky                      |
| 21.| Pine stand                               | 1905.00   | Stavropol'sky                   |
| 22.| Moss swamp                               | 50.33     | Syzran'sky                      |
| 23.| Birch tree stand                         | 89.86     | Shentalinsky                    |
| 24.| Novo-Kuvakskaya oak forest (oak stand)   | 149.48    | Shentalinsky                    |
| 25.| Muran Bor                                | 1922.17   | Shigonsky                       |
|    | Total                                    | 10 342.18 |                                 |

At first, the authorities gave the main preference when registering PAs to the natural complexes of the forest-steppe zone of the central, northern and right-bank parts of the region, which was expressed both in the number of conservation objects - 92.0%, and in their area - 88.7%. The steppe zone was completely undeservedly limited to only two natural monuments in two districts of the southern end of the region.

These natural objects were called state natural monuments of local importance, the formation of which subsequently proceeded at an uneven pace. The largest PAs institution in Samara Oblast falls on the 80s of the last century (1983 and 1989), when their number sharply increased by 152, which coincides in time with the adoption of environmental legislation in the country (table 2).

In subsequent years, the registration of natural monuments followed a decreasing trajectory. However, even in the 1990s, catastrophic for the country and the population, 24 objects were added. After that, for more than twenty years, there was a relative lull in the increase in their practical number, and only in 2017, in the all-Russian year of PAs, their number increased by 4 natural monuments. These new nature monuments are: Kostinsky logs on an area of 1763.7 hectares (in Bolsheglushitsky district - 279.79 hectares and Bolshechernigovsky district - 1483.91 hectares), the Telegasskaya steppe (759.97 hectares - Kamyshlinsky district) and Sterekh Ravine (281.04 hectares - Khvorostyansky district).
**Table 2.** Development of PAs of regional significance in the municipal districts of Samara Oblast

| Municipal District | Years of PAs foundation (units) | Share of PAs (%) | Municipal District Rating by area of PAs |
|--------------------|---------------------------------|------------------|----------------------------------------|
| Alekseevsky        | 9                               | 0.39             | 21                                     |
| Bezenchuksky       | 4                               | 4.38             | 4                                      |
| Bogatovsky         | 4                               | 0.53             | 24                                     |
| Bolsheglushitsky   | 1                               | 0.50             | 15                                     |
| Bolshechernigovsky | 1                               | 3.67             | 3                                      |
| Borsky             | 4                               | 0.05             | 27                                     |
| Volzhsky           | 5                               | 3.25             | 5                                      |
| Elkhovsky          | 1                               | 0.21             | 26                                     |
| Isaklinsky         | 3                               | 0.47             | 20                                     |
| Kamyshtinsky       | 2                               | 4.70             | 9                                      |
| Kinelensky         | 1                               | 6.84             | 1                                      |
| Kinel-Cherkassky   | 7                               | 0.45             | 16                                     |
| Klyavlinsky        | 2                               | 0.26             | 25                                     |
| Koshkinsky         | 2                               | 0.99             | 13                                     |
| Krasnoarmeysky     | 6                               | 0.49             | 17                                     |
| Krasnoyarsky       | 2                               | 0.88             | 11                                     |
| Neftegorsky        | 8                               | 0.56             | 19                                     |
| Pestrovsky         | 2                               | 2.33             | 8                                      |
| Pokhvistnevsky     | 9                               | 2.93             | 7                                      |
| Privolzhsky        | 7                               | 0.39             | 22                                     |
| Sergievsky         | 3                               | 0.38             | 18                                     |
| Stavropolinsky     | 1                               | 0.53             | 12                                     |
| Syzransky          | 1                               | 5.74             | 2                                      |
| Khvorostyansky     | 2                               | 0.29             | 23                                     |
| Chelno-Vershinsky  | 6                               | 2.04             | 10                                     |
| Shentalinsky       | 2                               | 1.20             | 14                                     |
| Shigonsky          | 1                               | 3.77             | 6                                      |
| Total              | 25                              | 152              | 24                                     |
| Average            |                                 | 1.79             |                                        |

The registration of regional PAs takes place on the basis of the object, population-specific and complex ecosystem principle. Natural monuments in Samara Oblast are represented mainly (47.8%) by forest stands, including natural forests and forest plantations of anthropogenic origin. This is quite natural due to the low forest cover in the region. Natural monuments also include sources of surface and underground waters and territories confined to them (25.6%), as well as geological objects, including high and low areas (18.6%) and steppe expanses (8%).

The average area of natural monuments in municipal districts has now reached more than 451 hectares, which is 38 hectares or 9.2% more than in 1967.

The dynamics of the involvement of natural objects in PAs indicates a significant variability of their territorial features. Along with small objects with an area of less than 0.5 hectares: Spring in the vicinity of the village Chubovka (0.01 hectares) in Kinelsky district, the Holy well (0.02 hectares), Barinovsky spring (0.03 hectares) in Neftegorsky district and others, there are registered large objects over 10 thousand hectares in size, i.e., they differ in area by a factor of one million. The relative shallowness and less variability at the initial stage of registering natural monuments with an area of
slightly more than 1900 hectares was replaced by the formation of large (more than 10 thousand hectares) protected areas.

Large natural monuments - landscape massifs are of a complex nature of registration, which includes a variety of natural and anthropogenic factors. Thus, the largest natural monument in the region in terms of area (13377.73 hectares), Krasnosamarsky pine forest, located in Kinelsky district, represents a special ecosystem. Here, according to the explication of land, large areas are occupied by forests (12,028.53 ha), meadows (1018.5 ha), swamps (91.5 ha), water bodies (27.4 ha), as well as roads (164.1 ha), glades and fire breaks (47.7 hectares). We believe that the ecosystem approach in the organization of PAs can be recognized as a positive phenomenon for the conservation of the natural environment, biological, hydrological and geological diversity.

Some PAs occupy the border areas of two districts at the same time, or an urban district and a municipal district. These are the Verkhovoy Ravine (in Krasnoyarsky district - 62.29 hectares and Kinelsky district - 9.71 hectares), the Genkovskaya forest belt, quarters 15-23 (in Volzhsky districts-280.85 hectares and Krasnoarmeisky district - 595.48 hectares), the Konduchinsky forest-steppe (in Shentalinsky district - 1043.52 hectares and Sergievsky district - 63.35 hectares), Kostinsky logs, Mastryukovsky lakes (Samara city - 298.68 hectares and Stavropol district - 22.61 hectares).

On average in the region, the share of PAs of regional significance is 1.79%, however, their distribution across municipal districts is extremely uneven. The amplitude of fluctuations is from 0.05% in Borsky to 6.84% in Kinelsky district, the difference is 137 times. At the same time, in 17 municipal districts, or approximately 63% of their total number, the share of PAs from the entire district land area is less than the regional average. Kinelsky, Syzransky, Bezenchuksky, Bolshechernigovsky districts are by far leading the aggregate rating of municipal districts in terms of area and the share of PAs from the total area of their territories, and Borsky, Elkhovsky, Klyavlyinsky, Khvorostyansky districts close this rating. Here we see a large reserve for lagging regions to bring their indicators to the average regional parameter.

The subjective factor is superimposed on the peculiarities of the distribution of regional PAs. We observe this when geographically close subregions with identical or very similar natural conditions differ significantly. So, if Kinelsky district occupies a leading position (1st place in the rating), then, respectively, in terms of area and share of PAs, the neighboring Kinel-Cherkassky district holds the 16th and 20th lines of the rating. Krasnoyarsky district – 11th and 13th, Neftegorsky – 19th and 14th lines of the rating.

The accessibility of PAs of regional significance in the municipal districts of Samara Oblast is relatively low and varies greatly (table 3). The accessibility is determined, first of all, by the very different size and density of the population in the municipal areas. More than 109 thousand people live in Volzhsky district with a population density of about 0.4 people / ha, and in Elkhovsky district - less than 10 thousand people with a population density of about 0.08 people / ha. The difference in these indicators is 11.7 and 5 times, respectively. The average number of PAs in the municipal districts is 7.6 objects, with a large variability from 2 in Koshkinsky and Stavropol to 13 in Syzran districts. In the Volzhsky district and in other densely populated areas, even despite the rather high indicators of the area and the share of protected areas, the accessibility of natural monuments for the population is rather problematic.

Currently, a widespread tendency has developed in the region: the higher the population and its density, the less chances for the preservation of natural objects of the organic world, the more destruction in the geological environment and disturbances in the hydrological sphere.

The average specific value of accessibility of PAs of regional significance in the municipal districts of Samara Oblast reached 0.121 ha / person. With a significant variation in the indicator of the outsider (0.004 ha / person) in Borsky district and the leader (0.597 ha / person) in Bolshechernigovsky district. In the latter case, this happened both due to the relatively large area of PAs in the district (3rd place in the region) and the relatively low population size (16th place). It can be unambiguously recognized as abnormal that only in 9 or 33% of the districts of Samara Oblast, the accessibility of PAs is higher than the regional average. We identified models or groups of territories...
with significant differences (table 4, 5) using the general statistical approach and ranking the municipal districts of Samara Oblast by the specific value and degree of accessibility of PAs.

**Table 3. Accessibility of PAs of Regional Significance in The Municipal Districts of Samara Oblast**

| Municipal District | Number of PAs (units) | Provision of the population with PAs (ha/person) | Municipal District Rating |
|--------------------|-----------------------|-------------------------------------------------|---------------------------|
|                    |                       |                                                 | by population | by number | by specific value |
| Alekseevsky        | 9                     | 0.063                                           | 25           | 5         | 14               |
| Bezenchuksky       | 7                     | 0.222                                           | 6            | 7         | 8                |
| Bogatovsky         | 4                     | 0.030                                           | 22           | 10        | 19               |
| Bolsheglushitsky   | 5                     | 0.070                                           | 15           | 9         | 13               |
| Bolshechernigovsky | 10                    | 0.597                                           | 16           | 4         | 1                |
| Borsky             | 5                     | 0.004                                           | 11           | 9         | 27               |
| Volzhsky           | 12                    | 0.073                                           | 1            | 2         | 12               |
| Elkhovsky          | 5                     | 0.026                                           | 27           | 9         | 20               |
| Isaklinsky         | 8                     | 0.062                                           | 24           | 6         | 16               |
| Kamyshinsky        | 10                    | 0.369                                           | 26           | 4         | 5                |
| Kinel-Cherkassky   | 7                     | 0.431                                           | 8            | 3         | 3                |
| Klyavlinsky        | 5                     | 0.026                                           | 23           | 9         | 25               |
| Koshkinsky         | 2                     | 0.075                                           | 13           | 11        | 11               |
| Krasnoarmeysky     | 6                     | 0.062                                           | 17           | 8         | 15               |
| Krasnoyarsky       | 9                     | 0.037                                           | 3            | 5         | 17               |
| Neftegorsky        | 8                     | 0.024                                           | 7            | 6         | 24               |
| Pestravsky         | 6                     | 0.281                                           | 18           | 8         | 6                |
| Pokhvistnevsky     | 9                     | 0.229                                           | 9            | 5         | 7                |
| Priluzhsky         | 7                     | 0.024                                           | 12           | 7         | 23               |
| Sergievsky         | 10                    | 0.023                                           | 4            | 4         | 26               |
| Stavropolsky       | 2                     | 0.025                                           | 2            | 11        | 22               |
| Syzransky          | 13                    | 0.445                                           | 10           | 1         | 2                |
| Khvorostyansky     | 8                     | 0.033                                           | 19           | 6         | 18               |
| Chelno-Vershinsky  | 6                     | 0.164                                           | 21           | 8         | 9                |
| Shentalinsky       | 7                     | 0.108                                           | 20           | 7         | 10               |
| Shigonsky          | 11                    | 0.394                                           | 14           | 3         | 4                |
| Total/Average      | 7.6                   | 0.121                                           |              |           |                 |

**Table 4. Distribution of municipal districts of Samara Oblast by specific size of PAs**

| Specific value of PAs, % | Municipal Districts |
|--------------------------|---------------------|
| more than 5.0            | Kinelsky, Syzransky |
| 4.9 – 2.0                | Bezenchuksky, Bolshechernigovsky, Volzhsky, Kamyshinsky, Pestravsky, Pokhvistnevsky, Chelno-Vershinsky, Shigonsky |
| less than 2.0            | Alekseevsky, Bogatovsky, Bolsheglushitsy, Borsky, Elkhovsky, Isaklinsky, Kinel-Cherkassky, Klyavlinsky, Koshkinsky, Krasnoarmeysky, Krasnoyarsky, Neftegorsky, Priluzhsky, Sergievsky, Stavropol, Khvorostyansky, Shentalinsky |
Table 5. Distribution of municipal districts of Samara Oblast by the accessibility of PAs

| Accessibility of PAs (ha / person) | Municipal Districts |
|-----------------------------------|---------------------|
| **Districts with high level of accessibility** | more than 0.40 |
| Bolshechernigovsky, Kinelsky, Syzransky |
| **Districts with an average level of accessibility** | 0.39 – 0.20 |
| Bezenchuksky, Kamyshlinsky, Pestravsky, Pokhvistnevsky, Shigonsky |
| **Districts with low level of accessibility** | less than 0.19 |
| Alekseevsky, Bogatovsky, Bolsheglushitsky, Borsky, Volzhsky, Elkhovsky, Isaklinsky, Kinel-Cherkassky, Klyavlinsky, Koshkinsky, Krasnoarmeytsky, Krasnoyartsky, Neftegorsky, Privolzhsky, Sergievsky, Stavropol, Khvorostyansky, Chelno-Vershinsky, Shentalinsky |

The grouping of municipal districts by classes of shares and accessibility of protected areas for the population has the character of an abnormal distribution with a shift to the left towards the area of low values by type, when a group of leaders with their relatively high indicators hides the general disadvantage of subregions. Most of the administrative units are classified in groups with a low proportion (17 districts) and low accessibility of the PAs for the population (19 districts). The groups with a high share of protected areas include 2 districts (Kinelsky and Syzransky), and with high accessibility - 3 districts (Bolshechernigovsky, Kinelsky and Syzransky).

The lack of accessibility for the population of PAs of regional significance is to some extent compensated by the presence of protected areas of a different status in Samara Oblast. An improvement in the PAs situation in municipal districts is expected in connection with the implementation of an important regulatory document adopted in Samara Oblast and updated in 2014: "A prospective scheme for the development of PAs of regional significance", which envisages an increase in the number of protected areas by 120 objects. However, its implementation may face significant financial, land, legal and other difficulties.

The use of exclusively municipal indicators in the analysis forms, to a certain extent, builds an ideal conflict-free model that can be extended to remote less urbanized and industrialized sub-regions of the northern and southern parts of Samara Oblast. In reality, it is much more complicated, especially in the central part of the region. In this regard let us assume three options or models of offsetting benefits and environmental costs for PAs.

The first option, associated with compensatory benefits, is typical for Borsky district, which ranks last in the region in terms of natural monuments of regional importance. However, within its borders there is a National Park "Buzuluk Bor" with an area of 51,288 hectares. If we summarize the data about PAs of regional and federal significance, then this municipal district becomes the unrivaled leader in the region. With hyperindicators of the total area of PAs (51491.7 ha), its specific value (24.5%) and the highest (2.19 ha / person) accessibility level for the population.

The second option - direct environmental costs - can be extended to the municipal districts in which the following urban districts are located: Kinelsky (Kinel), Pokhvistnevsky (Pokhvistnevo), Kinel-Cherkassky (Otradny), Syzransky (Syzran). Here, there is a joint pressure on the natural systems of municipal districts with a certain set of protected natural monuments and urban environments with little or no PAs. If we turn to the situation in the leader's Kinelsky district, then the integral environmental costs of the municipal and urban environment become extremely large. Municipal indicators are corrected for the worse and fall in terms of PAs accessibility from 0.431 to 0.153 ha / person or reduced by 2.8 times, due to an increase in the same proportion of the total urban and rural population to 90388 people.
The third option can be considered for municipal districts (Volzhsky and Stavropolsky), which are under the cumulative critical environmental pressure of Samara-Togliatti agglomeration, including the cities of Zhigulevsk, Novokuibyshevsk and Chapayevsk. On the one hand, for the municipal subregions one can see compensatory advantages in the location of the largest PAs of federal significance, National Park Samarskaya Luka with an area of 127186 hectares. Take, for example, Volzhsky municipal district: if extend these advantages to this district alone, then even without any calculations, an obvious gain is visible. However, if we evaluate objectively, and even taking into account the more than one million population of Samara, the environmental losses are also no less grandiose. Thus, ghostly compensation benefits translate into real environmental costs.

Undoubtedly, for the development of regional natural monuments, it is quite obvious to take into account compensatory advantages and direct environmental costs, the PAs of federal significance, as well as the influence of an aggregate municipal and urban environment. Based on this, we propose to use the obtained research results for making current managerial decisions, as well as for the formation and modernization of Territorial Development Strategies for the future. We believe that it is imperative to develop joint projects for environmental improvement, to agree on the Strategies for the socio-economic development of municipal and urban districts with a relatively common territorial affiliation.

4. Conclusions
In conclusion, we consider it important to note that based on the statistical analysis, we obtained the following results:
- we established the dynamics, features and accessibility of PAs of regional significance in the municipal districts of Samara Oblast;
- we demonstrated a significant variability of the areas of PAs and their specific value, accessibility for the population, the relationship of individual parameters; we have compiled a rating and a classification of municipal districts according to the given indicators;
- we identified categories of municipal districts with high, medium and low proportion of PAs in the total area of the subregional area and their accessibility for the population;
- we considered various options or models of compensatory benefits and environmental costs of municipal districts, taking into account PAs of federal significance and the influence of an urban environment.

We propose to use the obtained research results for making current managerial decisions in the interaction of regional environmental authorities with the administrations of municipal districts, for adjusting the long-term development scheme for PAs of regional significance and for improving the Territorial Development Strategies.

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