Ekoloji 27(106): 1713-1717 (2018)

Approaches to the Environmental Assessment of Landscapes in the Republic of Tatarstan

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Abstract

Research relevance: Various types of anthropogenic geosystems as a specific category of natural formations have recently been in the focus of modern landscape science. The goal of the study: This article aims to assess the ecological state of landscapes in the Republic of Tatarstan. Research methodology: the main research method used in this study was the analysis of the relationship between anthropogenic pressure and the current state of landscapes and their components. Research outcome: Drawing on the indicators of anthropogenic change calculated within this study we conducted their differentiation in accordance with their levels of ecological states. Following the areographic analysis we present the bioecological assessment of ornithologic fauna (avifauna) within the selected territorial areas. Then we attempt to identify any relationship (either direct or negative) between the indicators of ornithologic fauna population and ecological state of the selected territory. Practical implications: the findings of the study can be used for the development of relevant measures aimed at improving the current ecological state of the Republic of Tatarstan.

Keywords: geosystem, anthropogenic change, environmental security, ornithologic fauna

Ulengov RA, Khuziakhmetov AN, Nasibullov RR, Yarullin IF (2018) Approaches to the Environmental Assessment of Landscapes in the Republic of Tatarstan. Ekoloji 27(106): 1713-1717.

INTRODUCTION

In view of people's growing industrial activity and changing environment it is becoming obvious that there is a need to assess if certain territories are suitable for the life of humans and animals (Galeeva et al. 2014). The suitability of environment can be examined and assessed by different components but also as a whole system. Focusing on geosystems allows studying the whole complex of components' interconnections which indicate current and predicted changes (Brullot 2009). Functions related to resource production depend on the level and characteristics of geosystems which are important for living populations and vulnerable for human activity.

The unique ecological conditions of the Republic of Tatarstan have resulted from the combination of untouched natural habitat areas and completely transformed areas under heavy anthropogenic pressure (Rubtzov et al. 2015). This characteristic of the region reflects the pronounced specificities of shifting landscapes defined by human-induced transformation. This characteristic can also be used for assessing the level of anthropogenic impact on the ecological conditions of territories.

METHODOLOGY

The main research method used in the course of this study was theoretical analysis of relevant academic literature, historical documents, statistical information (Kochurov and Ivashkina 2015). The ecological state (conditions) of a territory can be assessed in accordance with its type of use and its population characteristics (including the level of urbanization). Environmental assessment involves the identification of various technological influences on geosystems while the usage exploration level can be measured through analyzing how the territory is being used (Kochurov 2003).

RESULTS

The location of Tatarstan on the border between sub-taiga and forest-steppe zones determines the high level of natural diversity in the region while long-term human exploration of the region resulted in a substantial human-induced territory transformation. The term 'territory' is used in many different disciplines and fields (physical geography, economic geography, ecology, etc.) and, therefore, can be defined differently (Safina et al. 2016). Within this study we focused on territories of various sizes which are united onto regional geosystems. The aforementioned territorial characteristics of the region reflect the most

 Received: 25 May 2018 / Accepted: 2 Oct 2018

pronounced features of a shifting landscape determined by their anthropogenic transformation. These characteristics also help assess the level of the anthropogenic impact (specific scoring system) on the ecological state of a territory as well as on its usage exploration level. There is no consensus when it comes to the issue of classifying urban landscapes as specific taxonomic units of a geographical environment (Yermolaev et al. 2007). Diverse biotypes create a colorful tapestry of habitats which have similarities with the majority of cities because similar biotypes are present in all inhabited localities. The landscape characteristics of geosystems in an area reflect the most pronounced features of a shifting landscape and can be manifested through various combinations of all territorial types (1 – industrial territories with a) high, b) low population density; 2 – industrial and agricultural territories with a) high, b) low population density; 3 – agricultural territories with a) high, b) low population density). This makes it difficult to identify the borders of these territories.

The species composition and ornithologic fauna population density in these territories is characterized by a high level of distinctness. It is possible to differentiate a range of smaller territorial allotments after analyzing the state of biodiversity within the studied types of territories taking into account physicogeographical, natural environment and climatic characteristics as well as the nature of use and exploration of territories. The Western and Eastern Predkamie are a 3a type territory, the Volga region is a 1a type territory, the Sviyazhsk region is a 3b type territory, the Western Zakamie is a 2b type territory, the Nizhnekamsk region and Eastern Zakamie are 1b type territories. The level of anthropogenic transformation among natural landscapes is defined by urban localities, main transport routes, and the nature of territorial use and exploration. Every aforementioned territorial complex has its own distinct avifauna with its spatial distribution. Various anthropogenic factors (which are determined by the type of territorial use and industrial activities) influence the composition of avifauna and contribute to its transformation and relative stabilization on a new level. Among the main anthropogenic factors influencing the environment and determining the level of anthropogenic transformation for a natural ecosystem are the level of agricultural development, industrial use, population density and urbanization.

In terms of the anthropogenic situation and the character of bird population distribution in Tatarstan we differentiated seven environmental-territorial complexes which range on their ecological and faunistic characteristics. At the core of this differentiation are the materials of economic and geographic zoning in Tatarstan, natural zoning in Tatarstan, the research findings of Rakhimov (2002) and other ornithologist from different parts of Tatarstan. The demographic situation of regions indicates the level of their exploration and resource use for industrial purposes.

When zoning the selected areas (which were zoned differently by different scientists) we took as a basis the system of natural regions. Various anthropogenic factors (which are determined by the type of territorial use and industrial activities) influence the composition of avifauna and contribute to its transformation and relative stabilization on a new level (Zamaletdinov et al. 2016). Among the main anthropogenic factors influencing the environment and determining the level of anthropogenic transformation for a natural ecosystem are the level of agricultural development, industrial use, population density and urbanization. Based on this we identified the adapted methodology for ecological assessment suitable for ornithological and geographic analysis within the selected natural territorial complexes.

Landscape, geographical position and the peculiarities of the main forms of agricultural activities in the area are the initial criteria for such an assessment (Kubishkina and Rafikova 2015). Our research explores geological systems of different dimensions in order to work out geographical methods for assessing the anthropogenic transformation of geological systems. They form spatial habitats and differ in their quality characteristics (Yermolaev and Selivanov 2014). The anthropogenic impact on the environment is measured by the system of evaluation scores in terms of ecological and agricultural condition of the area. The assessment of ecological and agricultural conditions of the area includes determining all types of anthropogenic transformation, environmental security of the area and of the lands that belong to the environmental fund. Anthropogenic transformation of the area can be assessed in comparable rates if the lands are grouped. The rates are absolute intensity ratio (Ka) and relative intensity ratio (Ko) of ecological and agricultural condition of the area, i.e. the ratio of the land size with high anthropogenic conversion (AC) to the land size with lower anthropogenic conversion. The attention should be focused on the ratio of the extreme values in order to balance high anthropogenic exposure with an aim of restoring the landscape and maintaining

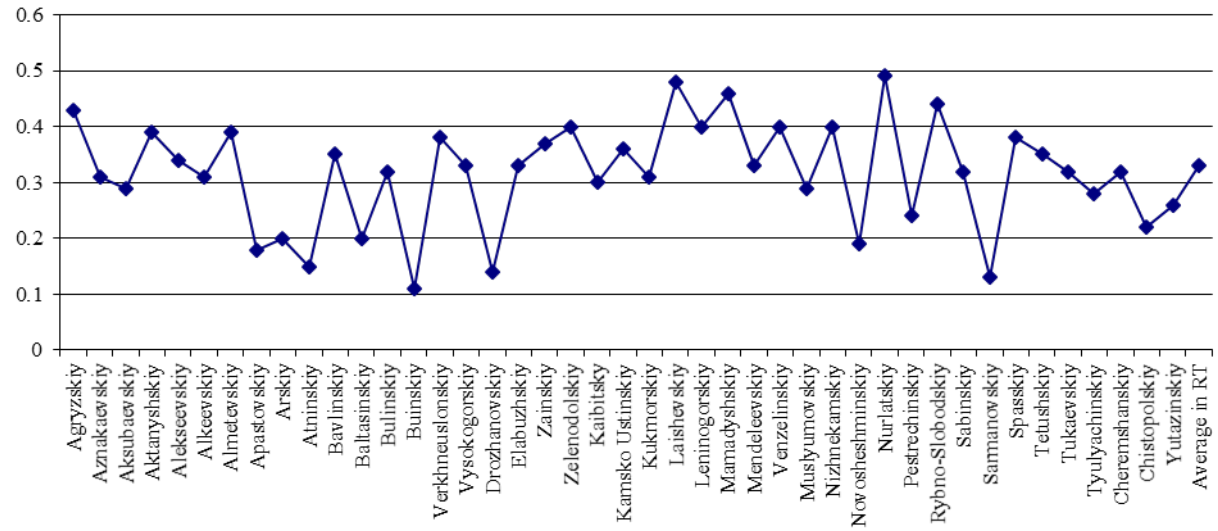

Fig. 1. Values of environmental security ratio in the municipal districts of the Republic of Tatarstan

Table 1. Ecological and agricultural state of natural reserve areas in the Republic of Tatarstan

Region	Ecological state	K_a	K_o	K_{e3}
Prikazanskiy	alert	0,35	1,57	0.39
Western Predkamie	alert	0,29	2,59	0.36
Eastern Predkamie	satisfactory	0,33	1,71	0.46
Nizhnekamskiy	alert	0,34	2,12	0.35
Eastern Zakamie	tense	0,41	3,3	0.29
Western Zakamie	alert	0,25	2,08	0.34
Sviyazhskiy	tense	0,44	3,22	0.28

necessary areas of reserves and other conservation areas at an appropriate level (Ulengov et al. 2014). Sviyazhsk region is characterized by the greatest intensity. Its Ka equals 0.44 which is why the ecologic situation in the region is characterized as tense. Rather a huge amount of secondary forests and no large cities in the region of the Western Zakamie reduces the absolute intensity ratio to 0.25. In general, ecological and agricultural condition of the area is mostly defined by Ko ratio as it considers the whole area. The decrease in the tension of the situation reduces Ko ratio. In case Ko ratio equals or is close to 1, intensity of ecological and agricultural condition of the area becomes balanced in terms of AC ratio and sustainability potential of nature. In Tatarstan only Laishevskiy district is balanced in terms of these two criteria (0.86). Nurlatskiy (1.06) and Mamadyshskiy (1.2) districts are close to being balanced. In addition to Sviyazhskiy region, an oil-producing region of the Western Zakamie is also characterized by a high intensity (Ulengov 2016).

The ratio of natural protection in the Republic of Tatarstan varies from 0.11 in Buinskiy district and 0.14 in Drozhanovskiy district up to 0.48 in Laishevskiy and 0.49 in Nurlatskiy districts. The average value in the republic is 0.33. It points at a low natural protection level of the area (**Fig. 1**).

DISCUSSION

Each anthropogenic exposure or their combinations have own limit of sustainability related to natural and anthropogenic landscapes. The more diverse the landscape, the more stable it is (Nabeyeva et al. 2015). It is characterized by a large amount of evenly distributed natural biogeocoenosis, conservation areas and designated conservation areas. They constitute ecological fund of the area, i.e. the total land area that fulfils environmental and resource stabilizing functions. The ratio of natural protection K_{E3} is integral. It can be used for a comprehensive assessment of the area and is defined as the ratio of the land area with resource-stabilizing functions to the total studied area.

The values of the intensity ratio and the ratio of environmental security act as indicators for identifying ecological condition (**Table 1**).

Each geographical landscape has its own faunistic and ecological unique features. Landscape and aerographic analysis was performed for identifying

ornithological characteristics of the areas. The analysis is based on the synthesis of two approaches: zoning and typology (Urazmetov and Smirnova 2014). The highest taxonomic units are related to the zoogeographic zoning, the middle and low units are related to the landscape typology. All the birds in the world constitute large avifaunas some of which consist of subfaunas. The name of the natural area indicates not only its belonging to a large fauna or subfauna (for example, Palaearctic) and its sector (trans-longitudinal, western, middle and eastern parts), but also its landscape positioning. One example is a temperate-subtropical distribution (temperate is a type which nesting area is found in boreal and subbreal types of landscape located in the temperate zone). Hierarchical classification is based on the similarity of the nesting areas of birds (Gukov 2004).

In the boreal landscapes of Tatarstan the fauna is mainly represented by southern taiga, subtaiga, deciduous forests, a subclass of pine forests, deciduous pine forests, which are distributed in the southern taiga up to the subzone of deciduous forests, and the class of the population groups of meadows following by the southern taiga, subtaiga and deciduous forests. These are Palaearctic trans-longitudinal, Palearctic-Paleogean *temperate-subtropical species* (Rakhimov 2016). The subboreal deciduous landscapes are dominated by the population groups of deciduous forests, the species of the population groups of forests, which are represented in the subzone of deciduous forests, and the class of the population groups of forest-steppe forests. These are the Western Palaearctic and Palaearctic trans-longitudinal *temperate subtropical* and *temperate* species. The class of the forest-steppe forests, forest-steppe meadows marshes, steppes and fields dominate in the subboreal forest-steppe landscapes. These are the Western Palaearctic and Holarctic *temperate subtropical* species.

The level of synantropization of ornithocomplexes determines bioecologic peculiarities of the given area. The criteria of synantropization are biotopical distribution, the diversity of species, population density, presence or domination of synanthropic species in ornithocomplexes, the factorial dependence of the converted PTC on the ornithocomplex parameters (Rakhimov and Ibragimova 2018).

CONCLUSION

The assumption that ecological situation depends on the type of landscape was not proven. Boreal and subboreal (broadleaved) landscapes have experienced a powerful anthropogenic impact for a long time. The forest areas are not larger, and in some cases are even less than the forest areas of subboreal forest-steppe landscapes. Forests act as the main sustainability factors that increase the coefficient of natural protection. Each natural-territorial habitat has its own faunistic and ecological features. The results of the analysis of biological diversity of avifauna in natural-territorial habitats in Tatarstan make it possible, when comparing data on avifauna and data on the intensity of the ecological and agricultural condition with natural protection ratio, to reveal a reliable inverse correlation between the relative intensity factor and the species composition coefficient. There is a decrease in the overall number of birds and the number of bird species in the field habitats of Tatarstan as they move from the west to the east and to the southeast. The total population density of birds is in direct relation to the mosaic of the landscape, the total forest cover, and tilled territory. The species composition of the region's avifauna increases due to a decrease in the intensity of the ecological and agricultural condition of the area (by increasing the land size that fulfills sustainability functions).

ACKNOWLEDGEMENTS

The work is performed according to the Russian Government Program of Competitive Growth of Kazan Federal University.

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