Ecological planning of urbanized areas in the south of the Far East (Birobidzhan city as an example)

V B Kalmanova

Institute for Complex Analysis of Regional Problems FEB RAS, 4 Sholom-Aleikhem St., Birobidzhan, 679000, Russia
E-mail: Kalmanova@yandex.ru

Abstract. Ecological planning of urbanized areas is an urgent demand of the time, because more than 70% of Russia's population lives in cities. The article describes that the city's ecological planning is an important part of the area's organization in its development strategy. The principles and features of the urban area's ecological organization are proposed. The basis for environmental planning is the ecological and functional zoning of urban areas. The algorithm of ecological-functional zoning is developed to optimize the quality of the urban environment. Based on it, it is possible to identify the planning structure's features, justify anthropogenic pressure on the natural components of the urban environment, etc. The article briefly presents the possibility of using the main conditions of the ecological framework in the planning of urban areas. Considering the perspective trends of the formation and development of cities in the south of the Far East, the ecological problems caused by regional natural and anthropogenic causes (features of relief, climate, functional-planning structure) are considered. The need for environmental planning of cities in the south of the Far East is shown. The results of the ecological framework's formation of Birobidzhan city based on its ecological and functional zoning are described. The total area of open unreformed spaces in the city is calculated to be 60.8%, which can serve as the main elements of the ecological framework and perspective reserve areas for ecological planning. The cartographic model of Birobidzhan's ecological framework is presented, which is the result and model of this type of planning. The practical use of the proposed model will facilitate the adoption of effective management decisions aimed at stabilized development of the city.

1. Introduction

Currently, 73% of the Russian population is concentrated in cities. In some countries, this proportion is even higher. Generally, the growth of cities leads to environmental problems, which are the result of numerous related problems. According to environmental indicators, approximately 15% of Russian territory is in a critical or near-critical condition. 60% of Russia's population lives in unfavorable environmental conditions (eg, 76% of the Northwestern economic region, 52% - Volga region , 54% of the West-Siberian region live in environmentally dangerous conditions (I category of danger); 46% of the population of the south of the Far East live in the region of the 2nd danger category, etc.) [1]. A certain "input" to the creation of these problems, together with the state of the natural environment and the development of natural processes, is also contributed by the territorial organization of the city (features of the planning structure, location of functional zones).

The issues of territorial planning in the spatial development of the city acquire a key importance, because they allow an approach to different types of urban areas and in each individual case to determine qualitatively different directions of environmental and town-planning policies and practices.

Ecological planning of urban areas allows not only to create favorable conditions for living and recreation of the population in residential areas, but also to protect ecologically valuable areas (recreational, coastal, water protection and sanitary protection zones) from illegal and chaotic building.

Recently, the planning of territories is increasingly focused on the inclusion of environmental functions, which are inherent in individual components of nature - landscapes, soils, vegetation, etc. Thereby, the functional zoning of urban territories in its various aspects acquires significance, one of which is the ecological and functional zoning. In contrast to the traditional segmentation of urban areas, which are divided into residential, industrial, communal, warehouse, sanitary-protective, landscape-recreational and other zones by type of use, this zoning takes into account the value and priority of ecological functions performed by urban ecosystems and their individual components and which have a environment-forming, environment-stabilizing (environmental control) or environmental destabilizing value [2]. Zones with a dominance of environment-forming functions create a basis for the ecological framework of area. In turn, ecologic -functional zoning and the ecological framework of the urban area serve as the basis for the development of a local ecological regulatory framework [3].

For cities in the south of the Far East, the experience of environmental planning is practically non-existent, in general, planning of the territory is subordinated to town-planning goals.

The Far East is one of the most urbanized regions of the Russian Federation, in connection with the natural features of the territory - 80% of the population is concentrated in cities. Technogenic pollution of the Far East's cities cannot determine an overwhelming part of their territory as favorable for human habitation. Many cities in the south of the Far East were formed as "power centers" with military and political goals, without taking into account the natural features of the territory to the detriment of the ecological state of the environment. A special feature of many Far Eastern cities is the gradual build-up of industrial potential, which was carried out at a time when economic growth was a priority to the detriment of environmental requirements. As a result, there is no demarcation zone (buffer zone) between the residential and industrial sectors. Some elements of infrastructure and social life are often located in the city. In the formation of the planning structure, the wind rose, geomorphological indicators, landscape and climatic differences of individual regions were not taken into account. The main results of negative impact are: pollution of ground and surface water, disruption of the hydrological regime; air pollution; land disturbance, etc. It is also important to note the specific features of the natural backgrounds, most often not quite comfortable, in which our cities "live". High vulnerability of natural systems, the character of the dynamics of natural processes do not "forgive the misses" in planning and lack of monitoring. This is exhibited not only in obvious and acute environmental problems, but also in higher economic costs for maintaining urban infrastructure (for example, road construction, the construction of sewage collectors, etc.) [4]. The acuteness of problems and the combination of causes leading to discomfort in different parts of the city and in the different towns of the region are changing.

The development of any city requires a complex geo-ecological approach to solve the issues of territorial planning and improving the state of environment. In the new social-economic conditions, it is necessary to develop approaches to geoecological research and integrated assessment of the territory, which allows determine the limitations of urban building, as well as to plan and adjust the prior urban and environmental measures [2, 3, 5].

2. Materials and Methods

Among the cities of the Far East, Birobidzhan was chosen as an object for the research, because it belongs to the category of medium-sized cities of the Far East, where the ecological situation is complicated by an indigested planning structure (chaotic location of functional zones, lack of sanitary protection zones). [6]. Unlike other cities of the Far East, Birobidzhan possesses a sufficient number of plantations (21%), open spaces (60.8%) and free zones (51%), related to potential reserve areas for ecological planning. Considering that, it is possible to develop a model for the optimal organization of the urban environment in order to improve the ecological situation in the city.

To optimize the quality of the urban environment, an algorithm for the ecological planning of the territory is proposed, which provides a clearly order of actions (figure 1). Ecological planning requires an objective and comprehensive ecological assessment of the state of the urban environment. Since a single integral indicator of ecological condition does not exist, the criteria for assessing natural components are a number of bio-indicators, spatial and dynamic indicators.

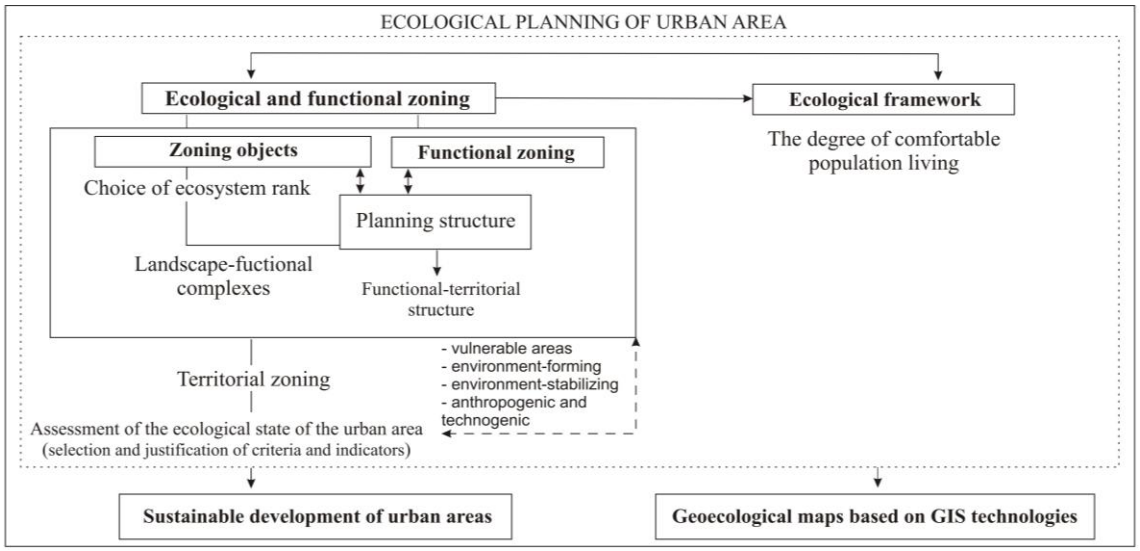


Figure 1. Algorithm of urban area's ecological planning.

At the regional level, each city should develop its own specific set of criteria for assessing the geoecological state of the natural environment, taking into account natural and anthropogenic factors, types of technogenic pressure. But the assessment should be made according to the same principles [1, 5, 7]: 1) the basic geoecological problems of the region should be identified; a systematic analysis of natural-anthropogenic and technogenic factors should be carried out; 2) a set of evaluative criteria and indicators should be developed; 3) classify the ecological state of the urban environment; 4) evaluative taxa- sectors, should be allocated; 5) a scale of expert evaluation should be developed; 6) calculations of evaluation points for all components of the urbanized environment and indicators for each site should be carried out and zoning of the territory should be made according to the geoecological state.

The result and model of this type of planning is the formation of the ecological framework of the urban area (EFUA), which should be preceded by the ecological and functional zoning of the territory, meaning the ranking of urban landscapes from the standpoint of their sustainability, combined with the performed ecological functions.

The published statistical data, literature, cartographic and stock materials of ICARP FEB RAS (Institute for complex analysis of regional problems of the Russian Academy of Sciences, Far Eastern branch), Federal State Statistics Service of Jewish Autonomous Region (Evrstat), The Federal Service for Controling in the Sphere of Nature Management of Jewish Autonomous Region were used in the working process. The main methods of research were comparative-geographic, semi-stationary methods of studying natural components, as well as a method of thematic mapping.

The methodology and principles for constructing the map "Ecological framework of Khabarovsk city", created by the Institute of Water and Environmental Problems (IWEP) of the Far East Branch of Russian Academy of Sciences [2]. The map of the ecological framework of Birobidzhan is made on a scale of 1: 25000 by the traditional method and digitized using the ArcView GIS software.

3. Results and discussion

Formation of the ecological framework of Birobidzhan was preceded by geoecological analysis of the territory and its ecological and functional zoning.

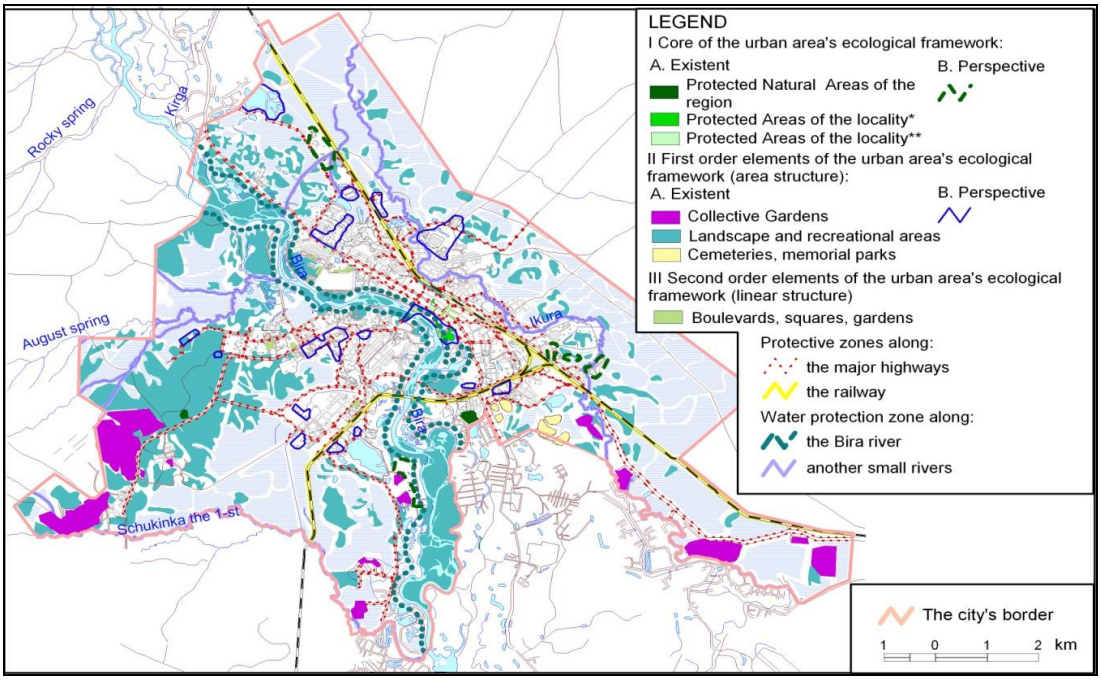
Based on the results of the geoecological assessment, zoning of the Birobidzhan territory was carried out according to the pollution level, which showed that 4% of the city area has a very high, 8% to high, 10% to above average, 47% to average pollution levels, 31% to relatively clean areas cities.

Ecological and functional zoning of the territory assumes the ranging of urban landscapes from the standpoint of their sustainability, united by the performed ecological functions. According to the ecological and functional zoning of the territory, a structure was developed for Birobidzhan; the core, first order elements of the urban area's ecological framework (area structure), second and third order elements of the urban area's ecological framework (linear structure) were identified (table 1, figure 2)

Table 1. Structure of ecological and functional zones of the Birobidzhan territory

Ecological and functional zone	Element of ecological-functional zone	Main functions
Vulnerable (7.1% of the total area of urban land)	Ravines, ash dumps, dumps, wastelands, industrial wastelands, quarries, plots of debris and landslides.	Destruction of natural and natural-anthropogenic complexes as a result of erosion and geological processes; Dust formation.
Environment-forming (46%)	1. Monuments of nature of regional importance (farm, dendropark). 2. Natural territories of local importance (Park of Culture and Recreation). 3. Landscaping and recreational areas. 4. Swamps.	Genetic conservation of biodiversity; microclimate formation; conservation of ecosystems of natural and anthropogenic value, as well as natural habitats of plants, terrestrial and soil fauna.
Environment-stabilizing (16.4%)	1. Natural territories of local importance (Square of Victory, Veterans, Teatralny; "Friendship of Peoples" Square, etc.). 2. Public gardens. 3.Boulevards, squares, promenades. 4. Cemeteries, memorial parks. 5. Water protection zone along the Bira river and other small rivers. 6. Protective zones along motorways, railways.	Erosion-stabilizing; ensuring water quality and normal hydrological regime; stabilization of the ratio of oxygen and carbon dioxide in the air; wind regime regulation.
Anthropogenic and technogenic (30.5%)	1. Residential, industrial, agricultural areas, 2. Linear and core infrastructure systems.	Ensuring the citizens life.

In the formation of an ecological framework of Birobidzhan, special attention was paid to the fact, that the main elements of the EFUA were connected by linear elements and adjoined to watercourses and water protection zones. The last ones, extending beyond the boundaries of the urban area, joined the landscape complexes of local and regional levels. Ash dumps and wastelands are perspective for the ecological framework. Dumps, ash dumps and quarries account 1.8% of the total area of Birobidzhan, while this number should be less than 1%. Wastelands (3.2%), including technogenic ones, are found in every district of the city. Depending on the plans for the future development of the urban area, they could be used to form EFUA elements.



Note: the dominant function (* environment-forming, ** environment-stabilizing)

Figure 2. Ecological framework of the Birobidzhan territory.

In the formation of EFUA, a special attention is given to a system of relative green areas of the city that perform environment-forming and environment-stabilizing functions. Determining the functional significance of green plantations, they should be considered as an integral part of general system – EFUA; and considering the structure and state - as an independent system - the "green" framework of the city. In Birobidzhan public green spaces comprise 18% of the city's area, restricted - 0.5%, special use - 2.8%. For 1 person is 561.6 m^2, taking into account the urban forests located in the environs of the city. Nevertheless, if we consider the territory within the urban development, there is a lack of green spaces: per person account for 4 m^2, at a rate of 21 m^2. It is very difficult to reach the norm, as the city is being built exactly within the boundaries of development and, accordingly, the green zones are being destroyed. The number of plantings of all categories has declined and continues to decline; their quality is deteriorating. Over the past 5 years there has been a general reduction in vegetation by 30%. It is possible to achieve the norm due to a sufficient number of open spaces (60.8%).

The main component of the EFUA is open spaces of the city, which include territories covered with greenery. Due to them, it is possible: 1) to minimize unfavourable climate and other environmental conditions; 2) to bring the number of green spaces to the regulatory parameters, which can perform protective, health and other functions; 3) to preserve and improve the quality of basin that can perform recreational functions; 4) to increase the ability of air to self-purify .

The obtained results can be used as a basis for optimizing the urban environment. For recommendations, the following options for planting the urban environment are proposed:

1) creation of one continuous green frame;
2) renovation and preservation of the connection between urban planting and the suburban area;
3) presence of large green areas, which are the centers of high biodiversity concentration;
4) maximum equability and accessibility of green areas of general use for city residents;
5) rational planning of planting, in accordance with the general plan for the development of the city;

6) creation of plantations, ecologically adapted to local climatic conditions and anthropogenic factors; protection of green spaces located on the territory of the city, regardless of the form of property, where these plantations are located (reconstruction of green spaces, if possible);

7) creation of a plan for the planting's regularization on the territory of the city, taking into account their functional significance;

8) increasing the level of workers' skills associated with the greening of the city.

4. Conclusions

An analysis of the complex of social and environmental problems, which are existed in the cities of the Far East, makes possible to come to conclusions about the causes and acuity of problems (especially architectural and planning). This is the result of natural and climatic conditions, but to a large extent - the effect of inefficient or poor-quality town-planning and engineering activities since the period of the formation and development of cities.

Birobidzhan is unique city that is different from other cities in the south of the Far East by the presence of a natural component. It belongs to the category of medium-sized cities in the south of the Far East, many of which receive an impulse for growth and development in recent years. Taking into account the intensification of economic activity within the Birobidzhan industrial hub in the short term, the most important component of environmental policy is the organization of the territory, at which its ecological part should be proactive and focused on carrying out the territorial structure of the economy in accordance with its resource base, orientation of strategic development plans, geosystem organization of natural complexes.

Consequently, environmental planning of the territory, taking into account the algorithm of its implementation and certain research methods, represents an important block of the integrated analysis of urbanized territories, which is necessary for making effective decisions with a view to formulating a city development strategy. The basis of its formation is ecological framework. Without legal status, the ecological framework of the urban area or its main provisions (developments) can be included in the general plan of the city. The mutual understanding of the developers of the ecological framework and the general plan can contribute to this. However, the general plan can effectively "work", if there are legal mechanisms for its implementation. Therefore, the creation of a local environmental regulatory framework becomes extremely important.

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