

## Model of Environmental Development of the Urbanized Areas: Accounting of Ecological and other Factors

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**Abstract.** Modern cities and towns are often characterized by poor administration, which could be the reason of environmental degradation, the poverty growth, decline in economic growth and social isolation. In these circumstances it is really important to conduct fresh researches forming new ways of sustainable development of administrative districts. This development of the urban areas depends on many interdependent factors: ecological, economic, social. In this article we show some theoretical aspects of forming a model of environmental progress of the urbanized areas. We submit some model containing four levels including natural resources capacities of the territory, its social features, economic growth and human impact. The author describes the interrelations of elements of the model. In this article the program of environmental development of a city is offered and it could be used in any urban area.

### 1. Introduction

Nowadays from about 7 billion population of the planet over a half (52%) live in the urbanized space, and the growth rates of number of city dwellers (on average annually 2.2%) considerably exceed rates of increase of mankind [1]. In many cities poor administration and wrong policy lead to quality degradation of the environment, poverty growth, lower economic growth and social isolation. For the purpose of coordination of such activities as settlements development in the UN system the United Nations Human Settlements Program (UN-Habitat) is founded. One of the priority UN-Habitat directions is a permanent urban development.

So for the solution of the above-mentioned problems the following programs are founded in the Russian Federation: social development, ecological development, economic development, development of science, development of industry, development of agriculture, etc. However, these separate programs don't solve a general problem of permanent development of the region taking into account all problems. The small exception is constituted by such strategies of regions development in which along with social and economic development actions of nature protection are also stated [2]. But even such strategy in general don't answer the common goal proclaimed UN-Habitat. The single Program as system of the interconnected subprograms taking into account all peculiarities of the region is necessary for achievement of permanent urban development.



The aim of this work is to develop a theoretical model of the program of environmental development of the urban areas taking into account ecological, human, social, economic factors of the specific territory.

Work tasks: to develop theoretical content of each "layer" of model that will act as a basis for the program of environmental development; to show the connection of all elements of each layer among themselves and between "layers"; to present the structure of this program based on the developed model.

## **2. The research object and work progress**

Materials for research are data from the official sources about the state of environment, social and economic constituent. In this research the basis for layers are the maps developed for creation of the general plan of Saratov city formed bases for layers in this work. The content of each layer in various regions (even in various administrative territorial units within one city) will differ, but the shown connections of elements of all layers will be the same for all regions. This model can become a copy for working out the development programs of any urbanized territory.

The object based on which the model will be created is Saratov city. Saratov is the administrative center of the Saratov region. Location – the right coast of the Volgograd reservoir.

Work progress:

1) the natural layer is developed. Natural and resource potential of the territory is determined; all natural resources are graphical displayed on the map.

2) the social group is developed. Human potential is determined; are graphical displayed on the map of a zone of density of population, incidence, and employment.

3) the economic layer is developed. The managing type, types and the level of development of all industries is determined. Because the creation of layers is subordinated to one purpose – creation of the program of environmental development, on this layer are displayed graphically area industry rankings, depending on level of impact on the environment.

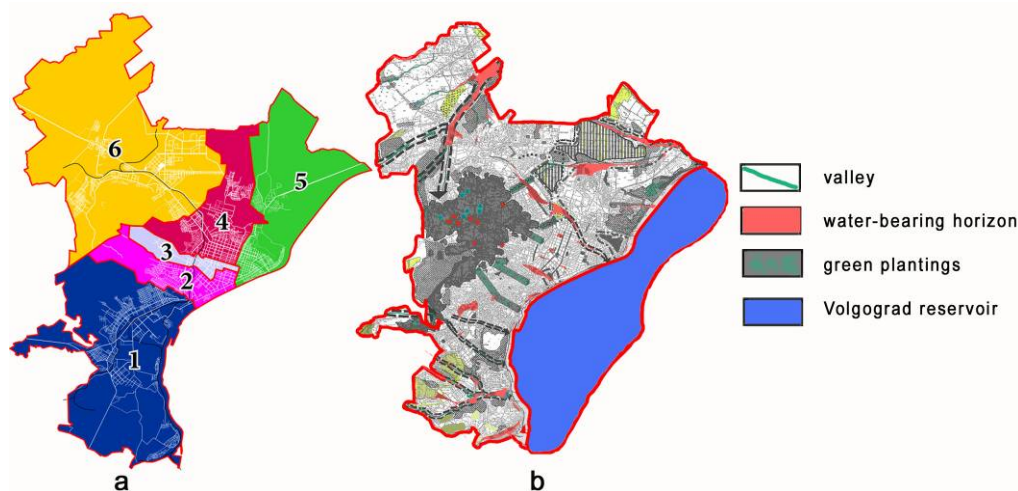
4) the layer "an environment condition" is developed. Environmental problems are defined; are graphical displayed on the map of a zone with a formation on the level of pollution of all natural resources: free air, water objects, soil, and snow cover.

5) all layers are compared; the model of the program of environmental development is formed.

## **3. Results and discussion**

The first layer is natural. Its constituent elements is a natural variety: presence of all or parts of natural components – surface and underground water, the woods, mountains, ravines; climatic features (temperature condition, humidity of air, etc.). By drawing up model of development of the whole region, on the map-layer the habitats of wildlife are noted, objects that are under the threat of disappearance (loss of a biodiversity) are noted. In region borders the biodiversity purchases great importance, especially recently when the steady tendency to reducing a biodiversity remains: in case of present methods of production and consumption by 2050 in comparison with the beginning of the 21st century the world can lose two thirds (from 61 to 72%) of flora and fauna [3].

The reasons of it are generally connected with human activities (pollution of the environment, destruction of separate animal species, climate change) [4]. Considering the fact climatic conditions in Saratov belong to moderate and continental and are characterized by minor deviations therefore aren't displayed on the map.

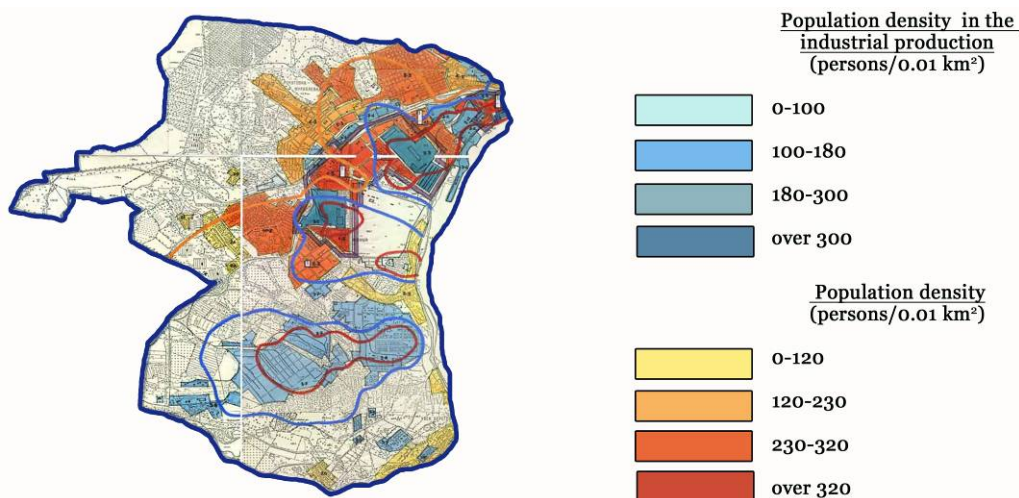


**Figure 1** – An object is Saratov city. a – An administrative-territorial division of the city: 1 – Zavodskoy district, 2 – Oktyabrskiy district, 3 – Frunzenskiy district, 4 – Kirovskiy district, 5 – the Volga district, 6 – Leninskiy district. b – Model of environmental development. 1 layer – natural

On this layer, it is possible to see not only the security with natural resources of all city but the common problems that are typical for whole territory. For example, by comparison of a layer of "b" and the map "a", we can draw a conclusion on small security with green plantings of the city. The woods settle down in areas 1, 2, 6. Therefore, it is necessary to provide gardening of areas 3,4 in the program of environmental development.

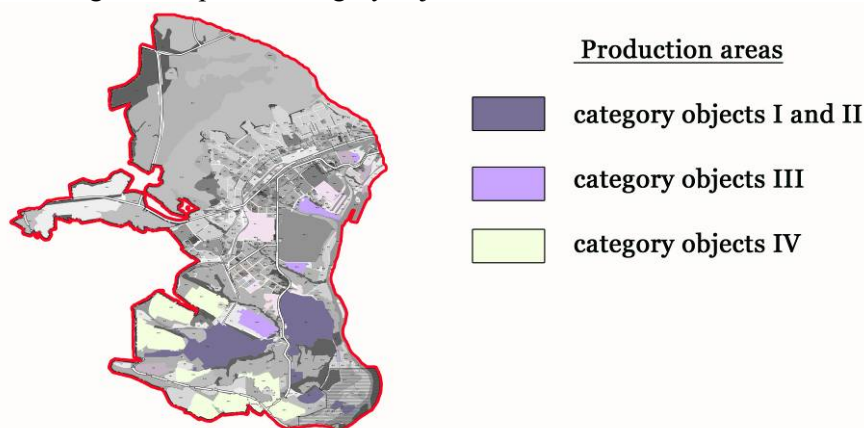
The second layer is social. Treats a social group: structure of labor resource potential; demographic situation; employment rate of the population. A very important indicator is an incidence rate. Types of the incidence are marked on the map: the general incidence, an infectious incidence, incidence by the major not epidemic diseases, and incidence with temporary disability. Serious threats for development of the region are mass spread of HIV infection, tuberculosis, drug addiction. These diseases are the indicator of social trouble, depression of the standard of living, deterioration of sanitary and epidemiologic control in regions [5]. At identification of environmental problems and creation of the program of environmental development paramount value gains population density. The limits of population density characterize the degree of familiarity of the territory, its industrial transformation. The second layer – the map of population density is given below.

The third layer – economic. It includes the type of the specification of the region; managing type. As our task is not the creation of complete model with all these factors, and an illustration of a possibility of creation of such model, during creation of an economic layer we will consider only one factor – production. Maintenance of ecological balance must be based on assessment of activities of all production enterprises occupied in all industries of economy [6]. In structure of the industry in Saratov region the greatest specific weight belongs to fuel and energy complex (45,5%), mechanical engineering (19,1%), chemical and petrochemical (15,6%), food (9,2%) industries.



**Figure 2** – Model of environmental development. The second layer is social. The object is the administrative and territorial unit – Zavodskoy district of Saratov city

The modern Russian ecological legislation orders to economic activity subjects which makes considerable negative impact on the environment, to apply the best available technologies to prevent and reduce negative impact on the environment. However not all entities have technical ability to use such technologies. Besides, as the results of researches show that specifics of a regional natural background influence the size of reduction of negative impact on the environment [7]. Therefore, despite all legislative and economic conditions, you can see areas with the objects making considerable negative impact on the environment from the maps of economic development. In model, we note locations of objects of production on a rank depending on the level of negative impact on the environment. Such objects are subdivided into four categories: the objects making significant negative impact on the environment – category objects I; moderate negative impact, – category objects II; minor and minimal negative impact, – category objects III and IV.



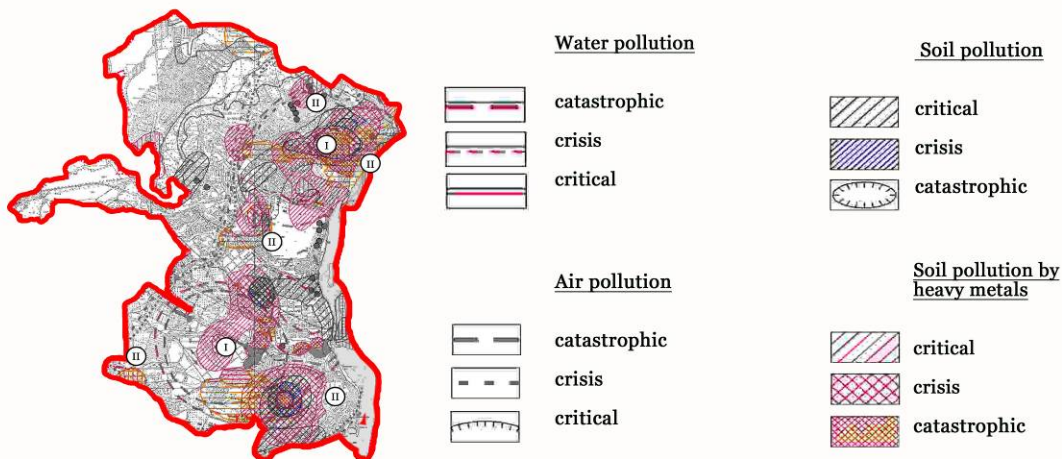
**Figure 3** – Model of environmental development. The 3rd layer is economic. The object is the administrative and territorial unit – Zavodskoy district of Saratov city

The fourth layer – «an environment condition». It includes results of economic activity impact on natural resources: surface and underground water objects, soil, free air. It is one of the most important layers. Based on data of monitoring it is necessary to establish precisely the polluted city zones therefore on the map zones of environmental problems of the urbanized area "appear". These zones influence the amount of financing environmental measures. Lack of attention to environmental problems leads to worsening of influence of pollution on the environment and human health. It is

especially important to set precisely zones and limits of air pollution and water objects. As for free air, data of daily monitoring taking into account atmospheric conditions are of great importance. In the presence in the urban areas of dangerous productions, as a rule, there are excessive emissions of pollutants. Need for more complete information demonstrates the fact that about 6% of city fatal cases can be connected with emissions of firm particles [8] to air pollution. The most dangerous elements to the person are carbon oxide and sulfur dioxide. Certain compounds of these substances are toxic: cause changes in blood circulation, strike nervous system, lead to allergic damages of skin [9]. However it is difficult to make sure generalization concerning quality of air in general as the scope of monitoring stations is poor, researches data are limited, and we can rely on government reports (at which there is a restriction of information) [8].

On Figure 1 (b map), you can noted the first water-bearing horizon where the question of safety and security becomes a priority task. As we see in Figure 3, in some places, this water-bearing horizon settles down in zones with intensive negative impact on the environment, and water is, as a rule, polluted there. For example, in 2014 in the Saratov region 1819 underground sources of water supply were operated. On chemical indicators the percent of non-standard tests has made 28,8%. Water pollution became a planetary problem. In science provisions strategies of water security are developed. Threats to water security differ geographically [10]. The feature of the explored city is its favor on the bank of a reservoir; both all-underground and surface waterways get to a reservoir. In addition, it must be taken into account when developing the program of the region.

After identification of environmental problems, it is necessary to perform ranging of these problems on the importance of their consequences and extent of manifestation. Taking into account cumulative impact of economic activity on the environment, depending on pollution level, the territory is divided into zones: I – catastrophic level of pollution; II – crisis, III – critical, IV – rather satisfactory. Zones of warehousing of production wastes and consumption influence the level of pollution. We intentionally do not include this indicator that there was no layer heap, but actually to create the program of environmental development, on this layer we add a zone of placement of waste.

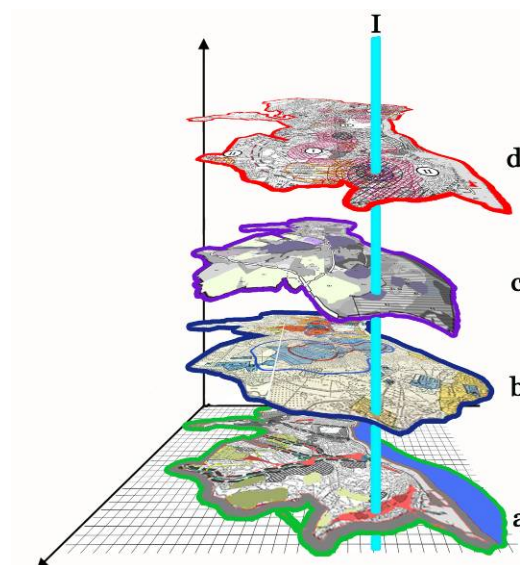


**Figure 4** – Model of environmental development. The 4th layer is an environment condition. The object – Zavodskoy district of Saratov city.

It is necessary to pay attention that availability of information on concentration of pollution, without any subsequent actions in itself won't lead to anything. It is necessary to understand who is a pollution source to have an opportunity to take measures to the entity-pollutant. Therefore, this layer shall be analyzed in a sheaf with a layer of 3 (Figure 3).

Having received four layers (map) with various content, we can make the Model program of environmental development. The main work of this stage is careful comparison of layers of model.

It is known that than more small scale, especially problems are generally formulated and the most significant problems come out on top. At increase in scale up to regional level, the problems appear inherent in all this territory. Both of these rules are applicable concerning creation of model. Working in small scale, by comparison of all points of maps layers we try not only to define environmental problems, but also we establish connection between these problems and existence of technological and social influence, and we predict possible responses of the environment to negative impact. All this is necessary to define the system of the program of environmental protection and calculation of financial support of such activities.



**Figure 5** – Model of environmental development. a – 1 layer (natural); b – 2nd layer (social); c – 3rd layer (economic); d – 4th layer (environment condition). The object – Zavodskoy district of Saratov city

On Figure 5, we determine the characteristic of the certain place.

Point of intersection of the line I and layer "a". In this place there are no forest plantings, the area is crossed by ravines, underground there passes the underground river, level of ground waters – less than 1 meter.

Point of intersection of the line I and layer of "b". In this place small density of population – to 120 people on 1 hectare (foot <sup>2</sup>). The increased incidence of adult population: diseases of respiratory organs; diseases of digestive organs; blood circulatory system diseases; diseases of endocrine system, frustration of food and metabolic disorder.

Point of intersection of the line I and layer "with". In this place, the production objects making considerable and moderate negative impact on the environment are located. Economy industry types – chemical and petrochemical.

Point of intersection of the line I and layer of "d". The place is characterized by dangerous pollution of the soil, at the same time dangerous and very dangerous pollution of the soil by heavy metals, and pollution of snow cover heavy metals (Zn, Pb, Cu, Ni) – dangerous and very dangerous is noted. Pollution of water objects is catastrophic. Free air pollution – crisis.

All these layers have mutual impact at each other. Dangerous production of environmental pollution increase in the incidence of possible responses of the environment – pollution of the adjacent areas (pollution of a water storage basin surface and underground water) reducing population recession of region's economic development. Thus, the plan of ecological development of this specific place should include the landing of forest plantings, strengthening of ravines, the creation of systems of a water disposal for a water flooding exception, the maximum arrangement of industrial facilities treatment by sewage disposal plant for reducing environmental pollution.

In the same way there is a scrupulous combination of all points of layers of model. As a result we receive the detailed ecological analysis (taking into account economic, social, human factors) of any urbanized area in small scale. In large scale, we can already create the directions of ecological development. Moreover, based on this model to create a basis of the program of environmental development, considering all researched factors (not just ecological). The program includes main units:

1. State of environment of the urbanized area. The basic principle of filling of the block – accuracy of the information.

2. Ecological strategic objectives and tasks of development of the urbanized area (proceeding from permanent development goals). The environmental goals and tasks for the first period (it is created of the directions of development because of work in large scale). Concerning Saratov city, it is reducing of free air pollution, soil, and water objects.

3. Subprograms with indication of the specific nature protection and other actions directed to goal achievement and tasks. Concerning Saratov city: Protection of water resources; Protection and reproduction of forest resources; Free air protection; Development system of the treatment of production wastes and consumption; Ecological education.

4. Indicators of environmental development: amount of emissions of pollutants from stationary sources; the population living in adverse conditions; population disease rate; a share of the utilized and processed production wastes; the number of the held events for ecological education.

5. Financing of ecological actions. The main difference from all existing programs of environmental protection where the direction without binding to the area is financed, has to be stated financing of problem ecological situations based on comparison in this program and the analysis of all layers of model.

#### 4. Conclusions

Environmental degradation, poverty growth, decrease in rates of economic growth in many respects depend on incorrectly chosen strategy and settlement development program. Incorrect arrangement of priorities, lack of environmental problems accounting in case of the solution of social and economic problems leads to deterioration in a situation. Based on the assumption of interrelation of ecological, economic, social factors we developed a theoretical model of environmental development of the urbanized area. It is established that all layers of the model exert mutual impact at each other and have a tough binding to the area. Therefore financing of ecological actions should not be the subject (to all areas the identical or conditional amount), and item-by-item: for a specific area within each administrative unit strictly calculated amount taking into account the revealed environmental, social and economic problems. Based on the obtained data the structure of the program of environmental development of the city is provided, can become the framework for Development programs of any urban area.

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