Innovative Technologies for Protective Structures Upon Creating Environmentally Safe Urban Systems

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Abstract. The article deals with the issues of sustainable development, which should meet the needs of the present and future generation – the environmental safety of urban systems including socio-economic and intellectual impact on human processes occurring in the environment, preservation and improvement of the quality of life. Rational use of natural resources is the main task of the modern social state. Ideal zoning of territories in and around the city should primarily be carried out in such a way that gradually, as the distance from the city increases, so the environment becomes cleaner and gradually nature would become absolutely virgin. For this purpose the spatial structure of ecological skeleton of settlement is offered. One of the directions of ensuring ecological safety of construction and municipal economy is ecorestoration of landscapes, which includes restoration of properties: of soil, water, atmosphere, relief and lithosphere; flora and fauna. It may encompass returning the contaminated landscape or its separate components to a state close to the natural one. The main problems of ecology of urban systems are revealed. The generalizing coefficient of influence of city (technical) systems on environment is offered including an assessment of morphological, technical, hydrotechnical, hydrobiological and biological changes of flora and fauna, water quality in adjacent water objects (water intakes); ecotoxicological and social changes; sanitary and hygienic diseases; effects of space-related changes and emergencies.

1. Introduction

In modern society, people have a significant impact on the development of the events, and they must solve the most important problems: to create a harmony of environmental and material needs; develop a safe industrial civilization; recreate and preserve the Earth’s environment. Nature and humanity are developing simultaneously, influencing each other, while the evolutionary process is much slower than the socio-economic development of society, so it is necessary to limit its anthropogenic impact, to create the noosphere, i.e. the sphere of mind, limiting the impact on nature, to destroy it not by ecological disasters. Environmental impact assessment should be planned and developed in conjunction with technical (including intellectual), environmental and socio-political assessments, i.e. with the establishment of an environmental infrastructure.

In addition, the rational use of natural resources is also the main task of the modern social state [1-5], which should be reflected in the laws enacted by the state [6].
2. Main part

Ideal zoning of territories in and around the city should primarily be carried out in such a way that gradually, as the distance from the city grows, so the environment would become cleaner and gradually nature would become absolutely virgin. The infrastructure of Novocherkassk partially corresponds to this skeleton. (Fig. 1). The sizes of necessary zones are appealing. For cities with a population of over 1 million inhabitants, the width of the restricted development zone should be 35–40 km, with a population of 0.5–1 million – 25–30 km, with a population of 100-500 thousand inhabitants – 20–25 km. Behind the restricted development zone there is an active development zone. For cities with population from 100 to 500 thousand people its width will be in average from 30 -35 km to 40-50 km.

These dimensions are very conventional, they do not take into account many functions assigned to the natural zone around the city, and the influence of a number of different factors, for example, the time of the year, landscape type, degree of pollution, the cumulative effect of anthropogenic impacts.

The idea of ecological zoning of territories of the city and adjacent natural landscapes, creation of green zones, which are entrusted with the task of processing urban pollution and maintaining the ecological balance, is not fully developed and is not completely ecological.

1-centers of regional settlement systems; 2- the same, but for communal ones; 3-other places of settlement; 4- main communications; 5...7 – zone of development of the respectively limited, preemptive, active; 8... 10 - zones of respectively ecological equilibrium, buffer, compensatory; 11, 12 – borders of systems of settlement - regional and communal, respectively

Figure 1. Zoning scheme.

This applies to almost all elements of landscapes: soil, terrain, vegetation, wildlife, water in all water bodies (rivers, lakes, seas, soil), air, lithosphere, etc. (table 1). Ecological restoration may consist of returning the polluted landscape or some of its components to a state close to the former natural (for example, when transferring a ground object to an underground space with the creation of a square or park on the surface), or in creating a new natural landscape on the disturbed territory (for
example, creating an artificial lake on the site of an open abandoned quarry for extraction of any raw materials).

Ecological restoration of polluted landscapes brings real positive results, if it is of a systemic nature, it involves the constant greening of technologies that earlier contributed to the landscape pollution. Thus, positive results of cleaning of the Great lakes in the USA, the river Rhine in Germany, etc are known. In Japan, the air in Tokyo is much cleaner today due to the greening, it returned back to the 70s of the last century by air quality. These are the usual positive results of technologies greening which lead to ecological restoration of landscape components [7-12].

Table 1. The main directions of ecological landscape representation.

| No. | Recovery item        | Green bio restoration of the landscape                                                                 |
|-----|----------------------|--------------------------------------------------------------------------------------------------------|
| 1   | Soil                 | Natural long-term recovery without intervention, Flushing, aeration, introduction of humus, phytomelioration, Microbial recovery |
| 2   | Waters               | Natural long-term recovery without intervention, Reduction of water consumption and the closed loop, Deep cleaning of water and silt in reservoirs |
| 3   | Atmosphere           | Greening, deep air purification from impurities, The revegetation, permaculture, Deodorization, odoration by natural smells |
| 4   | Relief and lithosphere | Prosthetics of broken and missing forms, Restoration of destroyed territories, Erosion control measures |
| 5   | Flora and fauna      | Recreation of natural landscape, arrangement of sustainable cultural landscape, Preservation of environmentally sound natural territory with creation of green zones and corridors, Arrangement of protected natural areas with impermeable boundaries |

All of the above leads to the fact that in order to ensure environmental safety it is necessary to create criteria for sustainable development at the local level. The main criteria are:
1. Establishment of working relations between the city plan and the state territorial planning;
2. Enabling people to participate in decision-making, assessing and protecting nature's diversity;
3. Achieving a harmonious unity and proportionate combination of functionality, aesthetics in architecture, construction, taking into account all local influences;
4. Access to skills, knowledge and information; the opportunity to find a satisfactory job in a multi-stage economy; fair wages;
5. Efficient use of resources; reduction of losses; recycling of materials; limitation of pollution that does not threaten natural ecosystems; health care, access to life services, goods, etc.;
6. Development of the rights and obligations of the city residents.

On the basis of this, the structure of planning for sustainable development (LIA – local issues of action) is formed. Here we develop an assessment of the state of the living environment and indicators of it in a particular city, that is, in the ecological system created by people.

The urban environment is a complex ecosystem consisting of two subsystems, one natural and one anthropogenic, each divided into subsystems of a lower order. The reliability of the ecosystem depends on the stability of equilibrium, survivability and safety (Fig.2) [13-20].
Constant monitoring of the living environment state will allow to objectively judge the improvement or deterioration of it for making decision on the development of the urban environment, for outlining measures to restore it.

We propose new technologies, measures and determination of the General coefficient of influence of urban (technical) systems on the environment.

Conditionally $K_{2S}$ - coefficient of influence of city systems on the environment, can be represented in a scoring system in the following form:

$$K_{2S}=K_m+K_t+K_{gh}+K_G+K_{kv}+K_{er}+K_S+K_Z+K_k$$

where $K_m=0 \ldots \pm 1$ - coefficient of morphological changes, taking into account changes in the territorial planning of the city and its infrastructure; $K_t=0 \ldots \pm 1$ – coefficient of technical changes, i.e. change (reconstruction, functional direction, etc.). buildings and structures of urban development); $K_{gh}=0 \ldots \pm 1$ is the coefficient of hydraulic changes that affect the hydrochemical composition of the soil and water by using different additives to mortar and materials in construction, falling as waste into the environment; $K_G=0 \ldots \pm 1$ – ratio of bionatural hydrobiological changes of flora and fauna, in comparison with previous years; $K_{kv}=0 \ldots \pm 1$ is the coefficient of water quality in adjacent water objects (water intakes), including their growth in emissions of urban enterprises; $K_{er}=0 \ldots \pm 1$ - the coefficient of ecotoxicological changes, which takes into account the spread in the territory of the city; $K_S=0 \ldots \pm 1$ - the coefficient of social change, i.e. the qualitative variable composition of urban residents, i.e. the increase in number of pensioners, taking into account new professions, etc., compliance with the rights and obligations of residents of urban systems; $K_Z=0 \ldots \pm 1$ the coefficient that determines the sanitary and hygienic composition of diseases characteristic of the city and changes depending on the quality of urban development, i.e. the presence of rubbish dumps etc. in the urban environment; $K_k=0 \ldots \pm 1$ - coefficient of influence of space changes, of the emergencies worsening quality of the life environment.

Obtaining the coefficient of impact of urban systems $K_{2S}$ with its maximum value $K_{2S}=9$ points means that in terms of ecology, the urban system copes with the effects of natural and technical systems, and the minimum value $K_{2S}=-9$ points indicate the inactivity of local administrative organizations.

3. Conclusion
With the aim of creating environmentally friendly urban systems, based on the leverage ratio of urban systems K2S, taking into account the main environmental problems of the city, criteria of sustainable development at the local (local) level as well as the main directions of ecorestoration landscape today,
we have already formed a number of innovative technologies for the urban systems protective structures from natural-technogenic impact [21, 22].

The application of the proposed evaluation criteria and schemes in the creation of environmentally friendly urban systems is one of the possible ways of progressive harmonious development of people, technologies and biosphere territory.

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