ASPECTS AND PROBLEMS OF NATURAL SELF-CLEANING POTENTIAL EVALUATION FOR URBANIZED ENVIRONMENT

Urbanizētās vides dabiskās pašattīrīšanas potenciālā novērtējuma aspekti un problēmas

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Abstract
The article deals with the concept of natural self-cleaning potential. It contains a description of available urbanized environment natural self-cleaning potential evaluation methodics and specific methods employed. Groups of criteria, producing different influence on self-cleaning geopotential were distinguished. Each criterion was evaluated by grades – related with parameters of impact factors – taking into consideration its rank in the general system of evaluation.
Keywords: *urban ecosystem, self-cleaning geopotential, chemical pollutio.*

Introduction

Seeking to optimize the ecological state of urban ecosystems under the conditions of uncontrolably increasing scale of technogenization, concentration of the population, pollution and other undesired related phenomena, it is very important to obtain a proper notion of dynamic links existing in the natural and technogenic complexes as well as of their autoregulation potential and resistance capacity against different anthropogenic loads.

This work is designed as a presentation of methodological aspects arising in evaluation of natural self-cleaning capacity of urbanized environment subject to chemical pollution. It is based on a preliminary study of many literary sources, devoted to analysis of the functioning of urbanized ecosystems and their components, and on available individual experience.

Methodological aspects of evaluation

In order to evaluate the natural self-cleaning potential of urbanized environment it is necessary, first of all, to reveal the integrated landscape response to pollution. The integrated landscape response depends on the self-cleaning potential of landscape components and on the mechanism of links between landscape components and elementary landscape territorial units. The migration links and conditions predetermining the natural self-cleaning capacity in relatively natural territories are more or less clear and have been many times discussed in research works [1-4]. Whereas, an integrated evaluation of natural self-cleaning potential of urbanized environment in terms of chemical pollution have not been done due to a specific character of the research object and due to a complexity of evaluation itself (an insufficient knowledge of discrete landscape components: no date about aerodynamics – i.e. microclimatic self-cleaning potential – of built up areas; lack of data about physical-chemical properties of urban soils predetermining their buffer capacity against pollution, about biochemical activity and about functioning mechanism of exposed soils; urban territories have been inadequately hydrogeologically investigated).

Nevertheless, on the existing database and after an evaluation of parameters responsible for genetic resistance of urbanized landscape (or ecological potential) it is possible to make on integrated evaluation of the natural self-cleaning potential of urbanized landscape in terms of chemical pollution.

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This kind of evaluation may be carried out on two planes:

I. Evaluation of urban natural potential depending on the position of cities on a general sensitivity background of geosystems, which is predetermined by certain properties of a landscape and its components.

Principal of evaluation: distinguishing of cities situated in low sensitivity, sensitive and very sensitive geosystems. The evaluation mechanism of geosystem sensitivity is discussed in detail in 'Assessment of geosystem's sensitivity...' [4]. The map 'Geosystem sensitivity to chemical impacts' (SC 1:300000) included in this work has been compiled on the basis of mentioned methodic.

II. Evaluation of natural potential in terms of sensitivity to anthropogenic pollution in the cities taking into consideration a number of natural and technogenic urbanistic indices.

The first principle is rather clear and related with an evaluation of natural territories geopotential (an area of a certain soil type is the point of departure and emphasis is placed on buffer capacity of soils, which predetermines the self-cleaning potential of the whole system).

Following the second principle the main point of the departure is a territory existent in a certain relief, having a similar spatial character of technogenic cover (the height and density of buildings, the area of built up surface) and functioning as a whole affected by natural and technogenic-urbanistic factors.

As has been pointed out the urban the urban environment is an especially complex system. Its natural self-cleaning potential is disrupted, destroyed, changed or simply artificially sustained. For this reason an integrated evaluation of urban environment sensitivity to pollution (following the first principle of evaluation) is impossible, because an entire natural complex – soil-ground – is buried under a technogenic cover (asphalt-concrete cover, dwelling-houses, industrial buildings) and, virtually, is excluded from the matter and energy circulation. It no longer plays the role of natural biogeochemical barrier because the surface and atmospheric water flows travel to the nearest water bodies through leakage pipes. This kind of environment (built up, screened) is unable to sustain the function of regeneration – i.e., all ecological functions, including the self-cleaning potential, are disrupted. In evaluation of the natural potential of such territories in terms of sensitivity to anthropogenic pollution the following main criteria were distinguished:

- area of technogenic cover (height and density of buildings also are important indices);
- buffer capacity against pollution (granulometric composition, content of humus, capacity to act as a barrier to flows of toxic substances, microorganism activity in decomposing the organic matter) of open territories (without the technogenic cover);
- areas of greeneries. It is a comon knowledge that the contribution of various plants to environment regeneration is different. Therefore, the species composition and the area occupied by vegetation must be taken into consideration;
- relief – directing migration flows of toxic substances or concentrating them – plays an important role in natural and built up territories (important indices: hypsometry, degree of dissectedness of a territory, slope inclinations, river valleys);
- water bedding depth, which may serve as an indicator of possible pollution or flooding of a city. Not infrequently the ground water table rises as a result of engeneering-economic activity. In sections with impermeable rocks covered with a technogenic cover the territory gets flooded. As a result, the chemical composition of the surface and ground waters changes and their aggressiveness increases.
- aerodynamic characteristics of a territory are very important in evaluation of atmospheric self-cleaning potential (predetermining the city air quality) of open and built-up territories;

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- actual pollution of deposition surfaces (at high levels of pollution the soil is unable to sorb, the greeneries to purify the air by absorption of dust and heavy metals and by reproduction of of oxygen);
- character of technogenic cover (building materials and distribution) in terms of water and air permeability.

The urbanized environment evaluation methodics was worked up following two groups of criteria:

- criteria whose importance may be graded (within a system of 100 grades) depending on the significance of indices. This group includes criteria, which can be measured by different methods (area of technogenic cover, area of greeneries, actual pollution of a territory with heavy metals, oil products and other toxic substances). The area of technogenic cover is regarded as the most important criteria (taking into consideration the height and density of buildings) because it predetermines the ecological potential of the whole urbanixed ecosystem (the greater the area of technogenic cover the lower the natural potential of a territory; concomitantly, the grade of chemical pollution is higher;
- criteria which, depending on their importance and character of impact, bring corrections to the sum of grades. They may increase the geopotential of a system by 100 %. This group includes criteria (soil buffer capacity to pollution, aerodynamic characteristics of a city territory, relief, ground water bedding depth, character of technogenic cover) whose importance was determined through examination (the greatest importance was ascribed to soil-ground buffer capacity against pollution and to aerodynamic characteristics of a city territory).

Results of methodology application

The following way of usage of the presented methodology is suggested. Firstly, the self-cleaning potential in respect of chemical pollution is estimated (in grades) for each quarter, microregion, etc. Next, according to every correction criterion the sum of lost grades is calculated. The result of subtraction of "losted grades" sum (theoretically it can reach 100) from the former self-cleaning potential estimation (up to 100 grades, as well) will indicate the final self-cleaning potential grade. Small grade meaning will designate the high geopotential of the territory towards the chemical pollution, large meaning – the low geopotential, i.e., high sensitivity of the territory to chemical pollution.

The methodology presented above was applied for creation of the map of Vilnius city landscape natural self-cleaning potential. Evaluation was conducted in the most detailed level (level of an urban quarter), on the grounds of 4000 technomorphological cells, distinguished by G. Godiene [5] in Vilnius city. As a result, a very patchy structure of Vilnius city landscape in respect of natural self-cleaning potential was defined (Fig. 1): areas of very high self-cleaning potential cover even 54.89%, high – 21.94%, medium – 20.57, and low & very low – 2.61% of city territory.

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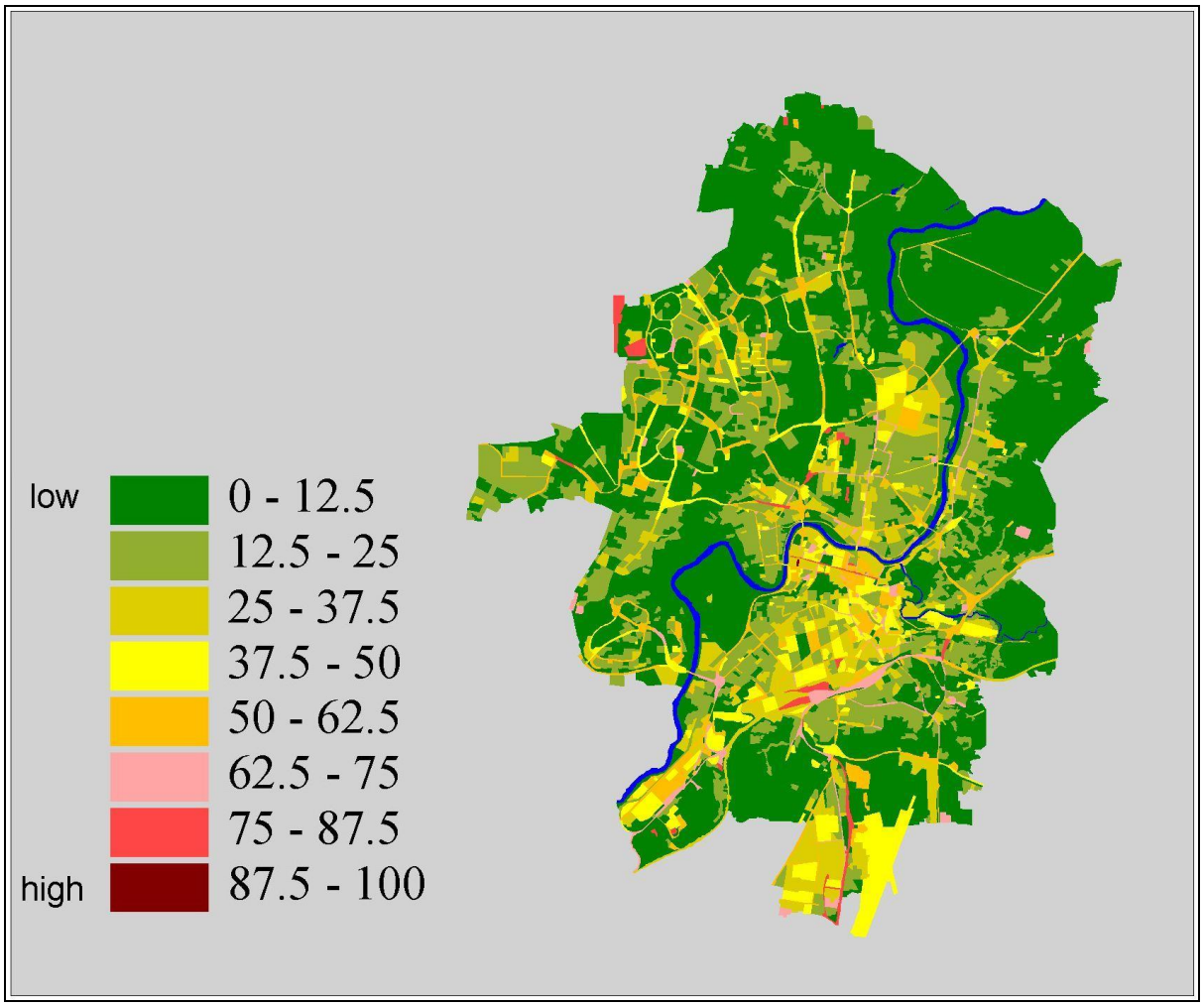

Fig. 1. Vilnius urbo-landscape self-cleaning potential in terms of chemical pollution.

Conclusions

Knowledge of potential genetic resistance of a landscape and reckoning with its natural ecological potential are the main premises of rational use of landscape.

The evaluation of natural self-cleaning potential of urbanized environment in terms of chemical pollution was an attempt to reveal an integrated response of landscape to chemical pollution (without confining to evaluation of self-cleaning potential of landscape components alone).

It was concluded that the mechanism of matter migration links and conditions predetermining the self-cleaning potential of relatively natural territories are rather clear and many times discussed in research works. Yet, an integrated evaluation of self-cleaning potential of urbanized landscape is rather problematic due to a specific character of the studied object and due to complicatedness of evaluation itself (an insufficient database on different landscape components).

In evaluating the self-cleaning potential of urbanized landscape the main point of departure is a territory which exists in a certain relief, has similar character of technogenic cover spacial distribution (height and density of buildings, area of technogenic cover) and is functioning as a whole affected by natural and technogenic urbanistic factors.

The worked up methodics of evaluation of urbanized landscape self-cleaning potential was based on two groups of criteria distinguished according to possibility of being measured, importance and character of contribution to self-cleaning potential. Each of distinguished

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criteria was examined for the importance to self-cleaning potential depending on the parameters of active factors and ‘weight’ of criteria in the general evaluation system.

Presented methodology was applied for creation of the map of Vilnius city landscape natural self-cleaning potential.

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