MONITORING OF GREEN SPACES' CONDITION IN MINSK CITY (THE REPUBLIC OF BELARUS)

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Abstract*. The article has presented monitoring results of public green spaces' condition of the Oktyabrsky district of Minsk (The Republic of Belarus), implemented during summer season of 2023. 17 field areas were laid, within which 510 trees were examined. The analysis and assessment were carried out based on the obtained set of dendrometric characteristics. Computing results made it possible to determine the categories of the vital state of public green spaces in Oktyabrsky district and identify areas (squares and boulevards) in need of preventive sanitary and protective work.*

Keywords: *urban green spaces, environmental monitoring of green spaces, tree stand condition index, vital state category of tree stands.*

The incessant city growth is becoming the main global trend. At present, the percentage of urban residents is more than 55% of the world's population and the cities themselves cover an area of more than 2 million square kilometers – and these parameters continue to increase. Becoming the main place of residence, urban environment condition strongly affects the life quality of urban population through many unfavorable factors. Here, natural components have been exposed both to urban planning transformations and all kinds of pollution due to the high industry and transport concentration, while the environment is characterized by low recreational and aesthetic potential. Among the possible adaptation techniques and mitigation strategies, the creation of an urban green spaces system is especially relevant. Green spaces can act as indicators of urban environment condition, pointing the appearance of certain environmental problems that may affect the health of the local population. However, the range of urban vegetation possibilities isn't limited to this. Due to green spaces, it's possible not only to identify unfavorable conditions, but also optimize environmental state. The improvement of the ecological situation in city is happening with the help of vegetation cover multifunctionality – capability of carrying out sanitary-hygienic, structural-planning, recreational, decorative and other valuable functions [2].

Despite such a valuable contribution to the optimization of urbanized space, the number of green areas in cities is decreasing, and existing ones are actively exposed to the negative influence of anthropogenic factors. In the Republic of Belarus, the settlement with the most striking manifestation of anthropogenic load is the capital – the city of Minsk. It's divided into 9 administrative districts, each of which differs in a certain type of development, transport routes location, industrial sphere peculiarities, etc. The spatial analysis of these administrative districts revealed that the most difficult situation with green areas is inherent in the Oktyabrsky district, which became the object of our study.

The district is located in the south-southwest of Minsk, occupying an area of 22,0 km^2. Its population reaches 8,5% of capital residents, while the density is about 7700 people/km^2 with an average value for the city 5720 people/km^2. On the territory of the district there're more than 20 largest industrial city enterprises. The district is also characterized by a well-formed green spaces system, which includes plantings that are diverse in their functional purpose, size, species and age composition. Meanwhile, the most valuable for the city and its residents

are public green spaces, which include parks, squares and boulevards. The total area of such green zones in the Oktyabrsky district is 114,7 hectares, mainly concentrated in the southern part, accounting for only 5,2% of the territory. The greatest contribution to the formation of the Oktyabrsky district's urban planting system is made by 2 parks, occupying 87,0 hectares or 75,9% of all reviewed plantings. Such large green areas are concentrated in the southern part of the district, being localized closer to the outskirts of the city. Secondary contribution is made by small squares and boulevards. In total, there're 17 squares with a total area of 24,4 hectares (21,3%) and 2 boulevards with a total area of 3,3 hectares (2,8%), which are relatively evenly distributed throughout the rest of the district. However, the provision of district residents with green areas calculation revealed its obvious insufficiency (7,3 m^2/person), while for Minsk this parameter should correspond to at least 8-10 m^2/person [https://pravo.by].

Analysis of the current situation in the system of green areas shows the need to preserve existing plantings in proper condition, allowing to fully perform the whole spectrum of possible urban vegetation functions. This was the fundamental factor for monitoring public green spaces ecological state in the Oktyabrsky district. Study results make it possible not only to identify the features and existing green areas problems extent, but also to prevent the development of the adverse factors influence at early stages. The entire field work cycle was carried out during summer season of 2023, a total number examined trees reached 510, including *Tilia cordata* (160), *Acer platanoides* (82), *Populus canadensis* (62), *Aesculus hippocastanum* (42), *Salix alba* (38), *Picea abies* (16), *Juglans mandshurica* (16), *Picea pungens* (15), *Betula pubescen*s (13), *Fraxinus excelsior* (13), *Sorbus aucuparia* (12), *Quercus rubra* (11), *Salix fragilis* (8), *Betula pendula* (4), *Acer saccharinum* (3).

The main research methods are field, descriptive, cartographic, mathematical. Green spaces' ecological condition research was carried out using the analysis of such dendrometric characteristics as crown density grade (percentage of gaps), the color of leaves or needles, the absence of drying leaves or needles, the absence of drying branches, the absence of cracks, bark abscission and other trunk mechanical damages. By aggregate of these features, dendrological parameters of trees were determined by 6 categories in accordance with the scale of V. A. Alekseev, according to which category 1 corresponds to healthy trees without signs of weakening [1]. The methodology for plantings ecological condition monitoring involves the inspection of at least 30 most representative trees within the boundaries of each green area of the district. If there a smaller number of trees grew on the territory, then the stands were combined between the nearest green areas. Thus, 17 field areas with stands were laid, covering all the public green spaces of the Oktyabrsky district in Minsk. Two of such research areas were laid within the parks, within which 60 plants were examined. 15 remaining areas were laid on the territory of squares and boulevards, within the boundaries of which 450 trees were examined.

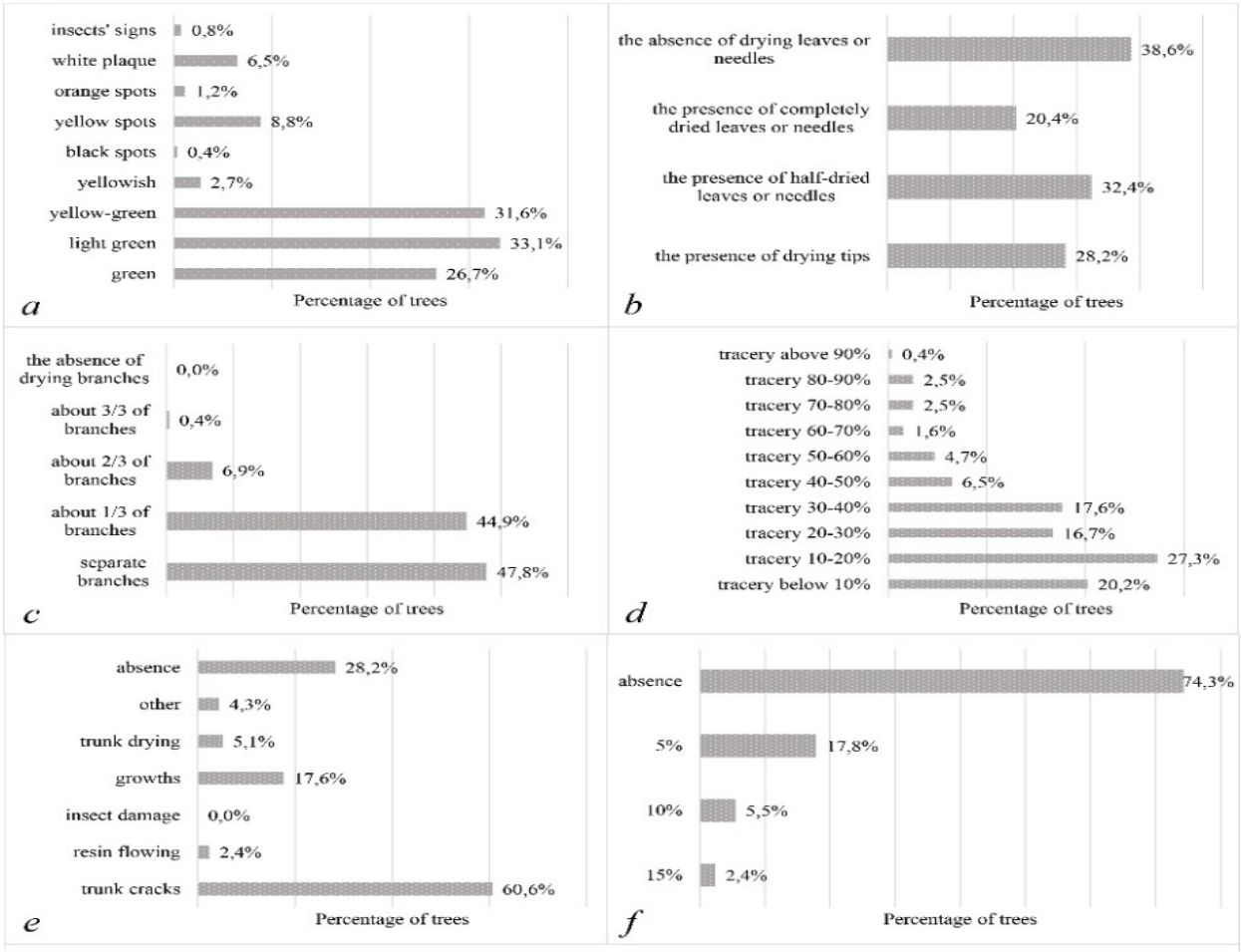

Fig. 1. Dendrometric characteristics of examined trees within the Oktyabrsky district in Minsk: a – color of leaves/needles; b – drying of leaves/needles; c – drying of branches; d – crown tracery; e – trunk mechanical damages; f – bark abscission.

The vast majority of examined plants of the district are characterized by the crown tracery in the range from0 до 40%, but at the same time light green and yellow-green shades of leaves and needles. Trees with a higher tracery index are spread in less degree, trees with tracery index more than 60% are practically not noticed. The green color is characteristic for only a quarter of the examined trees, plants with yellow leaf colorationare least represented. Among the untypical coloring or leaves damage, yellow spots were most often noted – about 9% of the plantings. The number of trees with orange or black spots, as well as traces of insects, is minimal. Such orange and yellow spots usually indicate the drying of leaves or needles caused either by extremely arid and hot weather, or by exposure to chemical pollution of atmospheric air or soil cover. Black spots are possibly a sign of the disease "black spotting" caused by fungi *Phomopsis viticola*. Also, in the sample was noted the presence of white plaque – in 6,5% of plantings, which is an indicator of a fungal disease called powdery mildew. 40% of the examined trees are characterized by the complete absence of dried leaves or needles. At the same time, about 30% of trees have leaves or needles with dried tips, another 30% have half- dried ones. Completely dried leaves or needles are found on about 20% of trees. Also, about 50% of the sample trees are characterized by separately fried branches, for 45% drying 1/3 of the total number of branches is inherent. The number of trees with drying 2/3 or 3/3 branches is minimum. Meanwhile, it's worth noting the absence of trees without dried branches. Bark abscission is observed in about 25% of all examined trees, among which plants with about 5% of abscission are dominated. Among other mechanical damages, trunk cracks and trunk growths are found most often.

According to the obtained results trees were assigned to one or another category of living condition according to the scale of V. A. Alekseev. Among 510 trees: 24,9% have no signs of weakening; 58,2% – are weakened; 11,4% – are severely weakened; 5,1% – are drying up; 0,4% – are deadwood. Then the next assessment stage is based on

the calculation of the tree stand condition index of public green spaces. The calculation is made according to the following formula [1]:

$$L_n = \frac{100n_1 \cdot 70n_2 \cdot 40n_3 \cdot 5n_4}{N},$$

where L_n – the relative tree stand condition; n_1 – the number of healthy (without signs of weakening) trees; n_2 – weakened trees; n_3 – severely weakened trees; n_4 – drying up trees; N – the total number of trees (including deadwood).

Ecological condition of trees is determined by attributing obtained results to a defined category of an ecological status based on the modified scale of V. A. Alekseev. Tree stands with a condition index equal to 90-100 % belong to the category of healthy, 80-89 % – healthy with signs of weakening, 70-79 % – weakened, 50-69 % – damaged, 20-49 % – severely damaged, less than 20 % – destroyed [1].

Calculations have shown that green spaces within the studied areas have different condition indexes and, accordingly, belong to different standcategories. Thus, out of 17 stand areas: 1 considered healthy, 4 – healthy with signs of weakening, 8 – weakened, 4 – damaged. At the same time, it's worth noting that there are no heavily damaged and destroyed stands. The stands of both parks are classified as healthy with signs of weakening, the remaining ones are related to squares and boulevards.

The analysis of the final results showed that the condition of public green spaces of the Oktyabrsky district in Minsk generally can be described as moderately unfavorable: only a quarter of the trees are healthy, while weakened and damaged ones predominate among the stands. The best condition belongs the vegetation of parks, which are characterized by the presence of a large buffer plantings areas, as well as a large species and age diversity of plants. In parks, it's also possible to disperse visitors around the perimeter, which reduces the overall anthropogenic load on the territory. At the same time, such green zones are located at a distance from the most polluted northern and eastern parts of the district. The worst condition is typical for squares and boulevards that are actively polluted due to the lack of peripheral plantings buffer zone, as well as a large anthropogenic load due to frequent attendance by residents. At the same time, such small-area green spaces are often located near large highways with heavy traffic, which isn't only a source of exhaust gases, but also salt pollution due to the use of deicing reagents in winter. This is especially noticeable at the approach to the north of the district, where the territories belong to the central districts of Minsk. Also, the age and species composition of plantings can affect green areas condition. Frequently the vegetation of the central city districts is characterized by a less favorable ecological state not only because of a higher level of pollution, but also because of the preference for plant species that have high decorative characteristics, but don't have sufficient resistance to pollution.

Thereby, monitoring of green spaces' condition showed not only the importance of conducting such surveys, but also the need to improve the current situation. The preservation and optimization of a healthy urban green spaces system can be achieved through the implementation of various preventive works of a sanitary and protective essence, the formation of stable plantings complexes by selecting pollution-resistant plants and ensuring species and age diversity of vegetation. Such diversity will allow to avoid a massive deterioration of green spaces condition.

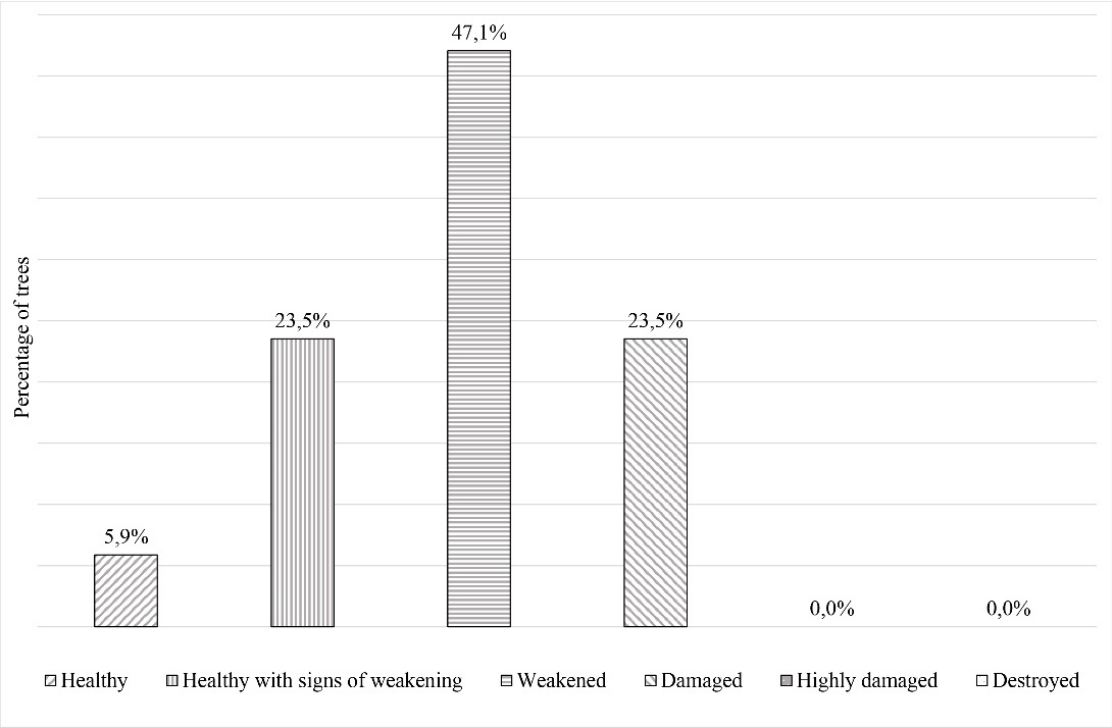

Fig. 2. Tree stand condition index of public green spaces of the Oktyabrsky district in Minsk.

Also, in order to reduce the level of anthropogenic load on the most visited squares of the district, it's recommended to create a number of additional green spaces that will not only disperse the number of visitors, but also expand urban green areas system of the district and make it more evenly spaced. This goal can also be achieved through the introduction of one of the most modern architectural and urban planning practices – vertical gardening. This form of green construction uses vertical surfaces of buildings and structures as a greening basis, allowing to expand urban green areas system without allocating additional territory. Meanwhile, vegetation retains its numerous functions that contribute to the optimization of the urban environment conditions.

References

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