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# IMPACT OF CLIMATE CHANGE ON URBAN LAWN ECOSYSTEMS

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*The article examines the impact of climatic changes on the ecosystems of urban lawns in the conditions of the steTAe zone of Ukraine. The purpose of the work was to establish the relationship between changes in air temperature and atmospheric moisture and structural and functional characteristics on different lawns: parterre, garden, meadow and special purpose. The general projective covering of grass, the ratio of lawn cereals and forbs, the floristic composition, as well as changes in the cenomorphic and hygromorphic structure were evaluated. A steady trend towards an increase in the average annual air temperature, most pronounced in the spring and autumn periods, as well as a reduction in the amount of atmospheric precipitation during the period of active vegetation of plants, has been established. It is shown that such changes are accompanied by a gradual decrease in the projective coating of lawn cereals, an increase in the participation of forbs and ruderal species, as well as xerophytization of the vegetation cover. Parterre lawns, where the largest reduction in the share of decorative cereals is observed, turned out to be the most sensitive to climatic changes. Meadow and garden lawns are characterized by higher ecological stability due to greater species diversity, while special-purpose lawns are rebuilt with grass in the direction of ruderal communities. Analysis of the ecomorphic structure confirmed a decrease in the proportion of pratants and mesophytes and an increase in the participation of stepants, xerophytes and ruderants, reflecting the adaptation of vegetation to arid habitat conditions. The obtained results indicate the need to revise traditional aTAroaches to the creation and maintenance of urban lawns in the conditions of climate change. To increase their durability and ecological efficiency, it is advisable to use climate-resistant grass mixtures and select plant species depending on the functional purpose and ecological conditions of the territory. The results of the study can be used during the planning of urban landscaping systems, the development of measures to adapt urban ecosystems to climate change, and the optimization of lawn plantation care.*

***Key words:*** *climate change, lawn phytocenoses, urban ecosystems, adaptation to climate change, ecological sustainability.*

***Кузнецова О.В. Вплив кліматичних змін на екосистеми міських газонів***

*У статті досліджено вплив кліматичних змін на екосистеми міських газонів в умовах степової зони України. Метою роботи було встановлення взаємозв'язку між змінами температури повітря та атмосферного зволоження і структурно-функціональними характеристиками на різних газонах у м. Дніпро: партерному, садовому, лучному і спеціального призначення. Оцінювали ознаки: загальне проективне покриття травостою, співвідношення газонних злаків і різнотрав'я, флористичний склад, а також зміни ценоморфної та гігроморфної структури. Встановлено стійку тенденцію до підвищення середньорічної температури повітря, найбільш виражену у весняний та осінній періоди, а також скорочення кількості атмосферних опадів у період активної вегетації рослин. Показано, що такі зміни супроводжуються поступовим зменшенням проективного покриття газонних злаків, збільшенням участі різнотрав'я та рудеральних видів, а також ксерофітизацію рослинного покриву. Найбільш чутливими до кліматичних змін виявилися партерні газони, де спостерігається найбільше скорочення частки декоративних злаків. Лучні та садові газони характеризуються вищою екологічною стійкістю завдяки більшому видовому різноманіттю, тоді як на газонах спеціального призначення відбувається перебудова*

*травостою у напрямі рудеральних угруповань. Аналіз екоморфної структури підтвердив зменшення частки пратантів і мезофітів та збільшення участі степантів, ксерофітів і рудерантів, що відображає адаптацію рослинності до посушливих умов існування. Отримані результати свідчать про необхідність перегляду традиційних підходів до створення й утримання міських газонів в умовах зміни клімату. Для підвищення їх довговічності та екологічної ефективності доцільно використовувати кліматично стійкі травосуміші та добирати види рослин залежно від функціонального призначення і екологічних умов території. Результати дослідження можуть бути використані під час планування систем міського озеленення, розроблення заходів адаптації урбанізованих екосистем до зміни клімату та оптимізації догляду за газонними насадженнями.*

***Ключові слова:*** *кліматичні зміни, газонні фітоценози, міські екосистеми, адаптація до змін клімату, екологічна стійкість.*

**Relevance of the research topic.** Climatic changes in the modern world are taking on a global scale throughout the globe, affecting any component of the biosphere. The species composition of plant communities undergoes transformation, displacement of the boundaries of natural habitats, disruption of interspecies relationships formed and adapted over a long period. A change in the temperature regime, amount and seasonal distribution of precipitation causes the gradual displacement of weak species more resistant to drought and temperature stress, causes a general restructuring of the structure of biocenoses. Ruderal, including invasive plants, come to the front row, which can cause significant damage to natural and anthropogenically transformed ecosystems, displacing native species [3, p. 31].

Scientists have already been shouting about the impact of climate change on biodiversity for a long period of time, paying attention to the shift in the phenological phases of plant development, the spread of invasive species and the gradual transformation of natural and urbanized ecosystems. This leads to the fact that phytocenoses become more vulnerable to droughts, temperature stresses, the spread of pests, which reduces resistance and the ability to recover from adverse effects [16]. Even ordinary people are increasingly talking about abnormally warm winters, increased duration of summer droughts, deterioration of green spaces, drying of plants, spread of pests, low resistance to diseases. These changes are becoming more and more noticeable both in private farms and in the landscaping of settlements and in natural landscapes.

Accelerated transformation of ecotopes takes place in urban ecosystems, as they suffer from both anthropogenic load and climatic changes. Therefore, the assessment of the impact of climatic changes on the functioning of urban lawn ecosystems, their ability to adapt is relevant in modern conditions of global warming and instability of natural phenomena. Studying the response of grass communities to climate change will identify the most sustainable species and develop effective approaches to the formation of environmentally sustainable and decoratively attractive lawn coverings.

**Problem statement.** Today, urban lawns occupy a significant part of the green spaces of settlements and will spread in the future. Simulations have calculated that in the United States their area may increase by 79% by 2030 [8]. As an element of the most common, but at the same time the most manageable, elements of urban green infrastructure, in the face of global warming, such grass covers can be considered not only as a decorative landscape design, but also as an important component of the ecosphere [9].

An increase in the average annual air temperature, a change in the regime of atmospheric precipitation, an increase in the frequency of extreme weather events lead to the transformation of natural ecosystems, especially in regions with an unstable water balance [15]. In recent years, the city of Dnipro has seen an increase in the average annual air temperature by 1.5°C, record summer heat waves are recorded, and atmospheric

precipitation is uneven throughout the year [2]. This leads to a shortage of soil moisture, deterioration of the water regime and degradation of the vegetation cover [13].

As a result of the increase in the average annual air temperature and long hot periods, urban lawn coverings become vulnerable. Formed from a limited number of cereals for better decorative greenery, they depend on regular watering and mowing, and may lose stability under conditions of prolonged droughts and insufficient moisture [14]. It is noted that, first of all, in such phytocenoses, the effect is manifested on the general species composition, and later – on the intraspecific variability of traits [11]. However, it is indicated that the relationship between vegetation and resistance depends on many factors, such as care, species composition and local conditions [10].

That is why, in order to improve forecasts of the consequences of climate change on lawns in industrial cities of eastern Ukraine, to determine reactions to drought, general ecological stability in certain ecosystems, this study was conducted. Its results aim to justify effective aTAroaches to the creation, reconstruction and maintenance of lawns in conditions of global warming.

**Research methodology.** In the city of Dnipro. 4 test areas (TA) measuring 100 $m^2$ were laid on lawns of various purposes according to the classification of O. O. Lapteva [5]: 1st TA – on parterre lawn; 2nd TA − on garden lawn; 3rd TA – on meadow lawn, 4th TA – on special purpose lawn.

On each of them, the percentage of projective coverage (PC) was determined: 1) of all grass; 2) of cereals; 3) of forbs; 4) of each species separately; 5) of cenomorph; 6) of hygromorph. 2025, 2026 and the period a decade ago – 2015 are taken for analysis.

The percentage of projective coating – is a sign that indicates qualitatively formed grass resistance and resistance to external factors. Its low indicators indicate grass degradation or damage [6, p. 14]. We determined this sign visually, from the height of the human eye, as a percentage of the occupied area [4, p. 7].

A floristic composition was recorded on each test area. Belonging to the species and ecological groups was determined by the descriptions of S. L. Mosyakin [12], V. V. Tarasov [13], using the atlas of the flora of Ukraine [2].

Climatic indicators were obtained from the information of the Dnipropetrovsk Regional Center for Hydrometeorology. The following were taken into consideration: air temperature, amount of precipitation.

Of course, lawns, especially parterres, in addition to climatic moisture, receive additional watering during the growing season, but we took their number and volume into account as the same for all options. In further studies, this feature can be considered separately for each local unit. As a result of the research, we needed: 1) an understanding of the response of species to drought; 2) a search for compromises in how drought resistance is related to the distribution of species; 3) an analysis of the general trend of climate change.

**Research results.** According to the calculated average annual air temperature indicators in the city of Dnipro, there is a clear trend towards an increase in the temperature regime from 2015 to 2026, although the changes have seasonal features (Fig. 1). There is a warming of the autumn season. In the winter period, temperature fluctuations are noted by year. In the spring, there is also an increase in the average air temperature. In summer, changes are less pronounced. Thus, the analysis of the average temperature in June, the month of the description of the test areas, shows minor fluctuations.

The amount of precipitation in the city of Dnipro turned out to be uneven in distribution between seasons and individual years (Fig. 1). In the autumn period, the average amount of precipitation in 2025 is higher compared to 2015. The winter period is characterized

by significant annual fluctuations, which indicates the instability of moisture during this period of the year and an increase in the frequency of dry or, conversely, wetter winters. A pronounced reduction in the amount of precipitation is observed in the spring.

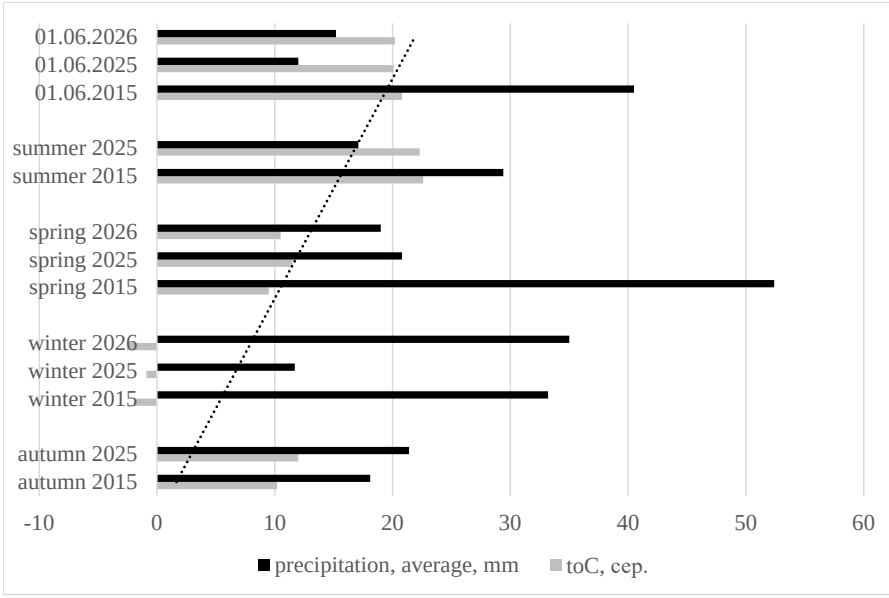


*Fig. 1. Air temperature and amount of precipitation in the city of Dnipro (average for the year)*

This trend is unfavorable for lawn plants, as this period is decisive for their vegetative development. In the summer period, a tendency to decrease the amount of precipitation was also noted. We observe similar fluctuations separately for June. In combination with an increase in air temperature, this leads to a shortage of soil moisture, deterioration of the vital condition of the grass, a decrease in the decorativeness of lawns, and destructuring of the species composition.

In this context, the processes of replacing lawn cereals with more hardy forbs and xerophytization of vegetation should take place in the grass stand. It turned out that the survival and distribution of plants on lawns changed according to drought conditions, and the effect varied depending on the place of growth (Fig. 2). But the general trend was a decrease in the total projective grass cover, a gradual reduction in the proportion of lawn cereals and an increase in the participation of forbs. This is characteristic of urbanized areas, where the action of climate change and high anthropogenic load is combined.

Cereals at TA 1 experienced the greatest displacement. This ground lawn was not sown during the study period, so their projective coating decreased by almost 20% by 2026. The total area occupied by plants remained relatively high due to replacement by drought-resistant ruderal species. Such a trend indicates the loss of decorativeness of the parterre lawn and its gradual degradation in conditions of increased temperature and lack of moisture. On the special purpose lawn, there was not a liquefaction of the vegetation cover, but its reconstruction into a one close to the ruderal one (Fig. 2; table). Garden and meadow lawns show higher resistance to reconstruction due to greater species diversity, but general manifestations of change persist.

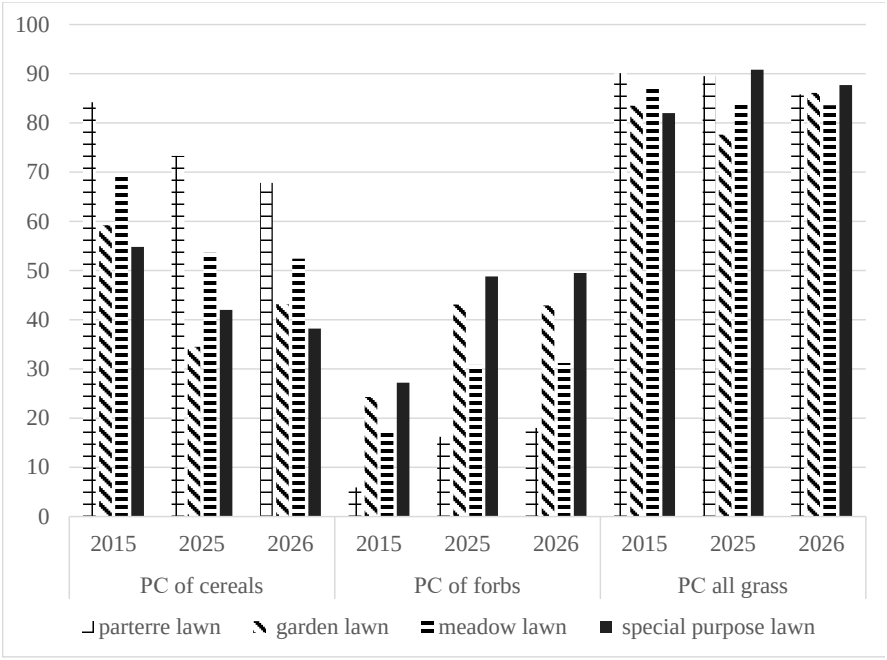


*Fig. 2. Dynamics of the percentage of projective coverage on test areas*

According to ecomorphs, all four experimental sites are dominated by pratants, which is a characteristic feature of lawn phytocenoses formed mainly by meadow species. However, their share gradually decreases during 2015–2026 (table 1). At the same time, there is an increase in the share of steppe people, which is consistent with the trend towards climate warming. An increase in the share of ruderants is even more indicative. They quickly inhabit weakened and liquefied areas of the lawn, which are formed as a result of plant loss during summer droughts, elevated temperatures and anthropogenic load.

Table 1

**Distribution of cenomorphs and hygromorphs on test areas by year**

| Trial areas | Years | Cenomorphs | | | Hygromorphs | | |
|---|---|---|---|---|---|---|---|
| | | St | Pr | Ru | Ks | MS | HgMs |
| TA 1 | 2015 | 0,5 | 82,3 | 7,3 | 0,5 | 86,1 | 3,5 |
| | 2025 | 0,8 | 76 | 12,6 | 0,9 | 81,3 | 7,3 |
| | 2026 | 1,3 | 71,6 | 12,4 | 1,4 | 75,7 | 8,5 |
| TA 2 | 2015 | 2 | 64,5 | 11,6 | 7,5 | 74,9 | 2,5 |
| | 2025 | 4 | 51,6 | 11 | 7,8 | 65,7 | 6,1 |
| | 2026 | 6,9 | 54,6 | 14,2 | 11 | 72,7 | 7,5 |
| TA 3 | 2015 | 2,8 | 69,8 | 14,5 | 11,2 | 71,9 | 4 |
| | 2025 | 5,6 | 58,7 | 20,1 | 15,4 | 65,5 | 3,5 |
| | 2026 | 7,7 | 52,5 | 23,4 | 19 | 61,3 | 3,3 |
| TA 4 | 2015 | 2,9 | 60,7 | 18,4 | 13,7 | 65,3 | 3 |
| | 2025 | 6 | 55,8 | 29 | 18,4 | 67,6 | 4,8 |
| | 2026 | 6,7 | 54 | 27 | 20,6 | 62 | 5,1 |

Mesophytes dominate grass stands in terms of moisture requirements. However, over the years, this ecological group is shrinking (table). The decrease in the participation of mesophilic species is explained by the lack of atmospheric and soil moisture, despite watering. A particularly intense increase in xerophytes is observed on lawns with a higher anthropogenic load, where moisture deficiency is most evident. The share of hygromesophytes also increases slightly, but their contribution remains small and is associated with local features of the microrelief or additional moistening of individual areas.

**Conclusions and prospects for further research.** The results obtained are in good agreement with climate trends. The warming of the climate, which is most clearly manifested in the autumn and spring periods, increases the evaporation of moisture, the risk of summer droughts and heat stress, and for the plants of urban lawns, it is manifested in the reduction of the projective coating of decorative cereals and the gradual replacement by more drought-resistant representatives of forbs and ruderal vegetation.

The studied dynamics of lawn grass stands are the result not only of climatic changes, but also the result of care. When it is insufficient, there is an increase in competition between cereals and forbs towards the preference of more drought-resistant weedy plants. As a result, lawn ecosystems move from dense grass communities to less homogeneous grass stands with an increased proportion of unwanted species, which negatively affects their decorative value.

Under the conditions of an increase in the average annual air temperature and annual fluctuations in precipitation, traditional approaches to the creation and care of lawns no longer ensure their durability and environmental efficiency. In order to improve the urban landscaping system, develop adaptation measures and form stable lawn coverings, it is necessary to implement grass mixtures selected according to the climate and focused on specific habitats.

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