ECOLOGICAL SOLUTIONS REGARDING THE MONITORIZATION OF THE URBAN ATMOSPHERE POLUTION INVOLVING BIOINDICATING TREES ON THE MAIN STREET ALINEAMENTS IN IAŞI

SOLUȚII ECOLOGICE PRIVIND MONITORIZAREA POLUĂRII ATMOSFERICE URBANE CU AJUTORUL ARBORILOR BIOINDICATORI PE ALINIAMENTELE STRADALE PRINCIPALE DIN MUNICIPIUL IAŞI

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Abstract. *Recent data underline that the evolution of the urban environment in Iaşi was mostly based on developing the street system infrastructure in detriment of the urban green areas, what led inevitably to the intensification of traffic and holding back the interest for developing in a sustainable mode a network of urban green areas. In many European countries a program of monitoring involving bio indicating trees is already implemented, based on the response of these "sentinel trees" to harsher life conditions of the intense traffic and poluted streets compared to the rest of the green areas. The present study aims the importance of dendrological street plantations through their positive impact on the fight against direct pollution toward the pedestrian traffic. The observations were conducted in alignments plantations from three main boulevards in Iaşi, underlining the insufficiency of woody vegetation, the precarious health state of most of the mature specimens, caused by improperly branch cutting, discontinuity of the green vegetation lines or the lack of them. The paper will propose solutions and landscaping measures meant to improve the quality and safety of the pedestrian traffic along the considered boulevards.*
Key words: the urban green areas, bio indicating trees, alignments.

Rezumat. *Ultimele constatări evidențiază că evoluția mediului urban ieşean s-a bazat mai mult pe dezvoltarea infrastructurii rutiere în detrimentul spațiilor verzi urbane, ceea ce a condus în mod inevitabil la intensificarea traficului auto şi la plasarea în plan secundar a interesului pentru conturarea sustenabilă a unei rețele de spații verzi urbane. În multe țări europene este implementat deja un program de monitorizarea a arborilor bioindicatori, pe baza răspunsului acestor "arbori santinelă" la condițiile de viață mai dure ale zonelor stradale aglomerate şi poluate, comparativ cu restul spațiilor verzi. Studiul de față vizează evidențierea importanței plantațiilor dendrologice stra-dale prin impactul pozitiv pe care acestea îl au asupra combaterii poluării directe la nivelul circulațiilor pietonale. Observațiile au fost efectuate în plantațiile de aliniament de la nivelul a trei bulevarde ieşene principale, evidențiind insuficiența vegetației lemnoase, starea fitosanitară precară a majorității exemplarelor mature de arbori, cauzată de aplicarea tăierilor encores-punzătoare în coroană, discontinuitatea fâşiilor verzi sau lipsa acestora. Se vor propune pe vitor soluții şi măsuri peisagere care să amelioreze calitatea şi siguranța traficului pietonal la nivelul bulevardelor analizate.*
Cuvinte cheie: spații verzi urbane, arbori bioindicatori, aliniamente.

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INTRODUCTION

Research on polluted air in major cities (Barnes,1972, cited by Peneghi, 2015) has shown that emissions from car transport in the modern urban atmosphere constitute over 90% of the total volume, which is why it is considered that fossil fuel based car transport is the main polluter of urban airspace. .

The European Parliament and the Council of the European Union issued Directive 2008/50 / EC of 21 May 2008 on air quality for the region of Europe, which regulates ambient air quality policies and obliges Member States of the European Union to reduce emissions. of PM2.5 and PM10 in urban areas. In our country, it is required, by Law 104/2011, that the values allowed by PM2.5 and PM10 be maximum 50 μg / m3 for PM10 and 25μg / m3 for PM2.5 in the air breathed (Oros, 2002).

It is known that there is a big difference between the very harsh living conditions (vegetation) of the trees in the road alignments compared to the conditions in the other categories of green spaces in the urban area (Bolea et Chira, 2008). Bio-indicator trees, also called "sentinel trees", can accurately reproduce the level of pollution, they are monitored to determine the degree of pollution and the type of pollutants due to which the woody vegetation is suffering. In other words, bio-indicators integrate the pollution produced over a certain period of time and reflect the effects of this integrated pollution (Oros, 2002).

The current situation of the urban environment of Iasi reveals an un-controlled extension of the urban area, which thus leads to an increase in the traffic of cars, to the detriment of the urban green spaces. This situation is strongly highlighted due to the development of the residential areas, in the absence of a judicious management of the road infrastructure and an increasingly intense traffic. The main link between the north and south of the city is represented by the Nicolina Road - Nicolina Street - Palat Street - Anastasie Panu Street - Elena Doamna Street - Independence Boulevard - Carol I Boulevard - Grigore Ghica Vodă Boulevard, thus becoming the most intensely circulated arteries. So the pedestrian traffic at the level of these boulevards and streets is conducted under unfavorable conditions of pollution with noxes and noise pollution.

The city of Iaşi is included in the management regime I for the polluting particulate matter PM10, based on the results obtained after the evaluation of the air quality, using measurements at fixed points, with the help of the 4 fixed measuring stations that are part of the National Monitoring Network. of Air Quality, as well as results regarding the modeling of the dispersion of pollutants in air, observations made based on local emission inventories.

The studies carried out by the researchers of the Physics laboratory of the University "Alexandru Ioan Cuza" showed that the limits allowed for both types of particles were exceeded, the measurements indicating values that exceed, sometimes, two or even three times the limits imposed by law (tab. 1).

Table 1

Indices of the suspended particles PM2.5 and PM10 obtained by measurements at the level of the boulevards analyzed, in January 2018

Place	$PM_{2,5}$ (µg/m^3)	PM_{10} (µg/m^3)	Admitted value: $PM_{2,5}$ (µg/m^3)	Admitted value: PM_{10} (µg/m^3)
Palatul Culturii	**76**	**174**	**25**	**50**
Palas	56	116		
Bulevardul Independenței	54	143		
Copou (U.A.I.C.)	53	140		

Source:https://www.bzi.ro/exclusiv-harta-explicita-cu-cele-mai-poluate-cartiere-din-orasul-iasi-foto-636358

The possibility of monitoring urban pollution in Iasi by observing the reaction of bio-indicator trees is considered to be about 15 times cheaper than using a network of physico-chemical analyzers (Ruscă and Rusu, 2018). The present paper highlights the need to monitor the highly polluted areas within the city of Iași using the biological response of the bio-indicator trees for the pollution with powders and exhaust gases.

MATERIAL AND METHOD

The observations were made between May 2019 - August 2019, at the level of Carol I, Independence and Strada Palat boulevards in Iasi. To begin with, it was necessary to illustrate the situation of the analyzed areas by highlighting the distances between the built and road areas, marking the situation of the road alignments and the location of the road alignments and highlighting the examples of bio-indicator trees, graphically presented in this paper in the AUTOCAD program. The vegetal component was analyzed by direct visual observation in the field by manually measuring with the roulette wheel, in order to establish the characteristic dendrometric elements for each bioindicator tree, the planting distances between the trees in the alignments, the crown projection on the ground, the trunk diameter, phytosanitary status of specimens determined as bioindicator trees.

A number of 12 alignment trees were monitored belonging to the species *Tilia cordata*, a species mentioned in the literature as the most resistant to air pollution by exhaust gas, this fact highlighting the value of this species as a bioindicator tree. (Tugulea, 2018).

RESULTS AND DISCUSSIONS

Field observations have highlighted the fact that car traffic is the main source of emissions containing harmful particles of small size, known as PM2.5 and PM10. These particles are of the order of microns and have the ability to penetrate the respiratory system to the lungs level, having negative effects on human and animal health, such as eye irritation, coughing, sneezing, allergies, asthma, cardio-vascular problems etc. (Ghidra and Zaharia, 2002). However, in the air polluted by exhaust gases, carbon monoxide, hydrocarbon residues, benzopyrene, aldehydes, nitrogen and sulfur oxides, heavy metals, soot are also encountered etc. (Ruscă and Rusu, 2018).

The analyzed boulevards are characterized by intense pedestrian traffic on both directions of movement, the sidewalks being separated from the road by

continuous and discontinuous green lanes, and on agglomerated segments the existence of a relatively discontinuous protection lane is noted. Road alignments are predominantly composed of mature and young specimens of *Tilia cordata*, *Tilia tomentosa*, *Tilia platy-phyllos*, *Aesculus hippocastanum* and *Fraxinus excelsior*. An analysis of the quality of these alignments shows that the mature trees are approximately 80% debilitated, having an uneven crown, due in large part to the improperly performed cutting actions. Thus, it is noticeable in the level of the crowns of dry branches of the second degree but also numerous "greedy branches" that are unsightly and unevenly distributed in space. The young trees, which are meant to rejuvenate the alignment plantations, have not been properly guarded at the planting, some of them having deviations of the trunk axis, on them no cutting of crown formation was applied according to the corresponding standards. Indeed, specialists recommend that *Tilia* species do not respond well to severe crown cutting (Bolea and Chira, 2008). On the boulevard Carol I, 5 specimens of bio-indicator trees of the species *Tilia cordata* were located and taken into consideration (fig. 1).

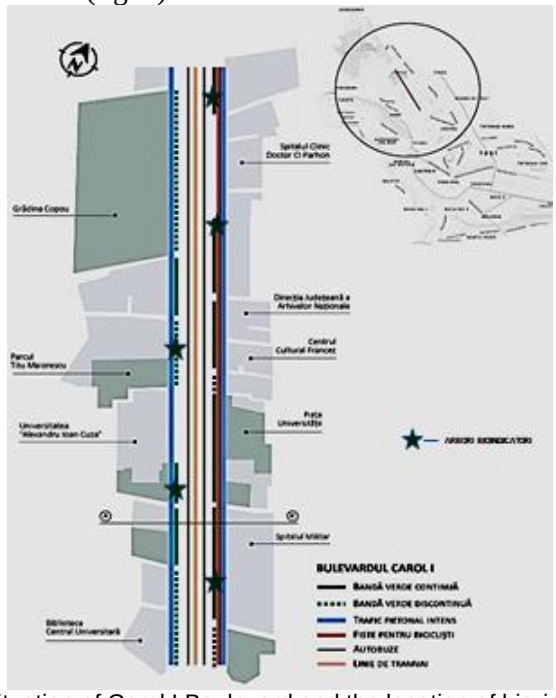

Fig. 1 The situation of Carol I Boulevard and the location of bio-indicator trees

The situation on Independence Boulevard (fig. 2) and Palat Street (fig. 3) has made it clear that for the height interval between 1.50 m and 1.70 m (the breathing interval for the average human height), there is no obstacle to the harmful factors of road traffic. The sidewalks are directly exposed to these harmful elements, since at the level of the separating green strips there are only tree trunks, without a consistent vegetative layer that will filter the emissions of

the road towards the pedestrian traffic. This analysis of the sites under study clearly highlights the need to monitor air pollution using bio-indicator trees. On these two sites, another 6 specimens of *Tilia cordata* (3 for each street alignment - Independence Boulevard and Palat street) were declared as bio-indicator trees, at distances of over 20 m between them for a better coverage of the analyzed site. . The observations will be compared with a control specimen of *Tilia cordata*, of close age with the analyzed ones, but located in the Iasi Botanical Garden, in a noxes pollution-free site due to inexisting car transport.

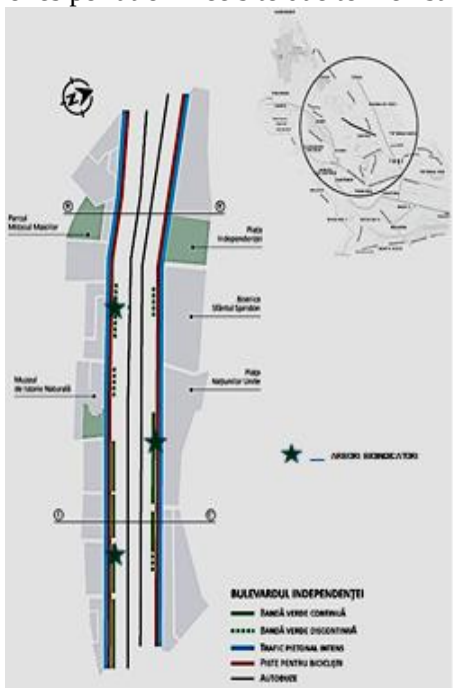

Fig.2 The situation of the Independence Boulevard and the location of the bio-indicator trees

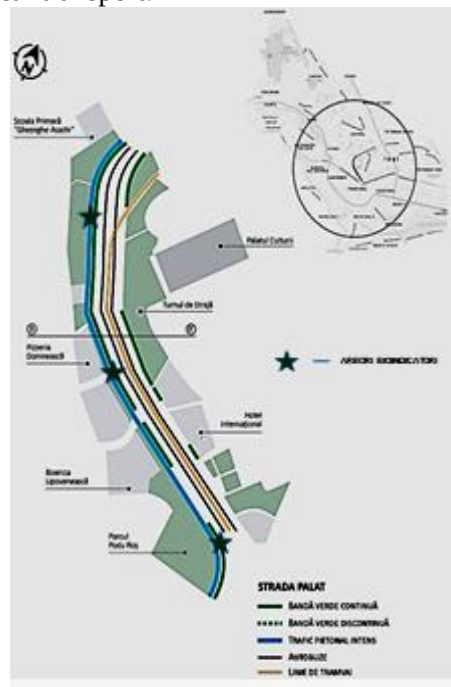

Fig. 3 The situation of the Palace Street and the location of the bio-indicator trees

The results of the field observations are centralized presented in table 2.

Table 2

Centralized situation of the analyzed bio-indicator trees

Bio-indicator trees	The situation of *Tilia cordata* bio-indicator trees (average values)						
	Height (m)	Trunk diameter, etentive bark (cm)	etentive age after dendrometric tables (years)	Crown projection (m)	Diameter/ height ratio	Phytosanitary condition (etentive)	Location
Tc 1	17,5	96	53	4,6	5,48	B	Bv. Carol
Tc 2	16	88	51	4,2	5,50	B	Bv. Carol
Tc 3	15,5	79	50	3,8	5,09	B	Bv. Carol
Tc 4	18	101	54	5,2	5,61	B	Bv. Carol
Tc 5	16	72	51	4,3	4,50	B	Bv. Carol

Tc 6	15	73	51	4,4	4,86	B	Bv. Indep
Tc 7	16,5	78	52	4,8	4,72	B	Bv. Indep
Tc 8	14,5	70	49	4,2	4,82	S	Bv. Indep
Tc 9	16,5	86	52	4,6	5,21	B	Str. Palat
Tc 10	17	92	53	4,8	5,41	B	Str. Palat
Tc 11	17,5	94	54	5,0	5,37	Fb	Str. Palat
Average	16,4	84,5	51,8	4,5	5,14	B	-
Tc control	18	98	52	5,8	5,11	Fb	Gr. Botanica

Legend: Phytosanitary condition: Fb - very good, B - good, S – satisfactory

The choice of the *Tilia cordata* species as a bio-indicator tree is justified by studies that show the high retentive capacity for nitrogen, sulphur and heavy metals, as well as a great capacity for bioaccumulation of silica, aluminum and cadmium in tissues, without significantly affecting biological functions of the species (Untea, 2010 and Peneghi, 2015).

CONCLUSIONS

1. The observations in the 4 established locations, (Carol I Boulevard, Independence Boulevard, Palat Street and Botanical Garden) for establishing a network for monitoring the atmospheric pollution in the road alignment plantations in Iasi, were made on a number of 12 mature specimens of *Tilia cordata* (fluffy linden).

2. The results of the dendrometric observations made during the active vegetation period (May-August 2019) highlighted the following: the phytosanitary state of the majority of the specimens is good, they have heights between 15 ÷ 18 m, the trunk diameter, on average, 91.25 cm, the average age of approx. 52 years, the projection of the crown of approx. 5.15 m and a diameter / height ratio of 5.12.

3. The specimens of the *Tilia cordata* species prove an adequate biological status in order to be included in a network of monitoring bio-indicators of the level of pollution with noxes in the road alignments.

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