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Effectiveness of Green Corridor in Reducing the Level of Tropospheric Ozone Concentration in Legnica (Lower Silesia, SW Poland)

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ABSTRACT

Introducing vegetation into towns and cities, for example through establishing green corridors which ensure a continuous character of urban green areas is a way to counteract negative effects of urban climate. The aim of the study was to assess the role of a green corridor and the contribution of vegetation to regulating the level of hourly tropospheric ozone concentrations in Legnica. Hourly values of tropospheric ozone concentrations (O_3, µg m^{-3}) and wind directions (D, °) collected between 2011 and 2014 from an urban background station for air quality monitoring of the Provincial Inspectorate for Environmental Protection were used in the study. To prepare a land cover map, data from the Database of Topographic Objects provided by the Geodesy and Cartography Department of the Marshal's Office of the Lower Silesian Voivodship were used. The estimations of frequency of hourly O_3 concentrations for given seasons of the year and the analysis of land cover within 2 km from the measuring point were made based on an 8-wind compass rose. In summer, the frequency of hourly O_3 concentrations was assessed for every direction and for every hour of the day. A Pearson correlation matrix was generated to illustrate the relationship between land cover type and the frequency of pollution coming from each direction, Between 21:00 and 6:00, increased frequency of hourly O_3 concentrations in the 0–40 µg m^{-3} range coming from the southwest was recorded, which accounted for 70–90% of all concentration ranges. Correlation analyses showed a statistically significant relationship between increased high vegetation coverage and decreased frequency of hourly O_3 concentrations in the 41–80 µg m^{-3} range. It was demonstrated that between 2011 and 2014, during summers, hourly O_3 concentrations <40 µg m^{-3} came most frequently from the direction characterised by the highest total share of vegetation-covered land. On the other hand, pollutants with concentrations in the 41–80 µg m^{-3} range came more frequently at night time from the directions characterised by compact and dense development. The obtained results demonstrated that in summer, the urban park, the Kaczawa River and the green areas along the river play an important role as a green ventilation corridor.

Keywords: urban greenery, air pollution, urban ventilation, parks, river, green infrastructure.

INTRODUCTION

Poor air quality increases mortality risk, especially among the elderly, children and people suffering from cardiovascular and respiratory diseases (Grass and Cane 2008; Thiering et al., 2013; Guo et al., 2017; Grigorieva and Lukyanets 2021). Tropospheric ozone is a particularly important secondary pollutant produced in a series of photochemical reactions, whose precursors include NO_x, CH_4, CO, and volatile organic compounds (VOCs) (Clapp and Jenkin 2001; Kleinman 2005; Monks et al., 2015; Tiwari et al., 2015, Nuvolone et al., 2018, Rozbicka et al., 2020). Using threshold values adopted by the EU and EEA, between 14% and 65% of urban population in the EU and EEA was exposed to high O_3 concentrations in 2011. From the point of view of stricter WHO air quality guidelines, 98% of the urban population was exposed to excessive O_3 concentrations (Guerreiro et al., 2014). Between 2013 and 2020, the said percentage oscillated in the 93–98% range (WHO 2021). Based on the O_3 concentration rates and cumulative exposure indicators, a clear north-south boundary of the spatial distribution of exceedance levels was observed. This indicates that exceedances are more frequent in central and southern Europe (Klumpp et al., 2006; Guerreiro et al., 2014; Sicard 2021). Although tropospheric ozone pollution is associated with agricultural areas, Paoletti et al. (2014) showed that annual mean ozone values increased at a faster rate in urban areas than in rural ones. Cakaj et al. (2023) reached similar conclusions – having analysed the O_3 pollution in Poland they demonstrated that, between 2010 and 2019, the levels of ground-level ozone rose at 75% and 62.5% of urban and rural monitoring stations, respectively. It is worth noting that in their report for the “European Topic Centre on Air pollution, transport, noise and industrial pollution”, Solberg et al. (2021) showed that although high peaks had been reduced, the annual mean ozone concentration had increased. However, the reductions described are minor and statistically insignificant.

One way of counteracting the adverse impact of urban climate is to introduce vegetation into cities. Results of modelling studies indicate that not only particulate matter but also O_3 make up the largest share of reduced pollutant concentrations (Yang et al., 2005; Nowak et al., 2006; Hirabayashi and Nowak 2016; Selmi et al., 2016). Wang et al. (2012) indicated that plants can reduce tropospheric ozone concentrations by between 0.78 and 5.50 g m^{-2} on average, however, the values obtained by direct measurement were several times lower than those derived from models. The study shows significant discrepancies between modelling results and real measurements. Plants, especially trees, may also cause an increase in O_3 levels since they are a source of biogenic volatile organic compounds (BVOCs) that are the precursors of this secondary pollution (Fitzky et al., 2019). Especially that the species composition itself may influence the mechanisms of tropospheric ozone removal or formation (Sicard et al., 2018). According to Loreto et al. (2014), BVOCs emissions may increase as a result of stress conditions of which there is no shortage in cities (Czaja et al., 2020; Orzechowska-Szajda et al., 2020; Franceschi et al., 2023).

Apart from numerous research confirming the positive impact of vegetation on urban environments, there are also those which indicate that the influence is limited (Lam et al., 2005, Setälä et al., 2013). One solution to eliminate those limitations is to create new and protect existing green corridors. The purpose of green corridors is to ensure a continuous character of urban green areas (Al Masri et al., 2019). The benefits of green corridors may include: increased and protected biodiversity (Beaugeard et al., 2021), reduced air and noise pollution (Yang et al 2020), urban heat island prevention (Novak et al., 2009, Li et al., 2023), increased water retention (Cui et al., 2021). Tan et al. (2016) and Milošević et al. (2016) indicate that green aeration corridors increase the impact of vegetation on urban climate, whilst the effectiveness of urban ventilation itself depends, for example, on such factors as the built-up area of the city (Yang et al., 2019) or its surface roughness (Suder and Szymanowski 2014). As Han et al. (2022) point out, the location of a green ventilation corridor is important for the quality of the air that flows into the city. When it is disadvantageously located with respect to the source of pollution, it may bring effects that are contrary to the expected ones. This raises a question about the role that green corridors play in shaping O_3 levels in cities, especially that the papers on city ventilation focus mainly on particulate matter (Chen and Dai 2022; Han et al., 2022, Gong et al., 2023).

The purpose of this study was to assess the role of a green corridor and vegetation in regulating hourly tropospheric ozone levels in Legnica. According to various pollution and land cover analyses, this town in Lower Silesia is located in a zone with the highest frequency of heat waves in Poland.

METHODOLOGY

Legnica is the third most densely populated town in the Lower Silesian Voivodeship, spanning an area of 56 km^2 (51°12′36″N, 16°09′42″E, 113–168 m MSL) (Fig. 1). It has a population density of 1661 people per·km^2, the 7th highest in the region. The Kaczawa River flowing through Legnica, the historic city park as well as vegetation stands and meadows form a SW-NE green corridor. Legnica is located in the zone with a high incidence of heatwaves, with three-day or longer heatwave events occurring 6–8 of every 10 years. The heatwaves that occur in the region may last even 10 days or more, and the highest temperature during such a heatwave may exceed 35.0 °C (Koźmiński and Michalska 2011). Kalbarczyk et al. (2018) demonstrated that the mean air temperature has been increasing by 0.24 °C

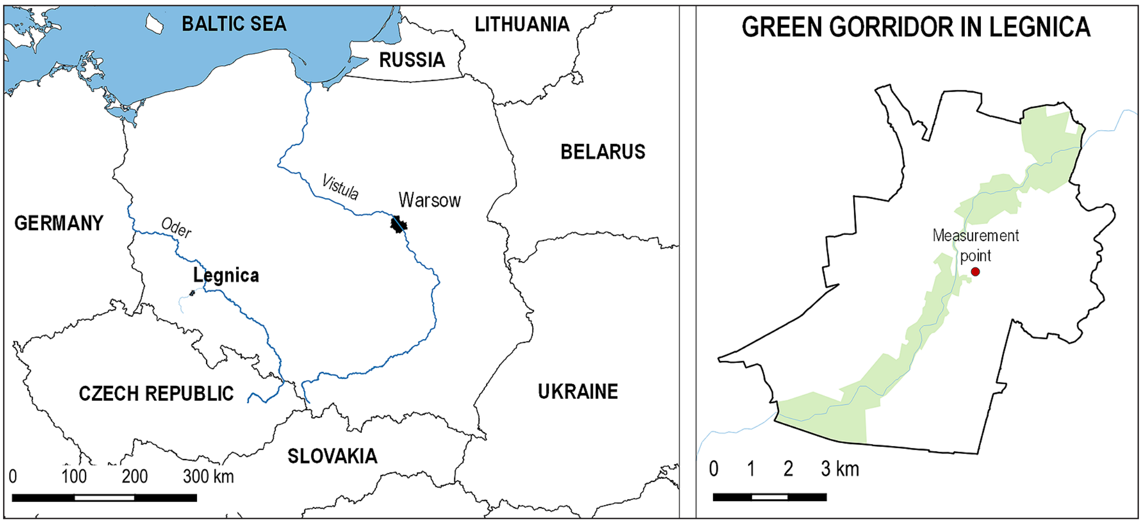

Fig. 1. Location of the study area

every 10 years in the 1951–2014 multiyear period, resulting in an average increase of mean air temperature of 1.44 °C during the 63 year period. In summer the temperature increased by 0.23 °C/10 years, whereas in spring and winter the average temperature increase was over 0.3 °C/10 years. The autumn temperature increase amounted to 0.1 °C/10 years. Hourly values of tropospheric ozone concentrations (O_3, $\mu g \cdot m^{-3}$) and wind directions (D, °) data, collected from the urban background station for air quality monitoring of the Provincial Inspectorate for Environmental Protection (Wojewódzki Inspektorat Ochrony Środowiska, WIOŚ*)* between 2011 and 2014 were used in the study. Data from the Database of Topographic Objects (BDOT10k), provided by the Geodesy and Cartography Department of the Marshal's Office of the Lower Silesian Voivodship, and land cover data provided by the Geoportal for Spatial Information (https://www.geoportal.gov.pl/dane/ortofotomapa) were used to prepare a land cover map, subsequently used to draw the land cover map of Legnica. The content and details of the BDOT10k generally correspond to a traditional topographic map at a scale of 1:10,000. Land cover classes were determined based on reviewed literature (Table 1). A total of 10 land cover classes were distinguished that have an impact on local climate conditions. Based on distribution analyses performed with the Statistica 12 software, hourly O_3 concentrations were divided into the following concentration ranges: 0–40 $\mu g \cdot m^{-3}$; 41–80 $\mu g \cdot m^{-3}$; 81–120 $\mu g \cdot m^{-3}$; >120 $\mu g \cdot m^{-3}$. The frequency of hourly O_3 concentrations was analysed for each season, using the wind rose, for 8 directions: north (N; 337.5–22.5°), north-east (NE; 22.5–67.5°), east (E; 67.5–112.5°), south-east (SE; 112.5–157.5°), south (S; 157.5–202.5°), south-west (SW; 202.5–247.5°), west (W; 247.5–292.5°) and north-west (NW; 292.5–337.5°).

Table 1. Literature-based land cover types

Land cover types	Abbrev.	Publications
Buildings	B	Oliveira et al. 2011, Herb et al. 2008, Walawender et al. 2014, Priyadarsini and Wong 2005
Impervious areas	Ia	Djekic et al. 2018
Streets	S	Herb et al. 2008, Nakashima et al. 2014
Railway	R	Dobrovolný 2013
Bare ground	Bg	Herb et al. 2008, Shiflett et al. 2017
Agriculture aeras	Aa	Herb i in. 2008
Lower greenery	Lg	Ca et al. 1998, Herb et al. 2008
Medium greenery	Mg	Zhang et al. 2013
High greenery	Hg	Saito et al. 1991, Lee et al. 2009, Shashua-Bar et al. 2010, Herb i in. 2008, Spangenberg et al. 2008, Cohen et al. 2012, de Abreu-Harbich et al. 2015, Yan et al. 2012
Water	W	Syafii i in. 2016

Afterwards, an assessment of frequency of hourly O_3 concentrations per every hour of the day was performed for each direction, for the summer period. Detailed analysis covered the area within 2 km from the measuring point. The percentage share of different types of land cover was estimated for four distances: 500 m, 1,000 m, 1,500 m and 2,000 m from the measuring point located at Rzeczypospolitej Avenue, for every direction of the pollution rose (Fig. 2). A Pearson correlation matrix was generated with $p = 0.05$ in order to illustrate the relationship between land cover type and the frequency of pollution originating from each direction.

RESULTS

Sectors to the southwest of the measuring point had the greatest total share of high, medium and low vegetation cover which accounted for approximately 70-80% of their areas (Fig. 3). All sectors located to the southwest of the measuring point have the highest share of high vegetation cover (between 32 and 40%) as compared to sectors assigned to other directions. Equally high shares of high vegetation cover were recorded in the southern direction, but only for 2 analysed sectors located at a distance of 1,000 m and 1,500 m from the measuring point. In other sectors the share of high vegetation cover did not exceed 32%. The lowest share of high vegetation was recorded in the northwest direction, and it increased by between ca. 5% and ca. 20% together with distance from the measuring point, whilst the share of built-up area decreased. Developed areas, impervious surfaces and roads dominated mainly in the west, northwest and north. In the northwest the total share of the above-mentioned land cover classes was the greatest and amounted to between 50 and 70% in various sectors. The share of developed land was the largest in the west, northwest and north directions, respectively. For sectors located to the west of the measuring point, the share of developed land increased with distance from the measuring point, whilst in the north it decreased. The share of built-up land was similar for all northwest sectors. The share of impervious surfaces for sectors located at a distance of 500 m and 1,000 m to the south and east was greater than at other distances. The further from the measuring point, the smaller the share of impervious surfaces and the larger the share of other land cover types, especially of the vegetation cover. On an annual scale, west and north-west winds, accounting for approximately 46% of all wind events during a year, are prevalent in Legnica (Fig. 4). North (3.2%) and north-east (4.9%) wind events occur with the lowest frequency. During winter no hourly O_3 concentrations >80 $\mu g/m^3$ were recorded (Fig. 5). The highest hourly O_3 concentrations in that period were in the 41–80 $\mu g \cdot m^{-3}$ range and they came from the northwest, southwest and west, accounting for up to 50% of all documented

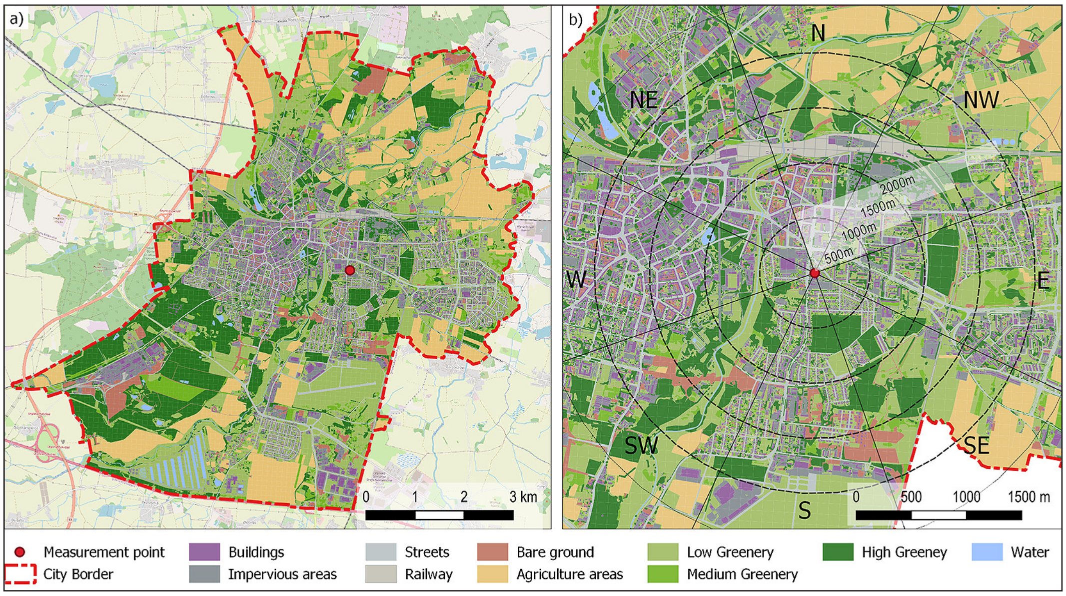

Fig. 2. Land cover map (a) division of the area based on the 8-wind compass rose and 4 distances: 500 m, 1,000 m, 1,500 m and 2,000 m from the measuring point (b)

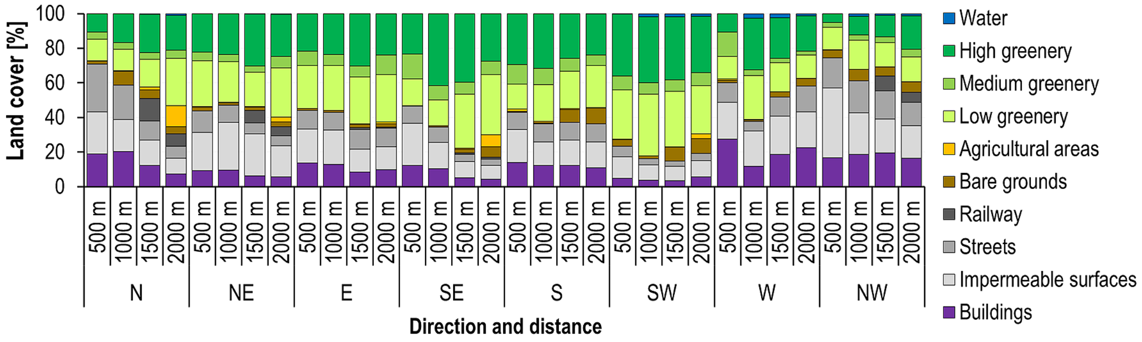

Fig. 3. Share of land cover types at 4 distances: 500 m, 1,000 m, 1,500 m and 2,000 m from the measuring point at the Rzeczypospolitej Avenue, depending on wind direction

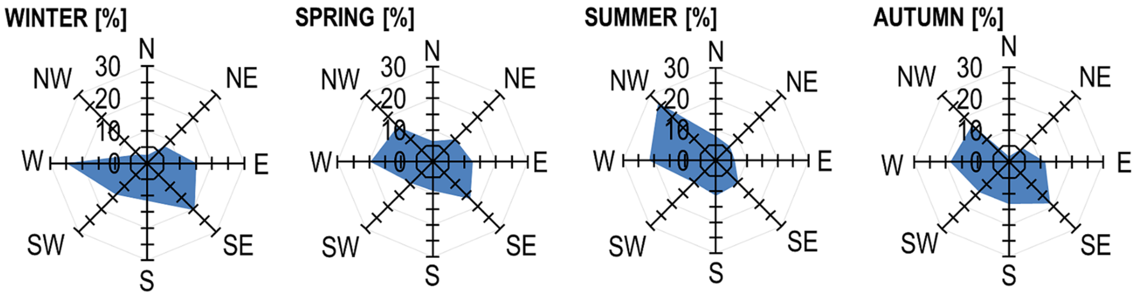

Fig. 4. Wind directions in different seasons (2005–2014)

occurrences. The lowest frequency for this range of concentrations, i.e. just 7%, was recorded as coming from the northeast. In spring, hourly O_3 concentrations >120 $\mu g \cdot m^{-3}$ arrived most frequently from the southeast, south and southwest, with a frequency of 3% to 5%. Hourly O_3 concentrations most frequently recorded from the south were in the 81–120 $\mu g \cdot m^{-3}$ range and accounted for almost 40% of all concentrations arriving from that direction. In contrast, hourly O_3 concentrations in the 41–80 $\mu g \cdot m^{-3}$ range were recorded from the south and southwest with a frequency below 40%. O_3 concentrations in the 0–40 $\mu g \cdot m^{-3}$ range accounted for almost 40% of all pollution coming from the southwest. In summer, hourly O_3 concentrations >120 $\mu g \cdot m^{-3}$ were recorded from the north and northwest directions and they accounted for less than 1%, whereas those from the southeast and south accounted for >10%, those from the east – for 20%. Hourly O_3 concentrations in the 0–40 $\mu g \cdot m^{-3}$ range were most frequently recorded as coming from the southwest and accounted for over 50% of all documented events. In autumn, the frequency of occurrence of hourly O_3 concentrations >120 $\mu g \cdot m^{-3}$ did not exceed 1%, regardless of wind direction, whereas hourly O_3 concentrations in the 41–80 $\mu g \cdot m^{-3}$ range were most frequently recorded when the wind blew from the south and northwest, and they occurred with the frequency of >40%.

In summer, the majority of hourly O_3 concentrations >120 $\mu g \cdot m^{-3}$ were recorded as arriving from the southeast, south and east, in the afternoons (Fig. 6.). Between 13:00 and 17:00 hourly O_3 concentrations >120 $\mu g \cdot m^{-3}$ arriving from the southeast accounted from over 40% of such concentrations coming from all directions. For 5 hours the share of concentrations >120 $\mu g \cdot m^{-3}$ persisted at levels of between 41 and 48%, and it varied across different hours. There were definitely less O_3 concentrations >120 $\mu g \cdot m^{-3}$ arriving from the south and east per hour. Between 13:00 and 18:00, pollution came from the south with a frequency of 20–27%, except for 15:00 when it reached 40%. The highest frequency of hourly O_3 concentrations >120 $\mu g \cdot m^{-3}$ coming from the east, i.e. 27–33%, was recorded between 15:00 and 17:00. Depending on the direction, the first instances of hourly O_3 concentrations >120 $\mu g \cdot m^{-3}$ were recorded between 9:00 and 11:00. At the earlier time, i.e. at 9:00, pollution came from the north, southeast, south and northwest, whilst at the later time, i.e. at 11:00, from the southwest and west. An increase in frequency of hourly O_3 concentrations in the

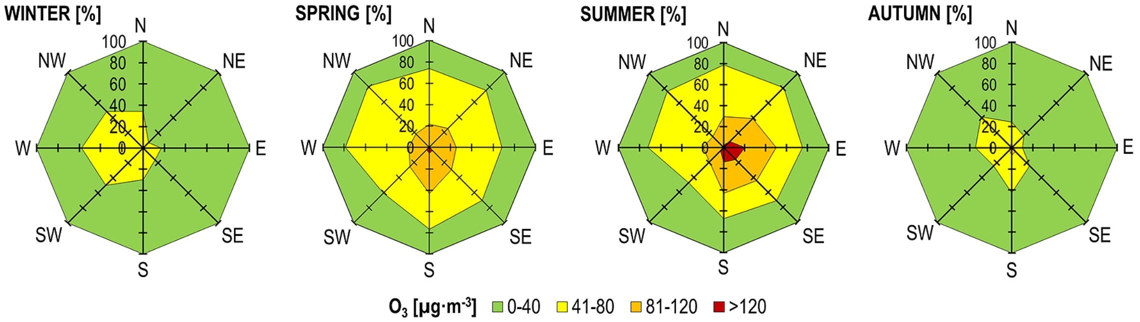

Fig. 5. Pollution roses of hourly O_3 concentrations in the adopted ranges (2011–2014)

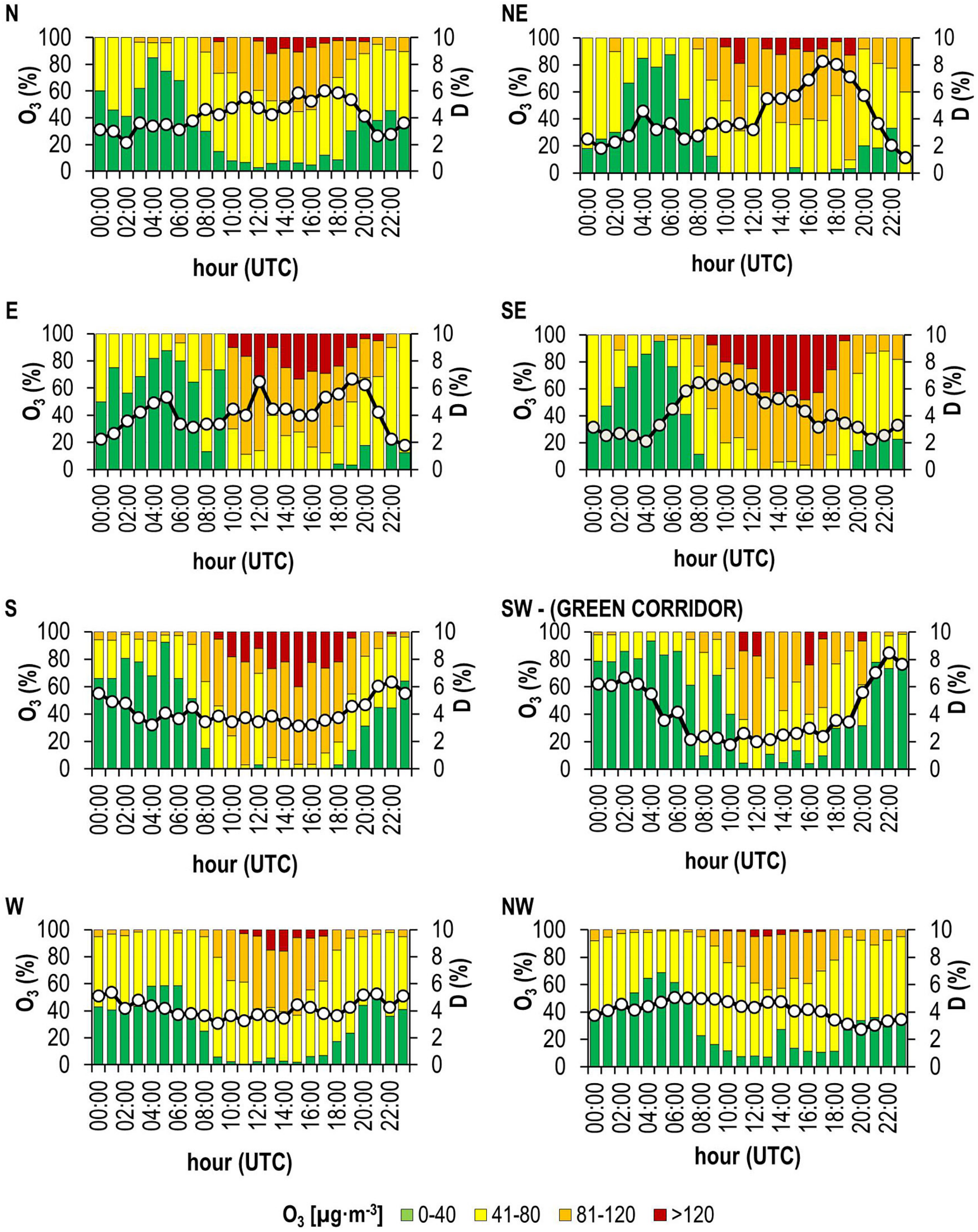

Fig. 6. Frequency of occurrence of hourly O_3 concentrations in summer, by hour, depending on wind direction (2011–2014)

0–40 $\mu g \cdot m^{-3}$ range was recorded mainly at night and in the early morning hours. Pollution in that concentration range most often arrived from the southwest between 21:00 and 6:00. It accounted for 70–90% of all hourly concentrations and it dominated for a total of 8 h a day. Such a large share of hourly concentrations in the 0–40 $\mu g \cdot m^{-3}$ range did not persist for more than 4 h a day for the other directions whilst no pollution concentrations arriving from the northwest and west exceeded 70% of all hourly concentrations. Within the same night and morning period, hourly O_3 concentrations in the 40–80 $\mu g \cdot m^{-3}$ range arrived more frequently from the north, northeast, west and northwest than from other directions. Relationships between hourly O_3 concentration ranges and land cover area were statistically significant when the correlation coefficient was 0.7 or higher (Tabele 2). The impact of the percentage of road areas on the frequency of concentrations <40 $\mu g \cdot m^{-3}$ in a sector within 500 m of the measuring point was an exception here. Statistically significant results related to the share of developed land, impervious surfaces and roads were recorded mainly at a distance of 500 m and 1,000 m from the measuring point. In the analysis of the sectors 2,000 m from the measuring point, all results for those land cover types turned out to be statistically insignificant. It was demonstrated that high vegetation had a positive impact on air quality since it reduced the frequency of occurrence of hourly concentrations in the 41–80 $\mu g \cdot m^{-3}$ range (Table 2). No statistically significant impact of high vegetation was noted for other concentration ranges, except for concentrations <40 $\mu g\ m^{-3}$. The analyses showed a clear positive effect of the presence of surface water on the decrease in the proportion of high O_3 concentrations >120 $\mu g \cdot m^{-3}$ at a distance of at least 1,000 m from the measuring point. On the other hand, it was noted that an increase in frequency was correlated with an increase in low vegetation cover.

DISCUSSION

Between 2011 and 2014, hourly O_3 concentrations <40 $\mu g \cdot m^{-3}$ came most frequently from the southwest. Tropospheric ozone concentrations <40 $\mu g \cdot m^{-3}$ coming from the southwest accounted for over 70% of all pollution concentrations flowing in between 21:00 and 6:00. However, for other directions, the inflow of hourly O_3 concentrations above 70% persisted for up to 5 hours a day, mainly between 0:00 and 5:00. Low O_3 concentrations arriving from the northwest and north were recorded for the shortest period of time, between 4:00 and 6:00. The results confirm that the vegetation zone situated along the Kaczawa River, together with the historic urban park, play the role of a green ventilation corridor at night and in the early morning hours. This may be partially due to the phenomenon of a park breeze, as pointed out by Eliasson and Upmani (2000) who analysed large parks and their surroundings in Gothenburg.Correlation analysis showed a statistically significant impact of a larger high vegetation cover on the decrease in hourly

Table 2. Matrix of correlations between the adopted ranges of hourly O_3 concentrations (summer) and percentage share of land cover

Land cover [%]	Distance from the measurement point															
	500 m				1000 m				1500 m				2000 m			
	O_3 <40 $\mu g \cdot m^{-3}$	O_3 41–80 $\mu g \cdot m^{-3}$	O_3 81–120 $\mu g \cdot m^{-3}$	O_3 >120 $\mu g \cdot m^{-3}$	O_3 <40 $\mu g \cdot m^{-3}$	O_3 41–80 $\mu g \cdot m^{-3}$	O_3 81–120 $\mu g \cdot m^{-3}$	O_3 >120 $\mu g \cdot m^{-3}$	O_3 <40 $\mu g \cdot m^{-3}$	O_3 41–80 $\mu g \cdot m^{-3}$	O_3 81–120 $\mu g \cdot m^{-3}$	O_3 >120 $\mu g \cdot m^{-3}$	O_3 <40 $\mu g \cdot m^{-3}$	O_3 41–80 $\mu g \cdot m^{-3}$	O_3 81–120 $\mu g \cdot m^{-3}$	O_3 >120 $\mu g \cdot m^{-3}$
	[%]															
B	n.s.	n.s.	n.s.	n.s.	-0.700*	n.s.	n.s.	n.s.	n.s.	0.758*	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Ia	n.s.	0.717*	n.s.	n.s.	-0.850**	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
S	-0.599*	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
R	n.d..	n.d..	n.d..	n.d..	n.d..	n.d..	n.d..	n.d..	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Bg	n.s.	n.s.	-0.746*	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	0.711*	n.s.	n.s.	n.s.
Aa	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Lg	n.s.	n.s.	n.s.	n.s.	0.711*	n.s.	n.s.	n.s.	n.s.	-0.845**	n.s.	n.s.	n.s.	-0.721*	n.s.	n.s.
Mg	n.s.	n.s.	n.s.	n.s.	n.s.	-0.889**	n.s.	0.729*	n.s.	-0.92***	n.s.	0.753*	n.s.	-0.756*	n.s.	0.842**
Hg	n.s.	-0.879**	n.s.	n.s.	n.s.	-0.713*	n.s.	n.s.	n.s.	-0.795*	n.s.	n.s.	0.797*	-0.715*	n.s.	n.s.
W	0.916***	n.s.	n.s.	n.s.	n.s.	n.s.	-0.881**	n.s.	n.s.	n.s.	-0.836**	-0.724*	n.s.	n.s.	-0.862*	-0.905**

* p = 0,05; ** p = 0,01; *** p = 0,001, n.s. – no significant

B – buildings; Ia – impervious areas; S – streets; R – railway; Bg – beer ground; Aa – agriculture aeras; Lg – lower greenery; Mg – medium greenery; Hg – high greenery; W – water

O_3 concentrations in the 41–80 µg·m^{-3} range. It was noted that during nighttime, pollution in that range came more often from the direction of the areas covered with compact and dense development than from any other directions. The results obtained in this way may confirm that ensuring a sufficient air movement in a densely built-up area, may play a more important role than the trees' ability to trap pollution. This was also confirmed by the results of research carried out by Buccolieri et al. (2011), Wania et al. (2012) and Vos et al. (2013). Maintaining green ventilation corridors is particularly important because it is not only high temperatures and solar radiation that contribute to the formation of high O_3 concentrations, but also reduced wind speeds (Wang et al., 2007). In order to make the most of the potential of green ventilation corridors, it is important to prevent their fragmentation – a risk which dynamically developing urban agglomerations are particularly exposed to (Paul and Nagendra 2015; Osińska-Skotak and Zawalich 2016; Wicht et al., 2017). Especially as the presence of development may reduce wind speeds by almost 30%) Javanroodi and Nik 2019). In Warsaw (Poland) in 1992, developed land occupied 15% of the total area of ventilation corridors, whereas by 2015 that percentage increased to as much as 23% (Osińska-Skotak and Zawalich 2016). Green areas most likely to be transformed are those covered with informal and spontaneous vegetation**.** In Wroclaw (Poland), despite a 10-fold increase in the area covered by informal forests between 1944 and 2017, which might potentially reinforce green ventilation corridors, their progressive fragmentation has been reported (Jaworek-Jakubska et al., 2019). Despite the fact that west and northwest winds dominate here, it is worth noting that the corridor fulfils its purpose. Since the winds blowing at night were recorded mainly from the southwest, they allow ventilation of the area subject to analysis. Lack of high O_3 concentrations, that is >120 µg·m^{-3}, coming from the west and northwest, may result from the specific spatial structure of the town, since the shaded area of adjacent areas also increases with the increase in the height of buildings (Oliveira et al., 2011, Ng et al., 2012), which has an impact on photochemical reactions. Another reason may be that the Kaczawa River crosses this area, contributing to the dispersion of pollution flowing in from the west and in particular from the northwest. It should be noted, however, that the data covered only 3.5 years during which the station carried out comprehensive meteorological measurements. The obtained results are an additional argument in the discussion on the impact of vegetation on the improvement of air quality and in particular on the still unclear impact of greenery on the level of ground-level ozone in cities.

CONCLUSIONS

In winter, the proportion of hourly O_3 concentrations >40 µg·m^{-3} coming from the southwest is highest compared to other seasons. In summer and spring, on the other hand, it is the lowest. In winter, that share is comparable to the frequency of the inflow of hourly O_3 concentrations from the west and northwest. In summer, the city park, the Kaczawa River and the green areas located along the river to the southwest of the measuring point create a ventilation wedge which ventilates the town at night and in the early morning hours. Hourly O_3 concentrations <40 µg·m^{-3} coming from the southwest account for more than 70% of all concentrations recorded between 21:00 and 6:00. The inflow of pollution at that concentration range lasts twice as long as that for other directions. Vegetation has a positive impact on air quality due to an increase in the share of low O_3 concentrations in the 0–40 µg·m^{-3} range and a decrease in frequency of occurrence of O_3 concentrations in the 41–80 µg·m^{-3} range. West and southwest winds prevail in Legnica, which results in an inflow of air from urban areas towards the measuring point. The study demonstrated that at night and in the morning, the air flowing from densely developed areas is more likely to be characterised by elevated hourly O_3 concentrations in 41–80 µg·m^{-3} range. The study confirms that pollution levels can be effectively managed by means of vegetation - not so much by increasing its coverage area, but primarily by its spatial distribution within the city structure. Therefore, the study results should be used as the basis for protecting vegetation-covered areas which function as ventilation corridors.

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