



ELISAH

*European Linkage of Initiative
from Science to Action in Health*

**Work Package 6: Urban environment and
breast cancer risk**

Deliverable 6.2

VERSION V. 1.0

AUTHORS

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UNIBS**

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- **PROJECT SUMMARY**

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DISCLAIMER

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ABBREVIATIONS

ELISAH WG: working group composed by coordinator (INT) and partners of the ELISAH project

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EXECUTIVE SUMMARY

The aim of WP6 of the ELISAH project is to study the urban environment as a conditioning factor for the development and progression of breast cancer. We previously analyzed built environment in a sample of ten European cities and towns identifying differences between them. We present in this document analysis of atmospheric pollution and built environment differences by neighborhood for Athens, Milan and Ivano-Frankivsk taking into account socio-economic differences. Large variations by neighborhoods were identified in the three cities for NO₂, not for PM_{2.5} and PM₁₀. For all the three considered cities concentrations were above the WHO guidelines, i.e. 5 and 10 µg/m³, for PM_{2.5} and NO₂, respectively. Primary and secondary roads, cycleways, and green spaces also showed large variations by neighbourhood. The relationship of the selected built environment and atmospheric pollutant elements (e.g. green spaces) and neighborhood deprivation is peculiar to cities and different according to elements. For example, in Athens, the more deprived neighbourhoods were more exposed to NO₂; on the other hand, in Milan, the less deprived neighborhoods are more exposed. According to the results of the ELISAH WP6 study city policies have to be closely tailored to the local environment.

The consortium

ELISAH brings together a consortium of 11 organizations from 4 countries, including cancer research centres, research infrastructures, universities, leading research groups, hospitals, Non-profit organisation of social utility and analytics institutions. Participating nations include Italy, Greece, Spain, Ukraine, with Fondazione IRCCS Istituto Nazionale dei Tumori (Milan, Italy), taking the lead as the project coordinator.

ELISAH partners



1. INTRODUCTION

The aim of WP6 of the ELISAH project is to study the urban environment as a conditioning factor for the development and progression of breast cancer. An analysis of built environment was initially conducted in a sample of ten European cities and towns (Deliverable 6.1), followed by a detailed neighbourhood-level analysis to suggest local actions aimed at improving the dialogue with Municipalities, citizens, and patient associations. The latter is present in this document for three cities: Athens (Greece), Ivano-Frankivs'k (Ukraine), and Milan (Italy). In ELISAH WP3, we showed how age-standardised incidence rates varied very sharply according to geographical space. We hypothesised that similar variations could be observed in built environment and for atmospheric pollutants, as outlined by recent studies on environmental justice [1] that identified spatial inequalities in the distribution of green spaces and atmospheric pollutants. We opted to study PM_{2.5}, PM₁₀, and NO₂ as atmospheric pollutants, alongside green spaces, cycleways, primary and secondary roads as built environment components.

We also analysed the issue of socio-economic inequalities in this neighbourhood-level study by using the Deprivation Index [2-3], a common metric for all ELISAH WPs.

The Deprivation Index was accessible for Italy at the national level and for the Attica region in Greece, but not available for Ukraine; hence, we started a pilot project to compute it. A preliminary calculation of the deprivation index has been conducted. Validation tests are currently ongoing; consequently, we will update the dataset used in this analysis, including Ivano-Frankivsk.

Schema of the document:

- A) Analysis of selected built environment components and atmospheric pollutants by neighbourhood
- B) Association with Deprivation at neighbourhood levels

2 Data and Methods for project development

2.1. Deprivation Index

Deprivation by neighbourhood was assessed by using different databases for Greece, Italy and Spain. For Italy we used the deprivation index set up by Caranci et al [4]. For Spain we used the national formulation of the deprivation index as proposed by Duque et al, split in quintiles [5]. In Greece a national deprivation index was not available so we restricted its application to the region of Attica making use of the index proposed by the Athens Social Atlas Group [6]. No Deprivation Index was not available in Ukraine at project start, the ELISAH working group has developed a pilot project to assess it. The first version of Ukraine Deprivation Index was used to classify Ivano-Frankivsk women included in the study described in this document.

2.2. Built environment data

OpenStreetMap (OSM) [7] is a map database maintained by a community of volunteers via open collaboration. OpenStreetMap represents physical features on the ground, using tags attached to its basic data map structures, in our case information on roads, bicycle lanes and green spaces were available for the cities under analysis. We used the methods described in ELISAH Deliverable 6.1 to extract useful data city by city from OSM. Once the selected built environment components were extracted, we intersected them with digital maps reporting neighbourhood boundaries. After these

operations we computed atmospheric pollutants concentrations, green spaces percentage by km², kilometres of cycleway by km², kilometres of primary and secondary roads by km² by neighbourhood for each of the three geographical entities above defined.

2.3. Air pollution data

Concentration of PM_{2.5}, PM₁₀ and NO₂ in Milan and Athens were retrieved from European Environmental Agency [8]. The datasets provide grid-level (1 km x 1 km resolution) concentrations of air pollutants, combining air quality monitoring data in a “regression-interpolation-merging” mapping methodology and observational values from air quality monitoring stations used in the interpolation, for all Europe, excluding Ukraine. We use the data by Copernicus provided at a resolution of 10 km × 10 km to assess Ivano-Frankivsk oblast PM_{2.5} and NO₂ concentrations, PM₁₀ concentrations were not available. Vector layers were processed using R-language SF and Terra package [8] and spatially clipped to the geographical extent of the urban area of Athens, the municipality of Milan which are included in the EEA spatial coverage, similar operations were performed for Ivano-Frankivsk by using Copernicus data [9]. For each cell falling within the boundaries of the neighbourhood units considered in the analysis, the geographic coordinates and the corresponding pollutant concentration values were extracted.

2.4. City case studies

To perform neighbourhood analysis, we considered the following geographical entities:

- The urban area of Athens, covering an area of 412 km² with 40 municipalities and hosting 3 059 764 inhabitants
- The oblast of Ivano-Frankivsk, covering an area of 13 900 km² with 19 second-level administrations and hosting 1 351 822 inhabitants

- The municipality of Milan, covering an area of 181 km² divided into 88 neighborhoods and hosting 1 363 964 inhabitants

2.5. Statistical elaboration

We used atmospheric pollutant data for 2019 to maintain uniformity with other ELISAH WPs. PM10 concentrations were not available for Ivano-Frankivsk.

We computed weighted means, maximums, minimums, and weighted standard deviations for green spaces, cycleways, primary and secondary roads considering neighbourhood as statistical unit of analysis.

Maximum, minimum, and standard deviation were used to measure the degree of variation for every variable under analysis.

We used Spearman's r to assess correlations between selected built environment, atmospheric pollutants and deprivation metrics. Spearman's r is a non-parametric measure of dependence between two variables based on case rankings and suitable to assess correlations for variables with skewed distributions.

Deprivation index goes from 1, less deprived, to 5 (Milan) or 6 (Athens), more deprived. The statistical analysis was performed by using the R-language package.

The framework of the statistical analyses is summarized in Fig.1 for Athens and Milan, and in Fig. 2 for Ivano-Frankivsk.

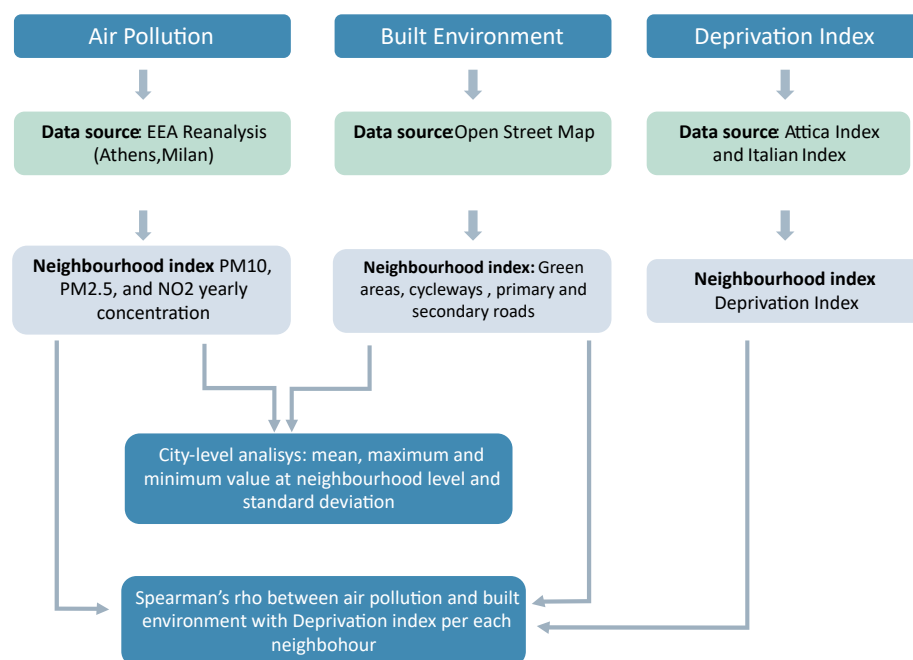


Figure 1. Workflow of the neighborhood-level analysis for Athens and Milan

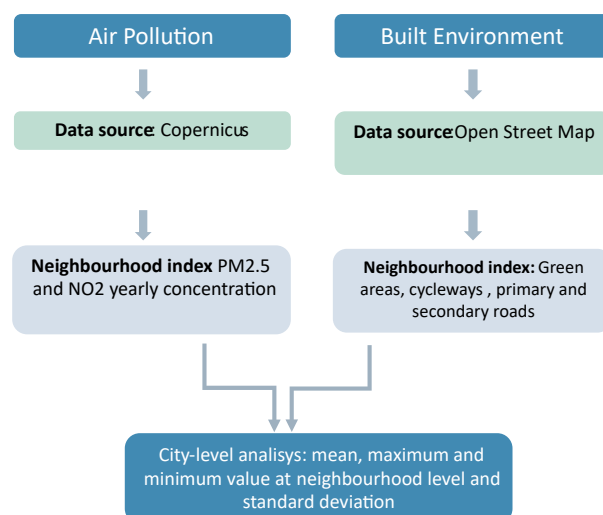


Figure 2. Workflow of the neighborhood-level analysis for Ivano-Frankivsk

3- Results

3.A

Table 1 shows the results on air pollution and the built environment for three cities, expressed as minimum, maximum, and mean values over the neighbourhood units. Interestingly mean values for PM_{2.5} in all the three cities exceed WHO guidelines, NO₂ mean in Milan was nearly 4 times the WHO limit, more than two times in Athens, in Ivano-Frankivsk near the limit. PM₁₀ WHO limit was overcome both in Athens and Milan, for Ivano-Frankivsk no data was available by Copernicus. Primary and secondary roads, cycleways, and green spaces also showed large variations by neighbourhood. Fig. 2, Fig. 3, and Fig. 4 graphically describe the spatial variations for selected built environment and atmospheric pollutant variables.

3.B

Table 2 shows variable means split by Deprivation Index, for Athens and Milan. Table 3 shows Spearman correlation indexes.

In both cities, PM_{2.5} and PM₁₀ showed no association with the Deprivation Index, due to the strong homogeneity of pollutant distribution in the two areas.

The correlation between Deprivation and NO₂ varies considerably between Athens and Milan. In Athens, the more deprived neighbourhoods were more exposed to NO₂; on the other hand, in Milan, the less deprived neighbourhoods are more exposed.

In Milan, the presence of green spaces was (statistically significant) associated with more deprived neighbourhoods, while secondary roads had a negative correlation with the deprivation index.

Except PM₁₀ all the Athens correlation showed an inverse association respect to Milan.

	Athens			Ivano-Frankivsk			Milan		
	Min	Mean (stand. dev.)	Max	Min	Mean (stand dev)	Max	Min	Mean (stand. dev)	Max
PM_{2.5} (µg/m³)	13.40	16.77 (2.08)	20.39	8.38	11.65 (1.19)	14.55	18.84	19.54 (0.38)	20.26
NO₂ (µg/m³)	9.15	22.57 (7.90)	35.03	1.54	3.19 (0.97)	5.72	28.31	39.39 (5.16)	47.96
PM₁₀ (µg/m³)	19.70	26.68 (3.92)	34.23	NA	NA	NA	28.05	29.00 (0.48)	30.11
Primary Roads (km/km²)	0.14	2.34 (1.38)	6.75	0.01	0.82 (0.07)	1	1.04	2.55 (1.67)	9.80
Secondary roads (km/km²)	4.15	14.20 (7.00)	29.94	0.31	0.76 (0.41)	5.06	0.03	6.76 (5.01)	19.35
Cycleway (km/km²)	0.01	0.72 (0.70)	4.10	0.01	0.06 (0.05)	0.89	0.57	5.01 (3.68)	34.49
Green Areas	2.27	30.70 (21.44)	85.75	13.89	55.78 (22.38)	83.95	2.34	30.95 (24.93)	82.83

Table 1: Statistical indicators for selected pollutant and built environment elements by city

	Athens						Milan				
	1	2	3	4	5	6	1	2	3	4	5
PM_{2.5} ($\mu\text{g}/\text{m}^3$)	17.00	18.32	18.41	16.69	16.79	17.67	19.36	19.54	19.55	19.44	19.68
NO₂ ($\mu\text{g}/\text{m}^3$)	21.85	23.99	29.52	26.72	30.21	27.41	44.49	44.02	40.89	39.67	37.41
PM₁₀ ($\mu\text{g}/\text{m}^3$)	27.41	29.29	29.26	26.25	26.74	28.32	28.99	29.19	29.10	28.92	29.01
Primary Roads	2.25	2.28	3.62	3.46	1.99	1.91	3.63	3.45	2.81	2.73	1.80
Secondary roads	14.98	16.62	17.31	18.29	22.58	19.85	9.19	13.28	8.14	6.51	2.65
Cycleway	0.88	0.96	1.12	1.18	0.48	0.50	8.20	5.65	6.30	4.58	10.93
Green Areas	27.16	36.61	16.20	18.39	12.91	26.30	37.89	10.08	24.16	25.21	49.94

Table 2: Measurement of selected pollutant and built environment elements by Deprivation Index, for Athens and Milan

	Athens Depr. Index	Milan Depr. Index
PM ₁₀	0.04 (-0.28;0.35)	-0.17 (-0.37;0.04)
PM _{2.5}	0.00 (-0.31;0.31)	0.00 (-0.21;0.21)
NO ₂	0.39 (0.09;0.63)	-0.39 (-0.55;-0.20)
Green spaces	-0.15 (-0.45;0.16)	0.38 (0.19-0.55)
Cycleways	-0.10 (-0.40;0.22)	0.08 (-0.13;0.28)
Primary roads	0.04 (-0.27;0.35)	-0.21 (-0.40;0.00)
Secondary roads	0.30 (-0.01;0.55)	-0.57 (-0.70;-0.41)

Table 3: Spearman's correlations between selected built environment, atmospheric pollutants and deprivation metrics

ATHENS

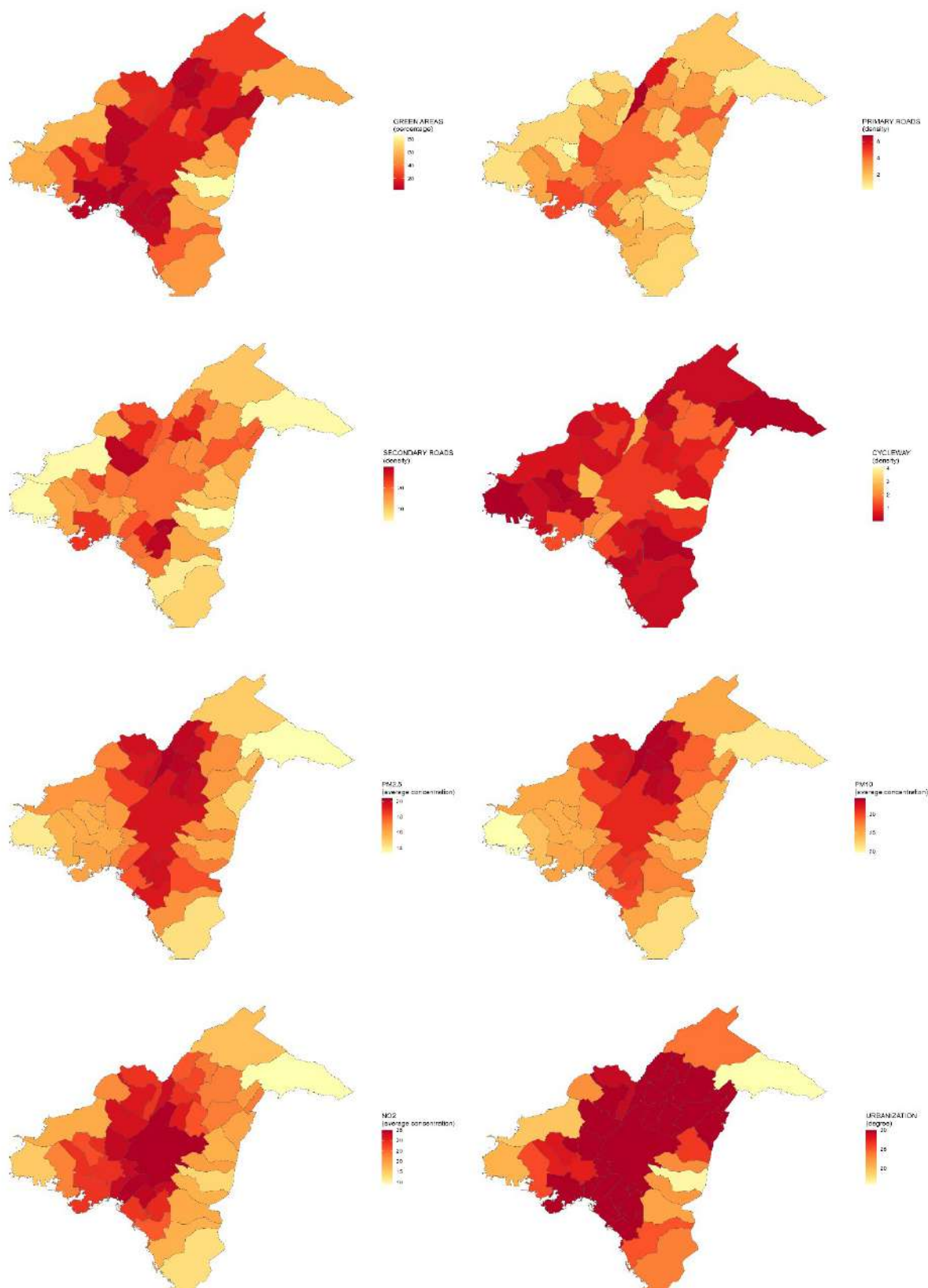


Fig 3: spatial distribution of selected built environment and atmospheric pollution variables, Athens

IVANO FRANKIVSK

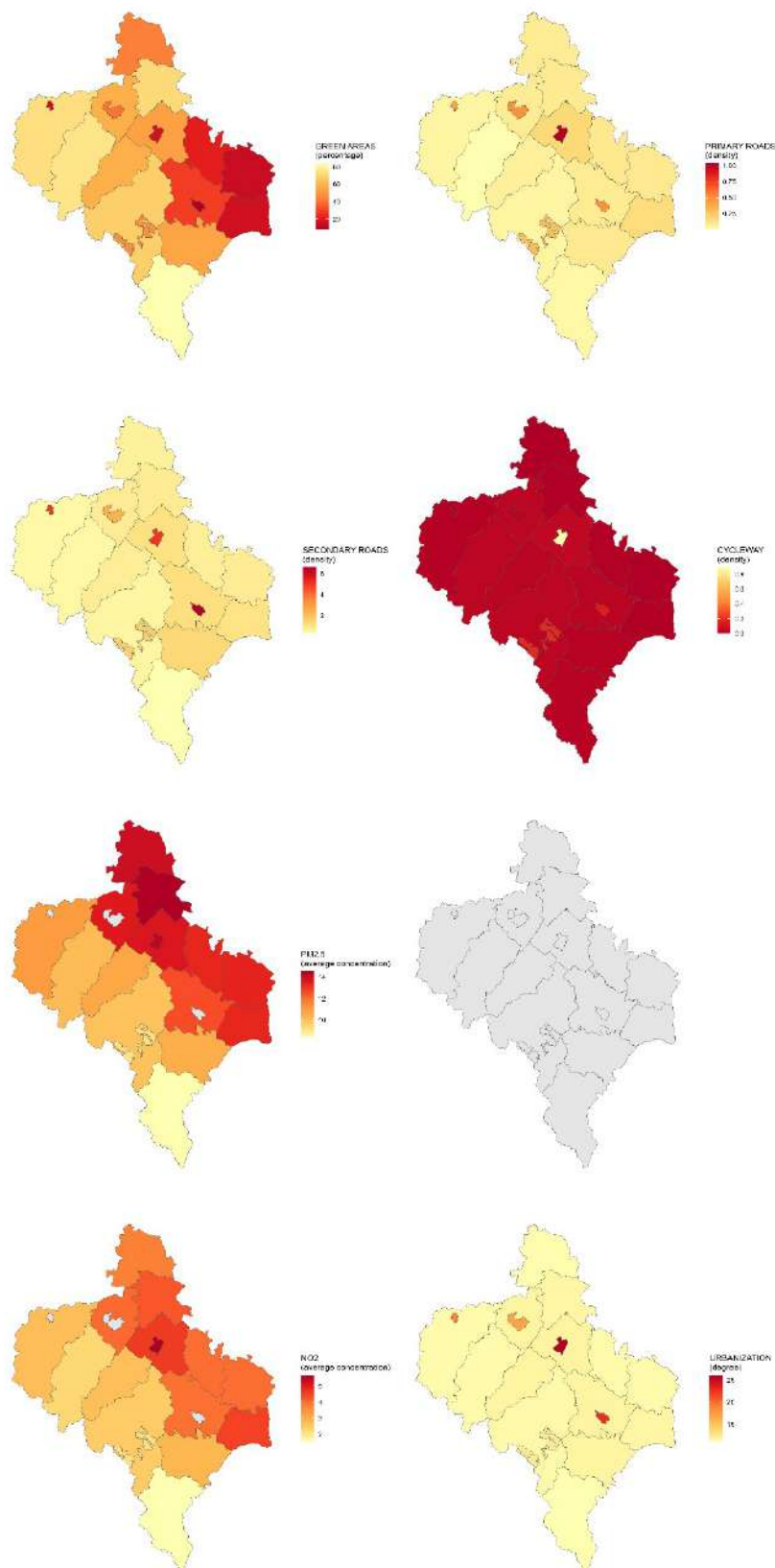


Fig 4: spatial distribution of selected built environment and atmospheric pollution variables, Ivano-Frankivsk

MILAN

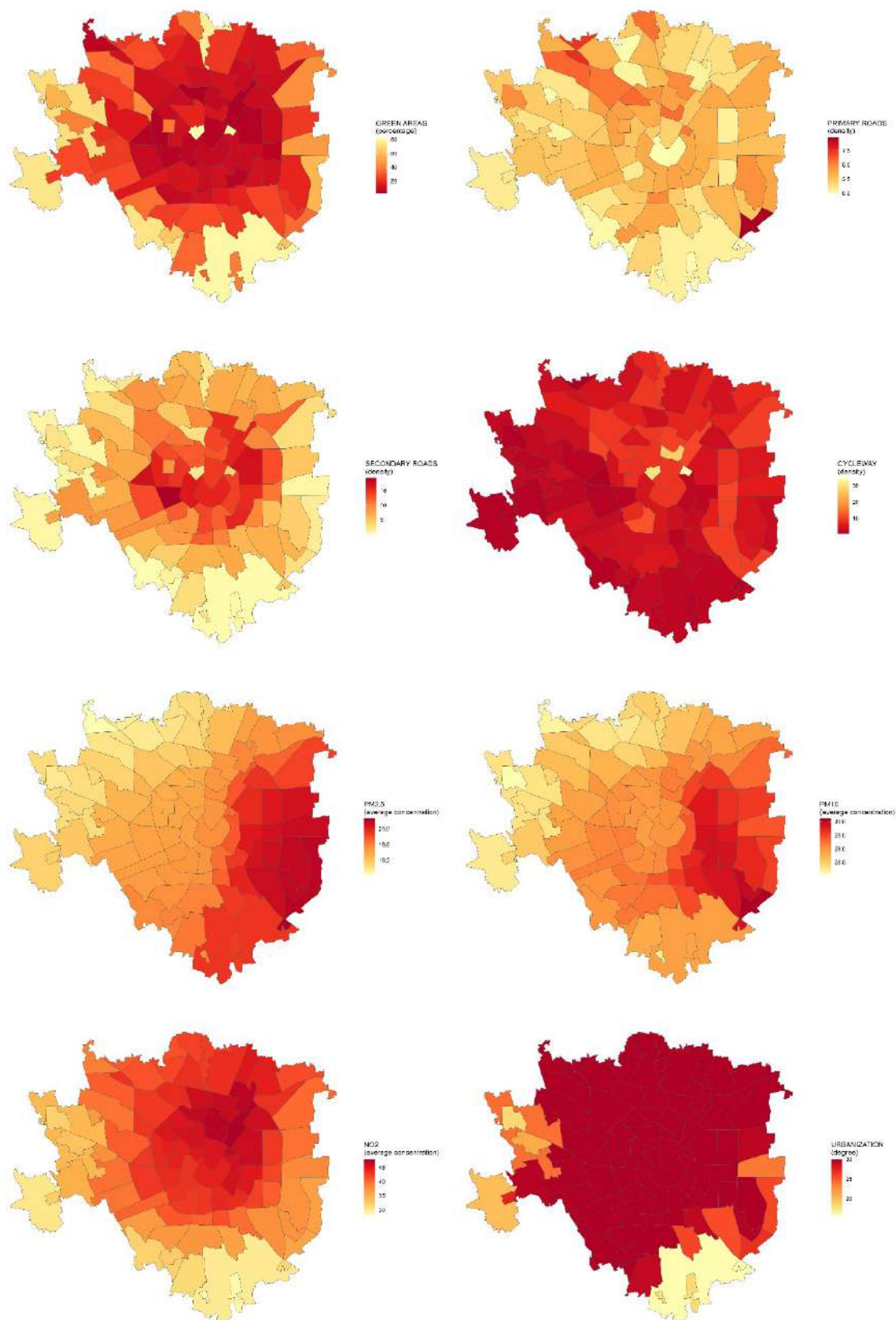


Fig 5: spatial distribution of selected built environment and atmospheric pollution variables, Milan

3 - Conclusion

Main points:

- Spatial distribution of pollutants showed large variations for NO₂, not for PM_{2.5} and PM₁₀
- For all the three considered cities concentrations are above the WHO guidelines, i.e, 5 and 10 $\mu\text{g}/\text{m}^3$, for PM_{2.5} and NO₂, respectively. This leads to a harmful effect on human health considering the exposure of population. In order to reduce population exposure, emission reduction measures need to be implemented. However, the relationship between emissions and ambient pollutant concentrations is not linear and is influenced by multiple factors, including atmospheric chemistry, meteorological conditions and spatial dispersion processes. As a result, it is often difficult for policymakers to identify which emission reduction measures are most effective at reducing pollutant concentrations at the local level. In this context, the JRC Air Quality Atlas [10] provides valuable support by indicating, at local scale, the potential reduction in pollutant concentrations that can be achieved through local emission abatement measures, as well as the extent to which local air quality is influenced by emissions originating outside the area of interest.

For the three considered cities, the atlas results for 2019, indicate that in Athens transport and residential followed by agriculture and industry were the main sources of PM_{2.5} pollution; the core city area accounts for about 20% of total PM_{2.5}, while major sources of pollution were outside the urban area. In Ivano-Frankivsk, the residential sector is the main sources of PM_{2.5}, followed by industry and agriculture [11]. The city contribution covers 10% overall concentration, rising to 30% when included the commuting zone, and the residual portion is attributable to external emissions. In Milan, residential and transport followed by agriculture were the major sources, and the city core accounted for 45% of PM_{2.5}, the rest were in the rest of the country. It is worth

noting that the ammonia emissions from agriculture are mainly produced outside the city boundary and contribute to 15% of total PM2.5 concentrations. Their influence is observed in the eastern part of the city with an increase of PM2.5 concentrations.

- The relationship between the selected atmospheric pollutant and built environment elements (e.g. green spaces) and deprivation is peculiar to cities and different according to elements. For example, in Athens, the more deprived neighborhoods were more exposed to NO2; on the other hand, in Milan, the less deprived neighborhoods are more exposed. According to the results of the ELISAH WP6 study city policies have to be tailored to local environment

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