



# INNOAIR

**INDEX: UIA05-202**

**Innovative demand responsive green  
public transportation for cleaner air in  
urban environment**

**Background concentrations of  
key pollutants for the district of  
interest**

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## Abbreviations

| Abbreviation | Explanation                                                              |
|--------------|--------------------------------------------------------------------------|
| AQ           | Air Quality                                                              |
| BgCWFS       | Bulgarian Chemical Weather Forecast System                               |
| DoI          | District of Interest                                                     |
| ExEA         | Executive Environmental Agency                                           |
| ODT          | On-demand transport                                                      |
| LEZ          | Low emission zone                                                        |
| LEZ0         | Low emission zone - center                                               |
| LEZ1         | Low emission zone - wide center                                          |
| NIMH         | National Institute of Meteorology and Hydrology                          |
| PM10         | Particulate matter with aerodynamic diameter less than 10 $\mu\text{m}$  |
| PM2.5        | Particulate matter with aerodynamic diameter less than 2.5 $\mu\text{m}$ |
|              |                                                                          |

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## Key data

|                      |                                                              |
|----------------------|--------------------------------------------------------------|
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## Abstract

Districts of Interest (DoI) refer to areas in the city of Sofia where the introduction of innovative on-demand transport (ODT) is taking place. At the same time, a low-emission zone (LEZ) is being designed and introduced in the centre of the city. Both initiatives are supported by the INNOAIR project with the main goal to improve the air quality (AQ) in the city of Sofia. Background concentrations of pollutants in a given area are those concentrations, due to emission sources outside of the area, but which are transported by atmospheric processes inside the area. The evaluation of the background concentration is an intermediate stage of the important issue for assessment of the effect of changes in transport schemes on AQ. By using modelling tools for the dispersion of air pollutants, maps and characteristic values of the annual background concentration of PM<sub>10</sub> in LEZ and DoI are obtained. The background concentration in LEZ and DoI cannot be influenced by the new transport schemes, but should be considered as they indicate the maximum possible AQ improvement that can be achieved by the expected changes in the transport schemes. The changes of transport schemes in DoI cannot influence the background in the DoI. However, the measures for AQ improvement foreseen in the AQ plan of Sofia municipality refer to the entire city, and thus might change the background concentrations in the DoI. Thus, the assessment of background concentrations is an important step when considering the effect of the new innovative transport changes on the air quality of the city of Sofia.

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# 1. Introduction

The term Districts of Interest (DoI) refers to an area in the Sofia city where introduction of innovative on-demand transport (ODT) is in progress. This initiative and the establishment of Low Emission Zone (LEZ) for the transport in the city centre are among the main subjects of the INNOAIR project. The goal of these initiatives is the improvement of air quality (AQ) in Sofia, and the assessment of the ODT and LEZ effect on the AQ is an important part of the project.

Background air pollution (abbreviated further as background) plays an important role for the AQ assessments in a specific area. The concentrations of air pollutants in a specific area are formed as the result of pollutants emitted inside the area and pollutants emitted outside the area but transported into it. The latter form the background concentrations for the area in consideration. For the DoI, two types of background concentrations can be considered. The first one is the background concentration for the whole city, or more precisely for the area of calculation (Figure 1.1). These background concentrations originate from emission sources located outside the Sofia region. In deliverable D6.4.1 (Syrakov et al., 2021, Kirova et al. 2022), this type of background was determined according to the results from the air pollution modelling system BgCWFS operated at NIMH.

Based on the assessment from BgCWFS, on the measurements at the background (rural near city) AQ station "Kopitoto" and on estimates from Copernicus - CAMS regional air quality model (<https://regional.atmosphere.copernicus.eu/>), a value of  $12 \mu\text{g m}^{-3}$  is assumed for the annual PM<sub>10</sub> background concentration for Sofia city in 2022.

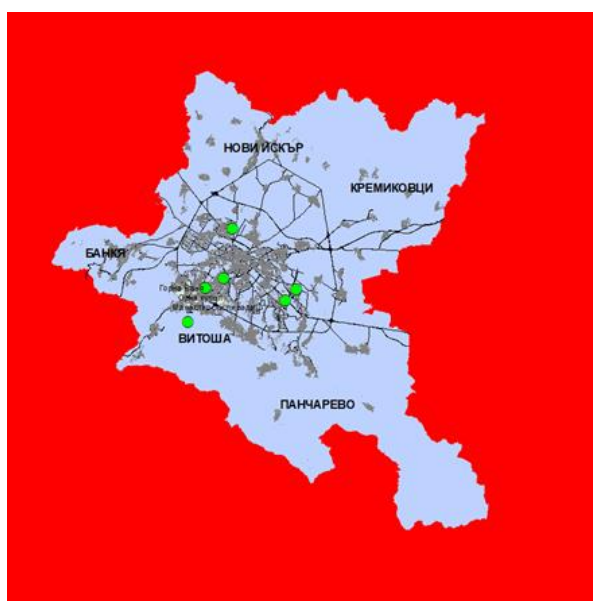


**Fig. 1.1** Area (in red) which emissions form the background air pollution for Sofia municipality (in blue) , AQ stations of the ExEA – green dots

The second type of background concentration is that formed in the DoI and in the LEZ zones from sources located outside these zones, in short "DoI and LEZ background". This background is a sum of two components:

- 1) the background concentration of  $12 \mu\text{g}/\text{m}^3$  for the city of Sofia, and
- 2) the concentrations emitted by sources in the city, but outside of the DoI and LEZ, abbreviated further as "close background".



**Fig. 1.2.** Areas (in red) which emissions form the background air pollution for LEZ (left) and for the DoI (right)

The subject of the present report is the determination of the annual background PM<sub>10</sub> concentrations for LEZ and for DoI for 2022. The importance of the background for LEZ and the background for DoI is because the changes in the transport schemes in LEZ and DoI will practically not affect the emission sources outside LEZ and DoI, and accordingly will not affect the background of DoI and LEZ in general. In other words, the background concentration in LEZ and DoI is something that the new transport schemes cannot influence.

The areas of LEZ and DoI are shown in Figure 1.2. Actually, two low emission zones are established in the Sofia city: zone centre (LEZ0) and zone wide centre (LEZ1) – Figure 1.3

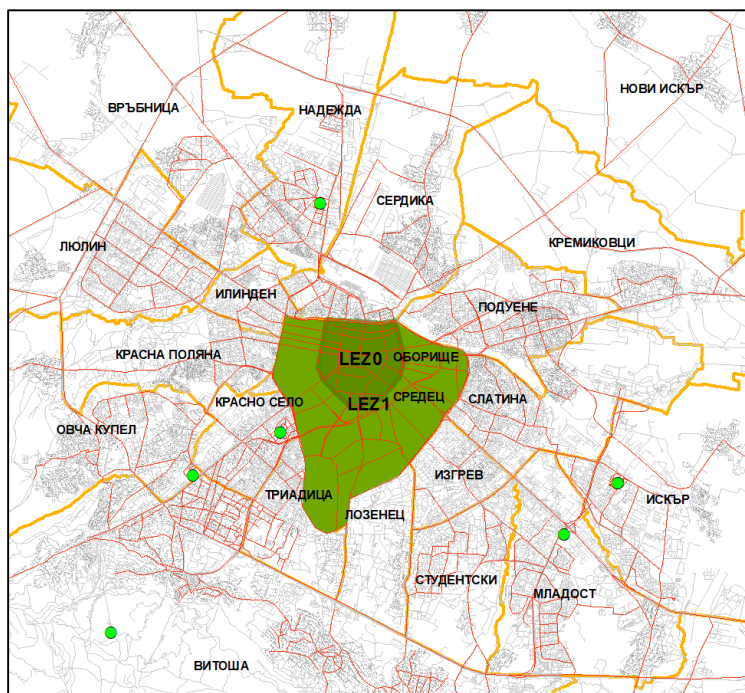


**Fig. 1.3.** The low emission zone centre (LEZ0) and the low emission zone wide centre (LEZ1)

## 2. Tools and data for assessment of the background concentration

The primary information for assessment of the background includes data on emissions of air pollutants and meteorological data. Based on this information, dispersion modelling is used to estimate the concentration of pollutants released outside the LEZ and DoI, i.e. to estimate the background concentration for LEZ and DoI.

Emission determination was described in D.6.4.3 "Development of possible scenarios on cultural shift in transportation on air quality" (Atanassov et al., 2022). The traffic emissions are of particular importance for the study. Traffic emissions have been updated according to the INNOAIR White book, 2022 and details could be found in Section 5.2 of D.6.4.4 "Effect of cultural shift in transport on air quality".

The emissions from the household heating were determined in D6.4.3 with great precision, using the 2011 national census data. The present study uses the same data, taking into account national trends in household heating patterns. The National Statistical Institute is expected to process and make available the national census data for 2021 very soon, thus, when the new information is available, the current survey could be updated.

New data on emissions from the industrial sector in 2022 are not present, but given their negligible impact on AQ, it is expected not to lead to significant errors in this study.

Different sources of meteorological information were considered (see Section 2 of D.6.4.4). After some tests and expert analyses, the information from the NIMH archive ProData was chosen for providing meteorological information needed for the dispersion modeling. ProData archive combines measurements, satellite and modelling data.

The dispersion calculations were performed with the system SELMA<sup>GIS</sup>- AUSTAL2000, which is described in Section 3.1 of D.6.4.4.

## 3. Background concentration in LEZ and DoI

Next step after evaluation of the background concentration for the Sofia city is determination of the background for LEZ and DoI including the close background.

### 3.1. Background of annual PM<sub>10</sub> concentration in LEZ1

The close background for LEZ1 is due to:

- the emissions released from the industrial sources in the city of Sofia, but located outside LEZ1 – Figure 3.1a,
- the emissions released from the household heating in the city of Sofia, but located outside LEZ1- Figure 3.1b,
- the emissions from the transport in the city of Sofia, released outside LEZ1 – Figure 3.1c.

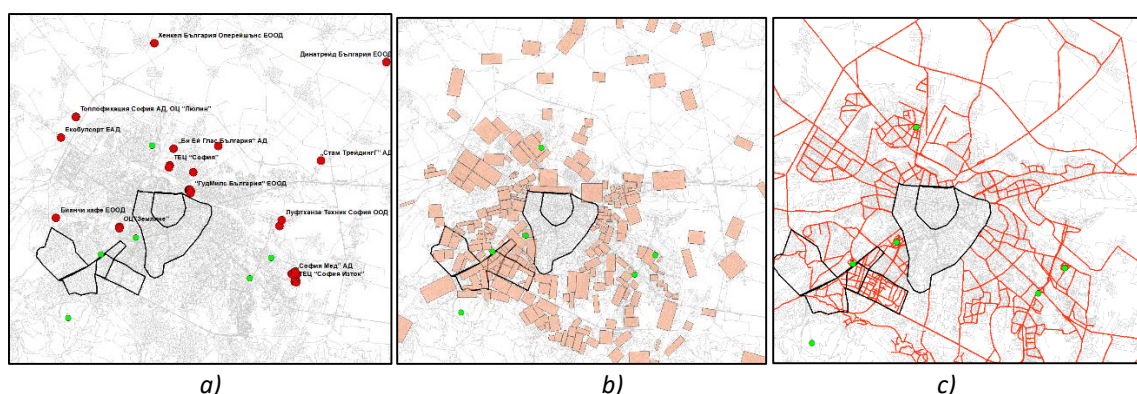


**Fig. 3.1.** The emission sources that form the close background for the low emission zone wide center LEZ1:  
a) industry b) household heating c) transport

The maps showing the close background concentration of annual PM<sub>10</sub> values for LEZ1 in 2022, is shown in Figures 3.2a - 3.2c, respectively due to emissions from industrial sources, from household heating and from the transport. The maps of the total background concentration, i.e. the background for Sofia city combined with the close background is shown if Figure 3.3.

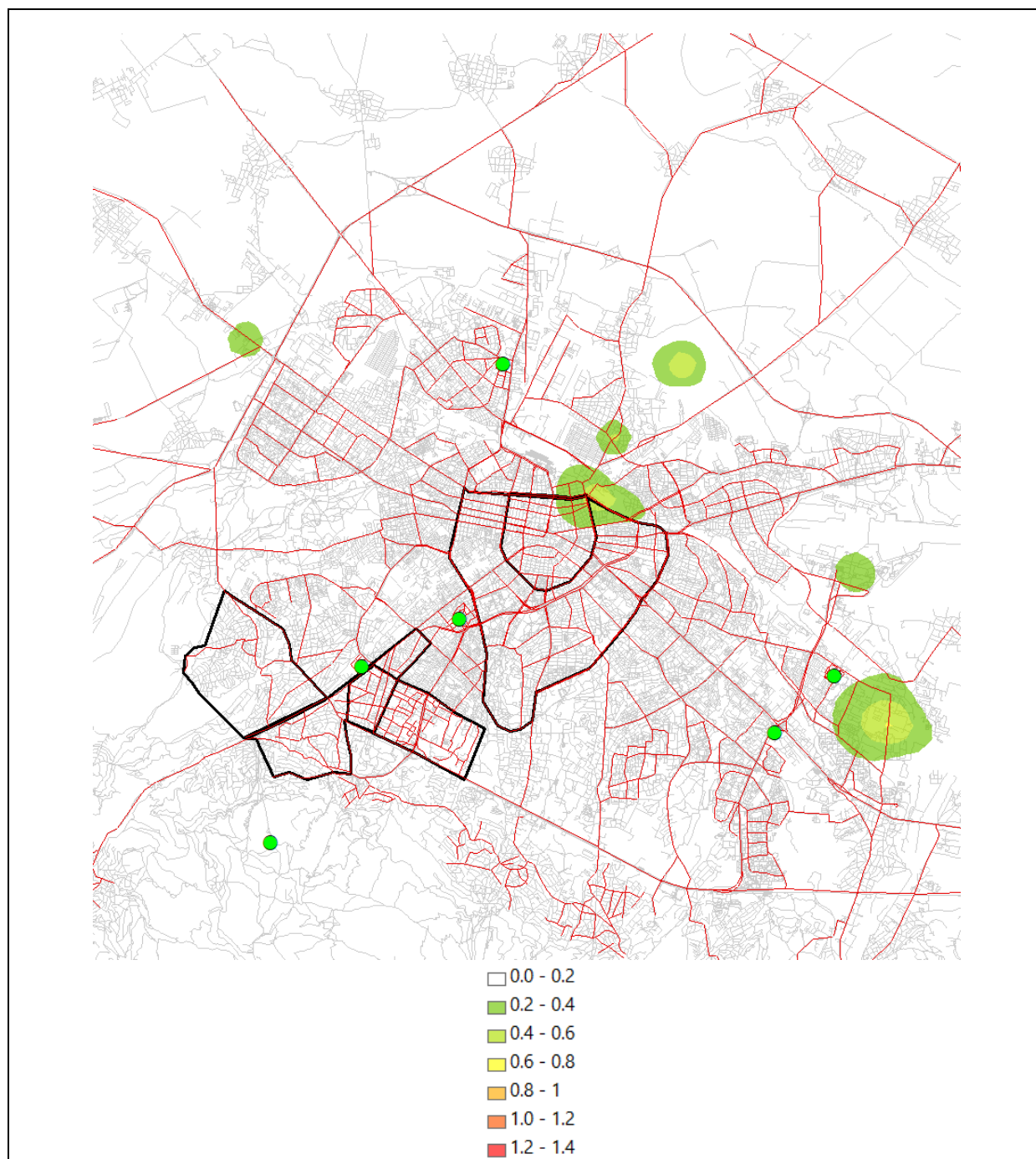


**Fig. 3.2a** The close background concentration of annual PM10 concentration for LEZ1 for 2022, due to the industrial sources

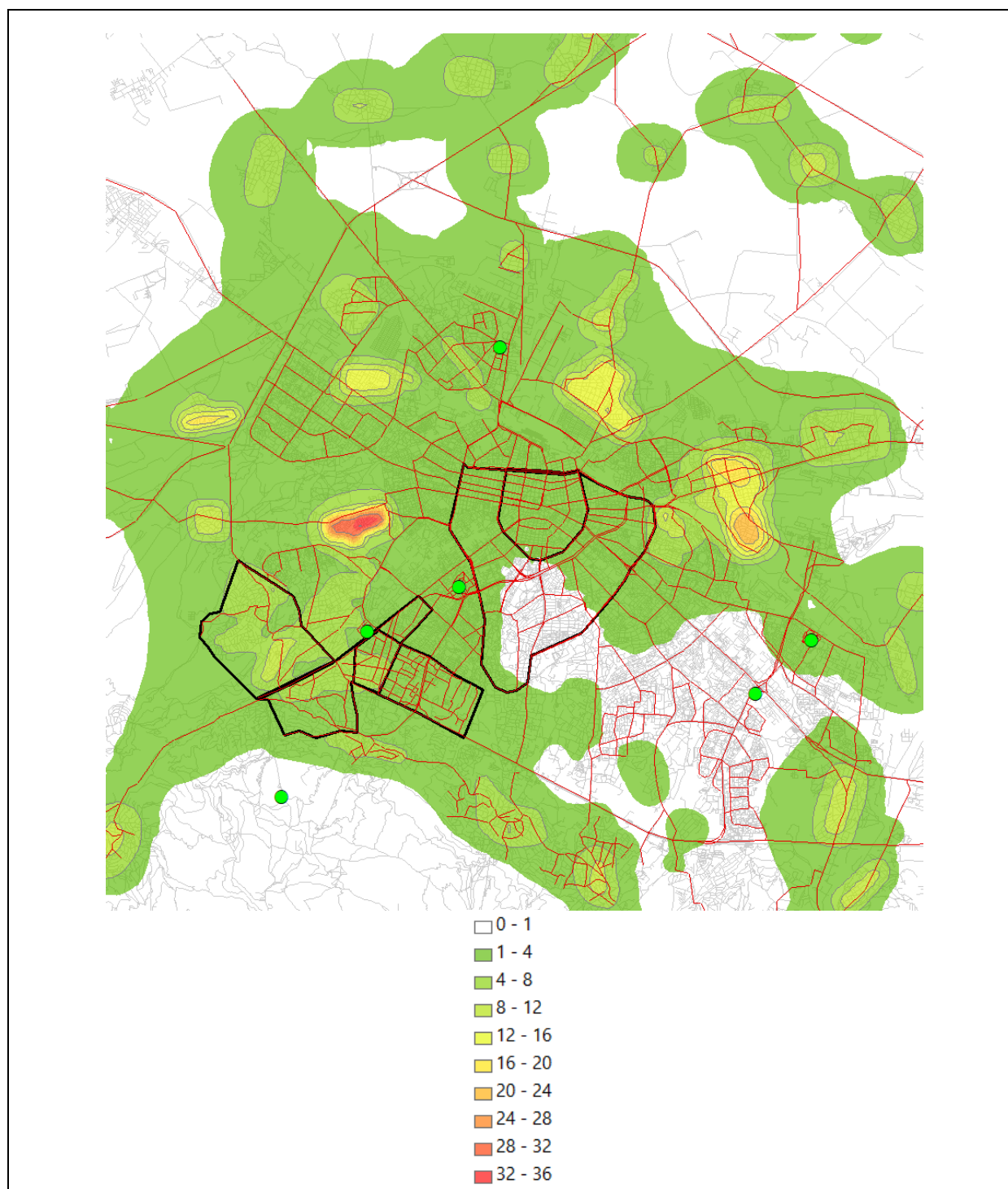


**Fig. 3.2b** The close background concentration of annual PM10 concentration for LEZ1 for 2022, due to the household heating

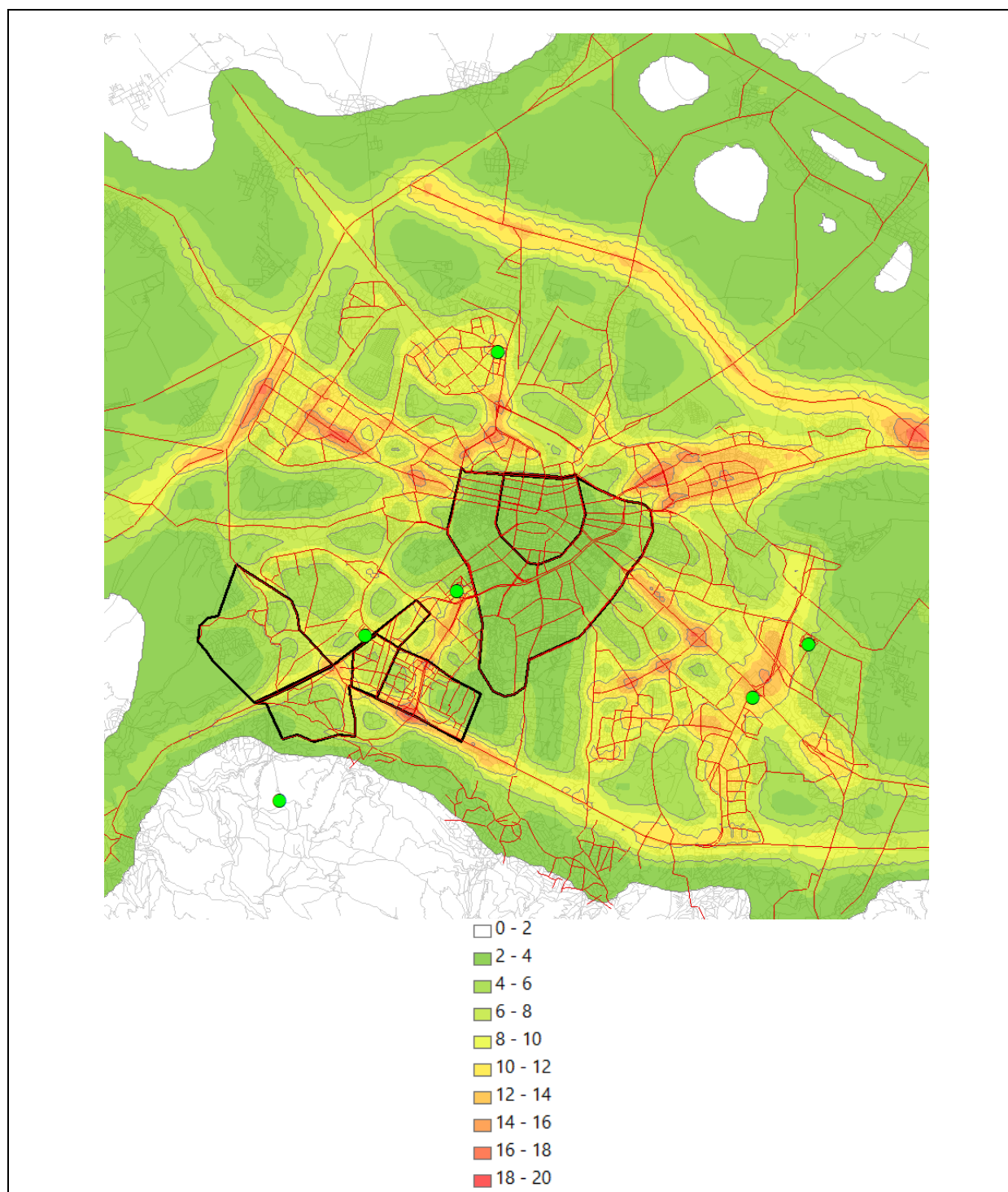


**Fig. 3.2c** The close background concentration of annual PM10 concentration for LEZ1 for 2022, due to the transport

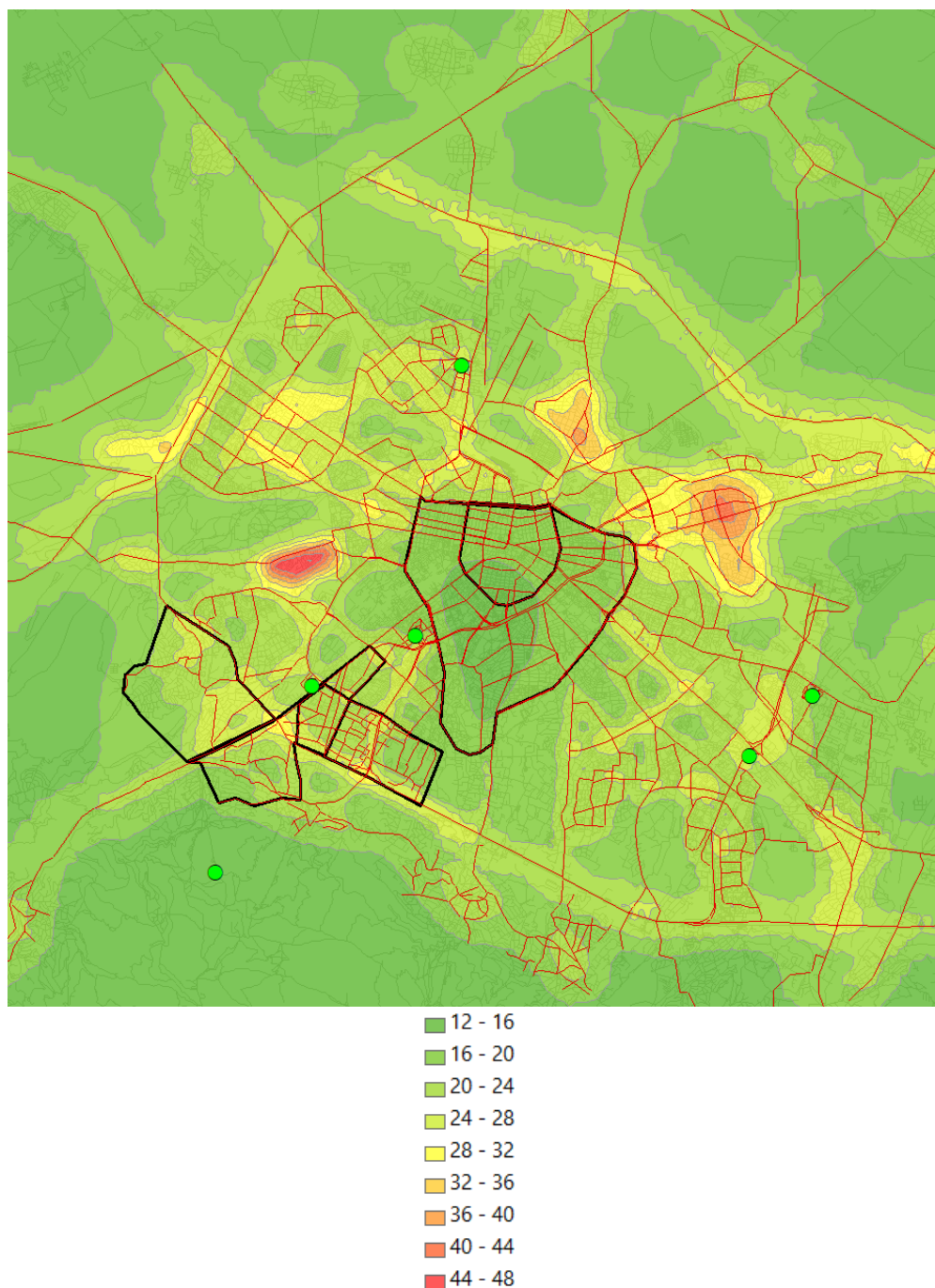


**Fig. 3.3.** The total background concentration of annual PM10 concentration for LEZ1 for 2022, due to the background for Sofia city and the close background

## 3.2. Background of annual PM10 concentration in DoI

The close background concentration for DoI is due to:

- the emissions released from the industrial sources in the city of Sofia, located outside DoI – Figure 3.4a,
- the emissions released from the household heating in the city of Sofia, but from outside DoI – Figure 3.4b,
- the emissions from the transport in the city of Sofia, released outside DoI – Figure 3.4c.

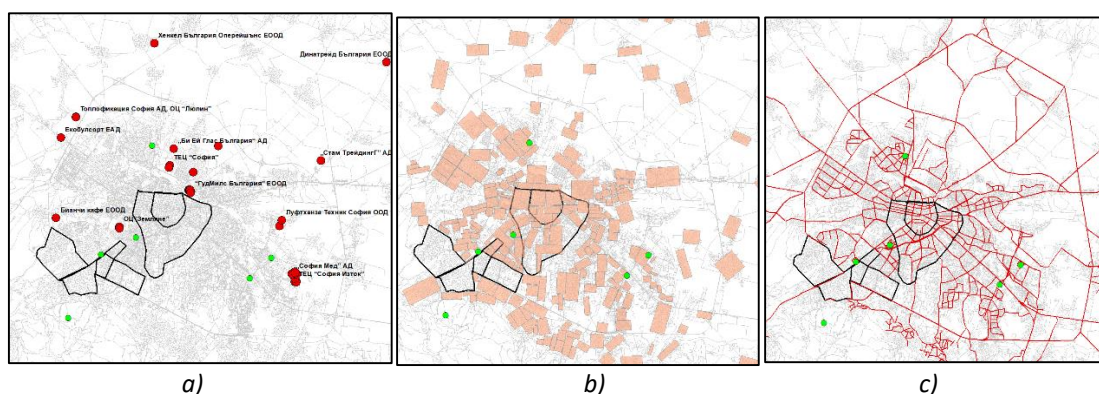


**Fig. 3.4.** The emission sources that form the close background for the district of interest DoI:  
a) industry b) household heating c) transport

The maps of the close background concentration of annual PM10 values for DoI for 2022, due to industrial sources, household heating and transport is shown in Figures 3.5a - 3.5c, respectively. The maps of the total background concentration, i.e. the background for Sofia city in addition to the close background is shown if Figure 3.6.

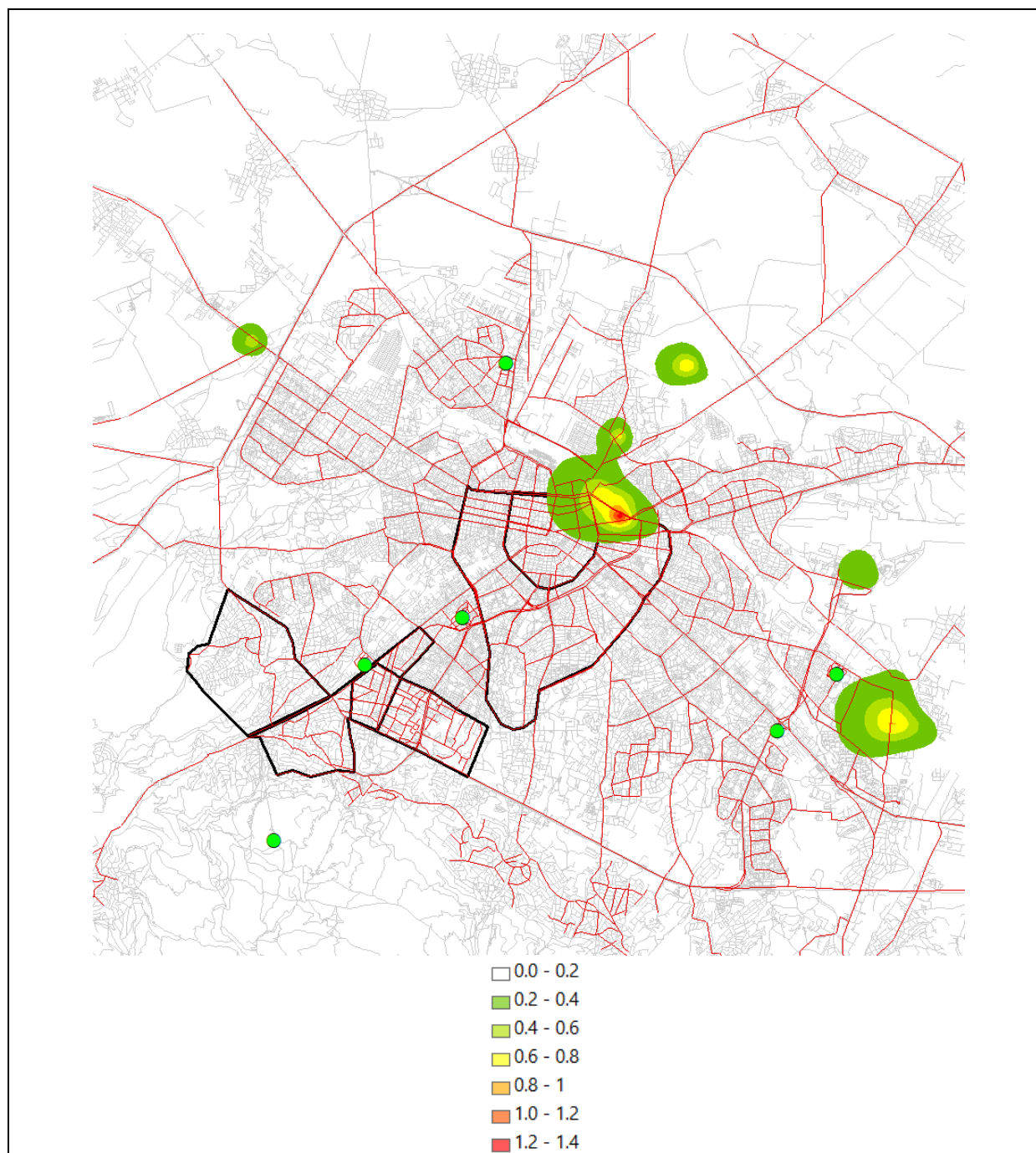


**Fig. 3.5a** The close background concentration of annual PM10 concentration for DoI for 2022, due to the industrial sources

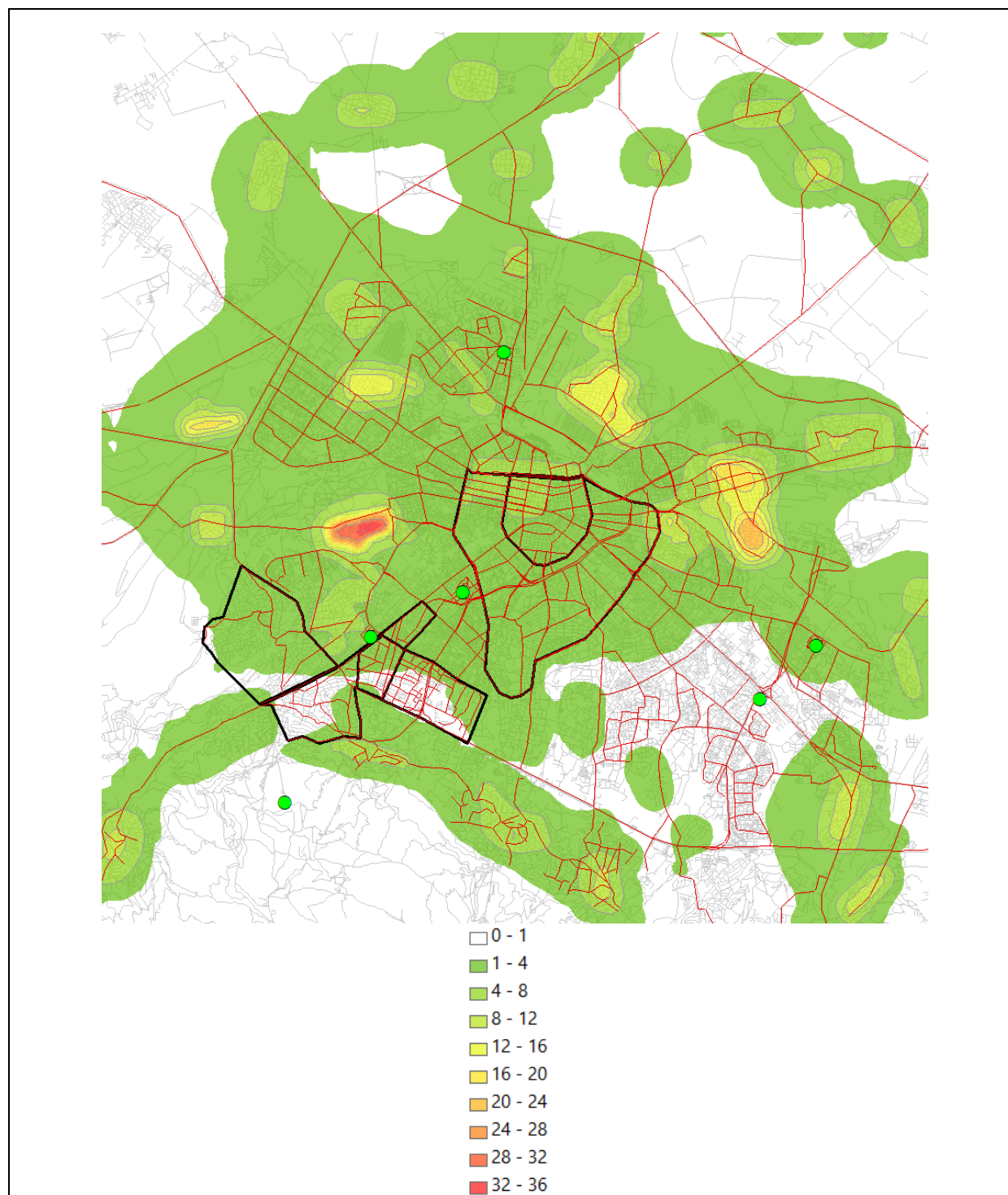


**Fig. 3.5b** The close background concentration of annual PM10 concentration for Dol for 2022, due to the household heating

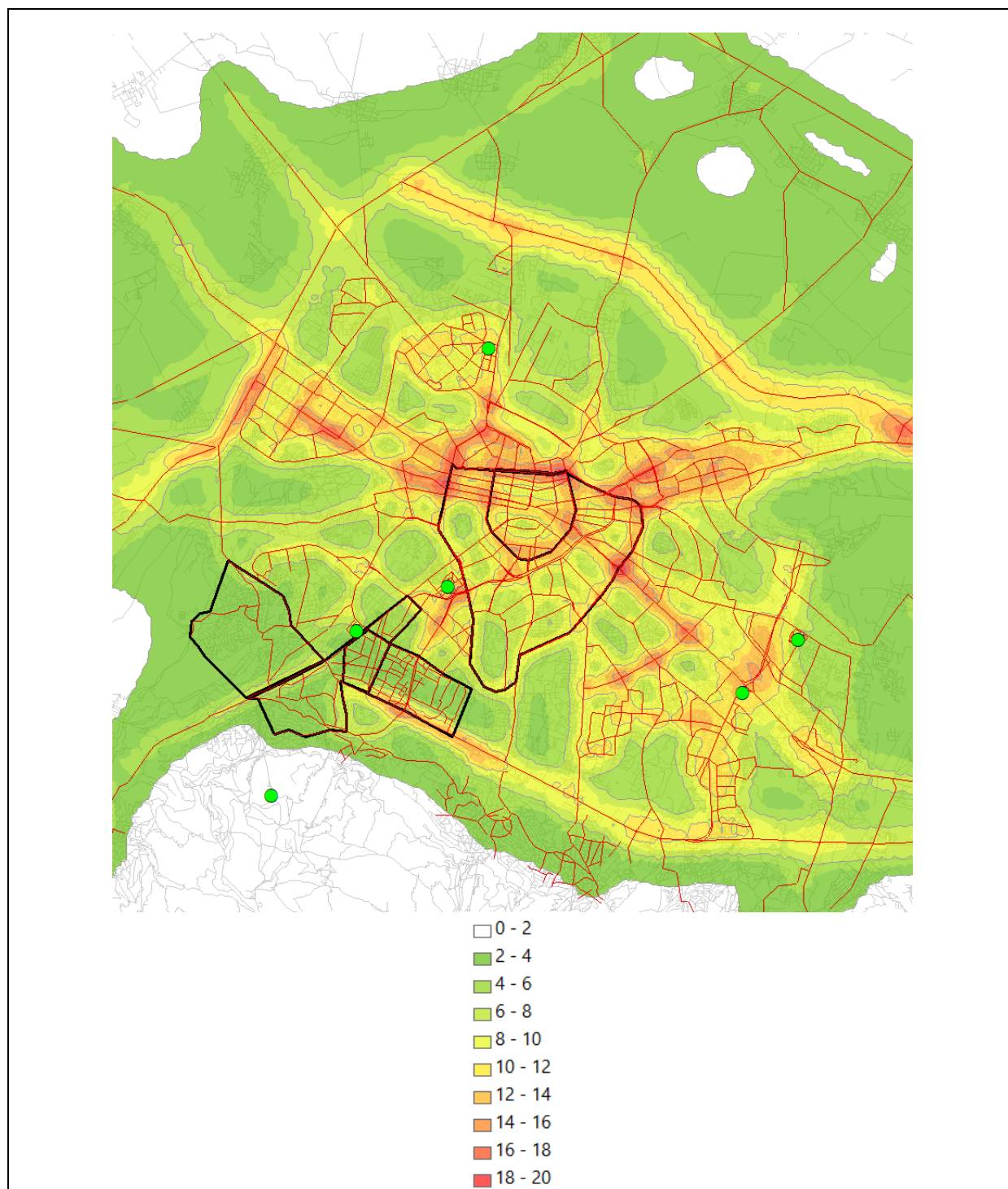


**Fig. 3.5c** The close background concentration of annual PM10 concentration for DoI for 2022, due to the transport

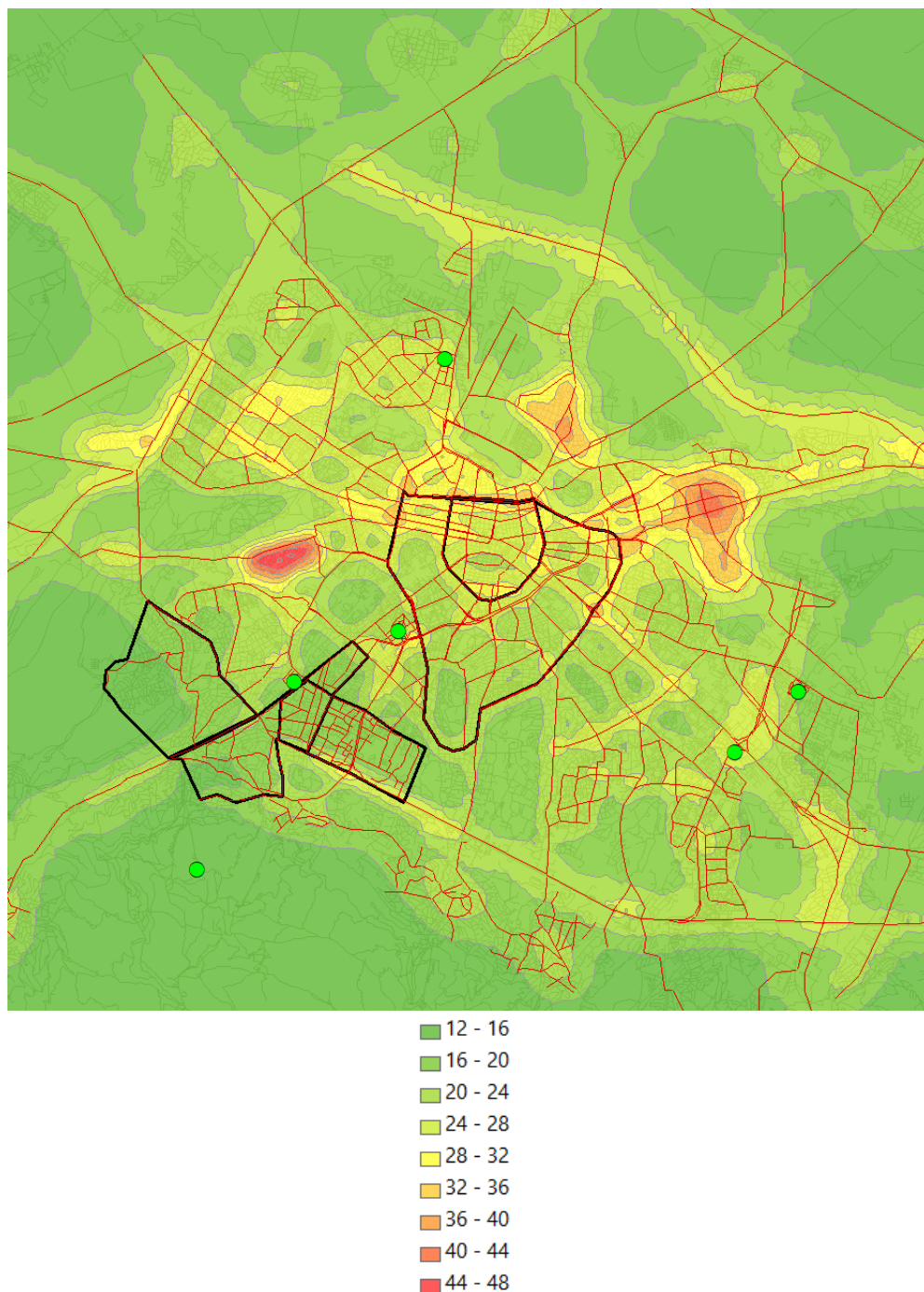


**Fig. 3.6.** The total background concentration of annual PM<sub>10</sub> concentration for DoI for 2022, due to the background for Sofia city and the close background

Some characteristic values of the annual PM<sub>10</sub> background concentrations in LEZ1 and in DoI are presented in Table 3.1. The contribution of the all emission sources together and the contribution of the industry, the domestic heating and the transport is evaluated separately.

**Table 3.1** Maximum and mean values of the annual PM<sub>10</sub> background concentrations in LEZ1 & LEZ0 and in DoI, caused by all sources and caused separately by industry, domestic heating and traffic

| Emissions from:    | Background annual PM <sub>10</sub> concentrations [ $\mu\text{g m}^{-3}$ ] |             |                           |             |
|--------------------|----------------------------------------------------------------------------|-------------|---------------------------|-------------|
|                    | Max. concentration in                                                      |             | Average* concentration in |             |
|                    | LEZ1 & LEZ0                                                                | DoI         | LEZ1 & LEZ0               | DoI         |
| <b>All sources</b> | <b>24.8</b>                                                                | <b>40.6</b> | <b>16.7</b>               | <b>17.3</b> |
| Industry           | 0.55                                                                       | 0.05        | 0.08                      | 0.03        |
| Households         | 5.4                                                                        | 3.9         | 1.3                       | 1.2         |
| Transport          | 9.0                                                                        | 27.6        | 3.3                       | 4.1         |

\* The average concentration is the annual PM<sub>10</sub> concentrations averaged over the respective zone.

The numbers in Table 3 have the following meaning. The numbers in the column **LEZ1 & LEZ0** are PM<sub>10</sub> concentrations caused by the respective emission sector, if the emissions from this sector released in the area **LEZ1 & LEZ0** are excluded. For example, the concentrations caused by all sectors, from which those emitted in **LEZ1 & LEZ0** are excluded, lead to a maximum concentration of 24.8  $\mu\text{g m}^{-3}$  in the area **LEZ1 & LEZ0**. In other words, even if, hypothetically, the release of emissions from the area of **LEZ1 & LEZ0** were completely suspended, there would be PM<sub>10</sub> concentration in this territory, the maximum value of which would reach 24.8  $\mu\text{g m}^{-3}$ , and the average for the territory would be 16.7  $\mu\text{g m}^{-3}$ .

## 4. Concluding remarks

The evaluation of the background concentration is an intermediate stage of the important issue for assessment of the effect of changes in transport schemes on AQ. The background concentration in LEZ and DoI is something that the new transport schemes cannot influence. The maps and characteristic values of the background show the maximum possible AQ improvement that can be achieved by the foreseen change in the transport schemes. The changes of transport schemes cannot influence the background; however the measures for AQ improvement foreseen in the AQ plan of the Sofia municipality will change the background concentrations. This is important to keep in mind when considering the effect of the new innovative transport changes subject of INNOAIR project on the air quality of the city of Sofia.

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