Non-Technical Summary of the Kosovo Air Quality Modelling

Overview

Air pollution is one of the major environmental problems in Europe and it has large impact on public health and ecosystems. According to EEA report[1] $PM_{2.5}$ concentrations in 2016 were responsible for about 412 000 premature deaths, originating from long-term exposure in Europe.

Kosovo has problem with air pollution, mainly due to high PM_{10} and $PM_{2.5}$ concentrations during the heating season (winter), especially in urban areas. In summer ozone may also reach high level of concentration. NO_2 can be a problem across the main roads and streets especially in large cities.

As part of the Millennium Foundation of Kosovo (MFK) project: '***Supply of project management, air quality information management, behavior change and communication services'*** an 'Air Quality Modelling' has been developed for Kosovo.

An Air Quality Modelling provides calculations of concentrations of pollutants in the air after their releases to the atmosphere from different emission sources. Apart of the Emission Inventory, it is the second of the major tools used in air quality management because it provides information where there are areas of harmful concentrations levels and an understanding of what contributions from activities and sources are, thereby allowing the development of effective actions to reduce emissions and improve ambient air quality.

The Kosovo Air Quality Modelling focuses on the following pollutants, all of which can negatively affect human health: particulate matter: PM_{10}, $PM_{2.5}$, nitrogen dioxide (NO_2) and sulphur dioxide (SO_2). It is the first air quality modelling for Kosovo.

The Air Quality Modelling itself consists of mathematical models for calculation of pollutants dispersion and chemical reactions in the atmosphere using meteorological data, topography, land cover data and emission data as input data. Results of the modelling are presented in a report which describes modelling system and the key findings[2].

It is important to distinguish between "emissions" of air pollutants and "ambient concentrations" of air pollutants. See Figure 1 below. 'Ambient concentrations' represent the amount of a pollutant in the air at an outdoor location where someone is likely to be exposed to it. The level of pollutant at a given location is affected by emission sources (mainly those nearby but also sometimes those a long way away) after they have undergone some level of 'dispersion' in the atmosphere. Ambient concentrations are usually presented as a mass per volume of air eg micrograms per cubic meter ($\mu g/m^3$). This is what the Air Quality Modelling represents.

'Emissions' represent the amount of pollution emitted from individual sources such as chimneys (at industrial installations, houses, restaurants, offices etc.) or activities like transport or mining. They are usually presented as a mass of pollutant over a time period eg megagrames per year (Mg/year). That is the focus of the Emissions Inventory. The connection between the Emissions Inventory and Air Quality Modelling is that emissions are a vital source of input data to a dispersion model which can then in turn be used to calculate ambient concentrations.

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[1] Air quality in Europe — 2019 report, EEA Report, No 10/2019

[2] "*Supply of project management, air quality information management, behavior change and communication services. TASK D1: Update of the Emission inventory: Detailed methodology for the inventory of emissions of substances in Kosovo and the scope of the electronic database"* (version 2). Prepared by ATMOTERM; MFK; December 2020;

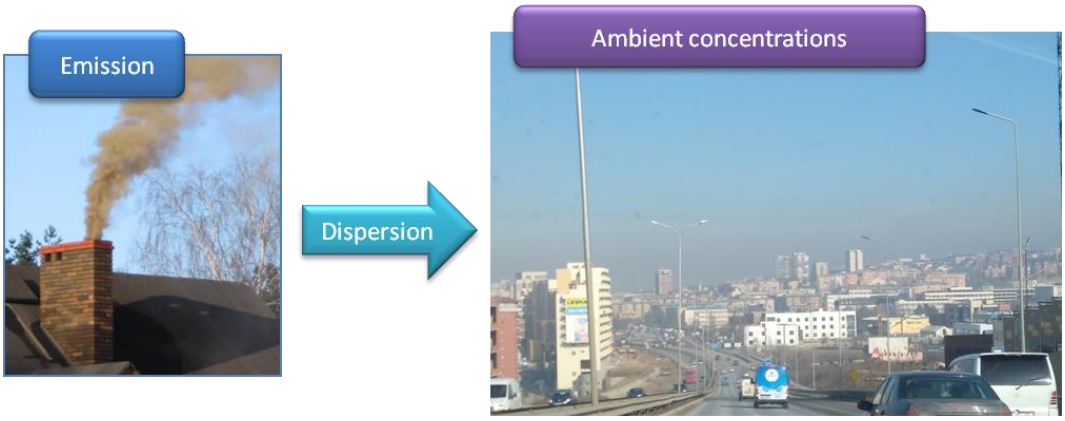

Figure 1 Emission versus ambient concentrations

Method and Data Sources

Kosovo Air Quality Modelling System was prepared using the following tools:

- WRF meteorological model,
- CALPUFF Modelling System,
- ENSEMBLE model based on several Eulerian photochemical models.

The base year for the modelling is 2018. The modelling of pollutants includes the following substances: Particulate Matter: PM_{10}, $PM_{2.5}$, nitrogen dioxide NO_2 and sulfur dioxide SO_2. Emissions from the Emission Inventory, described in one of the project's Reports[3], have been implemented as input data in the modelling. The following emission sources are included in the inventory: Small combustion – heating (also cooking) in domestic, public and business services, Transport, Industry: power plants and large industrial installations, Agriculture, Waste (Landfills), Mines, quarries, Natural sources: forests.

As a part of modelling process, analysis of Kosovo national air quality measurements in 2018 year was prepared. There are 12 monitoring stations in Kosovo and one mobile station. Most stations are located at urban areas: two in Pristina, Drenas, Gjilan, Prizren, Peja, Obiliq, Mitrovica. Three stations are located close to the large industrial installations (Hani i Elezit, Dardhishte, Palaj) and one is located at border in suburban area: Brezovica. These measurements were used to prepare preliminary analysis of air quality in Kosovo and then for model verification. The purpose of modelling verification is to test the model performance against real (measured) data.

Model presents very good agreement with observations for PM_{10} and $PM_{2.5}$. Calpuff modelling for Kosovo fulfils the national (based on UE CAFE Directive) modelling quality requirements for all of the monitoring stations, with exception for Palaj, where overestimation of model is observed. For NO_2 and SO_2 monitoring software has been changed and measurements show strange patterns, therefore proper model verification cannot be done for NO_2 and SO_2 for 2018.

Results and Conclusions

Air quality modelling for 2018 year supports the AQ analysis with spatial distribution of pollution in the area of the country (not only at measurements points). A summary of the air quality maps are presented in the Figure 2, contribution of different sources in air pollution is presented in Figure 3.

Figures below present spatial distribution of PM_{10}, $PM_{2.5}$ and NO_2 in Kosovo based on modelling for 2018 year (red colours mean concentrations above limit values).

[3] *TASK D1: Update of the Emission inventory: Detailed methodology for the inventory of emissions of substances in Kosovo and the scope of the electronic database and Excel database - version 2*; prepared by ATMOTERM; MFK, December 2020;

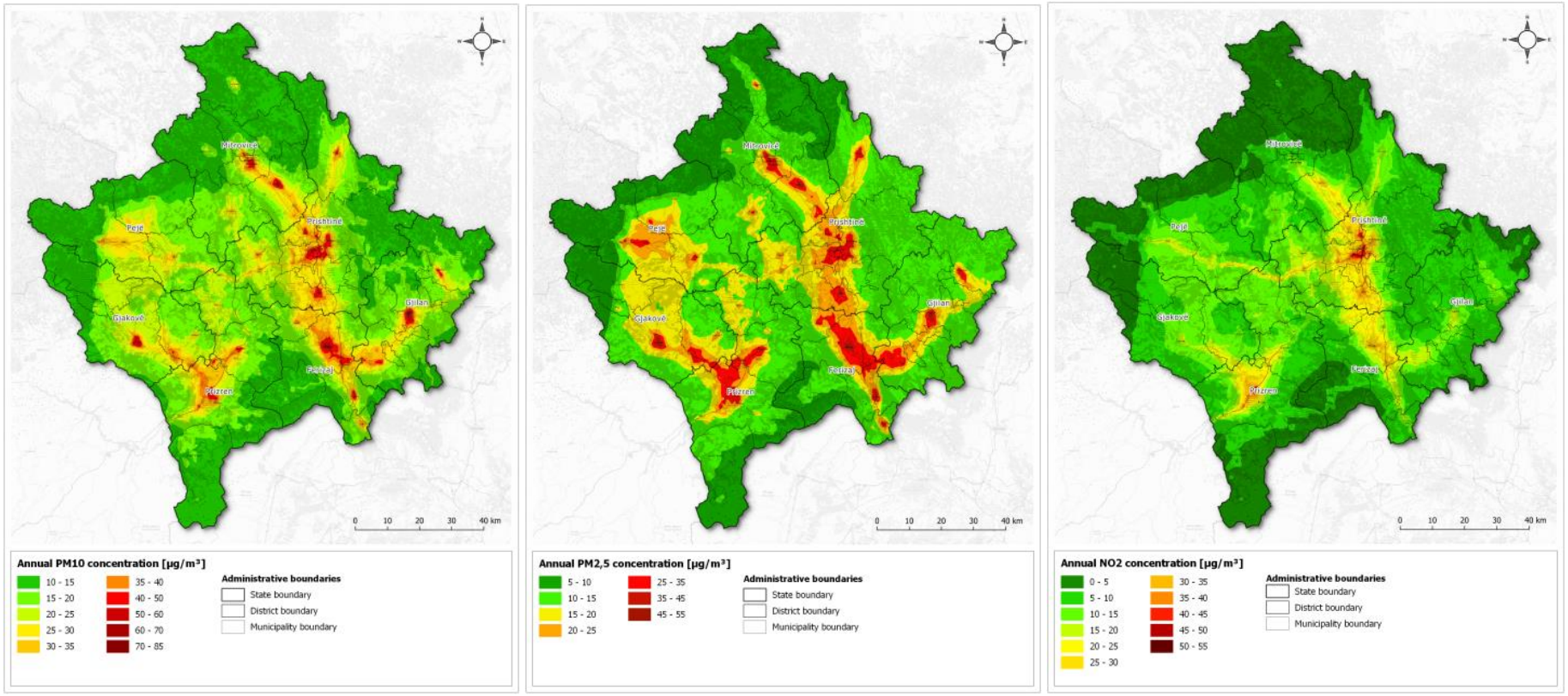

Figure 2 Annual concentration of PM_{10}, $PM_{2.5}$ and NO_2 in Kosovo in 2018

Figure below presents the share of different emission sources in the $PM_{2.5}$ and NO_2 annual concentrations for most polluted urban areas. In the case of $PM_{2.5}$, a dominant cause of pollution is small combustion and in the case of NO_2, transport.

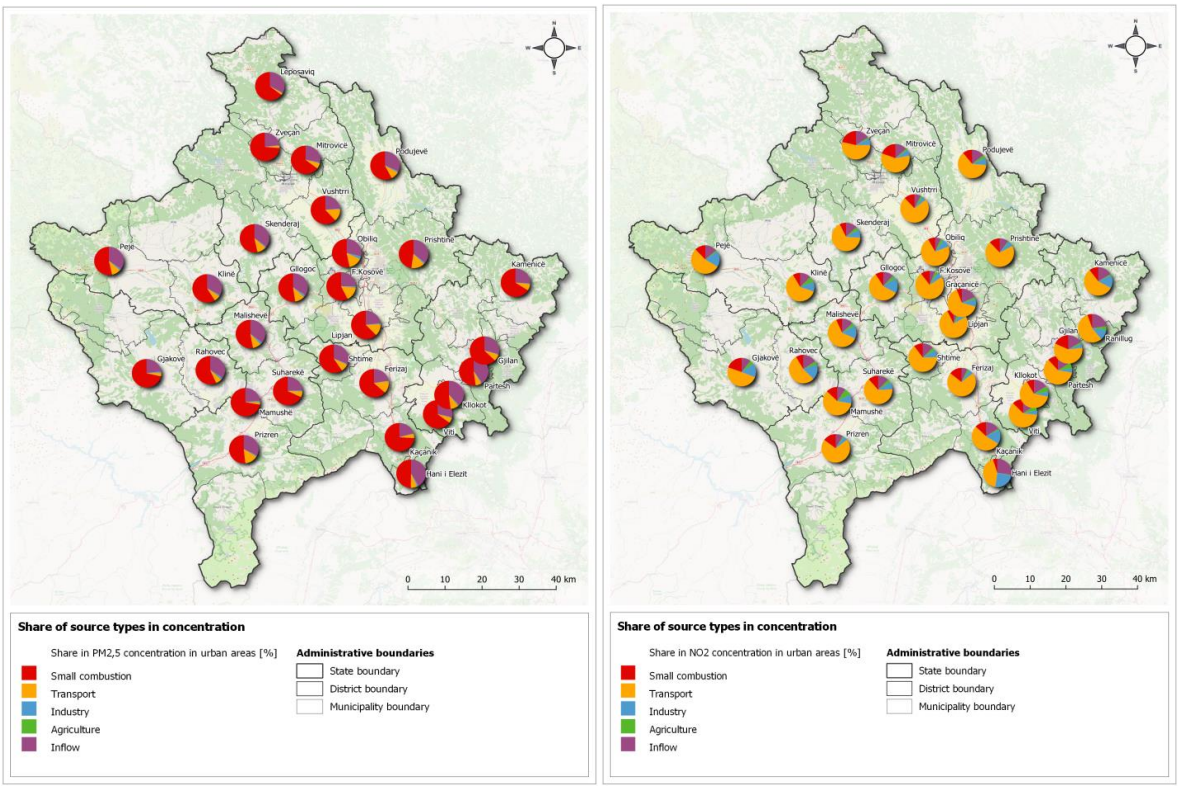

Figure 3 Share of different emission sources in the $PM_{2.5}$ and NO_2 annual concentrations in 2018

Key points to note are:

- The modelling results confirmed that the worst problem with air quality is caused by particulate matter (PM10 and PM2.5) from small combustion in urban areas.
- According to the modelling results, there are many areas in Kosovo where PM_{10} and $PM_{2.5}$ concentrations are above limit values. Generally areas of high PM_{10} and $PM_{2.5}$ concentrations overlap with location of main emission sources: large cities and main roads. High level of pollution is observed from Mitrovica via Vushtrii, Pristina, Lipljan, Ferizaj, Kacanik to Hani I Elezit, in Prizren, Gjilan, Gjakova, Podujevo and other smaller cities.
- Small combustion (mainly domestic heating) is responsible for high PM_{10} and $PM_{2.5}$ concentrations for most urban areas. The average share of small combustion sector in particulate matter concentration is about 50% (PM_{10}) and 55% ($PM_{2.5}$) and the highest shares of this sector reach 60% - 67%.
- The contribution of small combustions sources to PM_{10} daily concentrations increases with the increase of total PM_{10} concentrations. It means that during high pollution episodes small combustion plays the major role in high PM_{10} concentrations.
- Exceedances areas of NO_2 annual concentrations are small and concentrated in a few cities: Pristina, Gracanica, Fushe Kosovo, Obiliq and Prizren. There are no calculated exceedances of NO_2 hourly limit concentrations in the territory of Kosovo.

- In case of NO_2 transport has the largest contribution (59%) to the NO_2 annual concentration for most of the urban areas. In Pristina, transport is the main source responsible for NO_2 concentration with a share of 71%.
- There are no predicted exceedances of hourly and daily limits for SO_2.

Implementation of national modelling system is a long-term process which may take a few years of development of both emission inventory and modelling system. As these are the first Emissions Inventory and Air Quality Modelling of their kind for Kosovo, there are a number of opportunities to improve the accuracy in future such as through additional data collection or modelling in higher resolution in cities. Specific areas for improvement have been identified and it is expected that the Inventory and Modelling will be updated in future to allow this, and to account for changes in the emission sources.