USE OF EUROPEAN MULTICITY MODEL FOR CREATION OF NO2 AND PM2.5 BASE MAPS FOR BELGRADE

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Summary

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- Basemaps
  - definition and methods for creation (LUR, physics based modeling)
- Land use regression modeling
  - example of Belgrade and NO2, PM2.5 maps
- Method for correcting basemaps
  - data fusion techniques, example of fused Belgrade historic data

Intro

- Creation of air pollution maps is often hindered by absence of high spatial resolution measurement data of corresponding air pollutants.
- Use of low cost measurement platforms can increase the spatial resolution of measurements
  - additional data is needed in order to obtain **realistic spatial patterns** in maps.
- To this purpose it is necessary to include data obtained from the modelling
  - either physical or statistical (LUR)

Basemaps – definition and methods for creation

- Basemap is a rough estimate of a scalar quantity
  - typically used to predict (spatially) its long-term average.
- In this paper the quantities of interest are mass concentration of NO_2 and PM2.5 pollutant
- Basemaps can be obtained in a number of ways
  - LUR models and/or dispersion (physical modeling) based methods.

Basemap creation

- Main problem is gathering enough input data
- Typically physics based models need much more input data than LUR models
- Physics based models require detailed, high resolution input data
  - description of sources of emission, meteorology data (temperature, wind), height of terrain, initial conditions and boundary conditions

Basemap creation

- This was the reason why for Belgrade NO_2 and PM2.5 maps LUR approach was used
- LUR model was based on Wang European model (2014)
- LUR models are typically used for smaller urban areas
  - Wang model extended land use approach to model urban air polution in several urban areas

Basemap creation

- Wang model (2014)
  - Study proposed unified linear regression model for $PM_{2.5}$ and NO_2 pollutants for European cities
- Based on large dataset obtained from 36 urban areas
  - (20 areas had simulataneous campaings of both, $PM_{2.5}$ and NO_2 with 20 monitoring sites per area and 16 areas had only NO_2 measurements with 40 monitoring sites per area).
  - A total of 960 NO_2 sites and 356 PM sites (four sites were missing due to failed campaign)

Basemap creation

- Final result were linear regression formulas which connect NO_2 and $PM_{2.5}$ concentration to predictor variables
- NO_2 predictor variables
  - Regional background concentration, Traffic load in 50 m, Road length in 1,000 m, Natural and green in 5,000 m, Traffic intensity on the nearest road, Intercept
- $PM_{2.5}$ predictor variables
  - Regional background concentration, Traffic load between 50 m and 1,000 m, Traffic load in 50 m, Road length in 100 m, Intercept

Belgrade – making basemaps

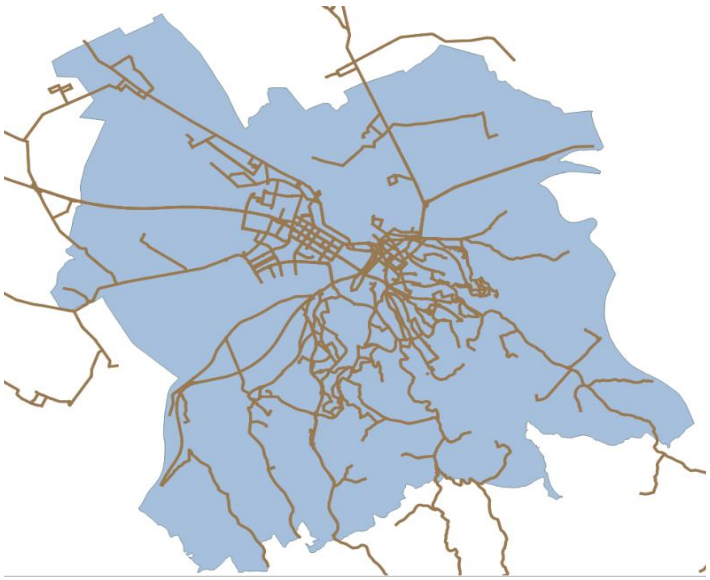
- One of the main problems is how to get high quality input data
- For example last large campaign for traffic data for Belgrade dates from 2006.
- A lot of things changed since then (for example 3% total growth of traffic per year)
- Workflow for map creation can be fully automatized so that map can be updated each time more relevant data is available

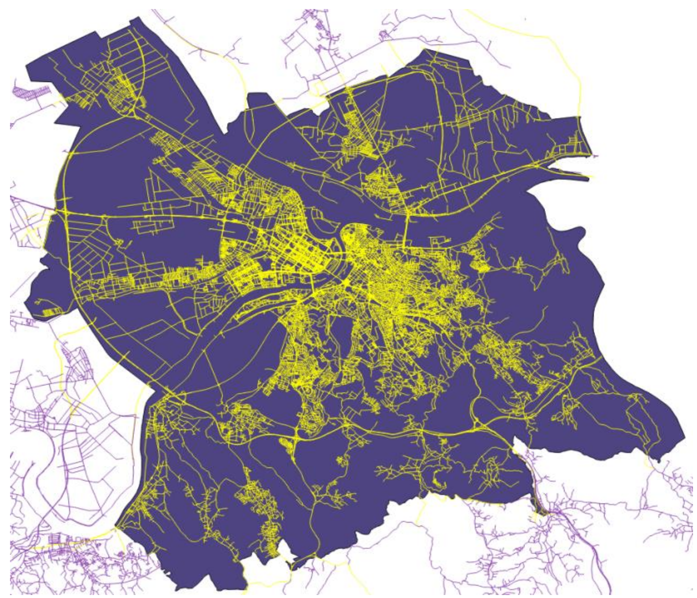
Belgrade – making basemaps

- In current iteration of base maps for Belgrade we used public transport data which is up to date
  - we used linear regression model to establish a connection between total traffic and public transport traffic.
- The regression was made using data from automatic counters
  - Counters separate the traffic to vehicle categories, and data is available for cca 20 counters in Belgrade area
- It is clear that this initial model has limitations, illustrated on next slide

Belgrade base maps

- Predictor variable (public transport #/day) is non zero only on roads shown in left image
- We need prediction for all roads (right image), so this is basically predicted using intercept
- Another problem is correct definition for traffic in large buffer (Wang model uses 1000m buffers)

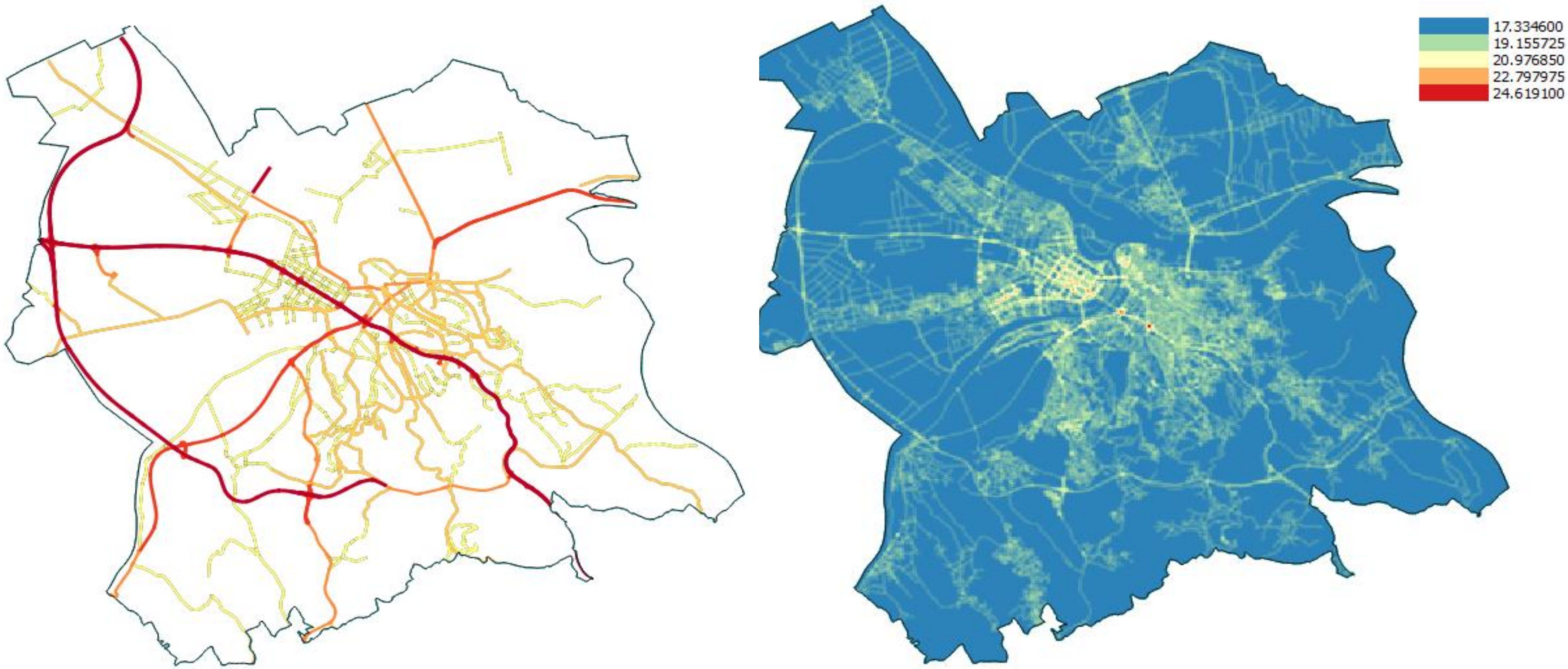




NO_2 [μg/m3]

- NO_2 base map requires: traffic load in 50m buffer, road length in 1000m buffer, green and natural in 5000m buffer, traffic intensity on the nearest road, regional background

PM2.5 [µg/m3]

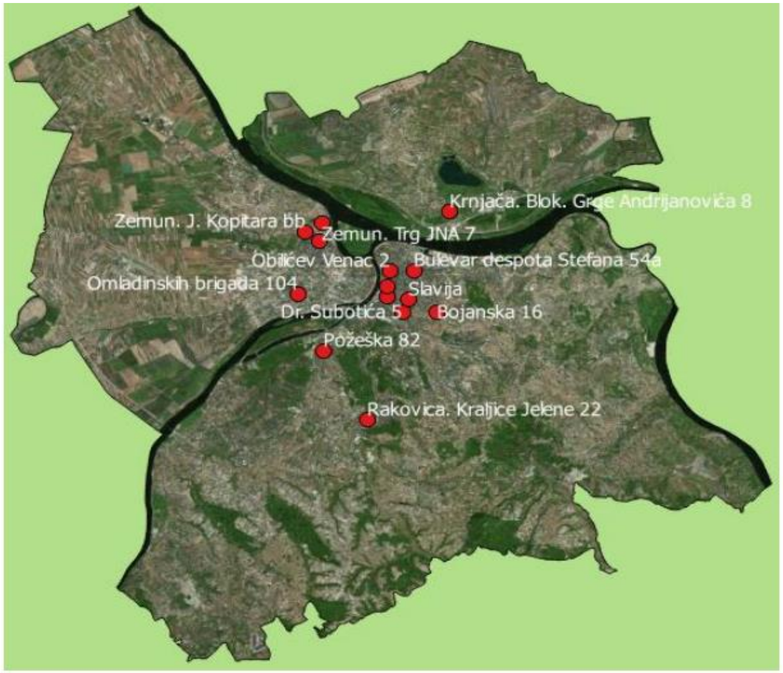


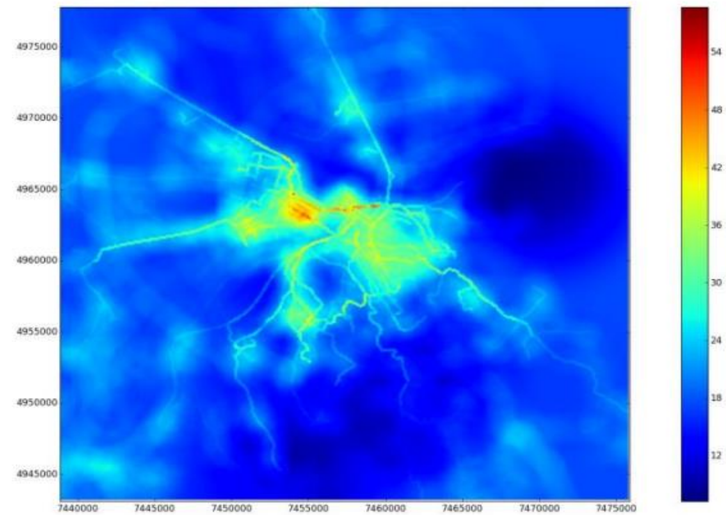
- Due to ambiguity in 1000m traffic load definition and very small contribution to total, this predictor was neglected. Need for better traffic model, and also better background estimate (location/smaller region dependent)

Method for correcting basemaps

- Integrate real-time measurements from large number of monitoring stations
  - Improving the mapping of urban scale air quality is one of the most promising potential applications of low cost microsensors
- The technique that will be used is data fusion, which was developed at Norwegian Institute for Air (NILU) Norway
- Fused map will use both basemap and measurement
  - Even at higher deployment densities possible with low-cost sensors, realistic spatial mapping still requires city-scale model information to supply spatial patterns
- As a test run we fused NO_2 historic data from 2011 (14 monitoring stations) to our basemap
  - Low cost AQ sensor can significantly increase the density of the monitoring network

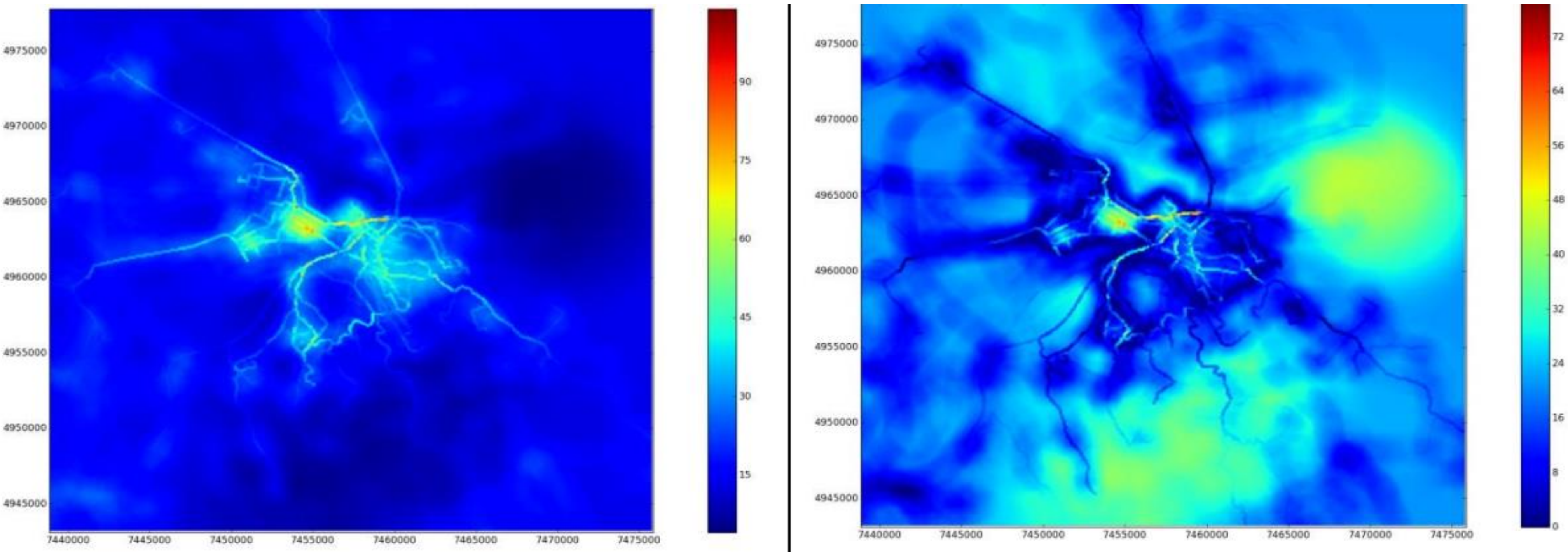
Method for correcting basemaps





- Fig 1. a) Local monitoring network for NO_2 (14 stations) plotted over Belgrade ortophoto image (source BingMaps). b) Basemap for NO_2 (estimate for average annual value) within area covered by Master plan of Belgrade. Note that scale is not relevant for basemap since it is additionally scaled during data fusion (up to 60 μg/m3)

Method for correcting basemaps



- Fig. 2 a) Fused map for NO_2 average annual concentration. Unit is µg/m3. Up to 90 µg/m3 b) relative error of fused map compared to basemap. Unit is percentage

Method for correcting basemaps

- Areas of lower NO_2 concentration correspond to the green and natural areas which are further away from larger roads.
- High concentration of NO_2 is limited to the urban city center with large number of high traffic roads.
- Areas with higher values of "relative error" were not covered by monitoring stations
  - However, those areas also correspond to areas of smaller NO_2 concentration in basemap.
- It should be noted that error introduced by kriging, i.e. spatial interpolation should not be regarded as complete error estimate
  - more as a lower bound for error
- In addition, monitoring platforms (automatic and semi-automatic stations) also introduce error, which is usually in 5-10% range even for high quality measurements.
  - Combined uncertainty would include both types or errors.

Thank you for you attention!

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