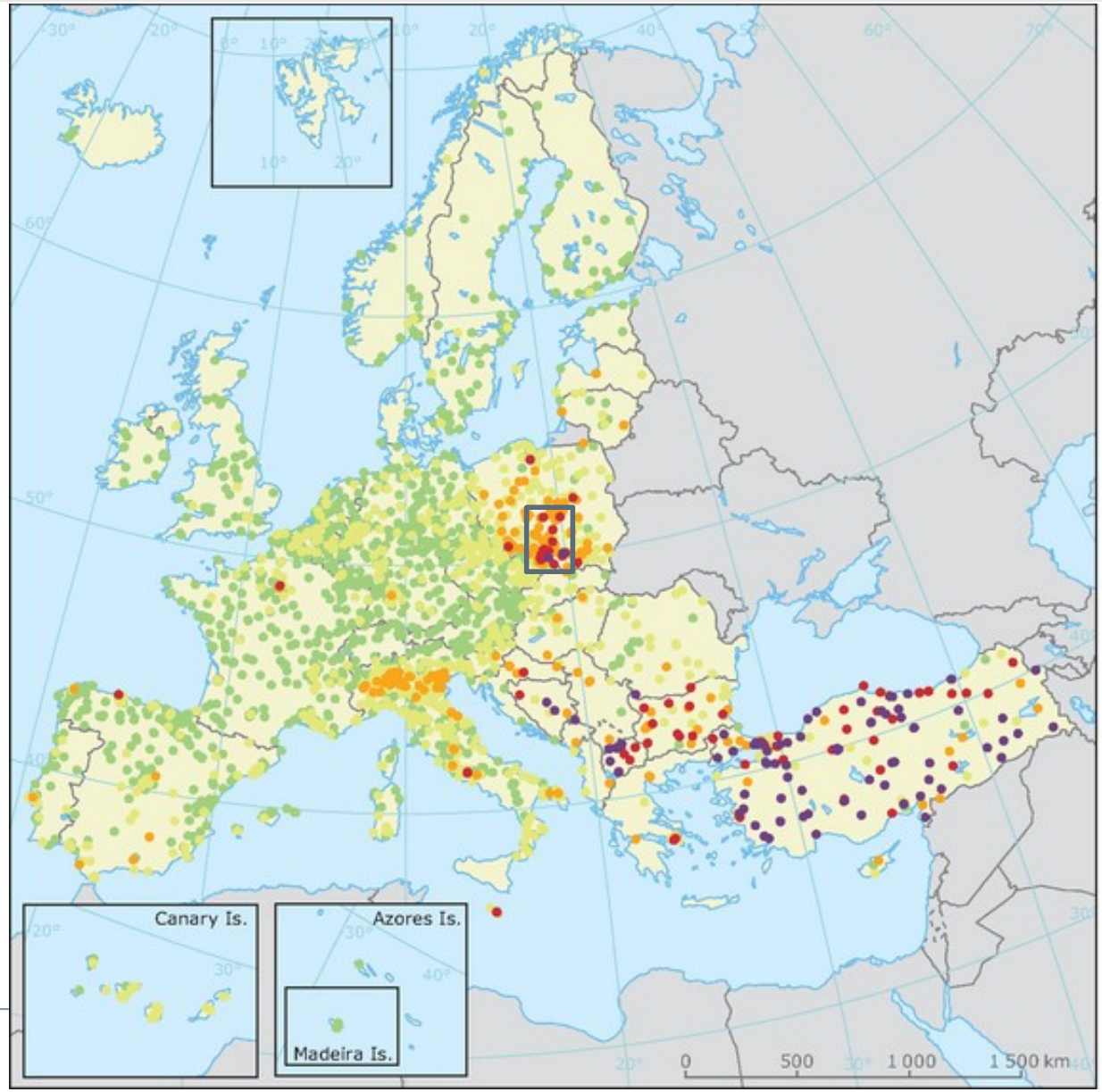
27-th International Seminaron Interaction of Neutrons with Nuclei, JINR, Dubna, RF

Air pollution characterization in industrial urbanized regions using INAA, mathematical modelling and GIS technology

Petr Jancik, Frank Laboratory of Neutron Physics, Sector of Neutron Activation Analysis and Applied Research

Vladislav Svozilik, Laboratory of Information Technologies

AIR POLLUTION IN EUROPE (2016)



Annual concentrations of PM_{10} in 2016

µg/m³

- ≤ 20
- 20-31
- 31-40
- 40-50
- > 50

No data

Countries/regions not included in the data exchange process

The TRITIA Region

AIR POLLUTION CHARACTERISATION

By measurement:

Using results of air quality monitoring stations.

By modelling:

Using results of mathematical models of air pollutions.

By special monitoring methods:

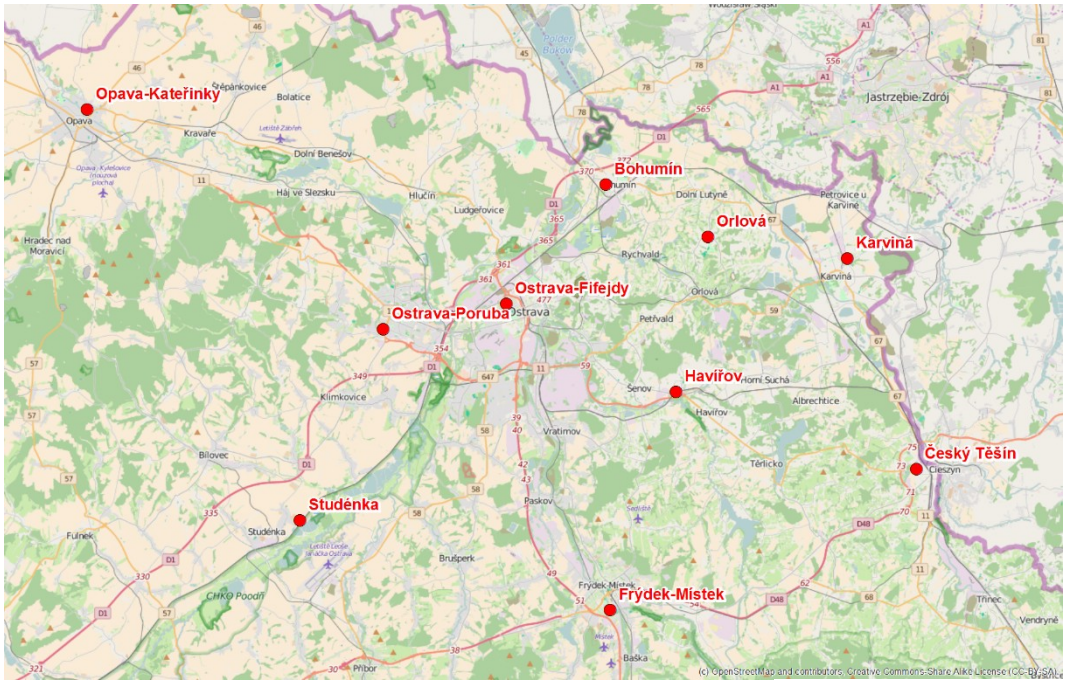
Using results of INAA

AIR POLLUTION CHARACTERISATION

By Measurement:

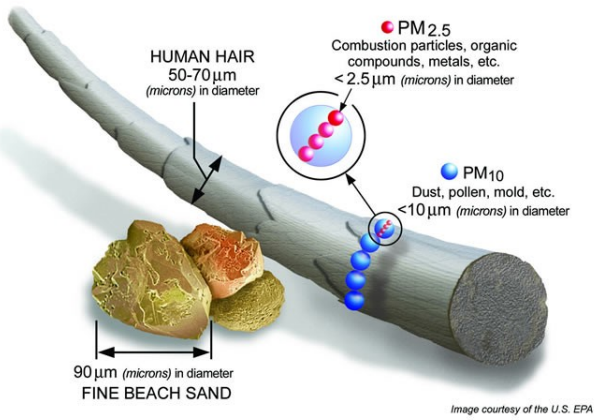
Using results of air quality monitoring stations (MS)

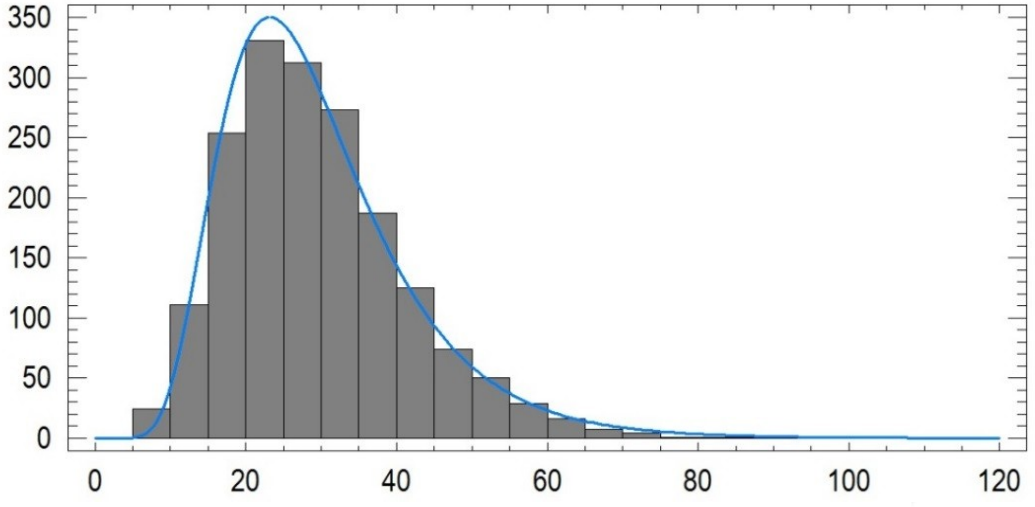
LONG TERM AIR POLLUTION TRENDS ANALYSIS OF 1 HOUR AVERAGE PM_{10} (1998 – 2014)



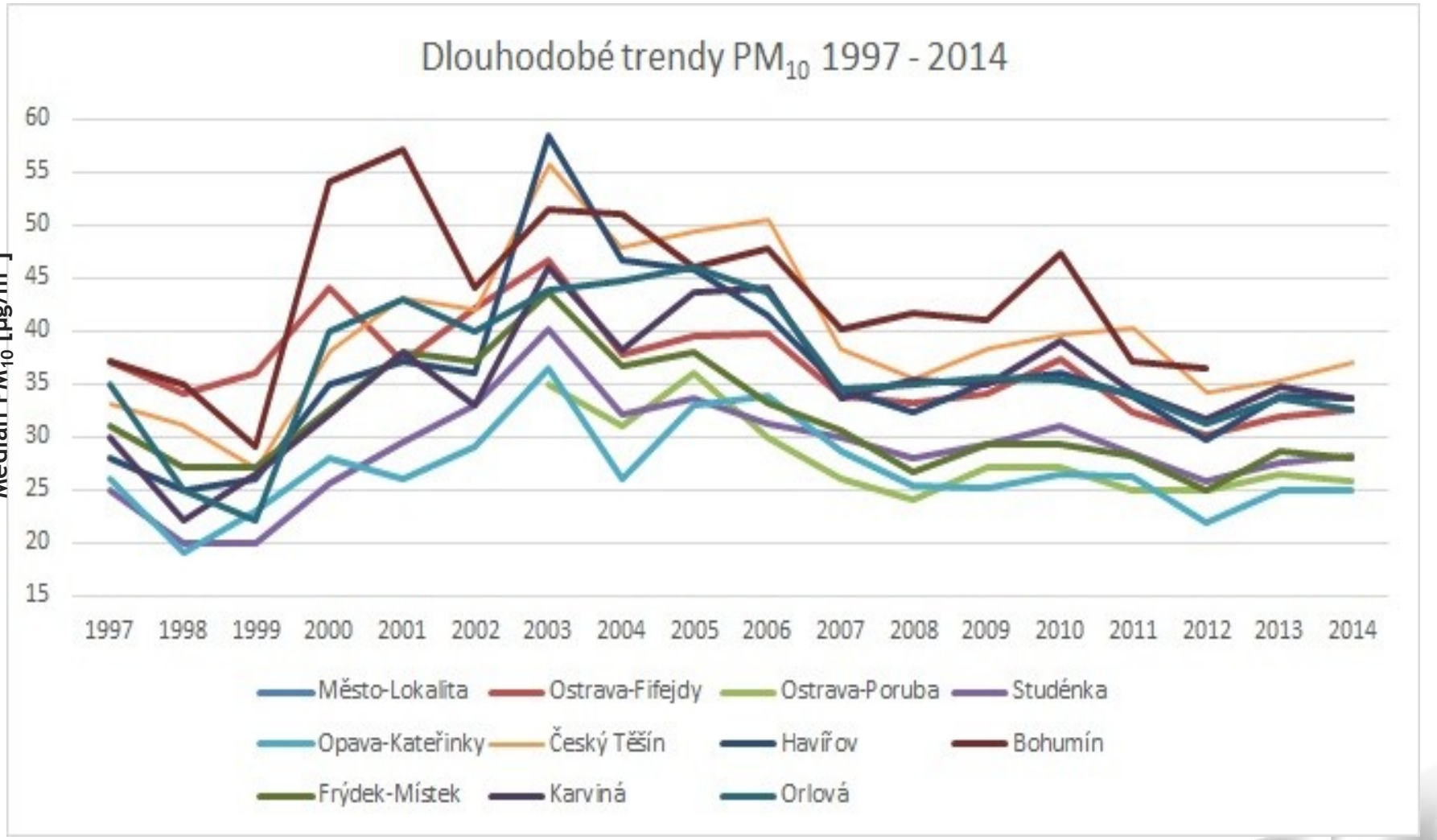
- Regional monitoring stations results behaviour as one system.

- Statistical distribution:

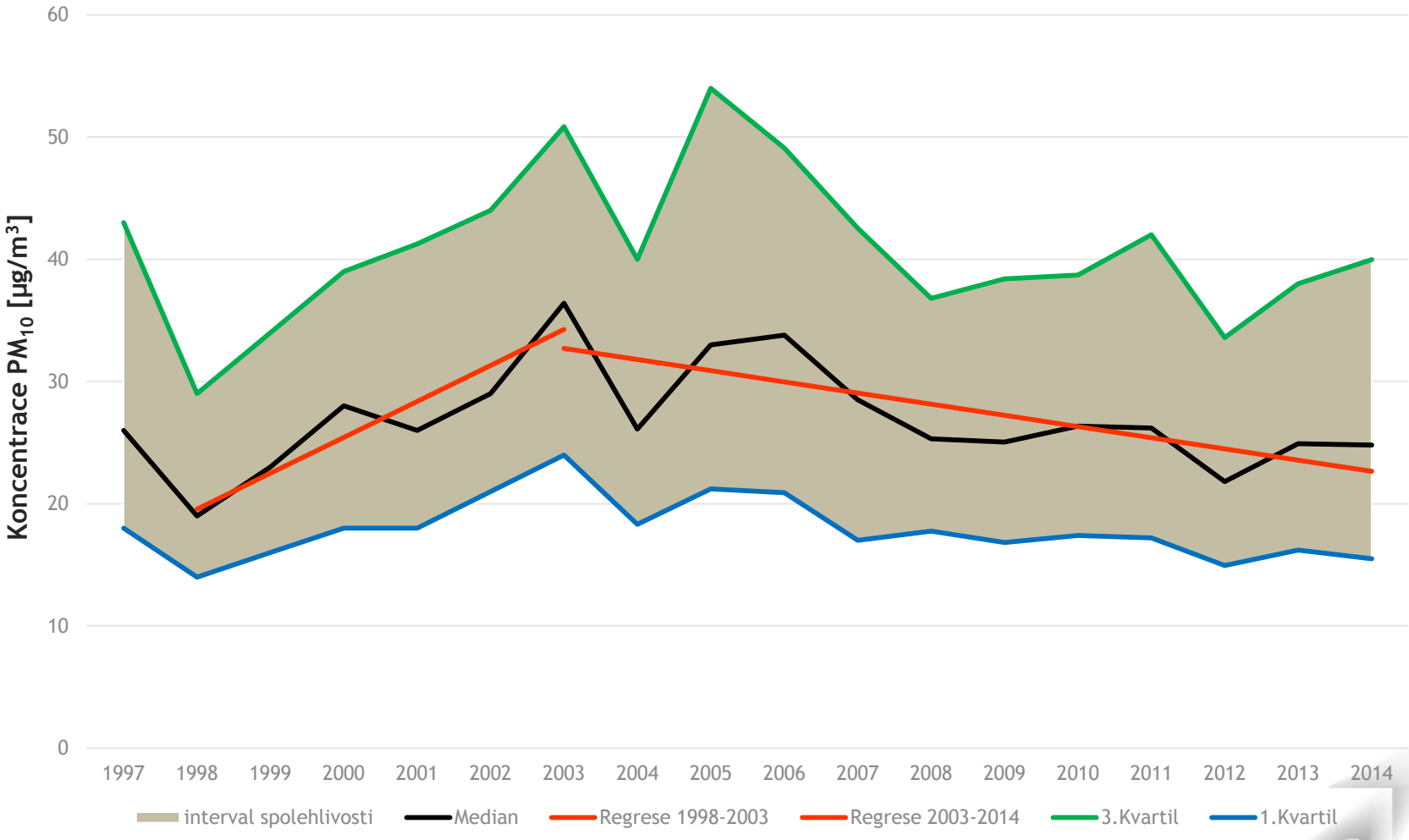




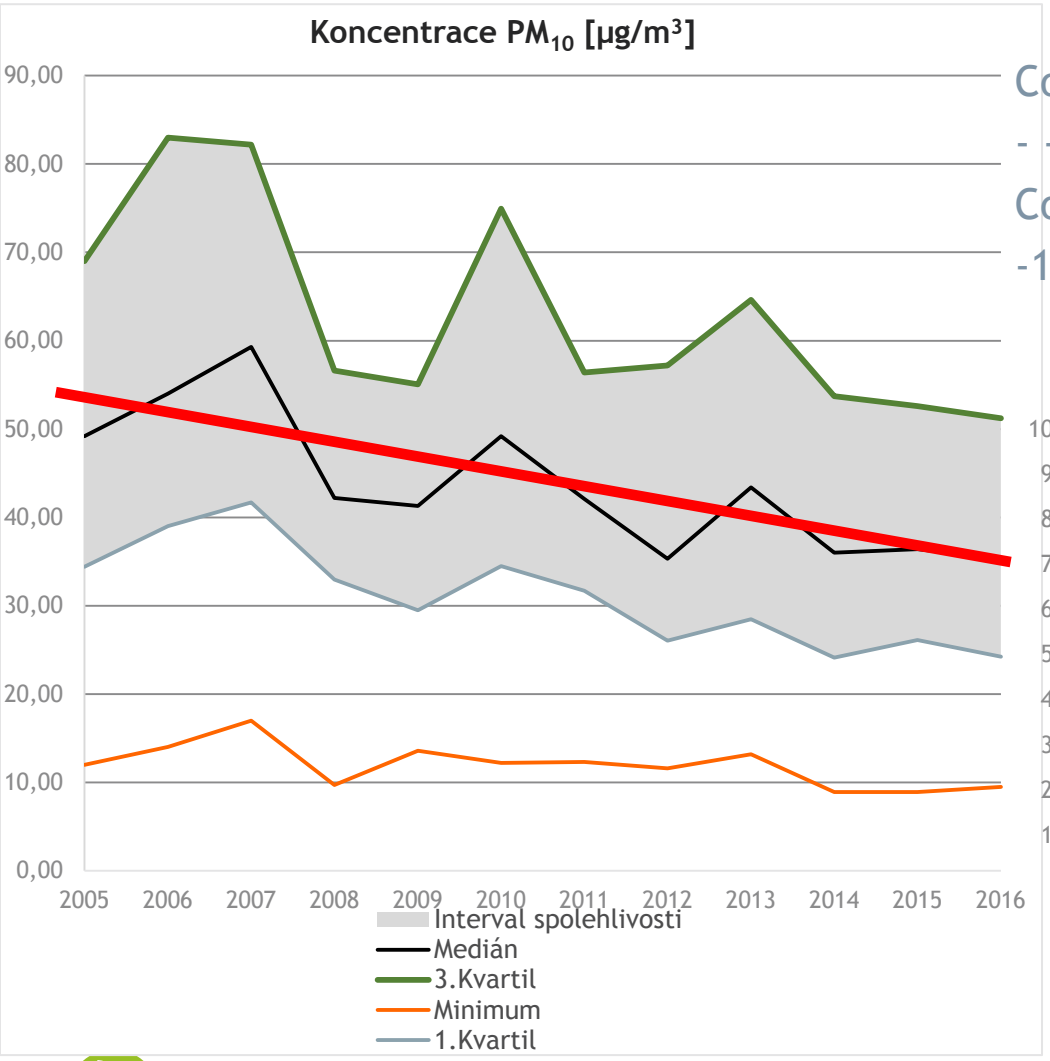
LONG TERM AIR POLLUTION TRENDS ANALYSIS OF YEAR AVERAGE PM_{10} (1998 - 2014)



LONG TERM AIR POLLUTION TRENDS ANALYSIS OF YEAR AVERAGE, OPAVA, PM_{10} (1998 - 2014)



LONG TERM AIR POLLUTION TRENDS ANALYSIS OF YEAR AVERAGE, OSTRAVA RADVANICE, PM_{10} (2005 - 2014)

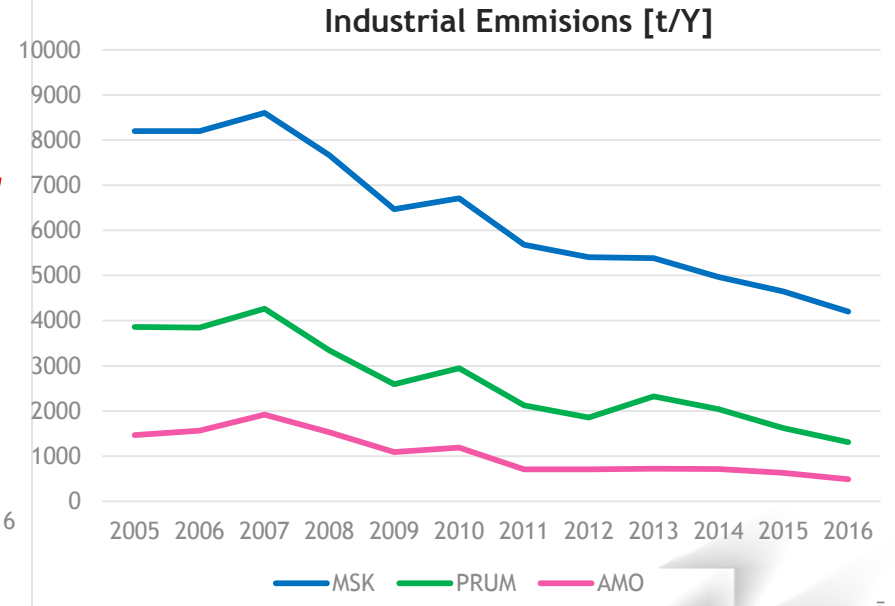


Correlation with AMO emissions = 92%

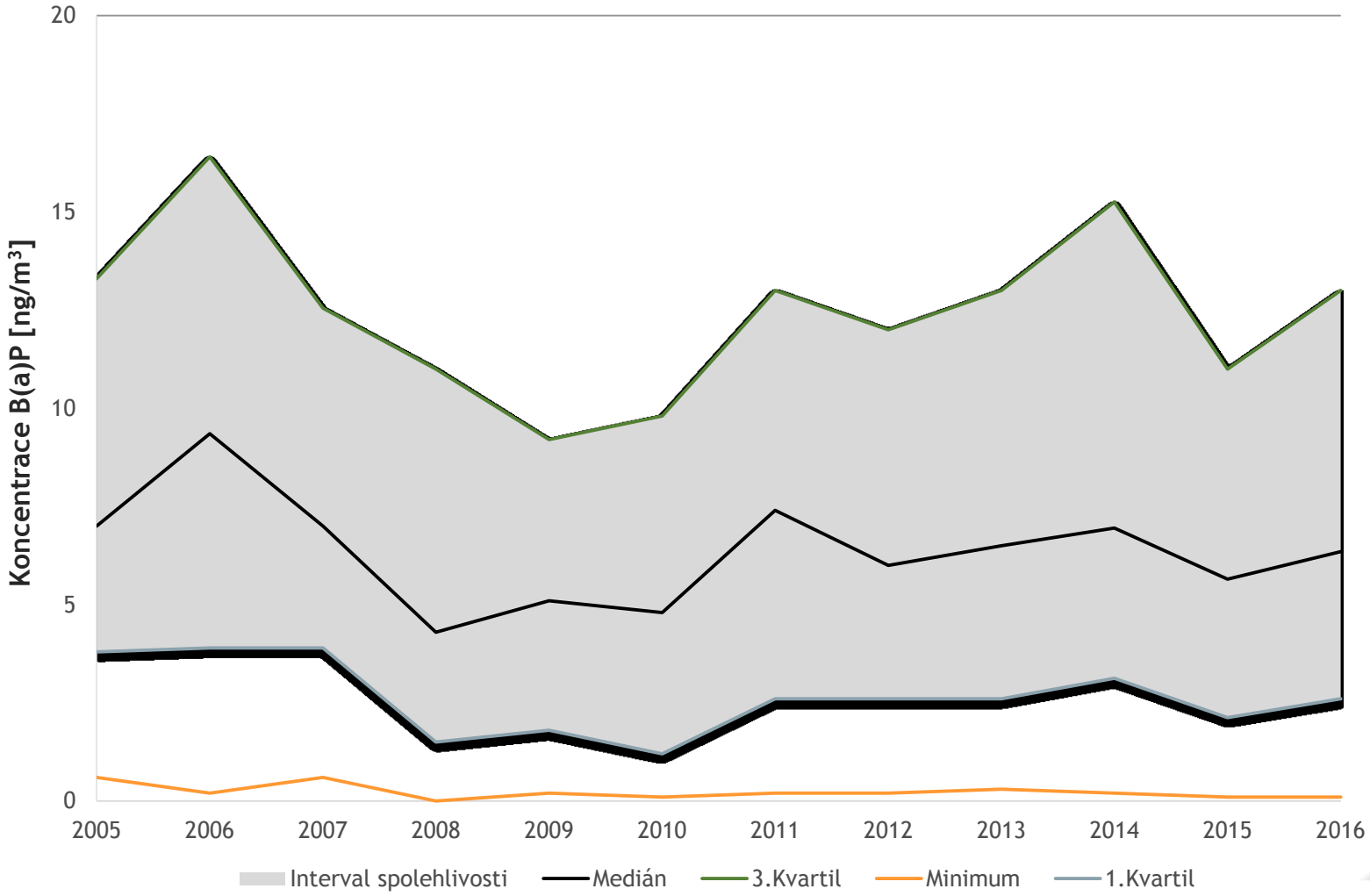
- -100 t/Y AMO cause -1.72 µg/m³ MS

Correlation with regional heavy industry = 91%

-1000 run/rok v MSK -> - 6.22 µg/m³ na IM



LONG TERM AIR POLLUTION TRENDS ANALYSIS OF YEAR AVERAGE, OSTRAVA RADVANICE, B(A)P (2005 - 2016)



LAST DECADE AVERAGE YEAR CONCENTRATIONS OF PM_{10}

MS	2006	2016	2017
O.-Radvanice, ZÚ	63.7	41.0	43.9
O.-Poruba, ČHMÚ	37.5	27.3	27.4
Studénka	41.1	27.3	29.3
Opava-Kateřinky	44.4	24.7	26.8
Čeladná	30.8	21.5	20.1*

*Průměrné roční koncentrace PM_{10} [µg/m³], * - Ostravice-golf*

STANDARD MONITORING DATA

Advantages:

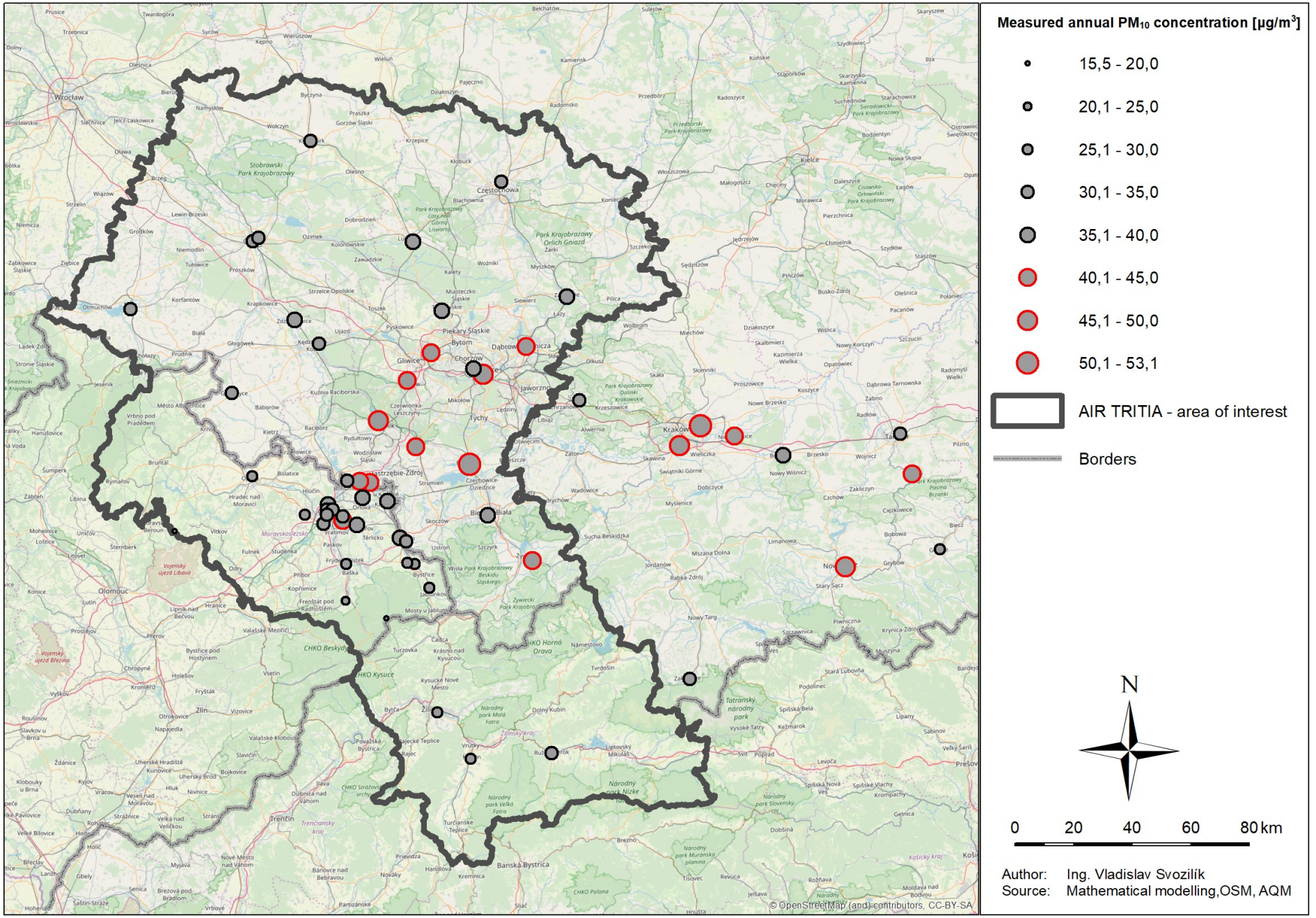
- Exact measurement by standard methods
- Long term data

Disadvantages:

- Local point data
- Uneasy to determine particular air pollution emission sources

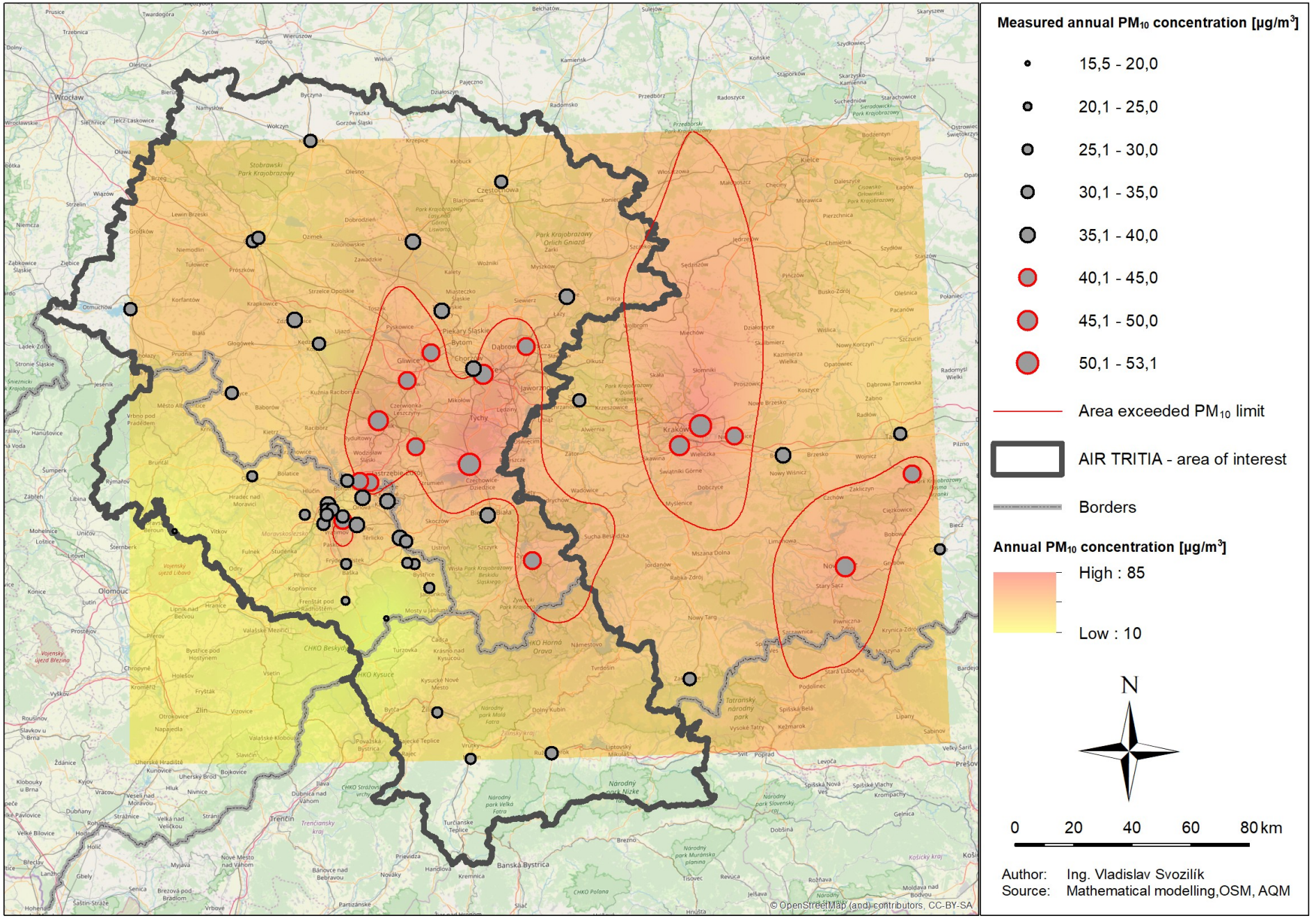
AIR TRITIA - AIR QUALITY MONITORING STATIONS

year 2015



AIR TRITIA - AIR QUALITY MONITORING STATIONS INTERPOLATION

year 2015, Spline_sa(SPLINE, "TENSION",WEIGHT "10",NUMBER OF POINTS "4")



AIR POLLUTION CHARACTERISATION

By measurement:

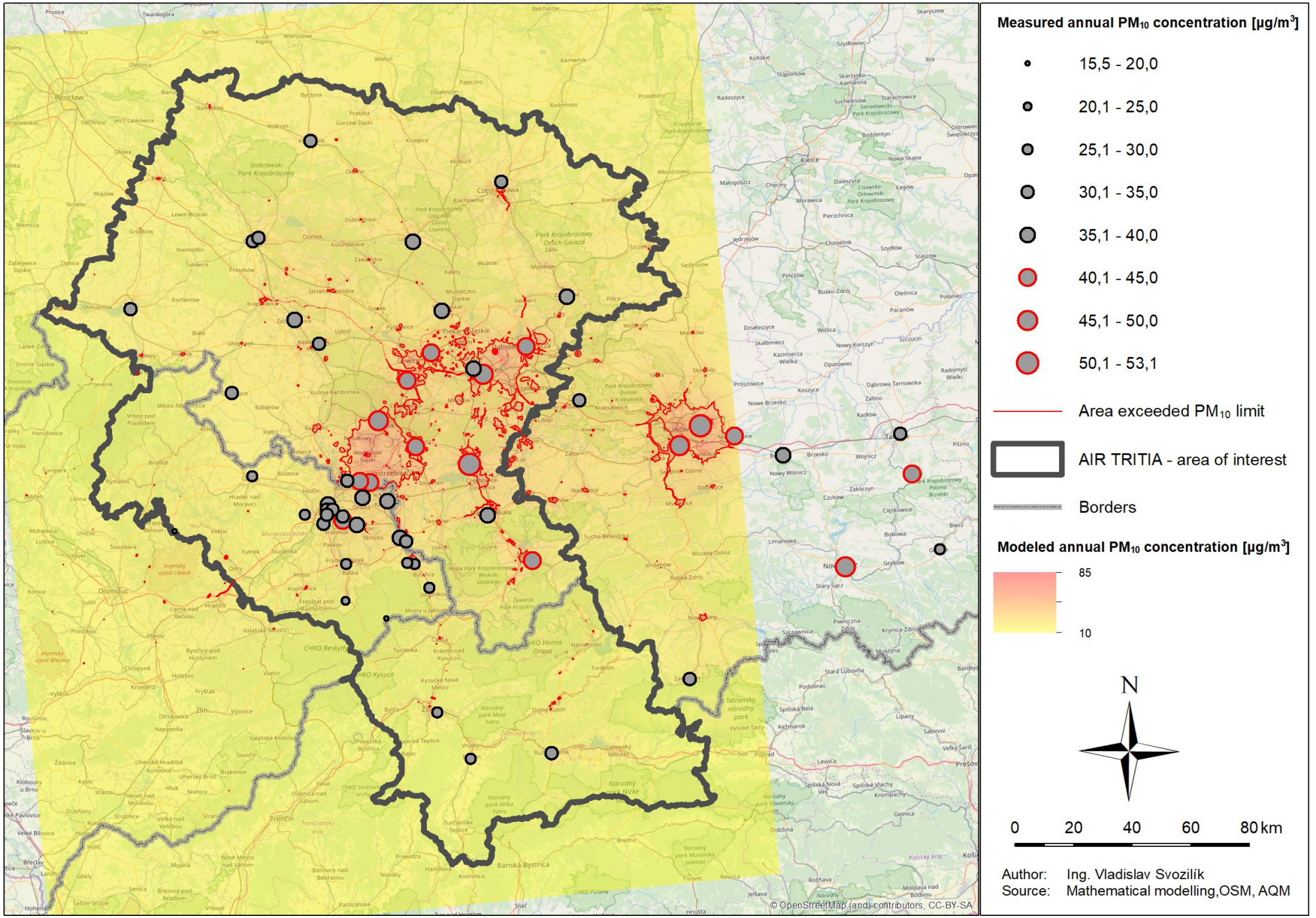
Using results of air quality monitoring stations.

By modelling:

Using results of mathematical models of air pollutions.

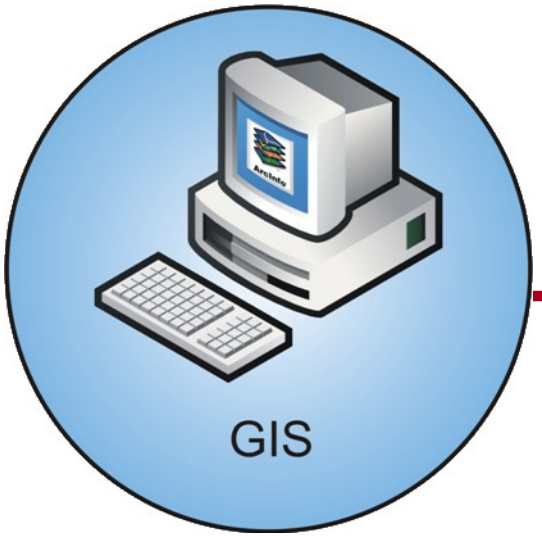
AIR TRITIA - AIR QUALITY MONITORING STATIONS AND MATHEMATICAL MODELLING

year 2015



ADMOSS

=



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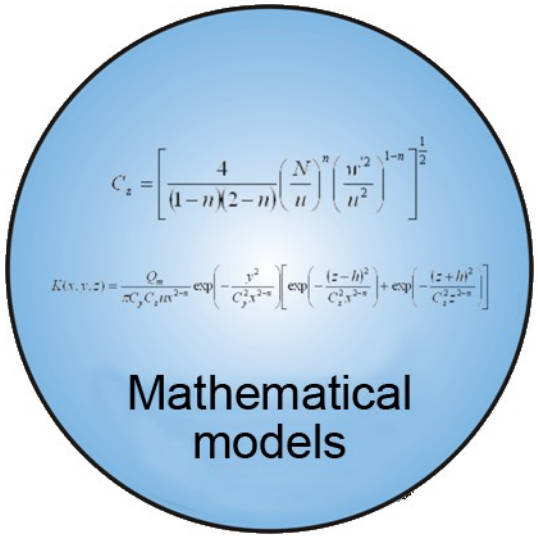
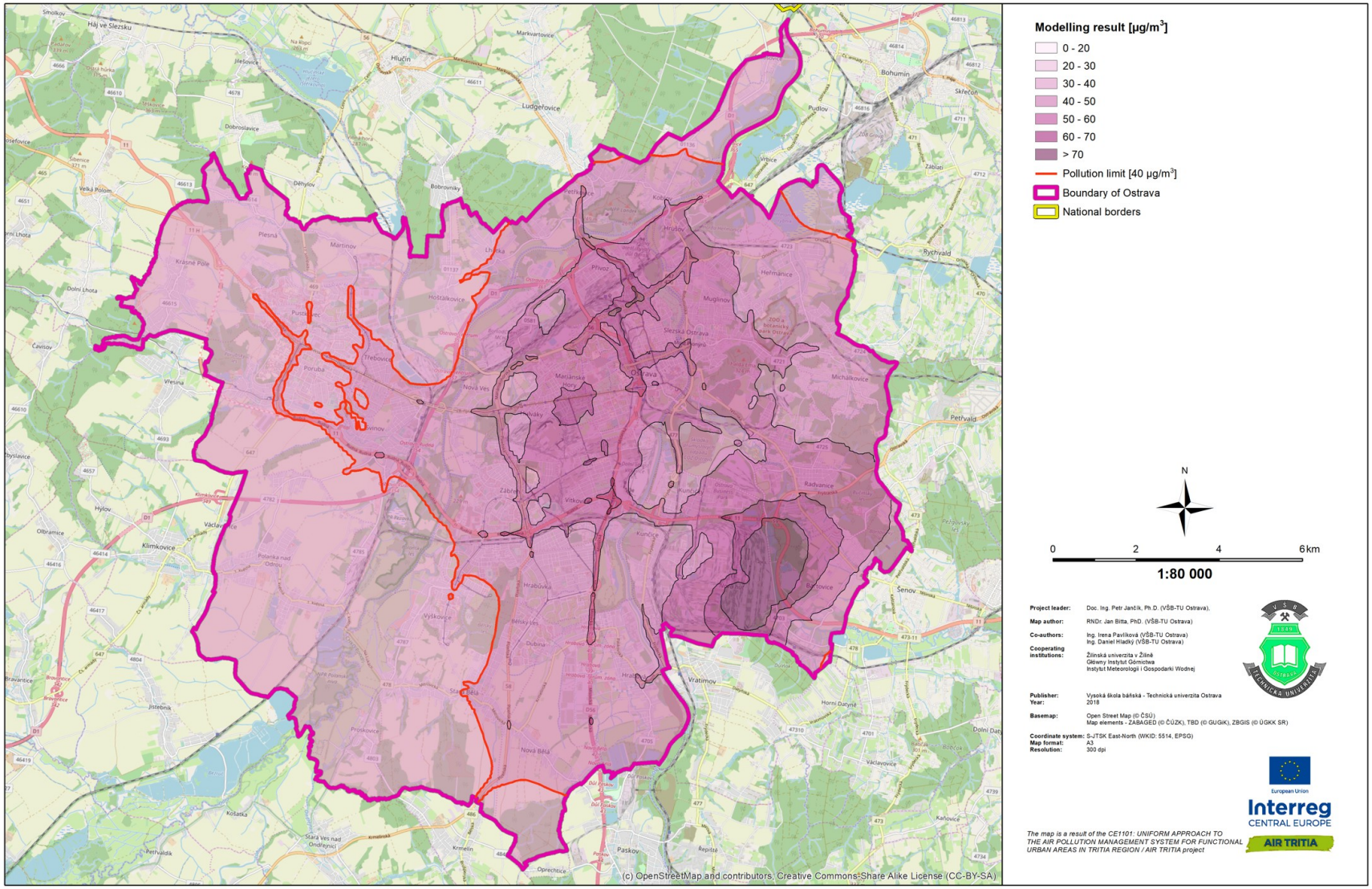


+

IS IT POSSIBLE TO VERIFY THE ADMOSS?

AVERAGE ANNUAL CONCENTRATION OF PM_{10} IN OSTRAVA

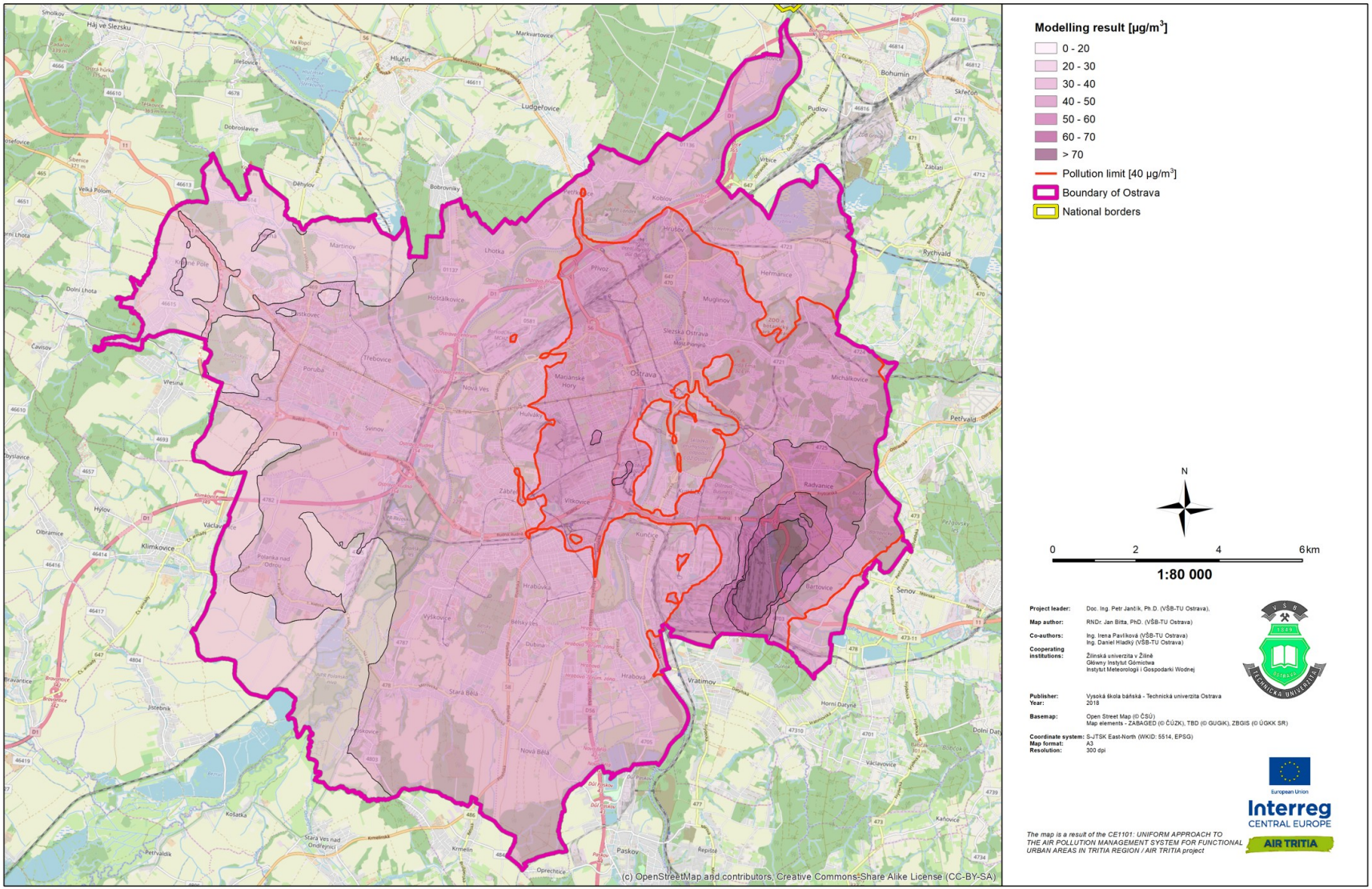
Total concentration, model SYMOS'97 with correction by pollution monitoring, year 2003



IS IT POSSIBLE TO VERIFY THE ADMOSS?

AVERAGE ANNUAL CONCENTRATION OF PM_{10} IN OSTRAVA

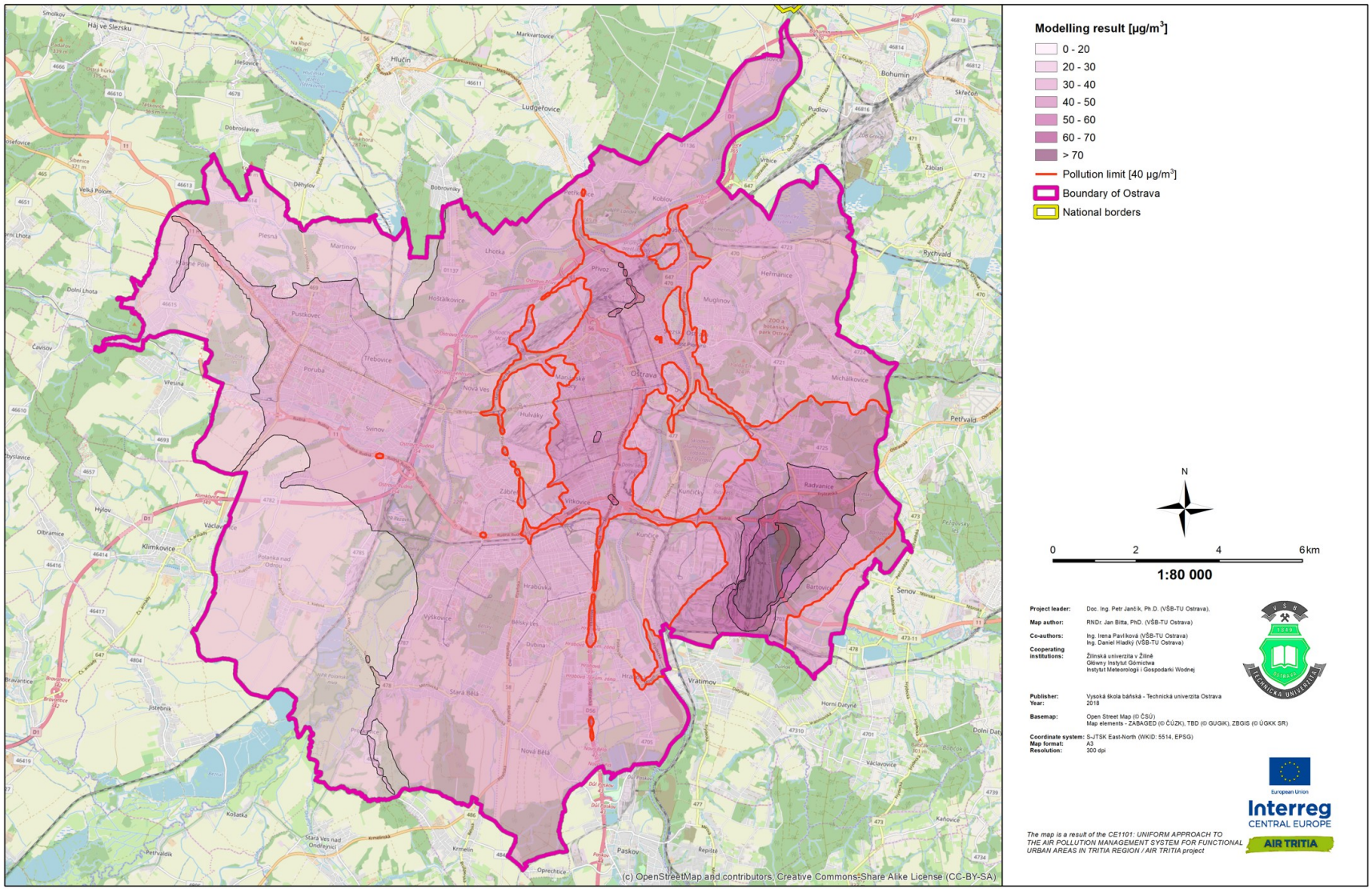
Changes in traffic, new roads, model SYMOS'97 with correction by pollution monitoring, year 2007



IS IT POSSIBLE TO VERIFY THE ADMOSS?

AVERAGE ANNUAL CONCENTRATION OF PM_{10} IN OSTRAVA

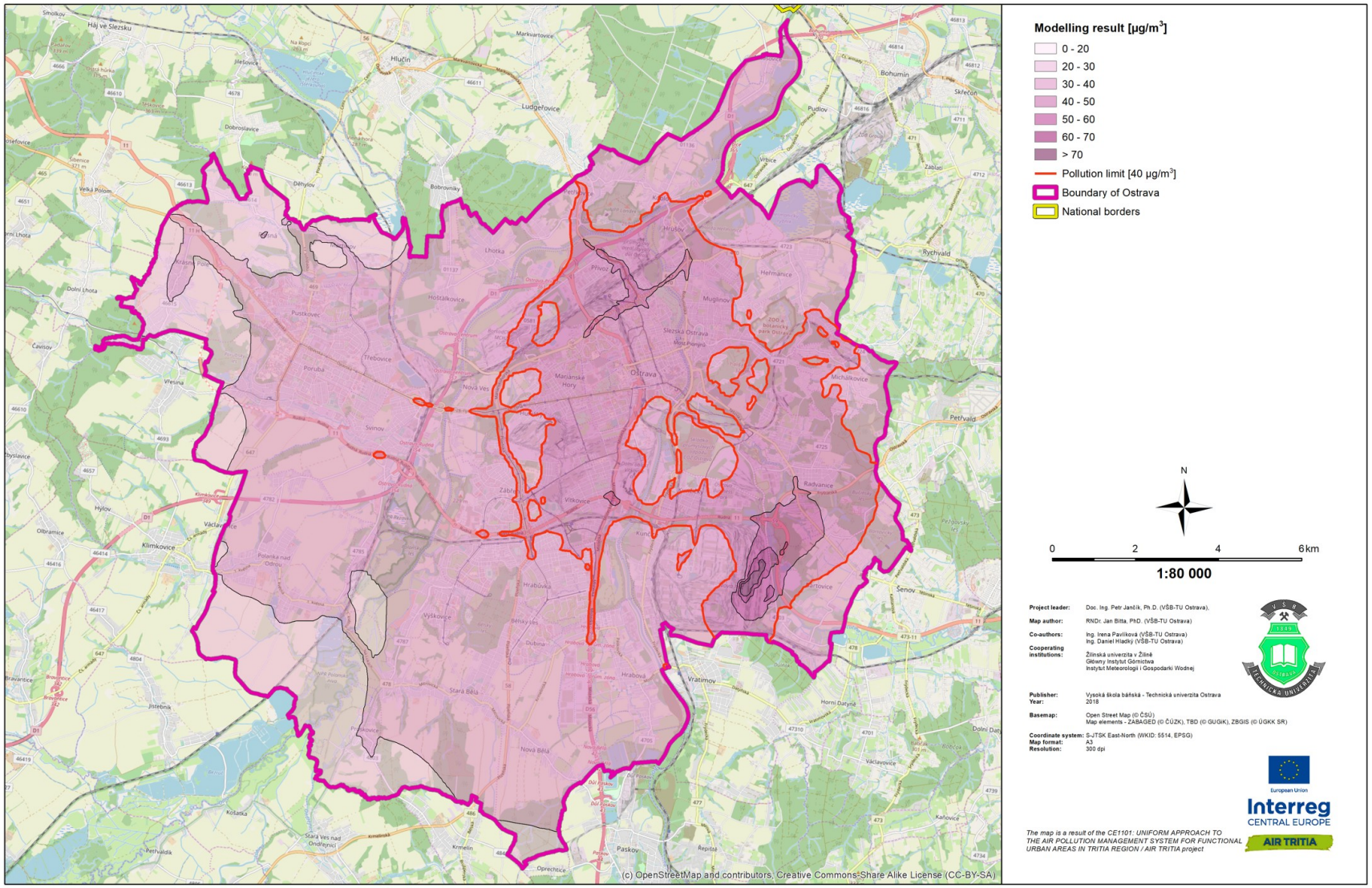
Solid fuel replacement in domestic heating, model SYMOS'97 with correction by pollution monitoring, year 2007



IS IT POSSIBLE TO VERIFY THE ADMOSS?

AVERAGE ANNUAL CONCENTRATION OF PM_{10} IN OSTRAVA

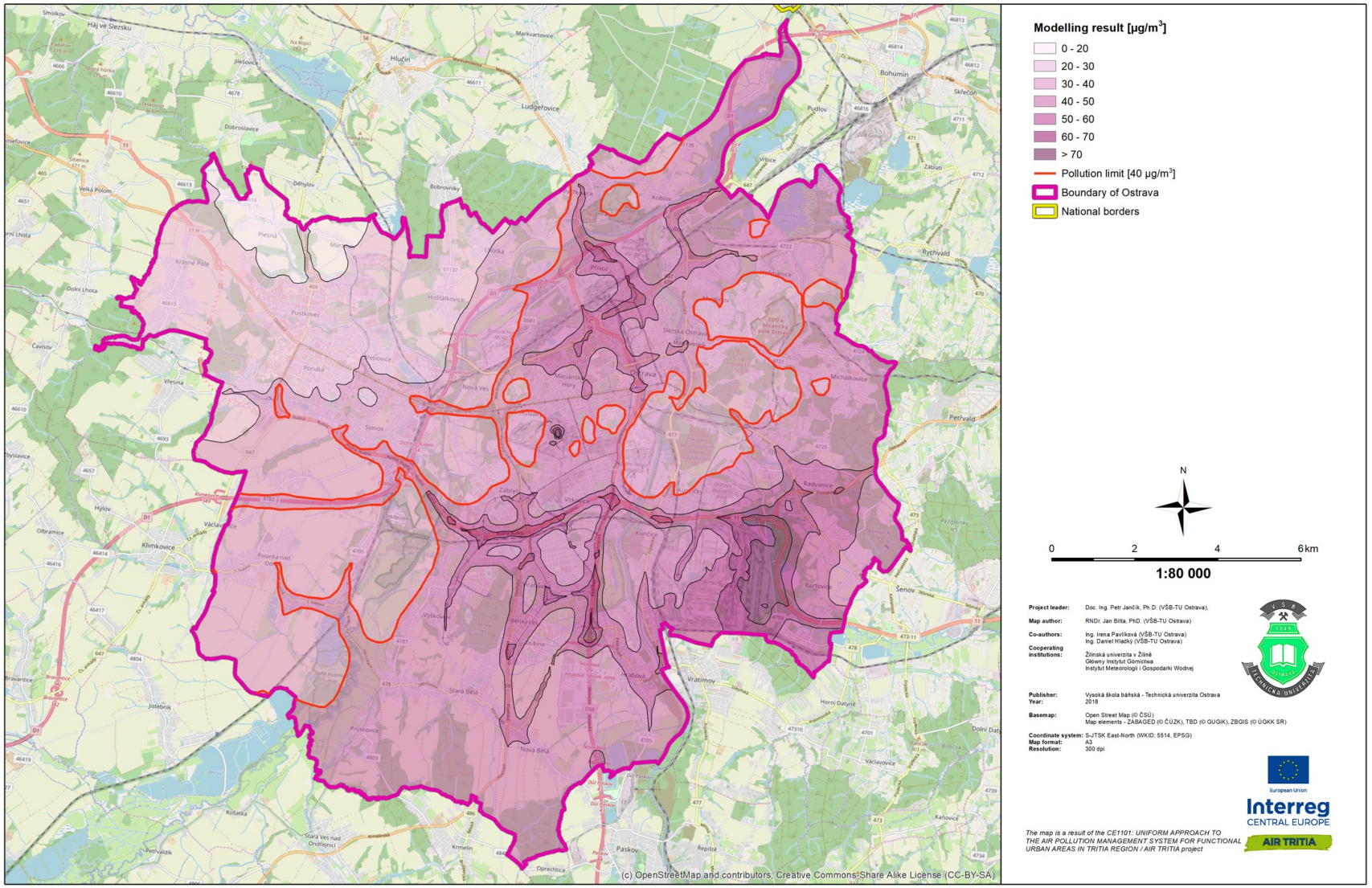
Emission ceiling for industrial sources, model SYMOS'97 with correction by pollution monitoring, year 2007



IS IT POSSIBLE TO VERIFY THE ADMOSS?

AVERAGE ANNUAL CONCENTRATION OF PM_{10} IN OSTRAVA

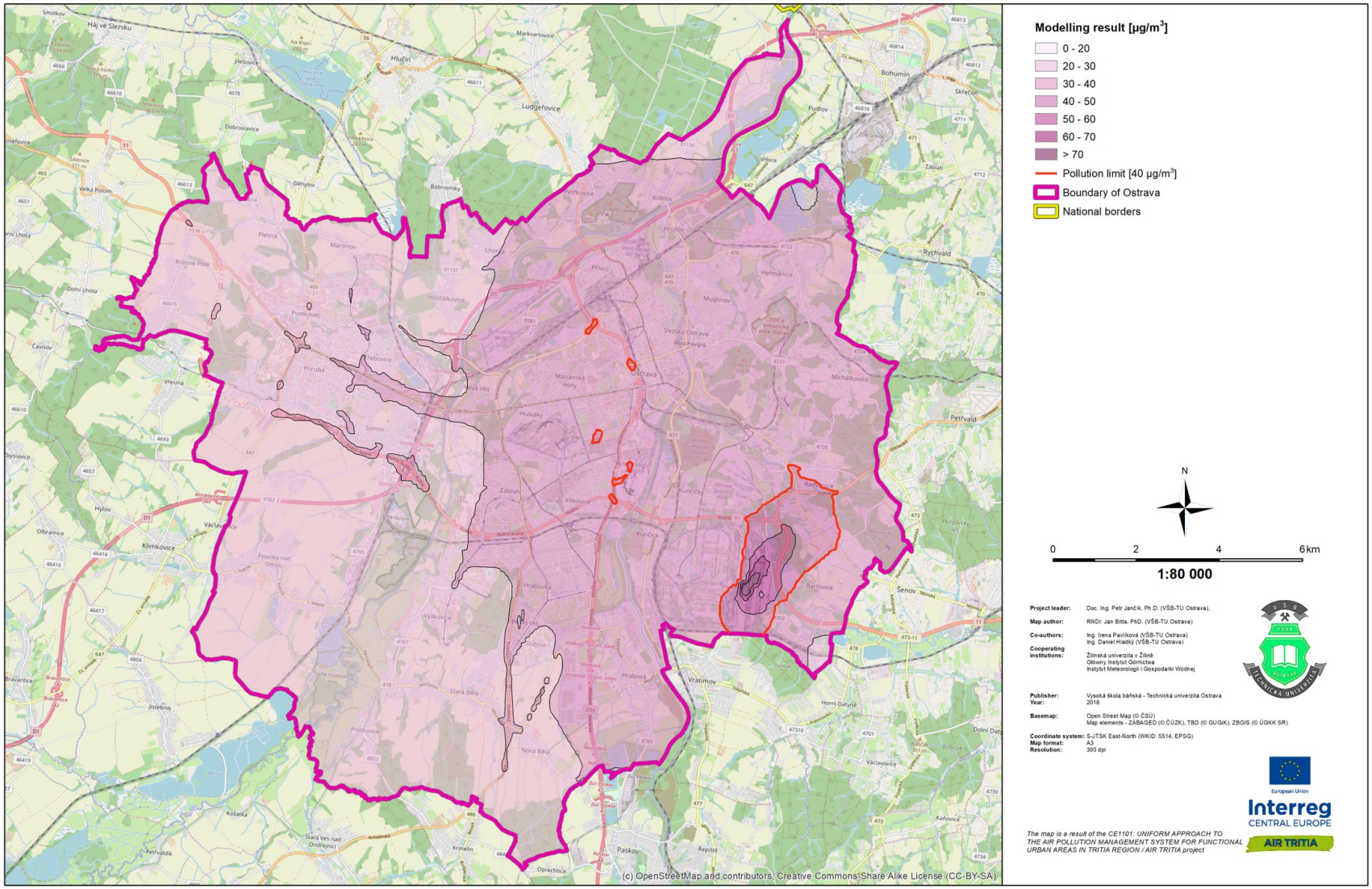
Total concentration, model SYMOS'97 with correction by pollution monitoring, year 2010



IS IT POSSIBLE TO VERIFY THE ADMOSS?

AVERAGE ANNUAL CONCENTRATION OF PM_{10} IN OSTRAVA

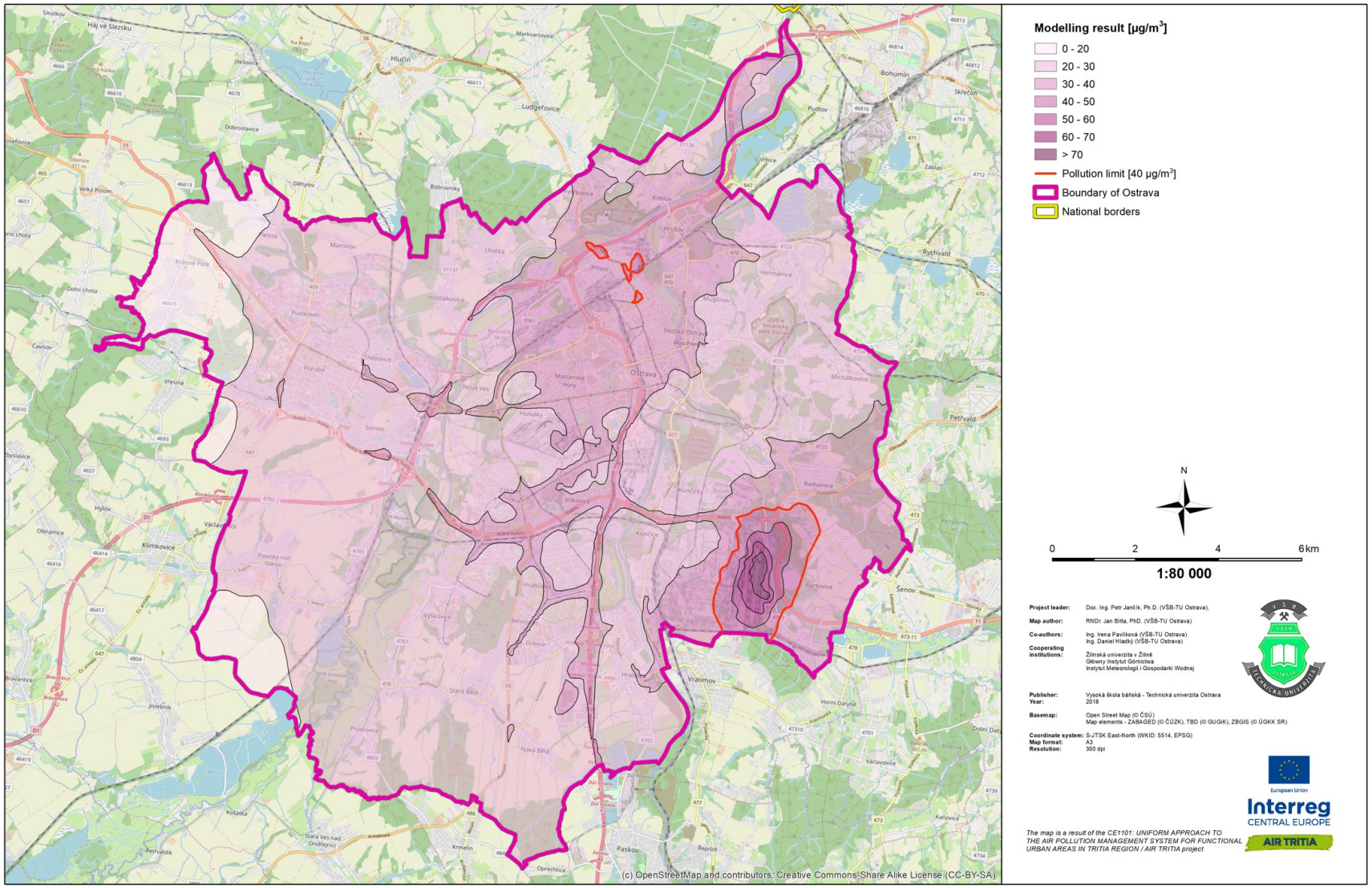
All pollution limiting provisions, model SYMOS'97 with correction by pollution monitoring, year 2007



IS IT POSSIBLE TO VERIFY THE ADMOSS?

AVERAGE ANNUAL CONCENTRATION OF PM_{10} IN OSTRAVA

Total concentration, model SYMOS'97 with correction by pollution monitoring, year 2015



AIR TRITIA PROJECT

- Collection of common data for the whole region.
- Characterisation of the region related to air pollutions (legislation, social structure, health risk, transport, air pollutions).
- Air Pollution Management System.
- https://labgis.vsb.cz/test/
- Ready for scenarios and variants of them.
- Preparing the strategies for selected cities and the whole region after evaluating particular variants. The core is ADMOSS.
- To make the evaluation believable, necessary to proof model results.
- We decided to use biomonitoring using moss samples with multi element analysis by INAA

INDICATION OF 7 MOST POLLUTED INDUSTRIAL AREAS

Czenstochowa area 1

Katowice-Gliwice area 2

Rybnik - Jastrzebie - area 3

Karvina – Ostrava area 4

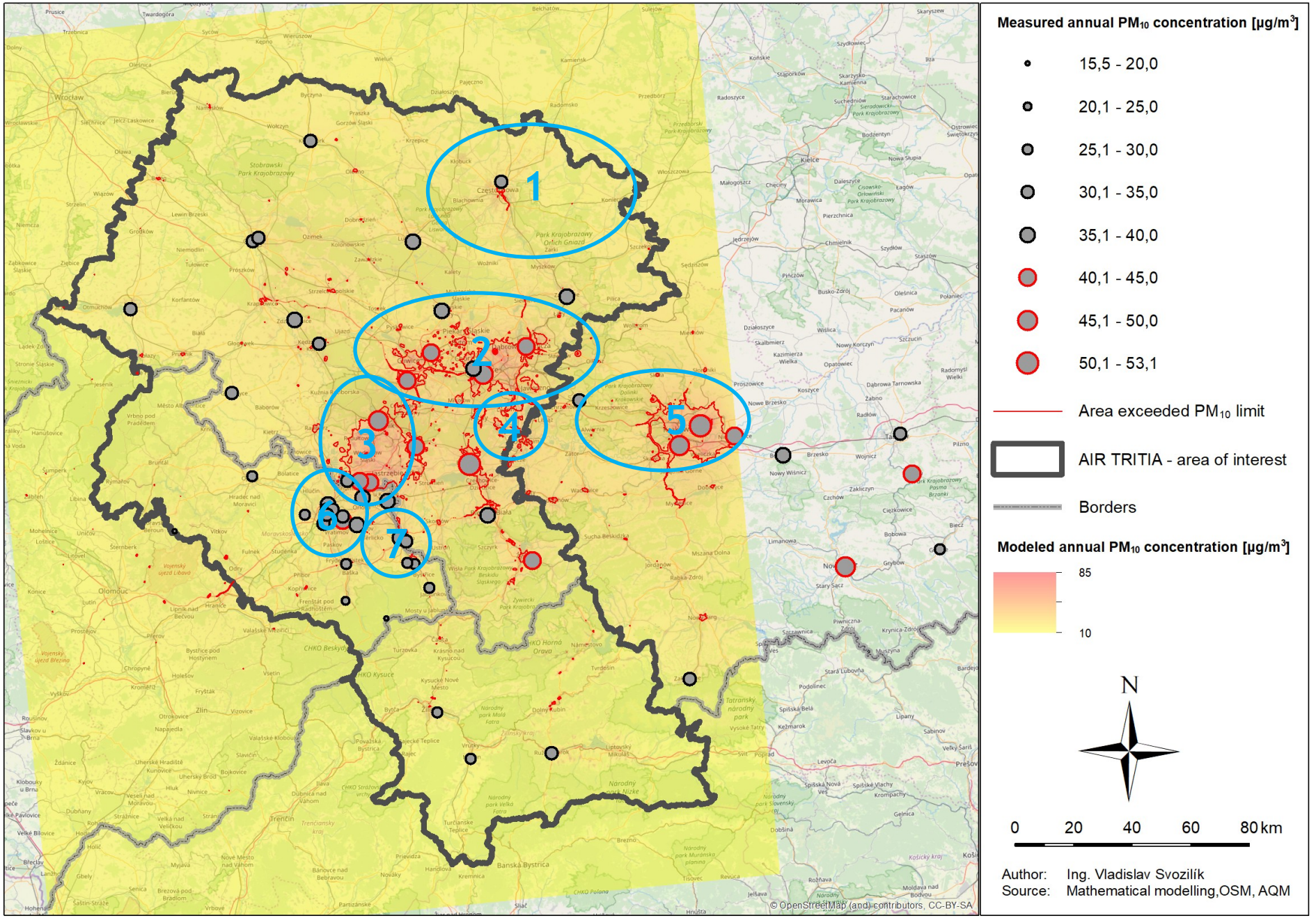
Oświęcim area 5

Krakow area 6

Trinec area 7

AIR TRITIA - AIR QUALITY MONITORING STATIONS AND MATHEMATICAL MODELLING

year 2015



AIR POLLUTION CHARACTERISATION

By measurement:

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By special monitoring methods:

Using results of INAA

USING RESULTS OF INAA

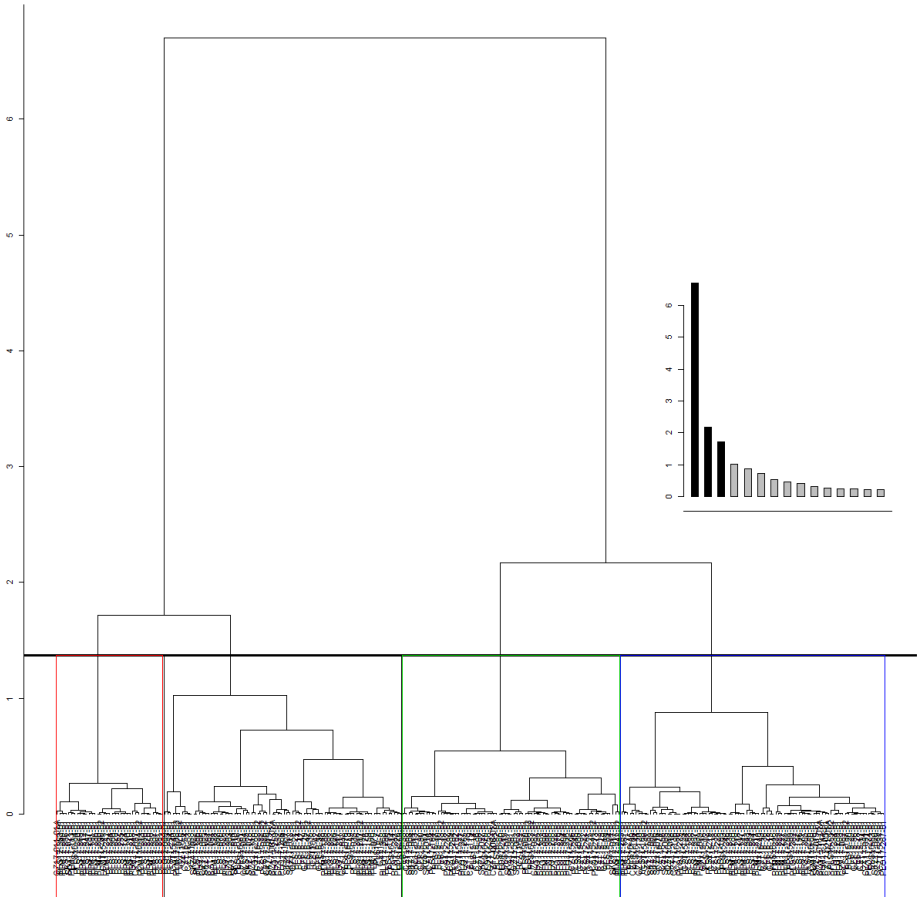
Statistical processing of INAA results:

1. Clustering according normalised elements concentrations combination.
2. Factor analysis.
3. Correlation between elements concentrations in samples.
4. Comparing some chosen tracing elements concentrations with mathematical model results .

THE CLUSTERING

HCPCA (The Hierarchical Clustering on Principal Components)

Author: Vladislav Svozilík

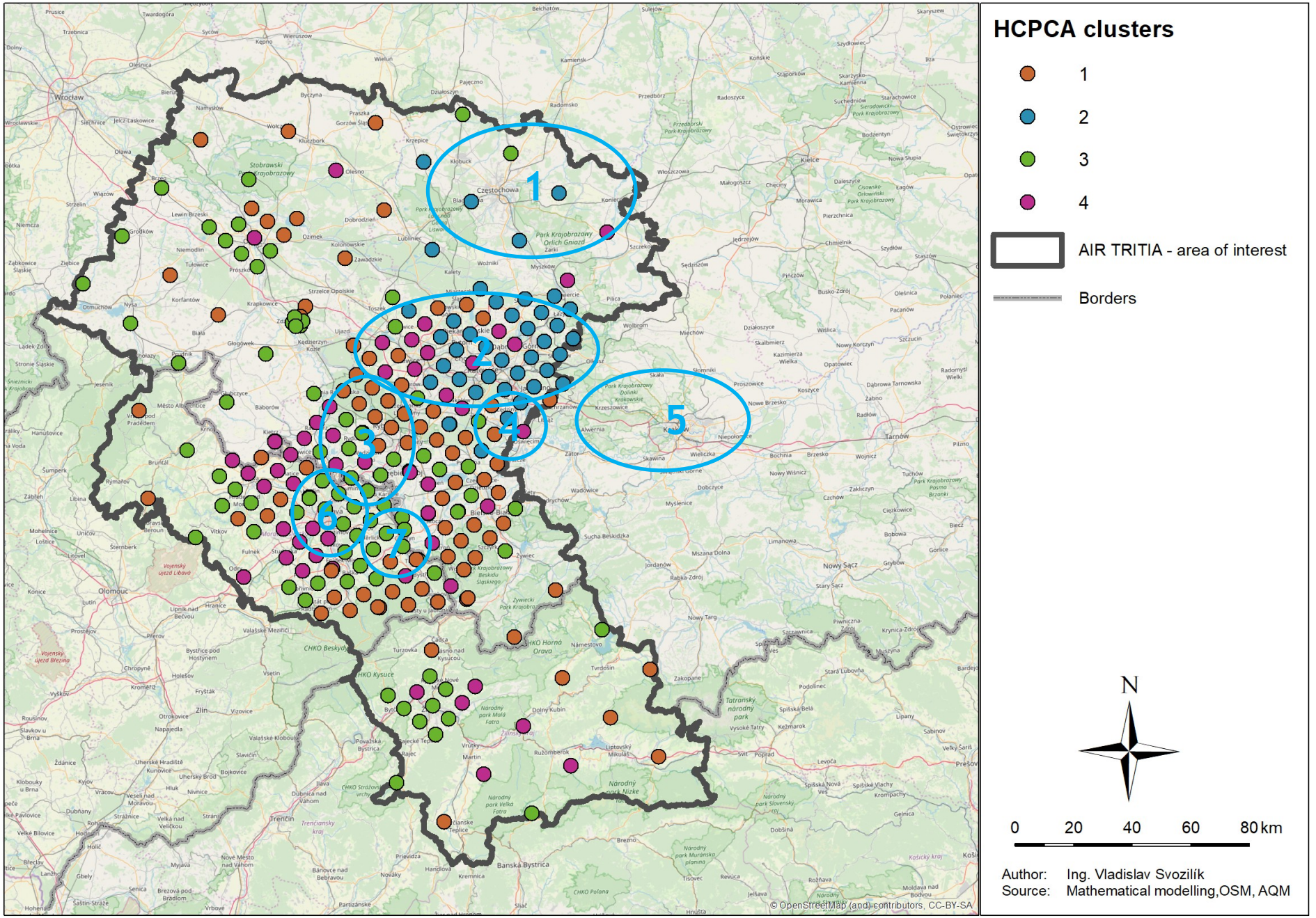


The result = 4 clusters:

Red
Brown
Green
Blue

AIR TRITIA - HCPC / HIERARCHICAL CLUSTERING ON PRINCIPAL COMPONENTS

year 2015



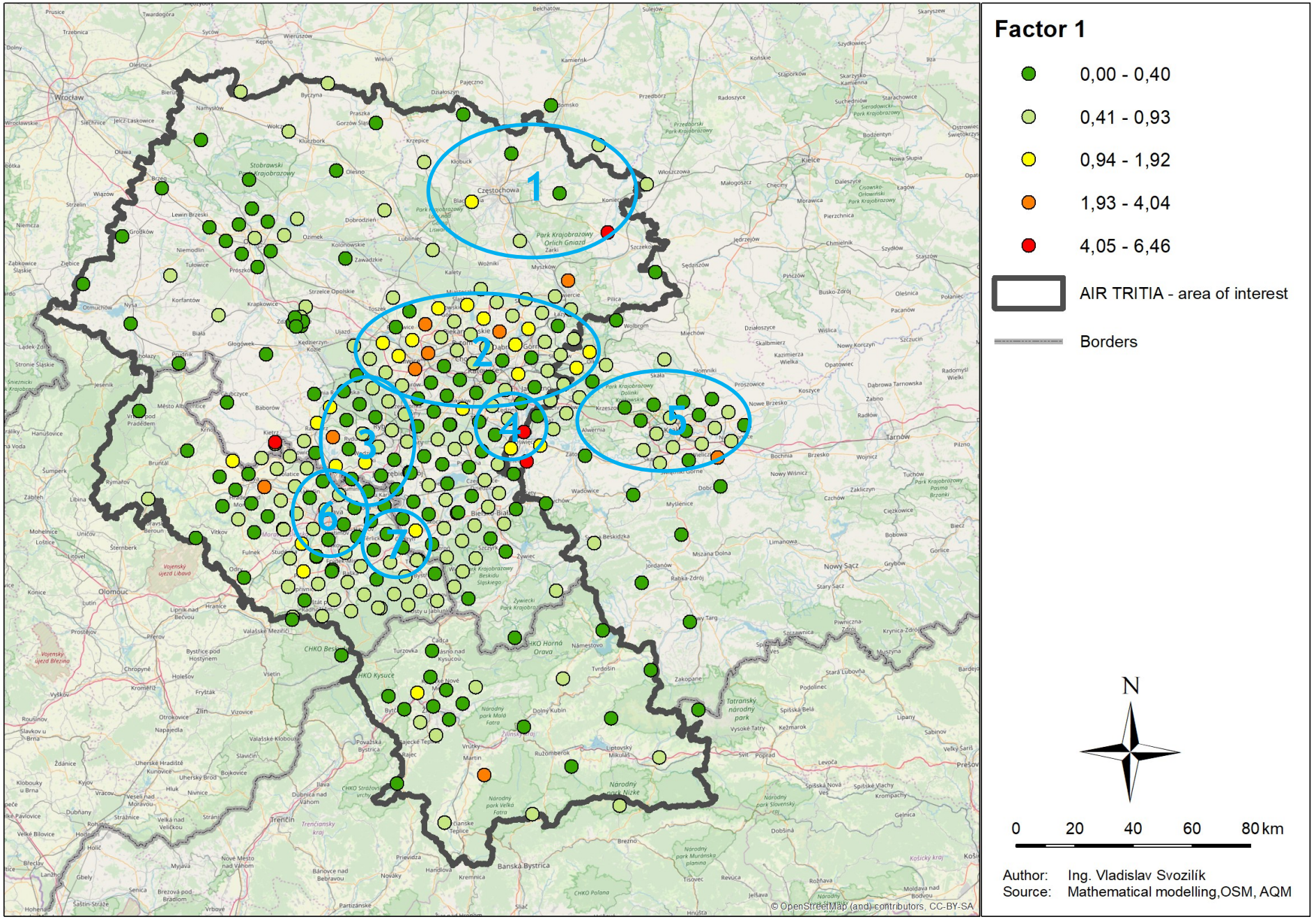
THE FACTOR ANALYSIS

The result = 4 factors, described by groups of elements:

Factor 1: Ni, V, Al, Co, Ce, Na, Sm, U, Nd, Tb, Th, Sc, Ti, La, Hf
Factor 2: Cr, Fe, Sb, Mo
Factor 3: K, Mg
Factor 4: Cd, Rb

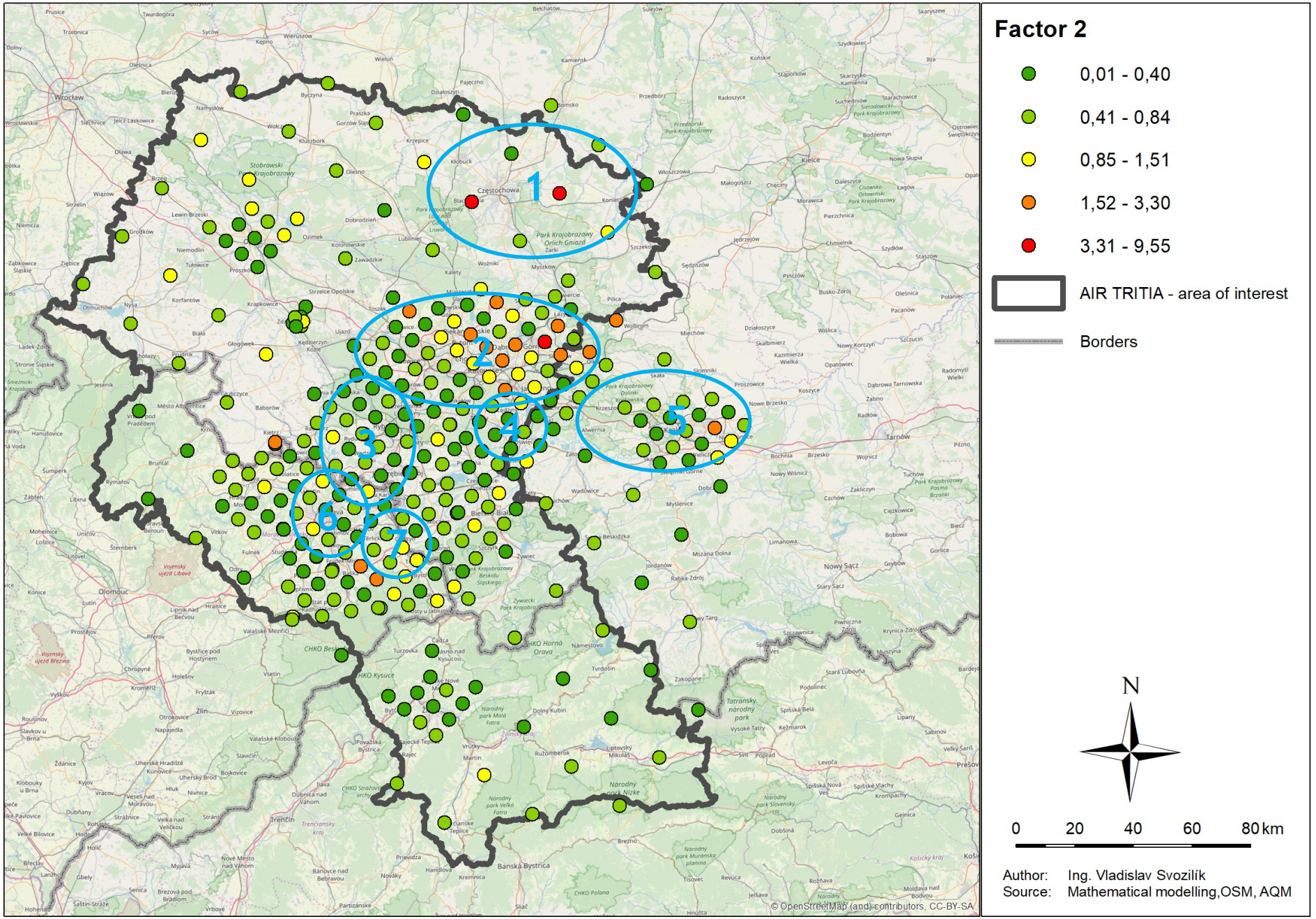
AIR TRITIA - FACTOR ANALYSIS RESULTS

year 2015



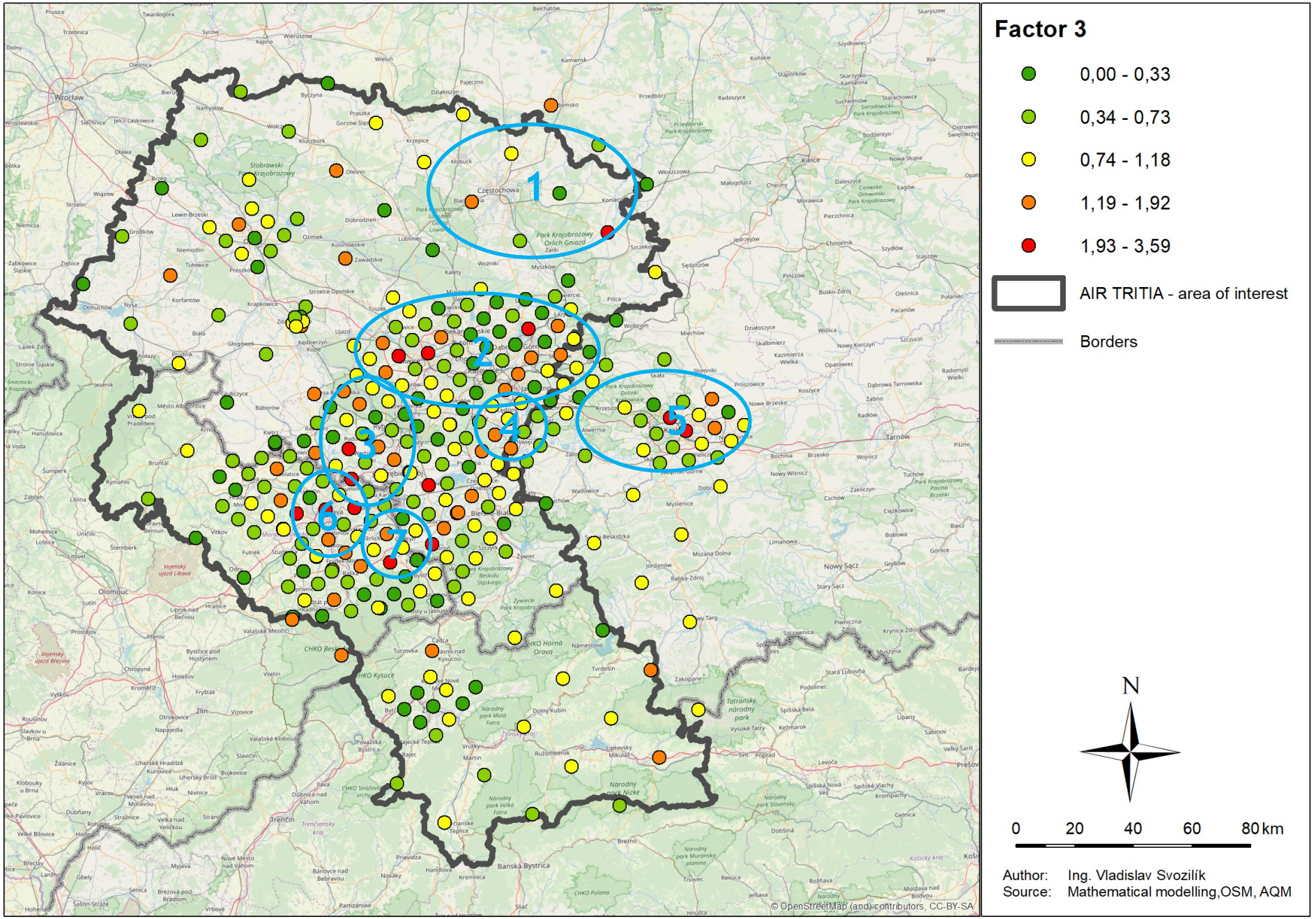
AIR TRITIA - FACTOR ANALYSIS RESULTS

year 2015



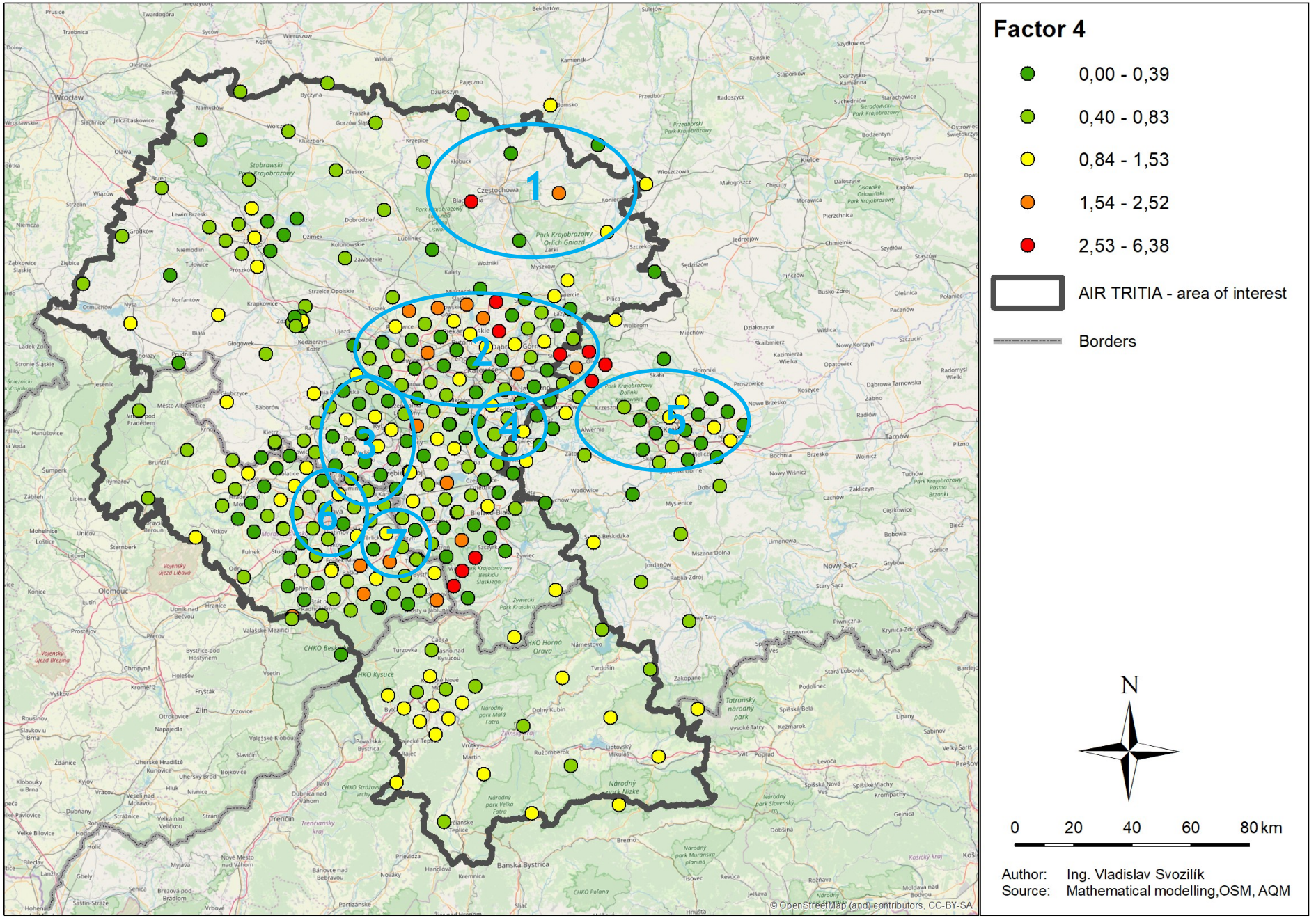
AIR TRITIA - FACTOR ANALYSIS RESULTS

year 2015

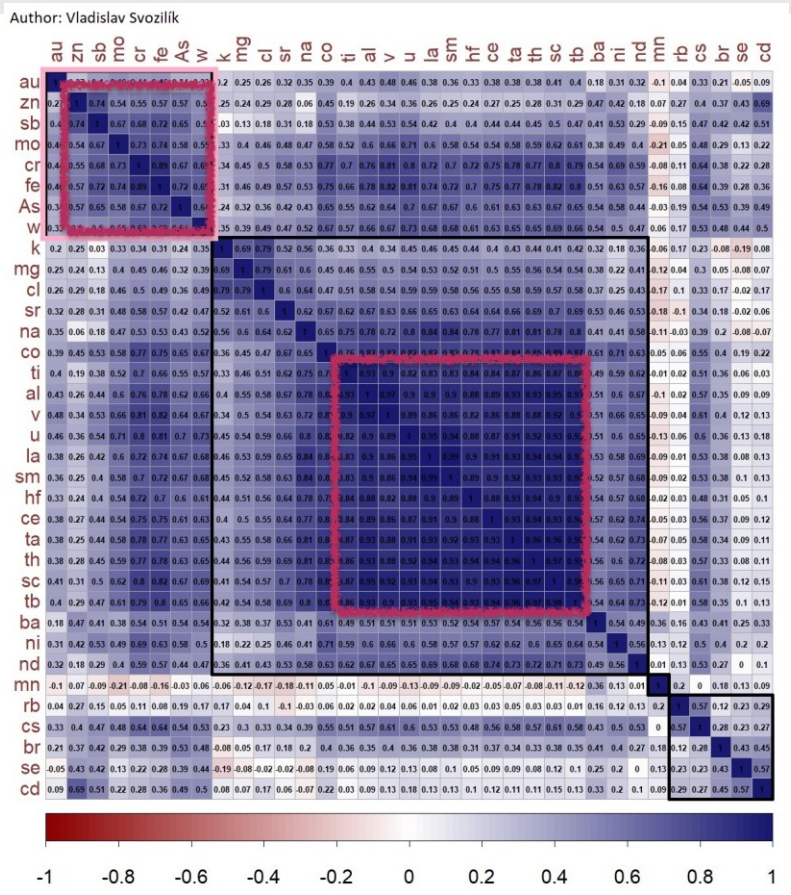


AIR TRITIA - FACTOR ANALYSIS RESULTS

year 2015



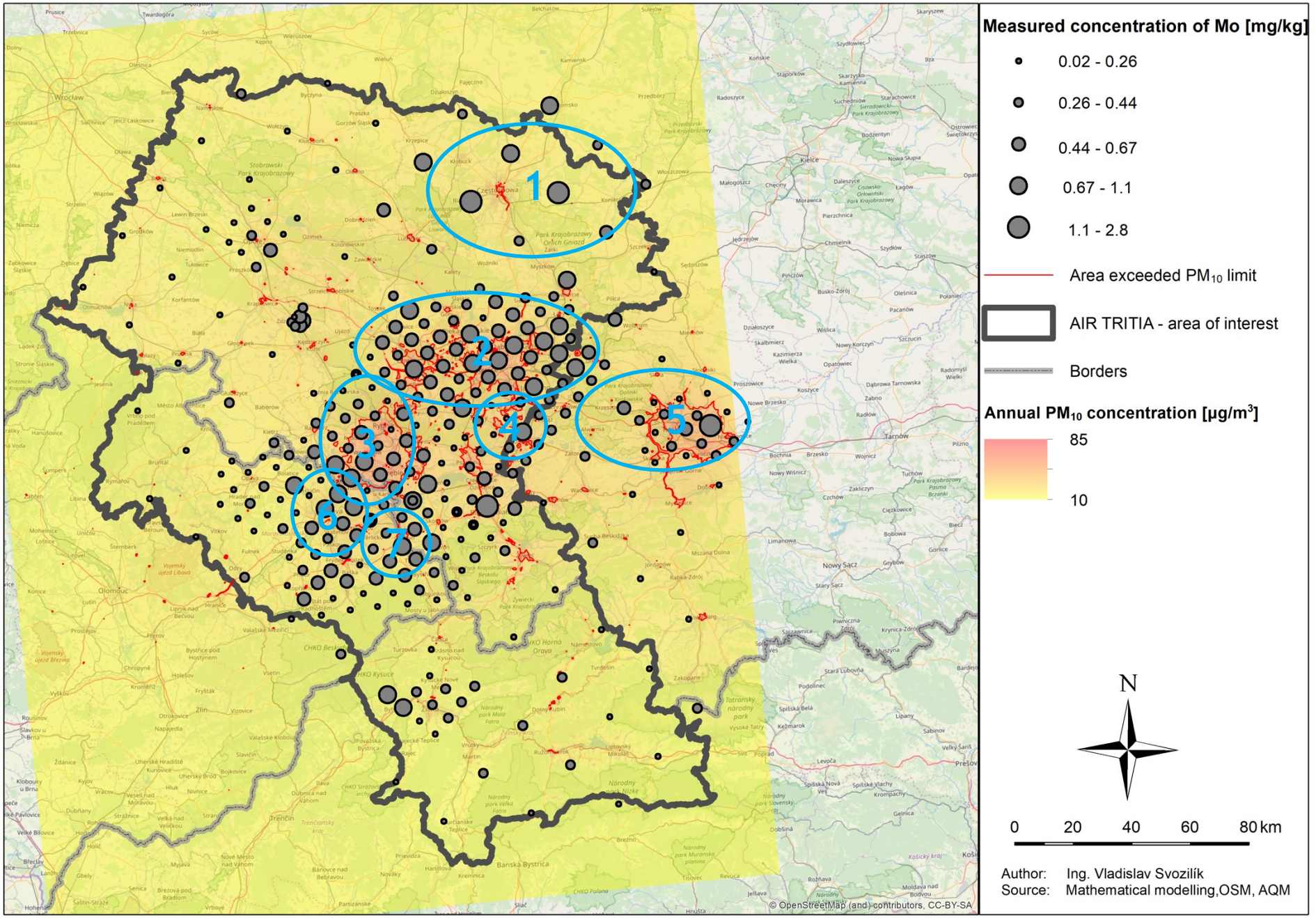
THE CORRELATIONS



Selected correlated elements Mo, Fe, As, Cr, Sb, W and Zn (similar to Factor 2) are compared with the ADMOSS results.

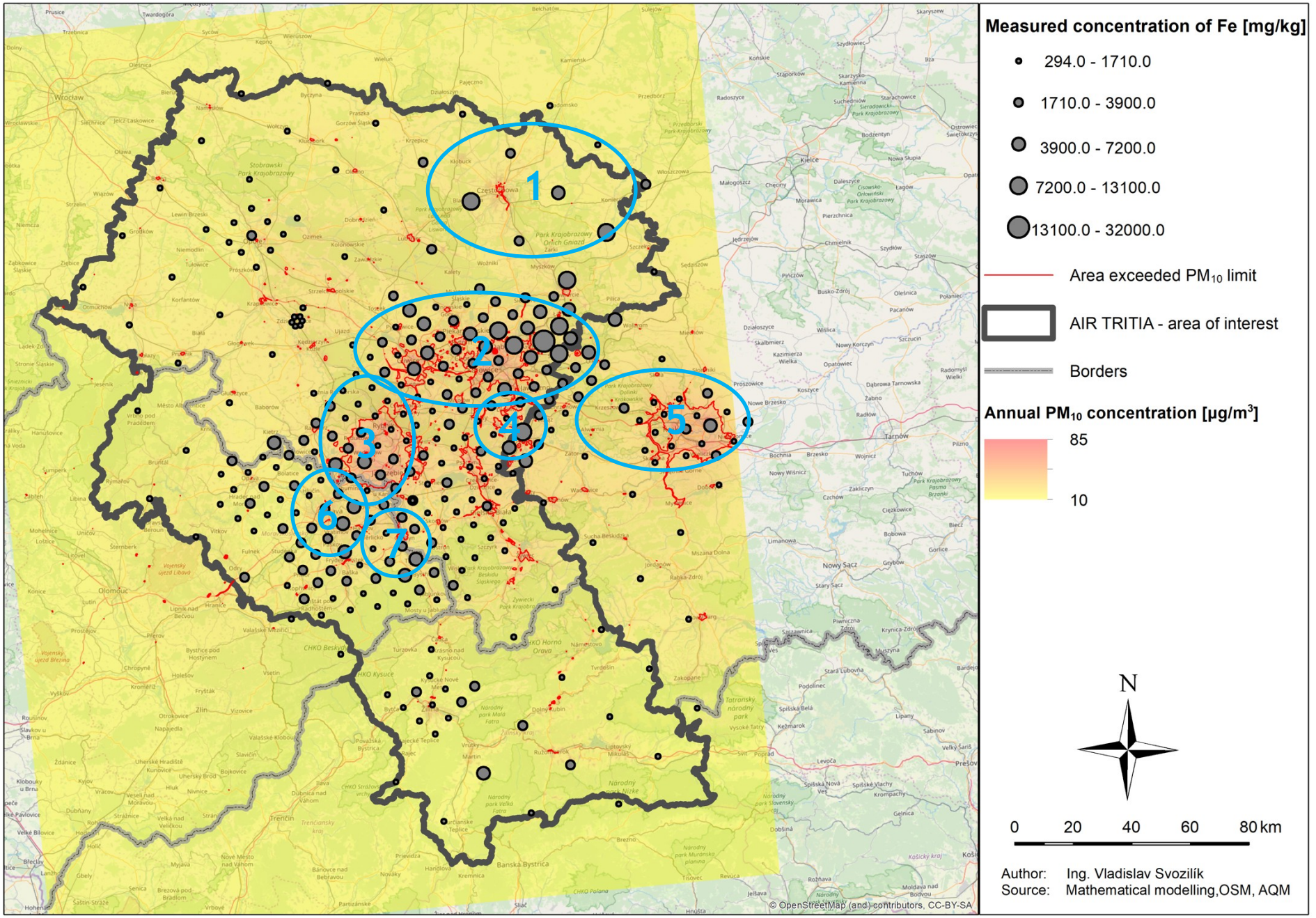
CONCENTRATION DETERMINED IN MOSS BY INAA

Year 2015, model SYMOS'97, Biomonitoring 2015, 2016, 2017



CONCENTRATION DETERMINED IN MOSS BY INAA

Year 2015, model SYMOS'97, Biomonitoring 2015, 2016, 2017



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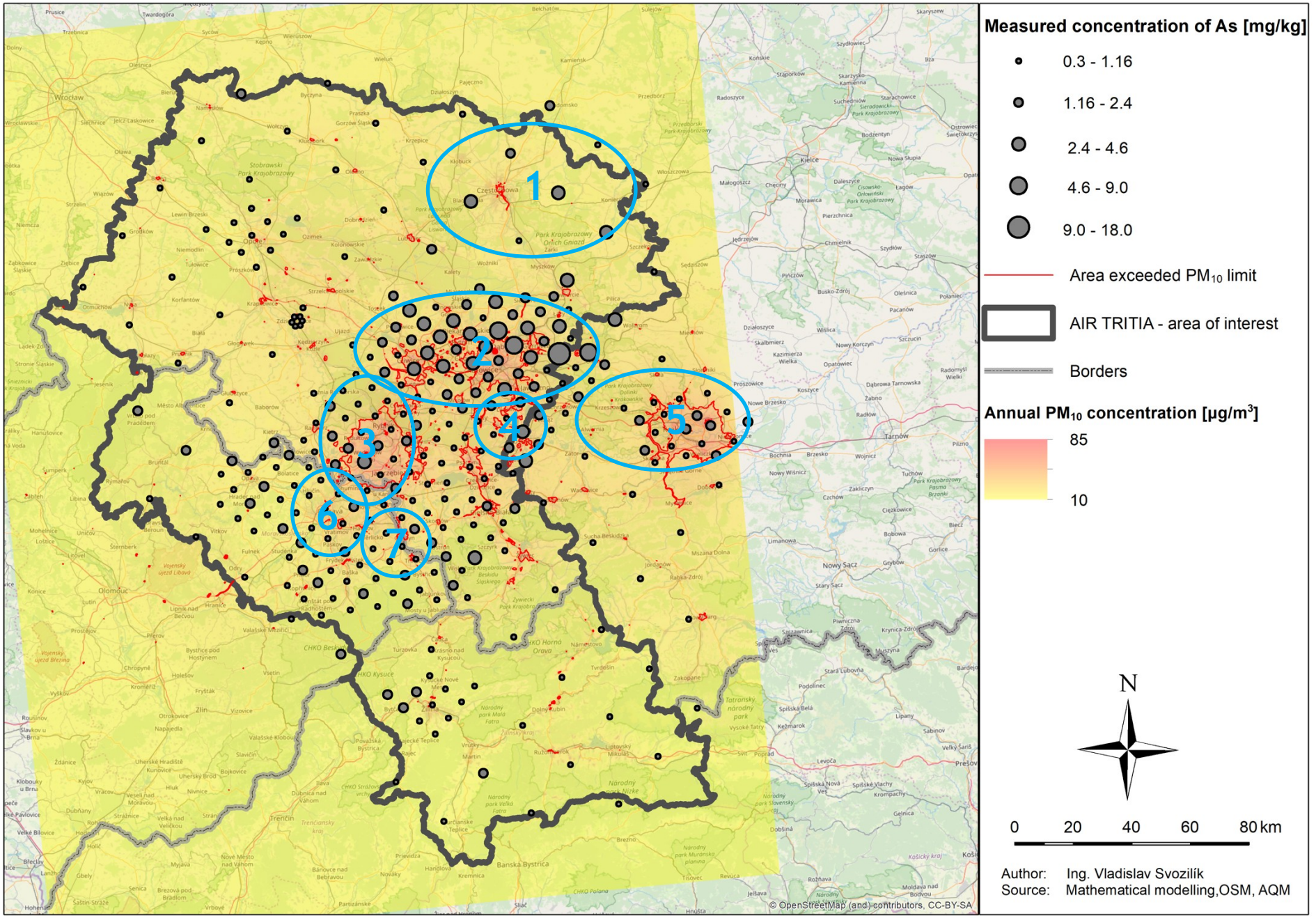

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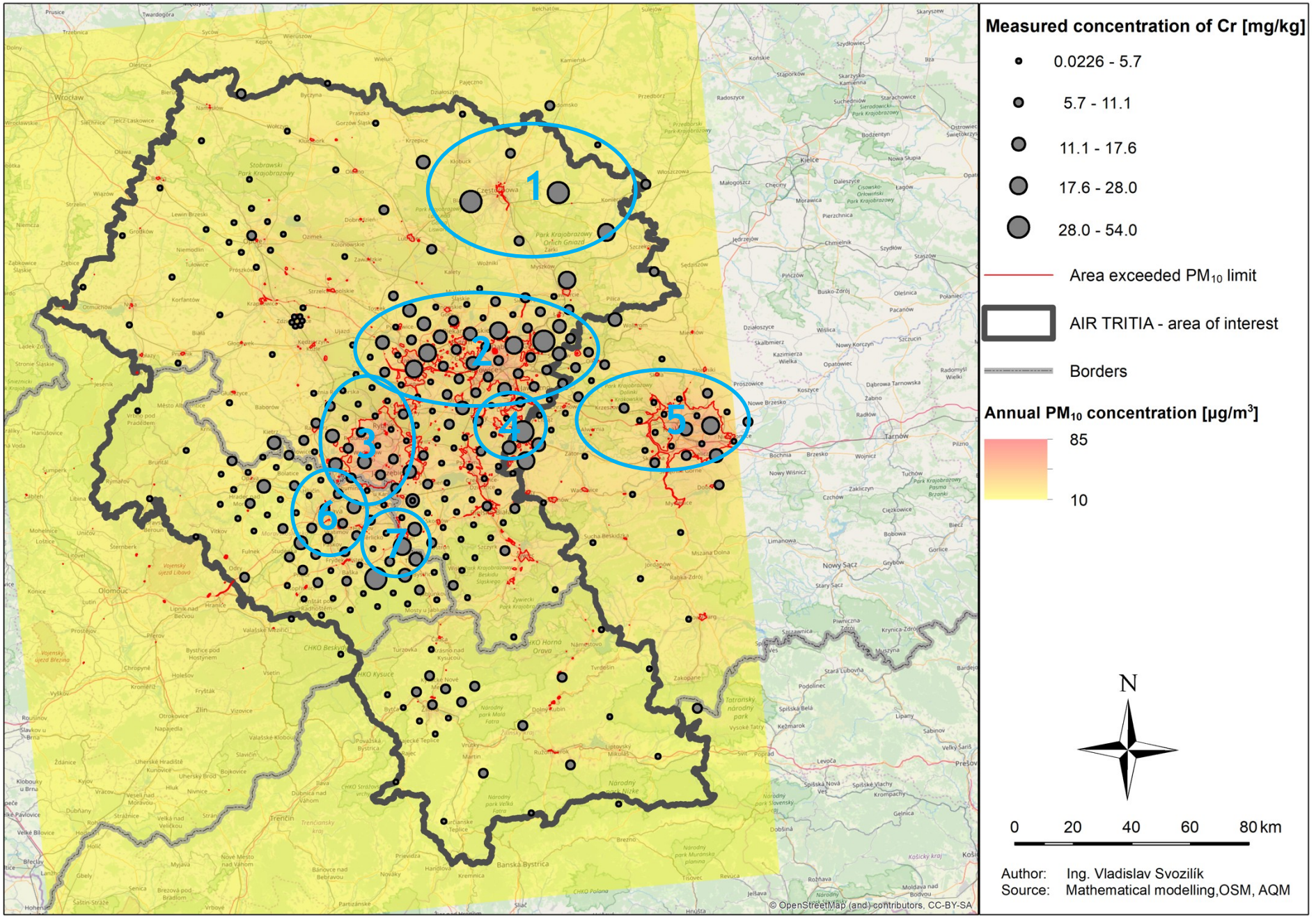
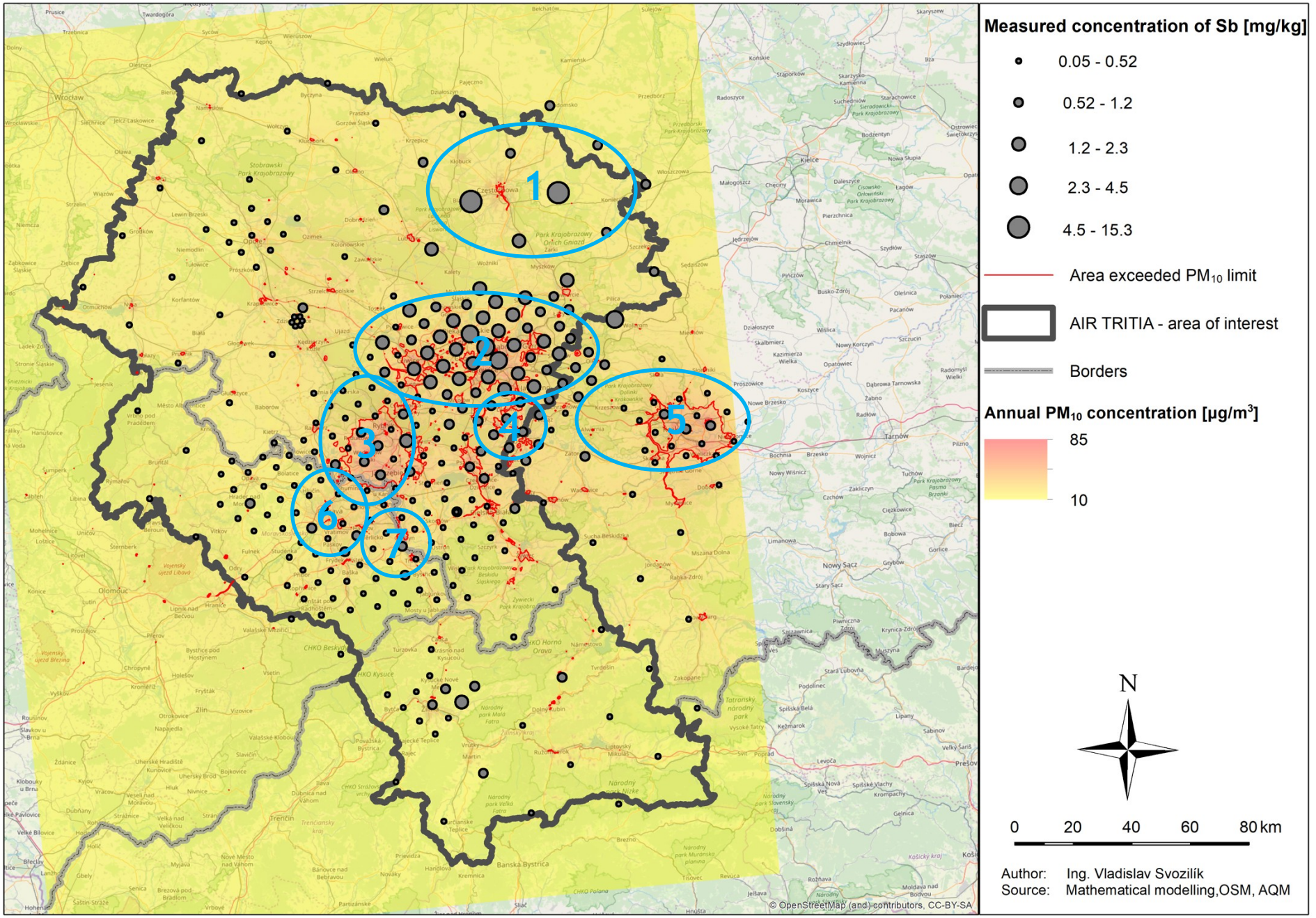


CONCENTRATION DETERMINED IN MOSS BY INAA

Year 2015, model SYMOS'97, Biomonitoring 2015, 2016, 2017



CONCENTRATION DETERMINED IN MOSS BY INAA

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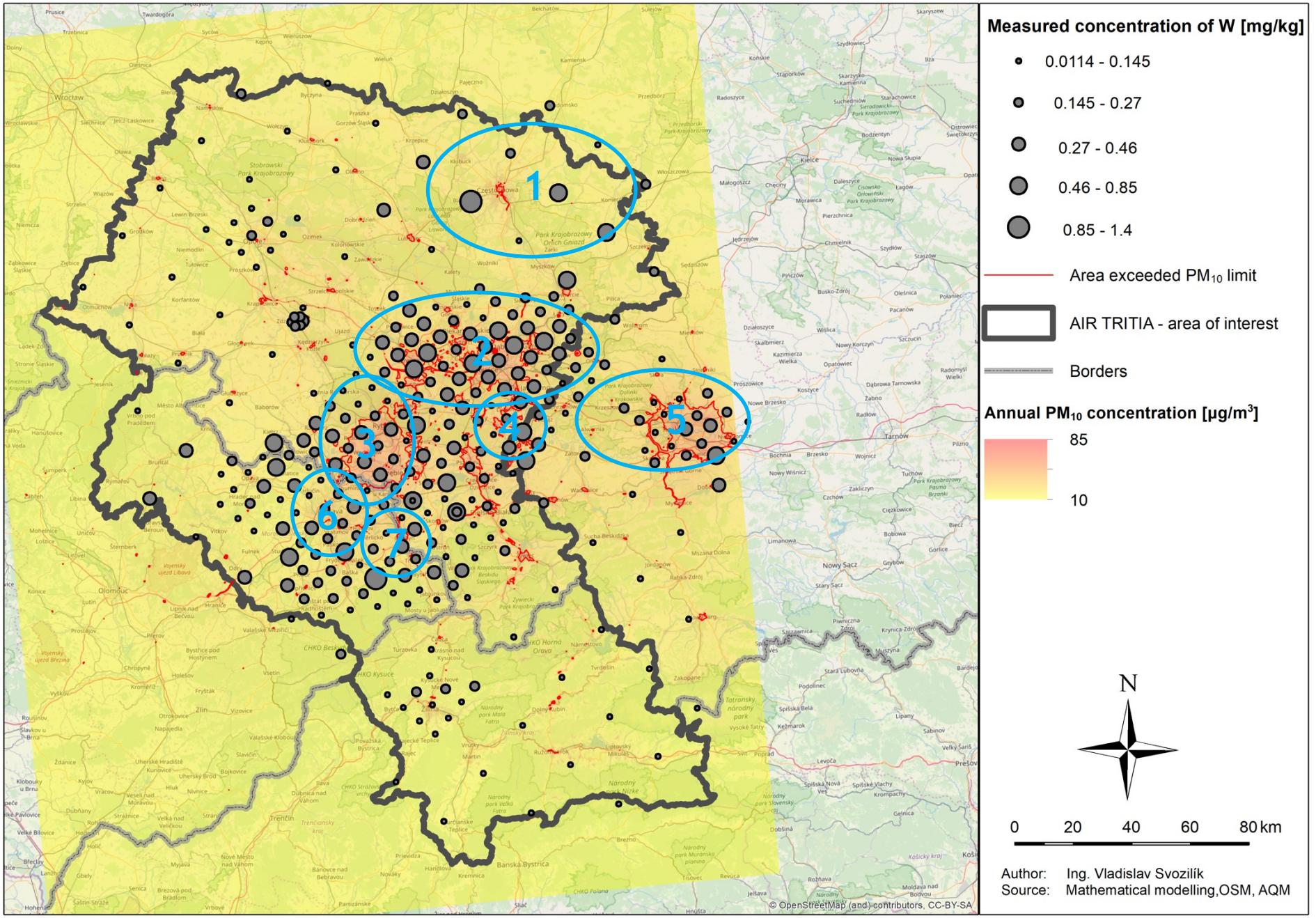

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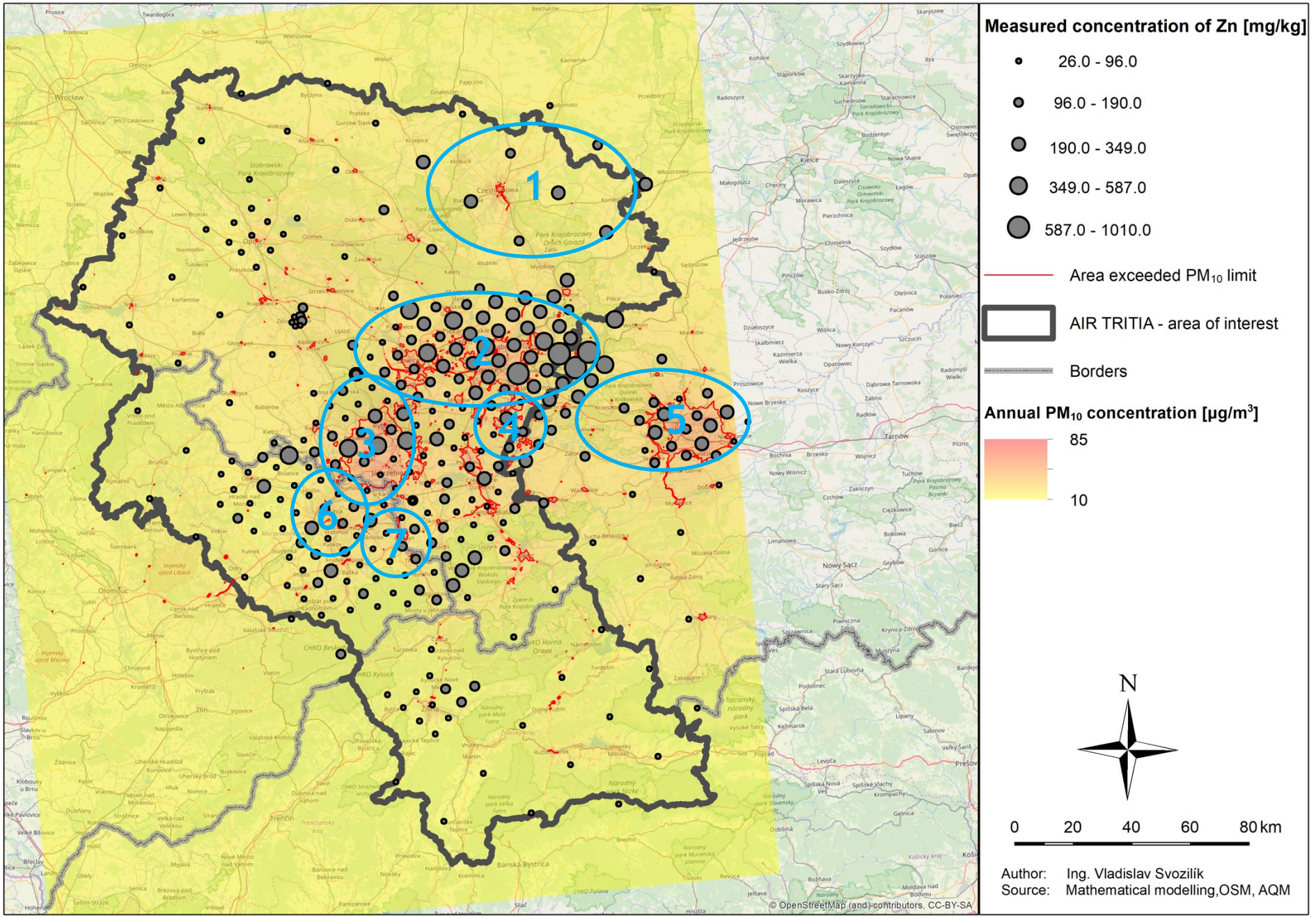

CONCLUSIONS

The model results distribution seems to be OK except area 1 (missing data?)

The air pollutions in Tritia is mixture of two basic sources influents: coal and iron ore

Southern part is also under influence of another group of sources (brown coal?)

Visible differences between sampling years. One campaign is necessary.

The biomonitoring with INAA is usable for regional air pollution characterisation in heavy industrial region.
Next step - whole Czech republic for ICP Vegetation UN project and AIR TRITIA+. Maybe.

The transport influence is almost invisible in both, modelling and monitoring

27-th International Seminar on Interaction of Neutrons with Nuclei, JINR, Dubna, RF

Thank You for attention.

Petr Jancik, Frank Laboratory of Neutron Physics, Sector of Neutron Activation Analysis and Applied Research petr.jancik@vsb.cz

Vladislav Svozilik, Laboratory of Information Technologies