

TAKING  
**COOPERATION**  
FORWARD



Ostrava, Ostrava University |  
19.11. 2018



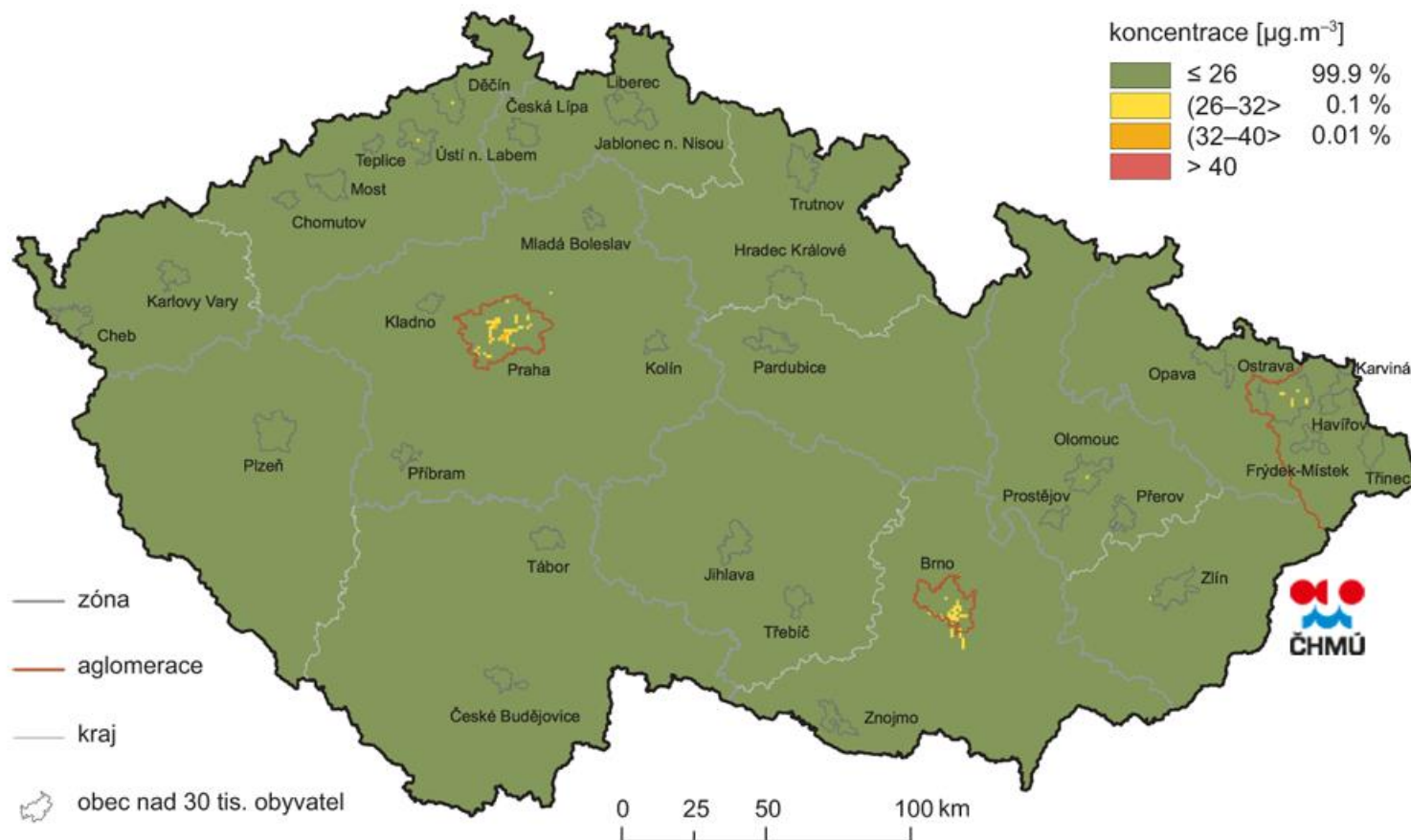
**Technical and technological possibilities to reduce  
pollution from the steelworks - the story of Ostrava**



AIR TRITIA | VŠB - TU OSTRAVA | Petr Jančík, Jan Bitta, Irena Pavlíková

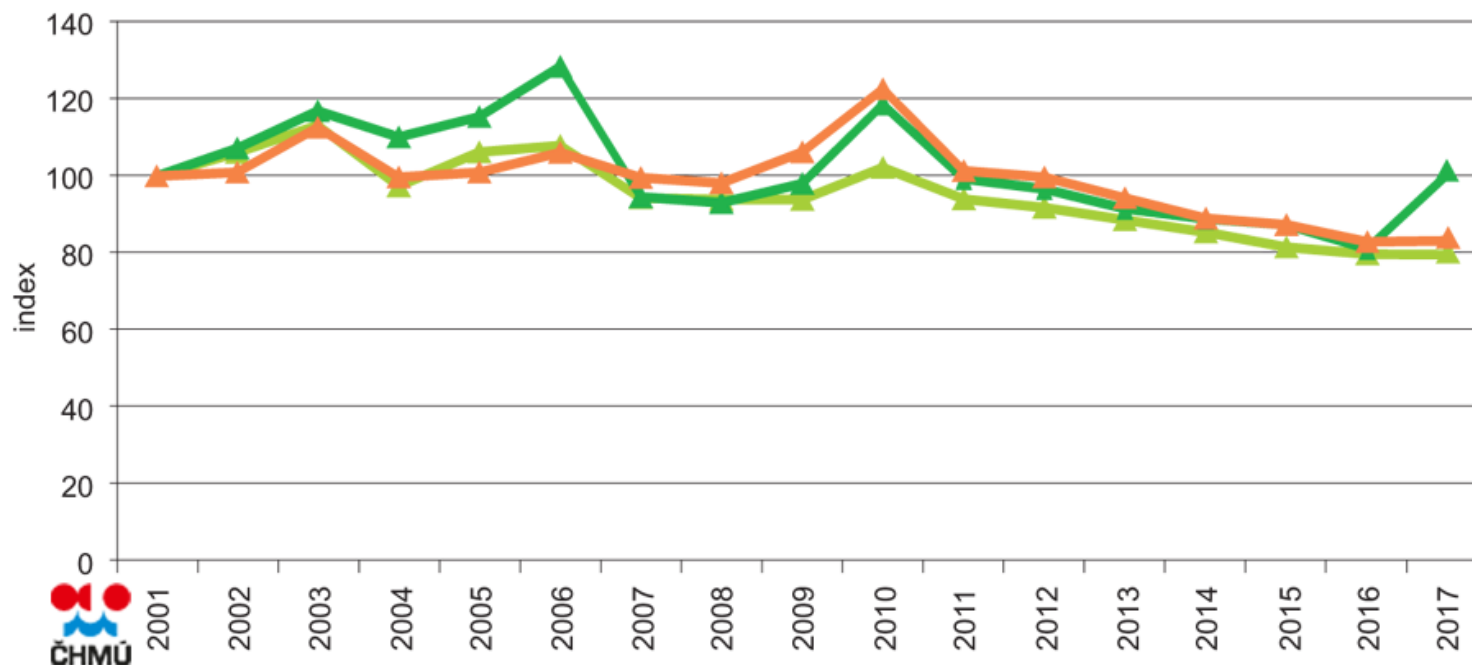
# AIR POLLUTION IN CZECH REPUBLIC (2017)

## Pole roční průměrné koncentrace NO<sub>2</sub>, 2017



## Average year concentration of NO<sub>2</sub>

Trendy vybraných imisních charakteristik NO<sub>2</sub> a NO<sub>x</sub> (index, rok 2001 = 100),  
2001–2017



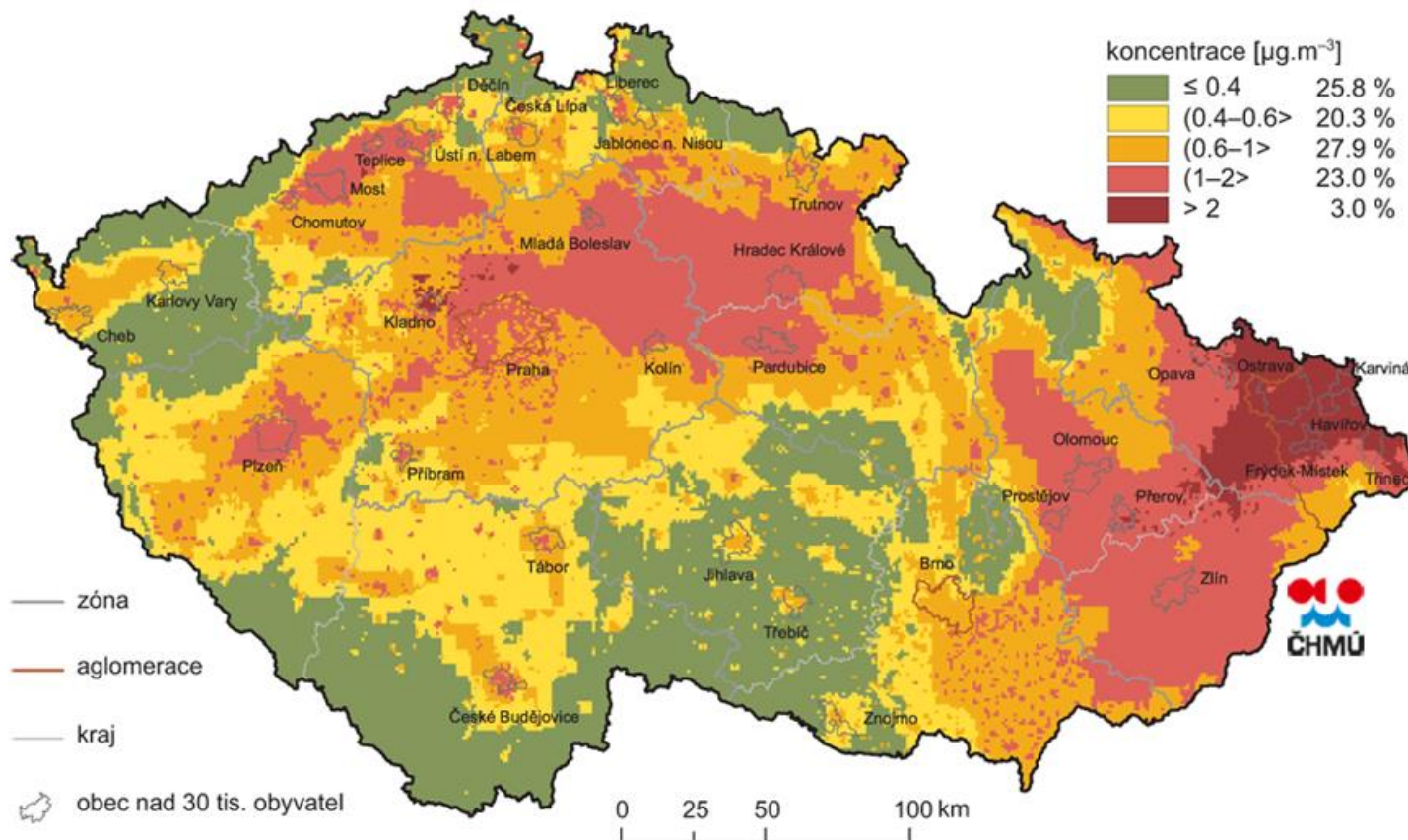
- ▲ NO<sub>2</sub> – roční průměr (index, rok 2001 = 100)
- ▲ NO<sub>2</sub> – 19. nejvyšší hodinová koncentrace (index, rok 2001 = 100)
- ▲ NO<sub>x</sub> – roční průměr (index, rok 2001 = 100)

## Average year concentration of NO<sub>2</sub> - trends



# AIR POLLUTION IN CZECH REPUBLIC (2017)

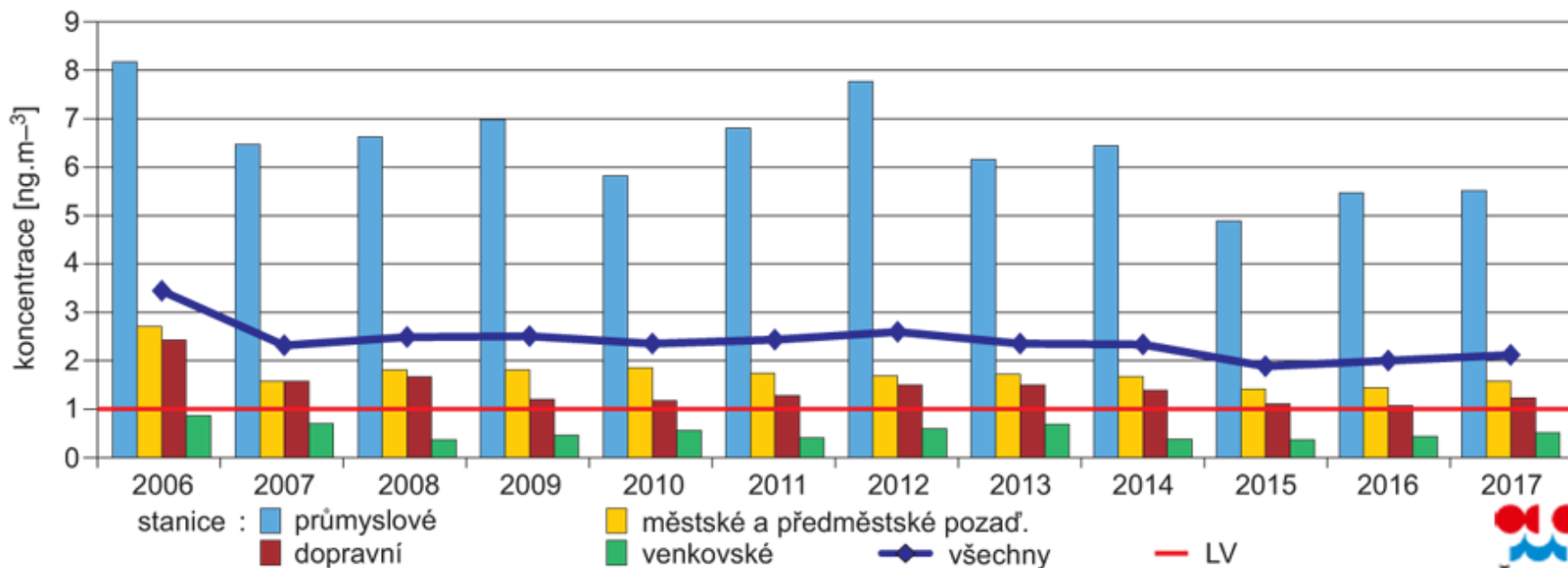
Pole roční průměrné koncentrace benzo[a]pyrenu, 2017



Average year concentration of benzo(a)pyren



## Trendy ročních charakteristik benzo[a]pyrenu v České republice, 2006–2017



Pozn.: Není uvedeno znečištění v malých sídlech (málo měření). Lze předpokládat, že mnohde je nadlimitní.

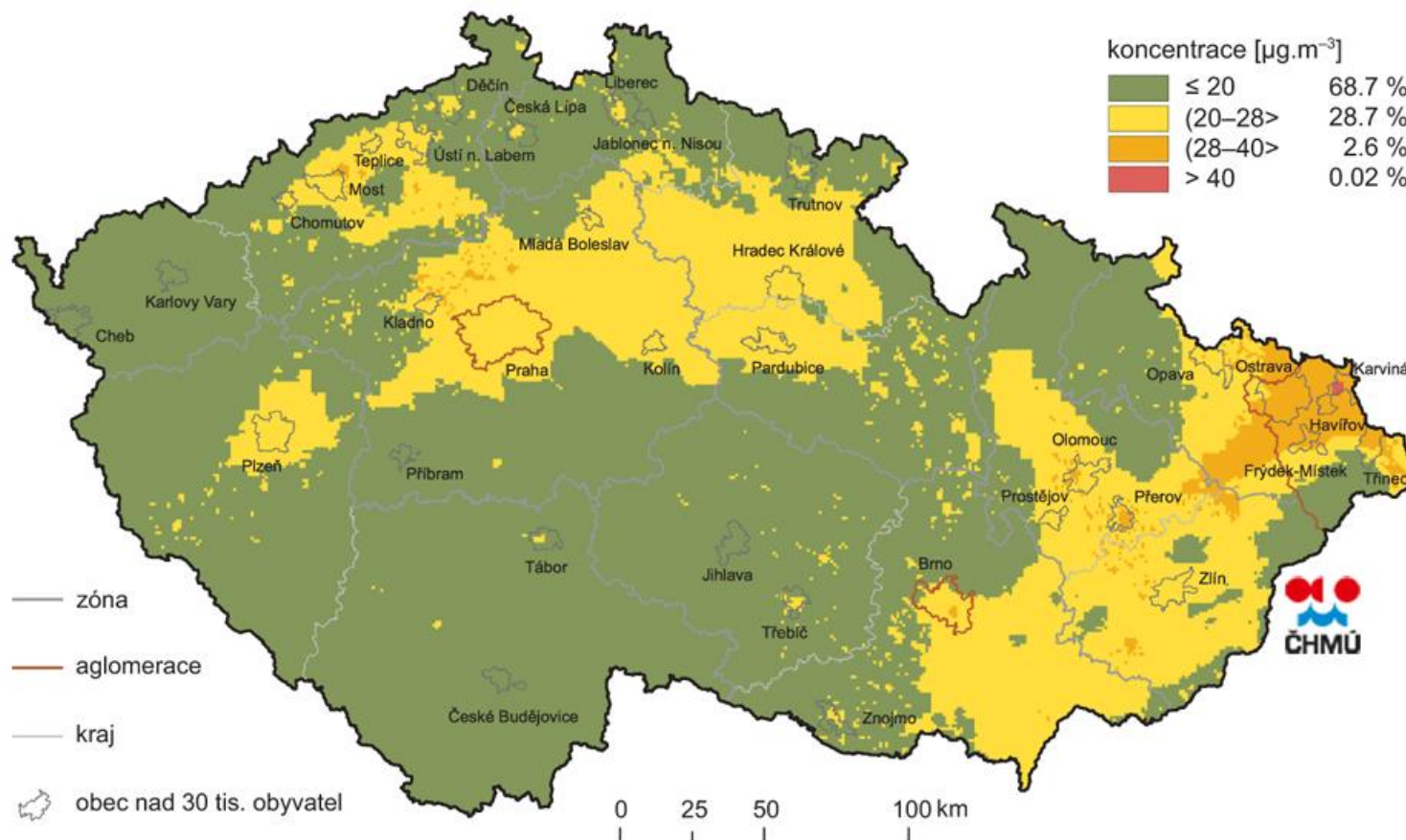


## Average year concentration of PM<sub>10</sub> - trends



# AIR POLLUTION IN CZECH REPUBLIC (2017)

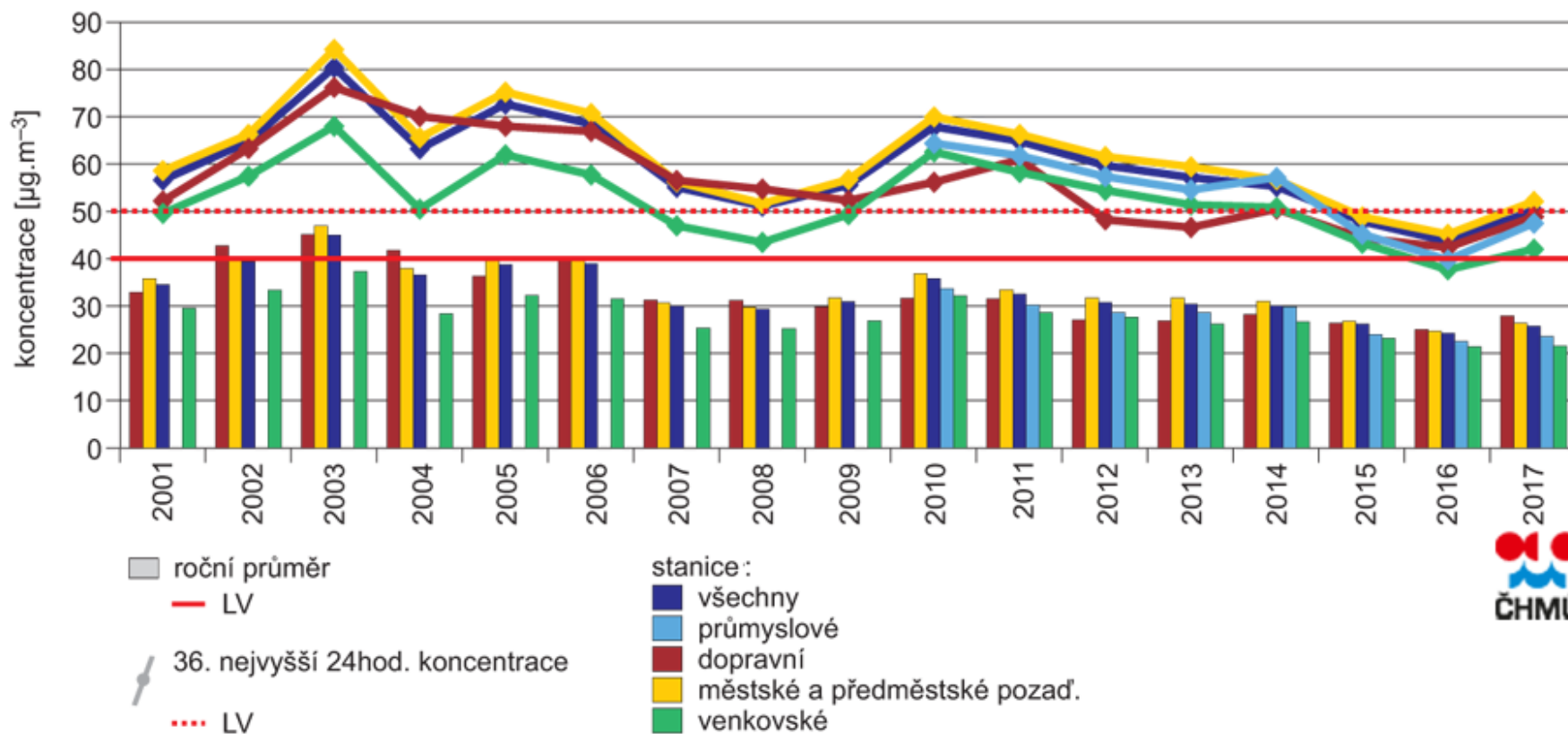
## Pole roční průměrné koncentrace PM<sub>10</sub>, 2017



## Average year concentration of PM<sub>10</sub>



## Trendy ročních charakteristik PM<sub>10</sub> v České republice, 2001–2017



## Average year concentrations of PM<sub>10</sub> - trends



# CHANGE OF AVERAGE YEAR CONCENTRATION OF PM<sub>10</sub> IN OUR REGION

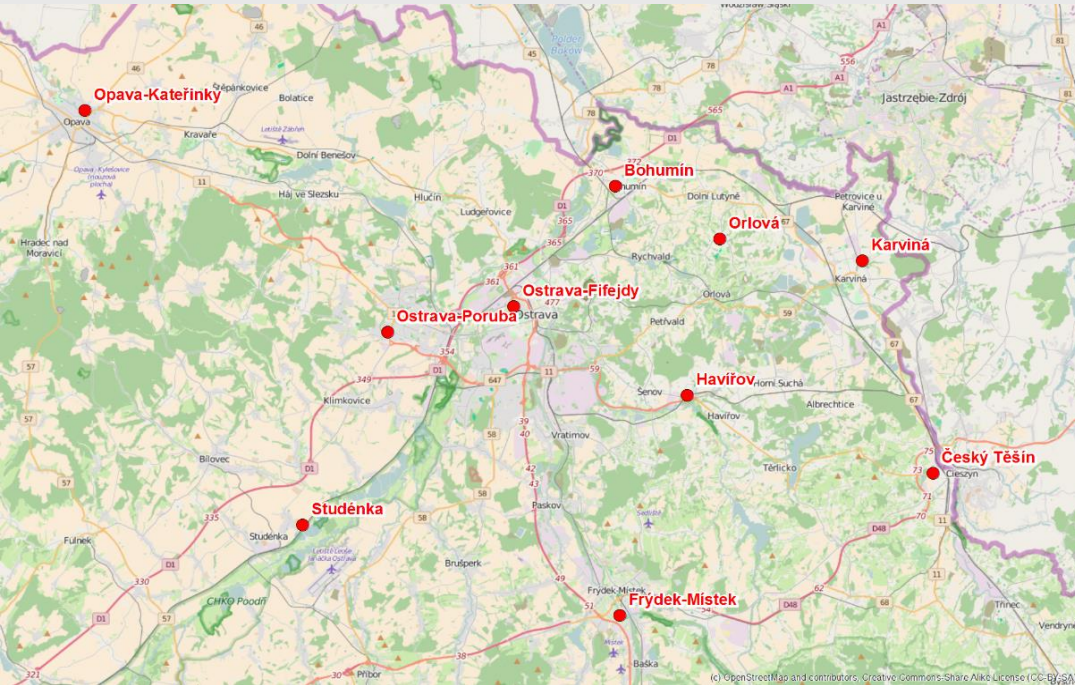
| Stanice IM       | 2006 | 2016 | 2017  |
|------------------|------|------|-------|
| O.-Radvanice, ZÚ | 63.7 | 41.0 | 43.9  |
| O.-Poruba, ČHMÚ  | 37.5 | 27.3 | 27.4  |
| Studénka         | 41.1 | 27.3 | 29.3  |
| Opava-Kateřinky  | 44.4 | 24.7 | 26.8  |
| Čeladná          | 30.8 | 21.5 | 20.1* |

*Průměrné roční koncentrace PM<sub>10</sub> [μg/m<sup>3</sup>], \* - Ostravice-golf*



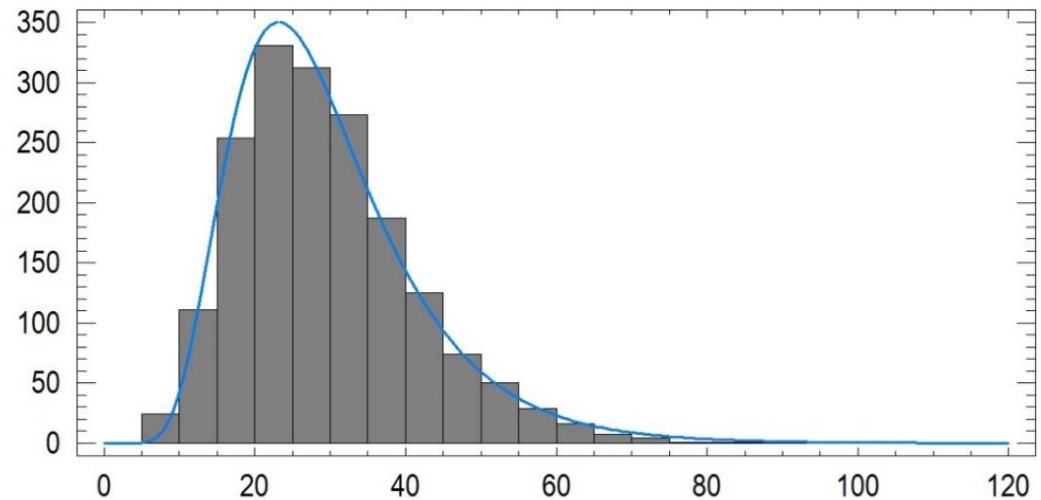


# LONG TERM AIR POLLUTION TRENDS ANALYSES IN OSTRAVA REGION

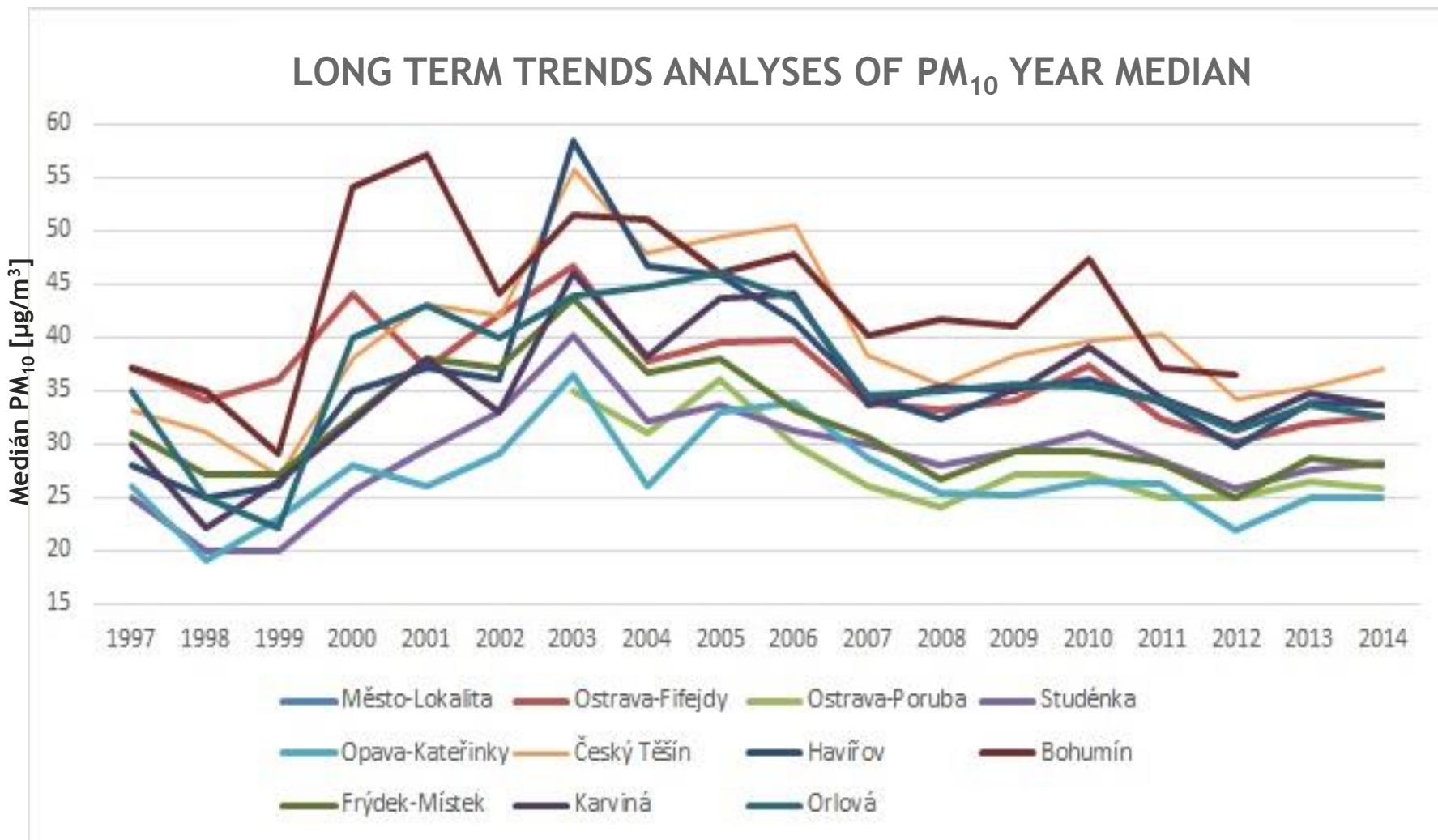


- Behaviour of air pollution monitoring in Ostrava region is like one common system
- Statistic distribution of air pollution concentrations

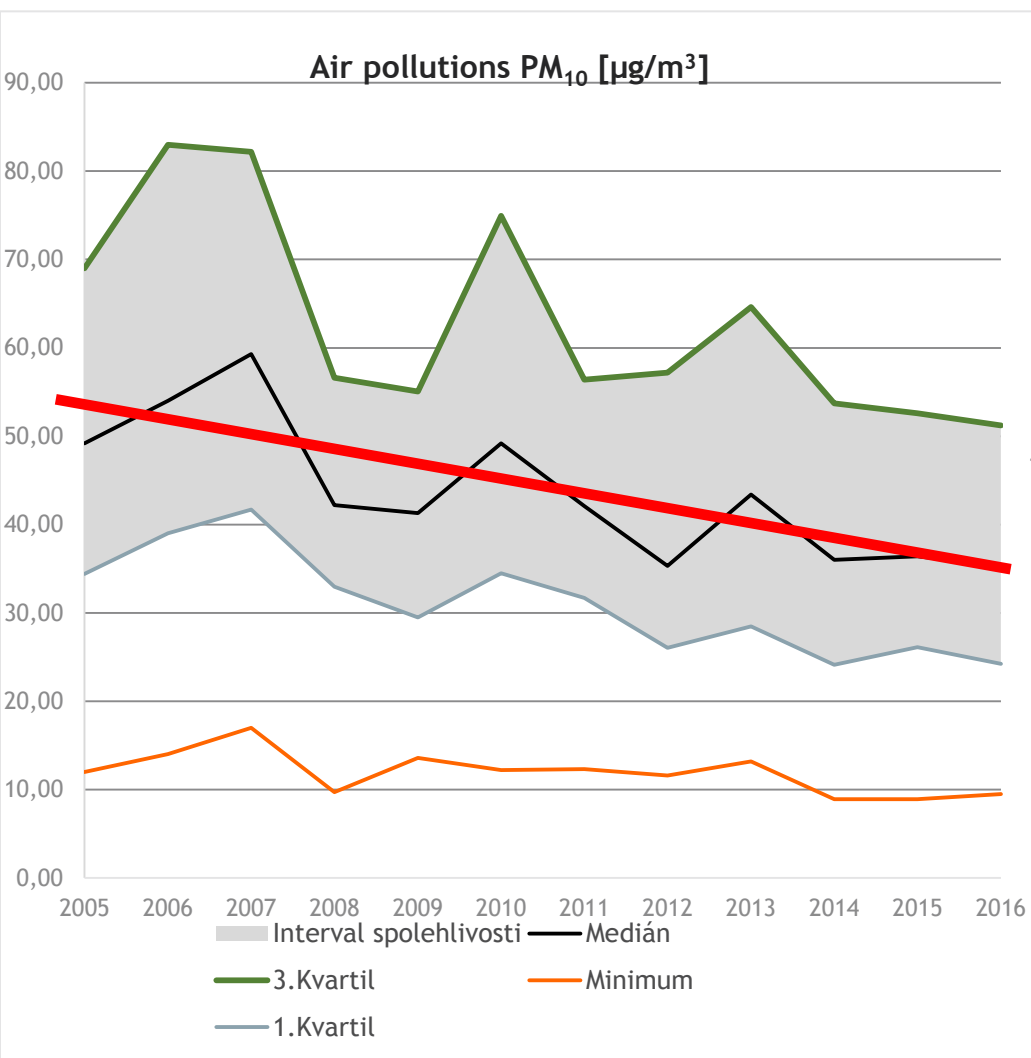
Probably regional impact of important AP sources



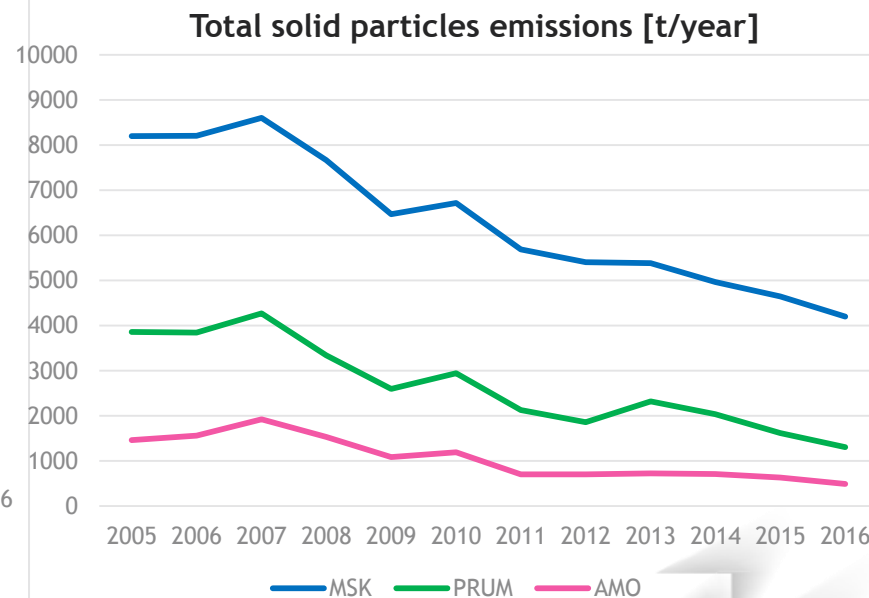
# AIR POLLUTION IN OSTRAVA REGION (2017)



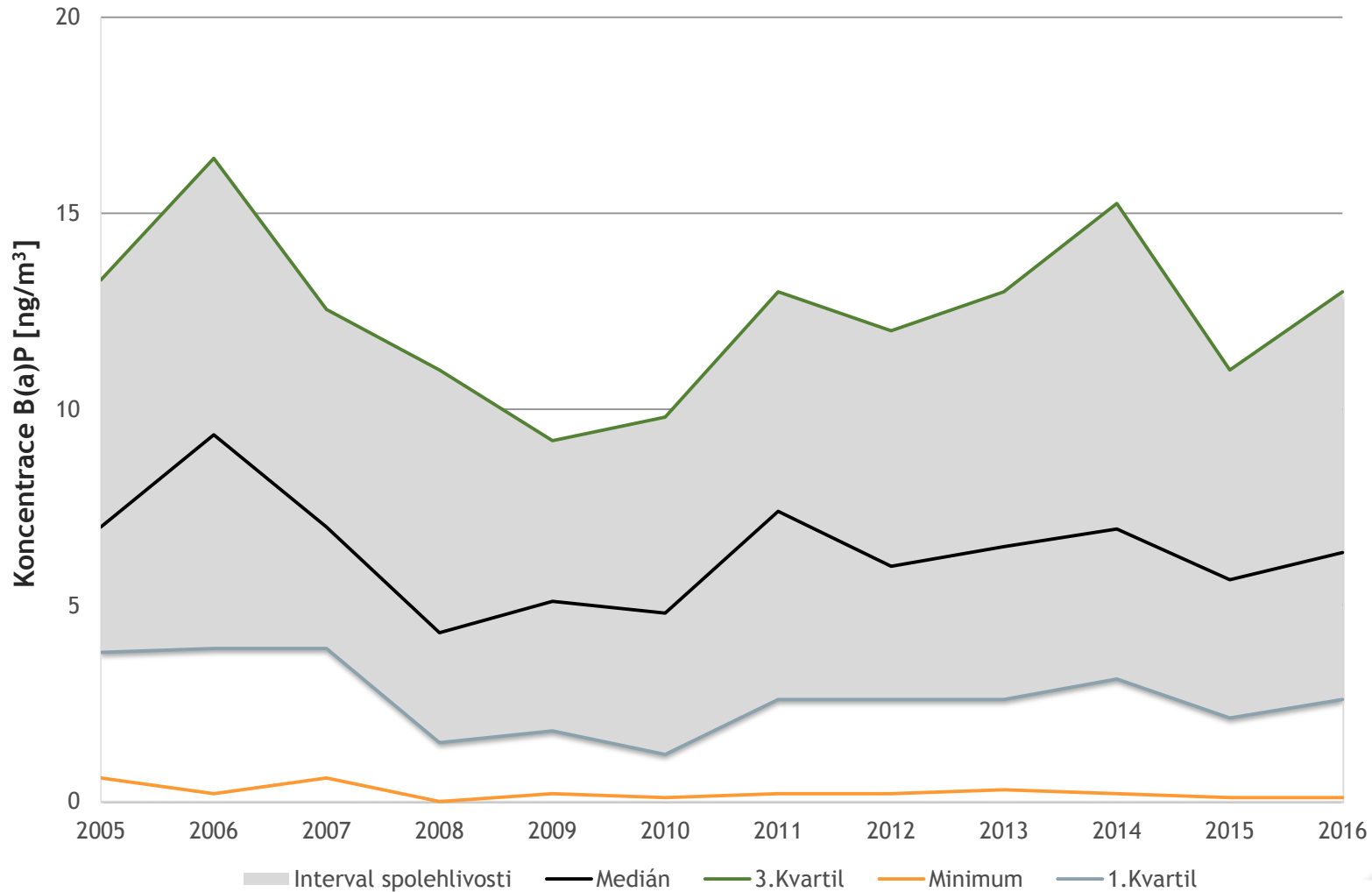
# LONG TERM TRENDS ANALYSES OF PM<sub>10</sub> MEDIAN IN OSTRAVA RADVANICE



Correlation with AMO emission is 92%  
 -100 t/year AMO = -1.72 µg/m<sup>3</sup>  
 - Correlation with regional emission is 91%  
 -1000 t/year in MSK -> - 6.22 µg/m<sup>3</sup>



# LONG TERM TRENDS ANALYSES OF B(A)P MEDIAN IN OSTRAVA RADVANICE



# CONCLUSION OF THE DATA ANALYSE

- Trend for Ostrava region is positive for PM<sub>10</sub> in last 5 years.  
(And emissions from metallurgical sources was significantly reduced by application of number of technical solutions.)
- Trend for Ostrava region for B[a]P is neutral - remains extremely high.  
(And emissions from coke oven plants was reduced theoretically 10x, but it was only by change of methodology of assessment.)

*See next sample:*

*In summer, when values of all Czech stations remains under detection limit (0,04 ng.m<sup>-3</sup>), values on stations under influence of coke plants exceeds 1 ng.m<sup>-3</sup> .*

*Ostrava-Radvanice ZÚ 19,0 ng.m<sup>-3</sup> (25. 7. 2017),*

*Ostrava-Radvanice OZO 15,0 ng.m<sup>-3</sup> (19. 7. 2017),*

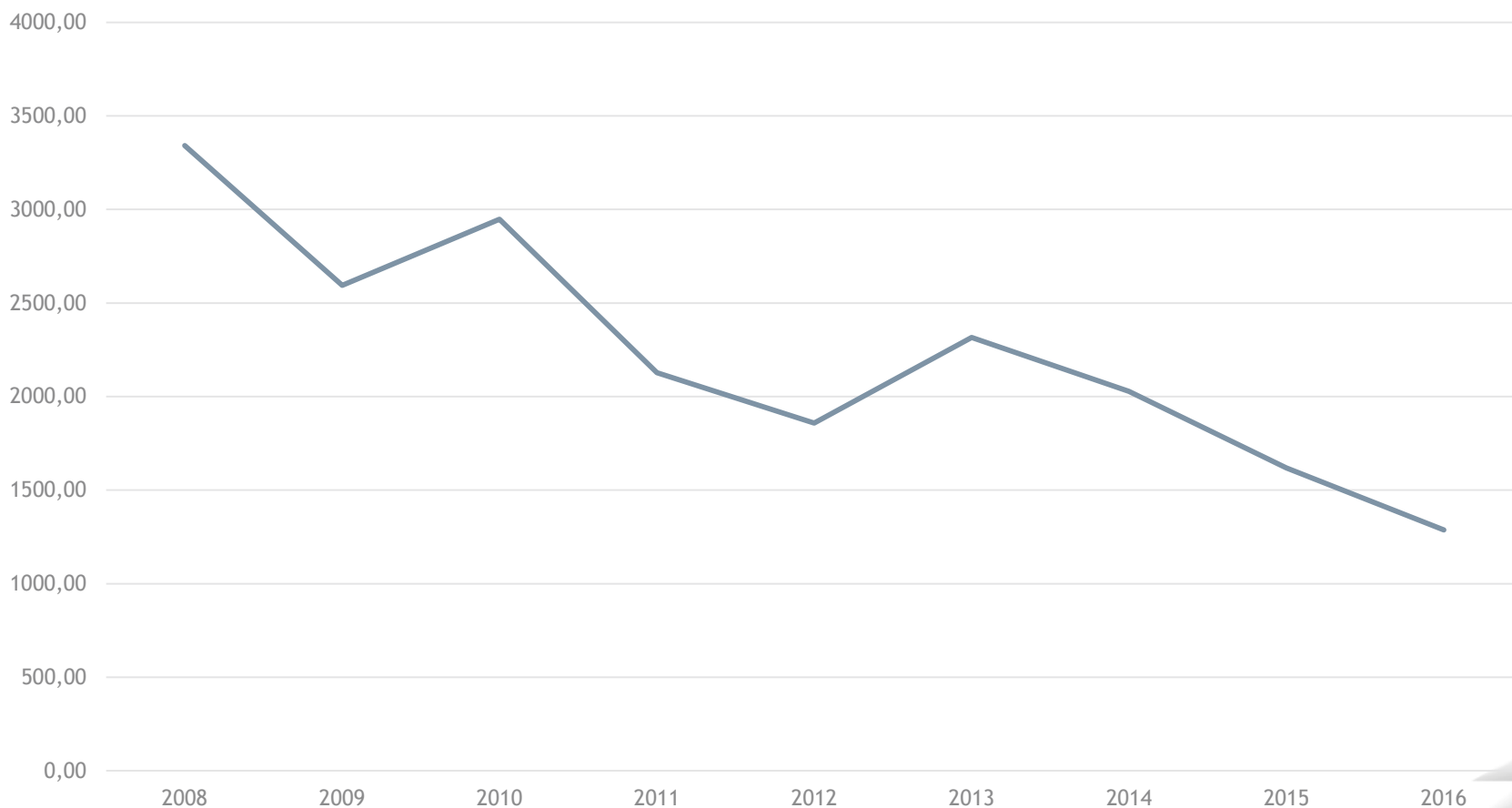
*Ostrava-Přívoz 2,5 ng.m<sup>-3</sup> (19. 7. 2017) and*

*Český Těšín 1,2 ng.m<sup>-3</sup> (30. 8. 2017).*



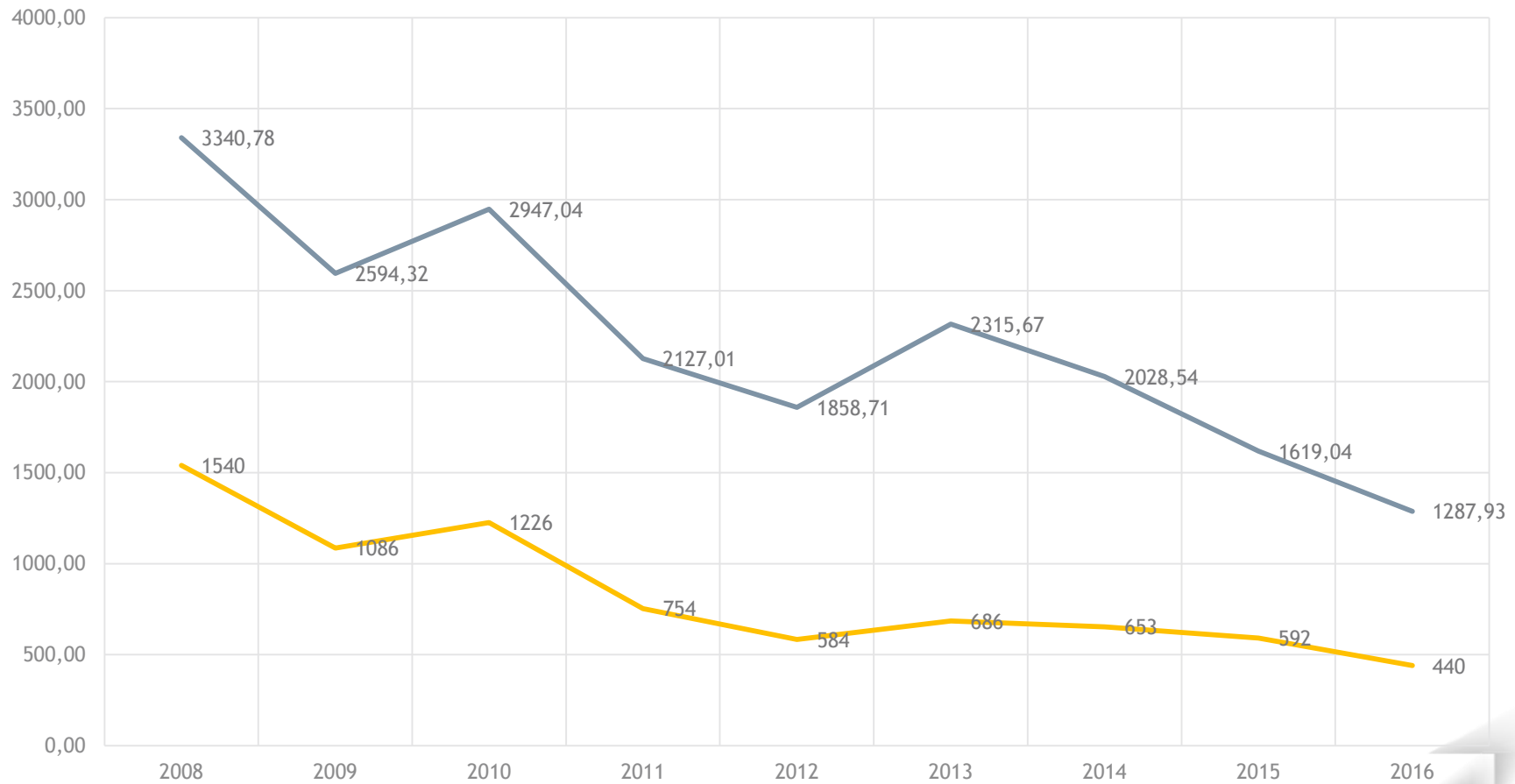
# TREND IN EMISSIONS OF TSP

## Emissions of TSP in Moravia Silesian Region [t/years]



# WHAT'S HAPPENED IN THE MOST IMPORTANT OSTRAVA METALLURGICAL PLANT ?

## Emissions of TSP in ArcelorMittal Ostrava [t/years]



# THE MOST IMPORTANT OSTRAVA METALLURGICAL PLANT

ArcelorMittal Ostrava:  
topically in operation

1. Coke Oven Plant (1,5 Mt of coke per year)
2. Sinter Plant (< 2 Mt of sintered iron ores)
3. Blast Furnances Plant - 3 Blast Furnances (max 3Mt of liquid iron)
4. Steel Plant - 3 tandem furnaces (2,1 Mt of steel per year)
5. Energy complex TAMEH Czech s.r.o. (daughter enterprise, new modern gas boiler 254 MWe, 248 MWth steam)
6. Secondary metallurgy (Rolling Mills, Tubular Products)





# BRIEFLY CHARACTERISTICS

Ad 1. Coke Oven Plant - **needs to be modernised or removed**  
**(unacceptable emissions of B[a]P and other hydrocarbons)**

Ad 2. Sinter Plant - **modernised**  
**(new hi-tech textile end of pipe filters, fugitive emissions filters)**

Ad 3. Blast Furnaces Plant - **modernised**  
**(fugitive emissions filters, coal injection)**

Ad 4. Steel Plant - 3 tandem furnaces - **ancient technology,**  
**needs to be modernised or removed**

Ad 5. Energy complex - **new modern gas boiler**  
**instead of old coal ones**

Ad 6. Other secondary products - not big problems to compare with  
primary metallurgy and Steel Plant.



## Blast Furnaces Plant:

- iron ore manipulation fugitive emissions
- wagons cleaning
- hot iron casting
- filling of blast furnaces

## Sinter Plant:

- South - textile filter ( -97 t/Year )
- North - textile filter ( -265 t/Year )
- fugitive emissions from sintering belts
- fugitive emissions from raw materials manipulations

## Coke Oven Plant:

- improving of cooling tower construction

## Steel Plant:

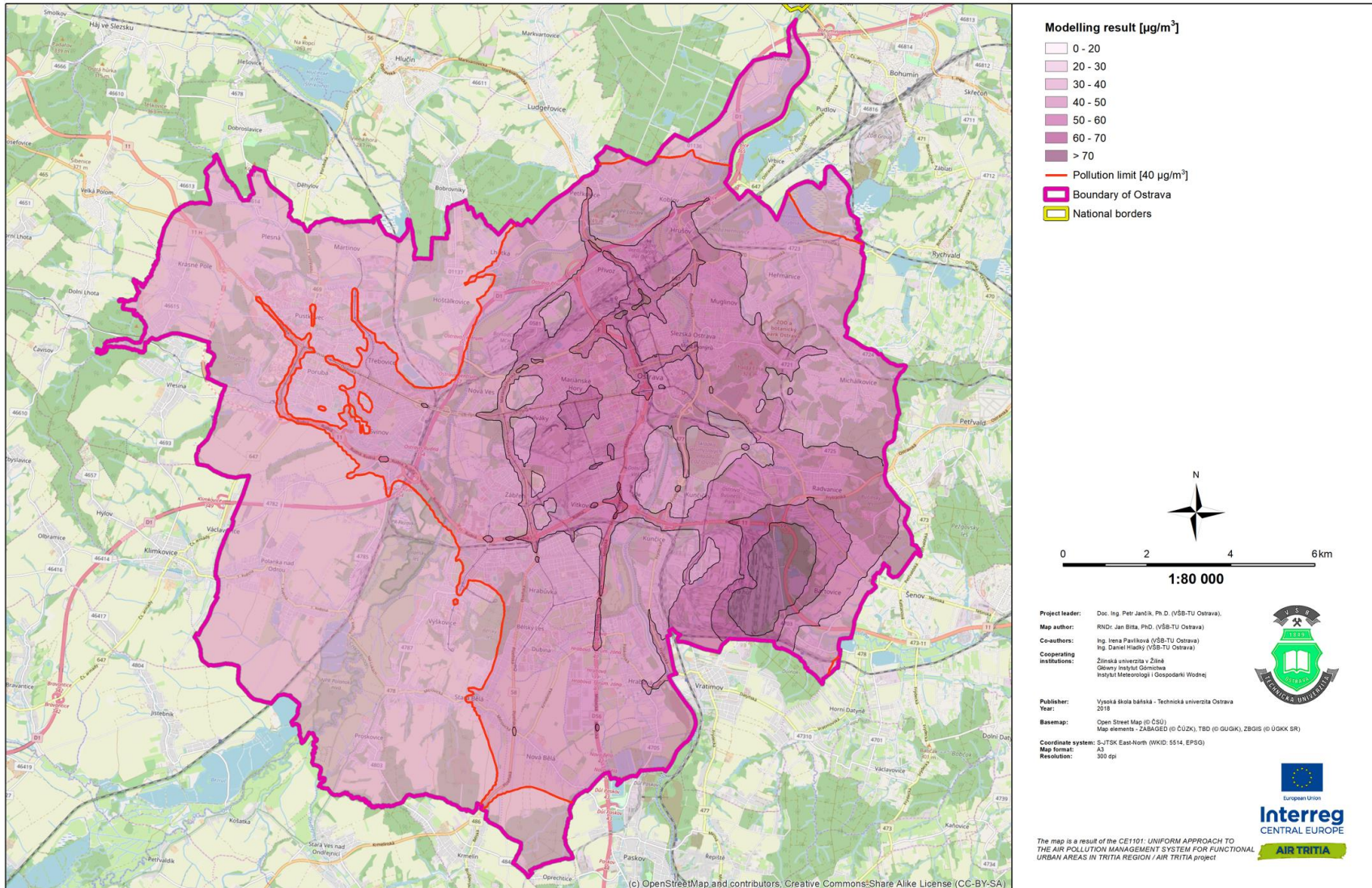
- limestone manipulation fugitive emissions



# IS IT POSSIBLE TO VERIFY, WHAT WILL BE RESULT OF THIS BIG INVESTMENT?

## AVERAGE ANNUAL CONCENTRATION OF PM<sub>10</sub> IN OSTRAVA

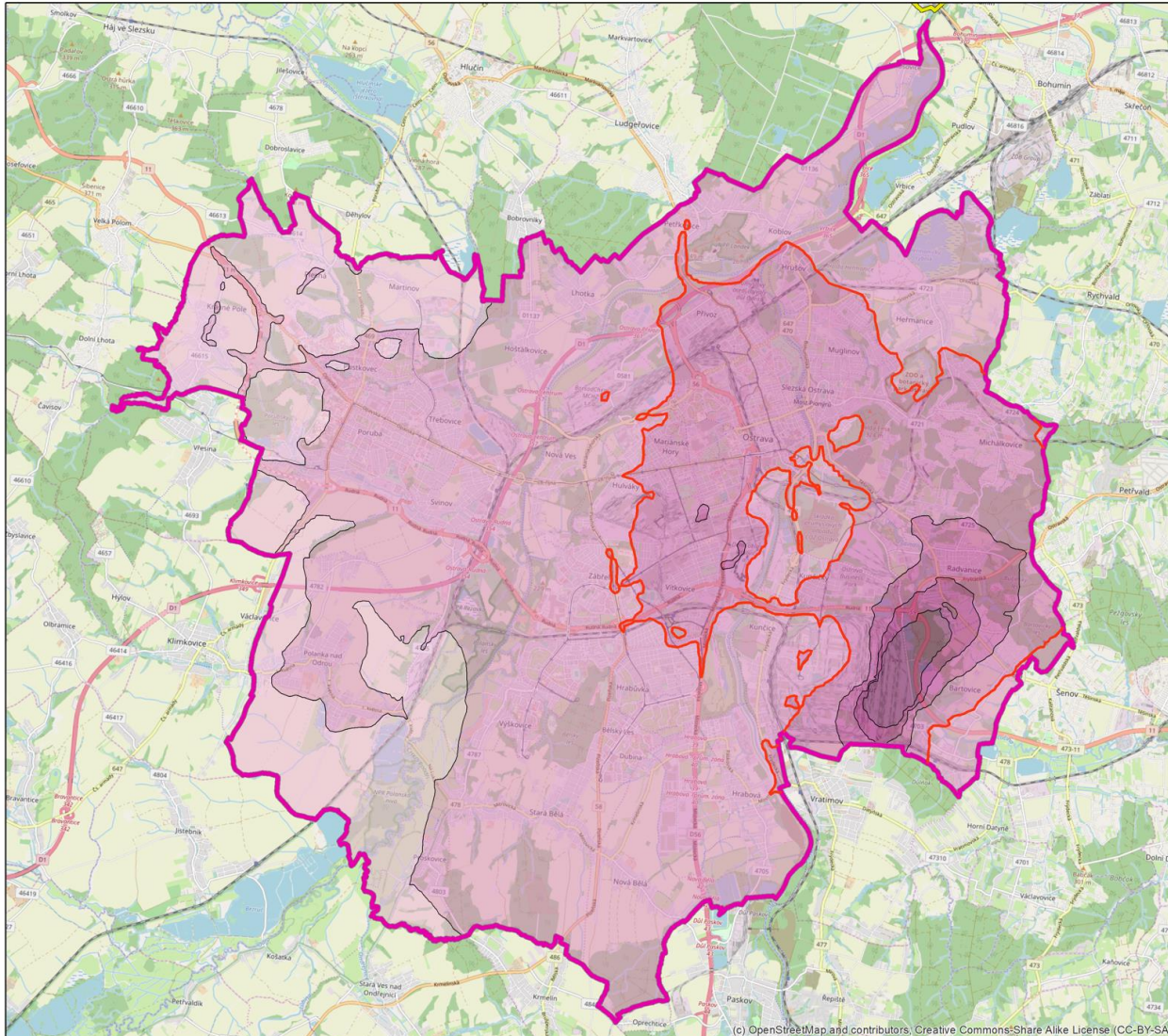
Total concentration, model SYMOS'97 with correction by pollution monitoring, year 2003



# IS IT POSSIBLE TO VERIFY, WHAT WILL BE RESULT OF THIS BIG INVESTMENT?

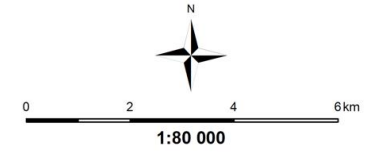
## AVERAGE ANNUAL CONCENTRATION OF PM<sub>10</sub> IN OSTRAVA

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



### Modelling result [ $\mu\text{g}/\text{m}^3$ ]

- 0 - 20
- 20 - 30
- 30 - 40
- 40 - 50
- 50 - 60
- 60 - 70
- > 70
- Pollution limit [ $40 \mu\text{g}/\text{m}^3$ ]
- Boundary of Ostrava
- National borders



**Project leader:** Doc. Ing. Petr Jančík, Ph.D. (VSB-TU Ostrava).  
**Map author:** RNDr. Jan Bitta, Ph.D. (VSB-TU Ostrava)  
**Co-authors:** Ing. Irena Pavliková (VSB-TU Ostrava)  
 Ing. Daniel Hladký (VSB-TU Ostrava)  
**Cooperating institutions:** Žitná univerzita v Žitě  
 Ostrava Institut Górnictva  
 Institut Meteorologíi i Gospodarki Wodnej  
**Publisher:** Vysoká škola báňská - Technická univerzita Ostrava  
**Year:** 2018  
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**Coordinate system:** S-JTSK East-North (WKID: 5514, EPSG)  
**Map format:** A3  
**Resolution:** 300 dpi

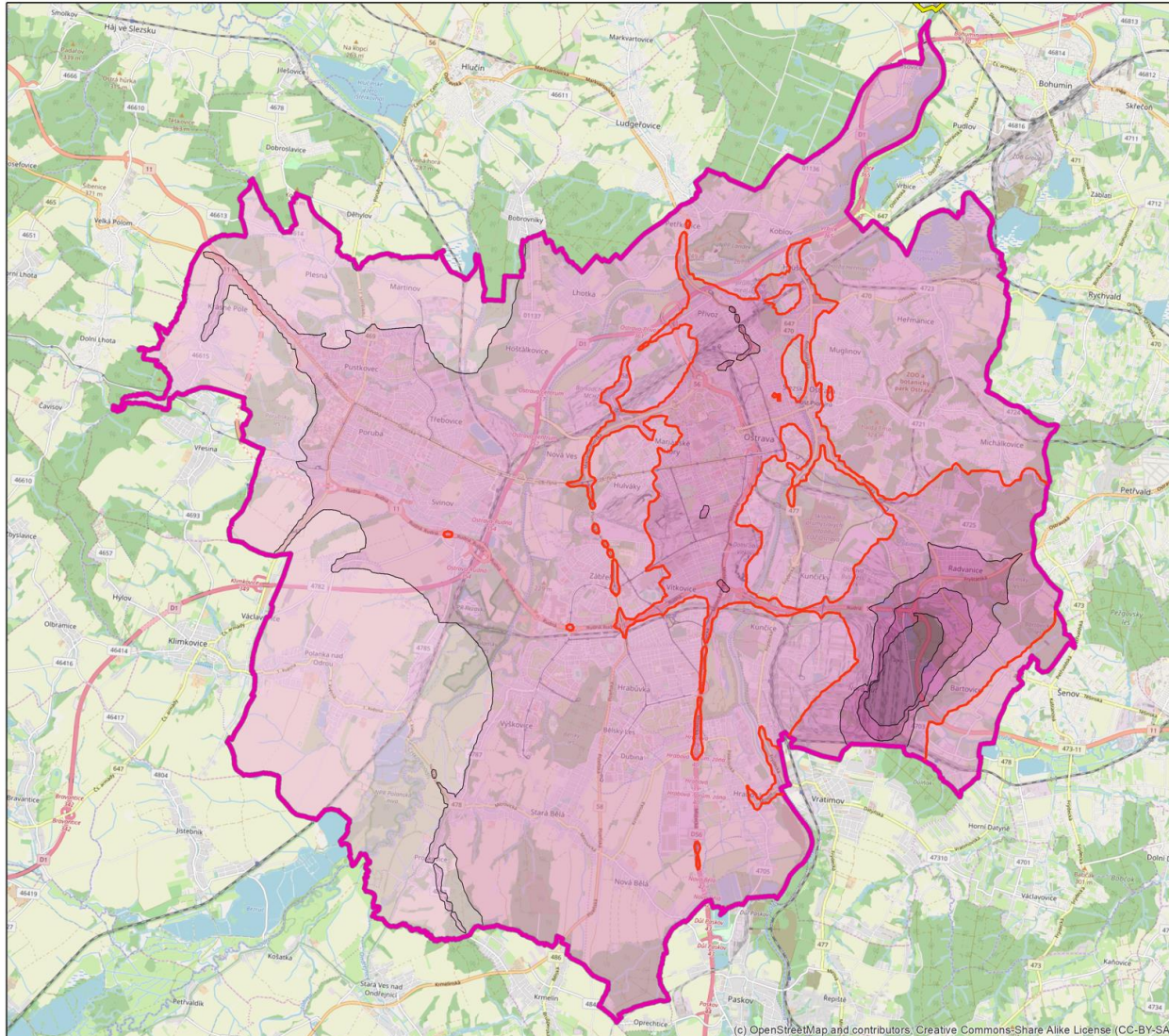


The map is a result of the CE1101: UNIFORM APPROACH TO THE AIR POLLUTION MANAGEMENT SYSTEM FOR FUNCTIONAL URBAN AREAS IN TRITIA REGION / AIR TRITIA project

# IS IT POSSIBLE TO VERIFY, WHAT WILL BE RESULT OF THIS BIG INVESTMENT?

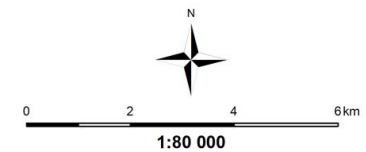
## AVERAGE ANNUAL CONCENTRATION OF PM<sub>10</sub> IN OSTRAVA

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



### Modelling result [ $\mu\text{g}/\text{m}^3$ ]

- 0 - 20
- 20 - 30
- 30 - 40
- 40 - 50
- 50 - 60
- 60 - 70
- > 70
- Pollution limit [ $40 \mu\text{g}/\text{m}^3$ ]
- Boundary of Ostrava
- National borders



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 Ústřední úřad pro životní prostředí  
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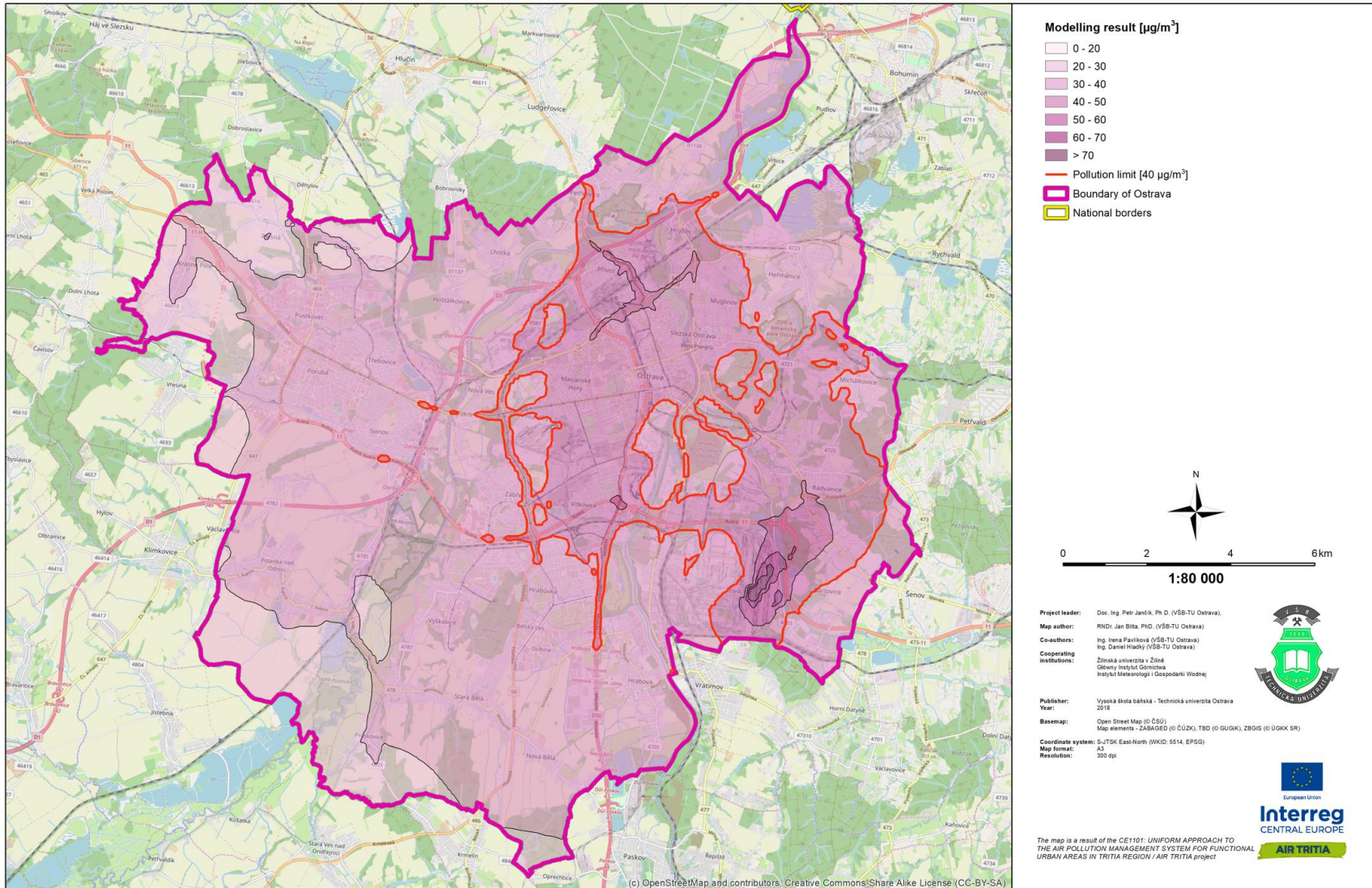


The map is a result of the CE1101: UNIFORM APPROACH TO THE AIR POLLUTION MANAGEMENT SYSTEM FOR FUNCTIONAL URBAN AREAS IN TRITIA REGION / AIR TRITIA project

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## AVERAGE ANNUAL CONCENTRATION OF PM<sub>10</sub> IN OSTRAVA

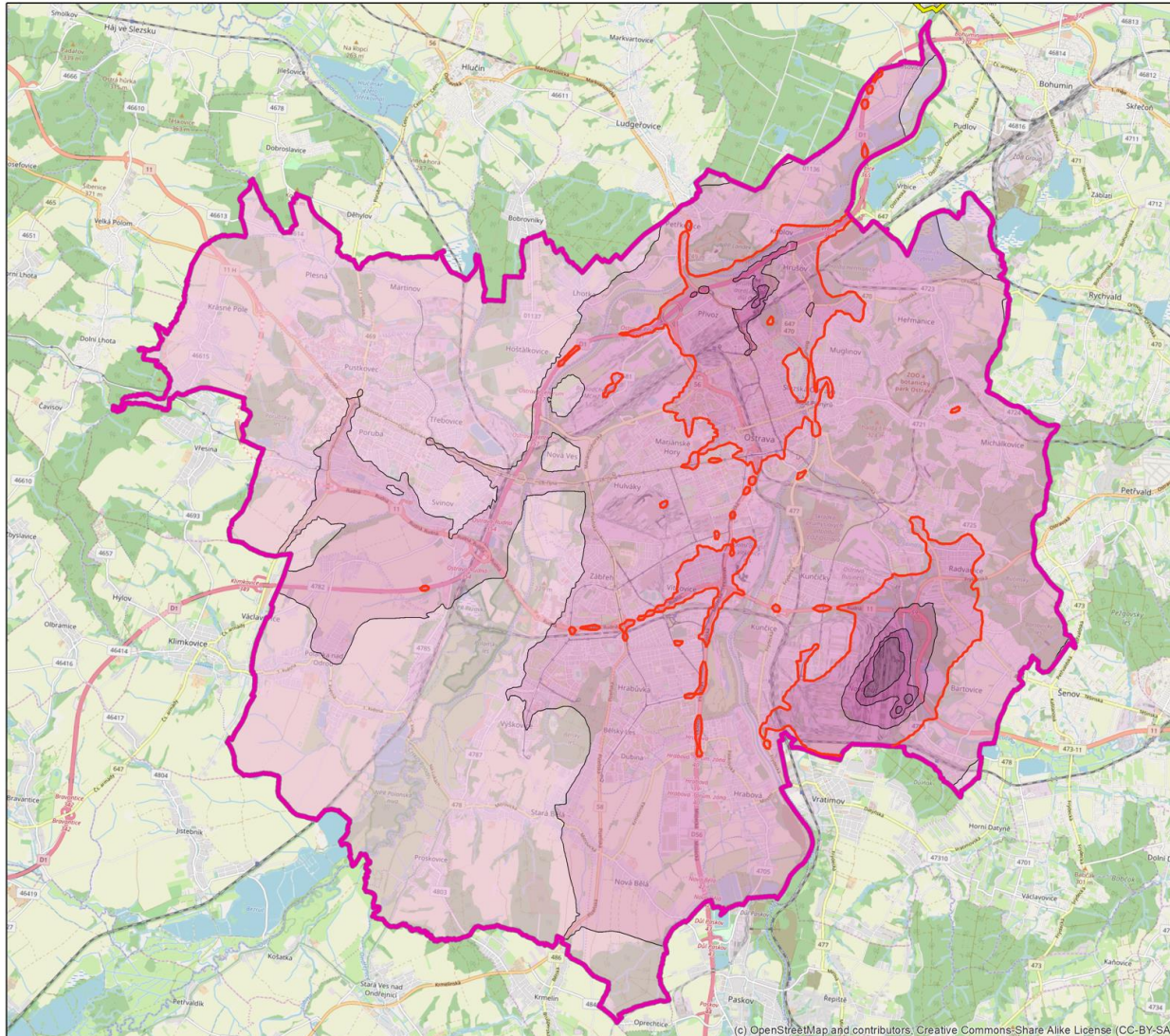
Emission ceiling for industrial sources, model SYMOS'97 with correction by pollution monitoring, year 2007



# IS IT POSSIBLE TO VERIFY, WHAT WILL BE RESULT OF THIS BIG INVESTMENT?

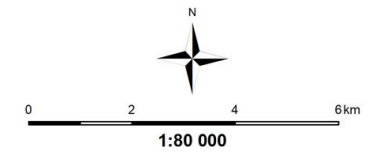
## AVERAGE ANNUAL CONCENTRATION OF PM<sub>10</sub> IN OSTRAVA

Total concentration, model SYMOS'97 with correction by pollution monitoring, year 2009



### Modelling result [ $\mu\text{g}/\text{m}^3$ ]

- 0 - 20
- 20 - 30
- 30 - 40
- 40 - 50
- 50 - 60
- 60 - 70
- > 70
- Pollution limit [ $40 \mu\text{g}/\text{m}^3$ ]
- Boundary of Ostrava
- National borders



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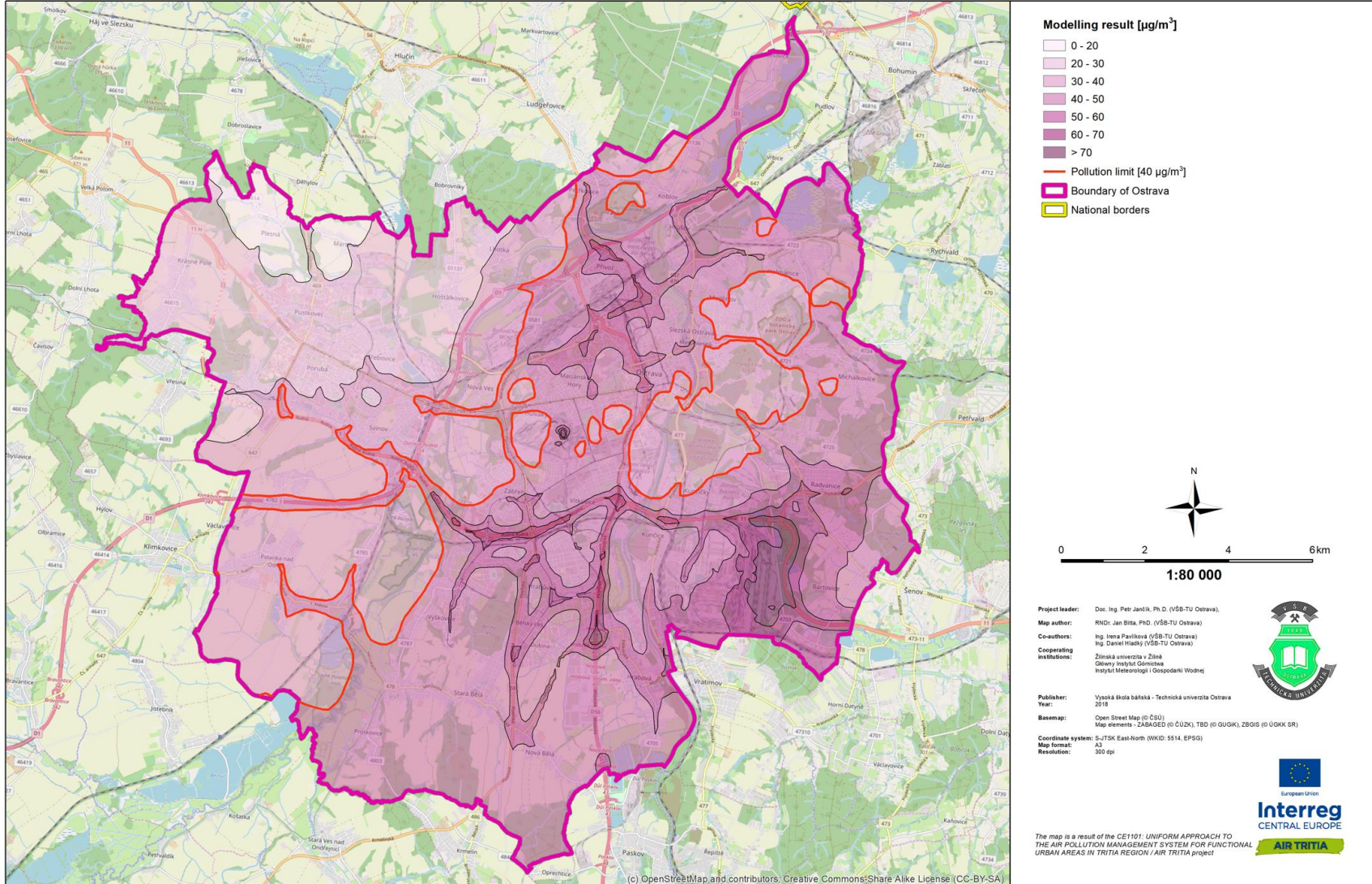


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# IS IT POSSIBLE TO VERIFY, WHAT WILL BE RESULT OF THIS BIG INVESTMENT?

## AVERAGE ANNUAL CONCENTRATION OF PM<sub>10</sub> IN OSTRAVA

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

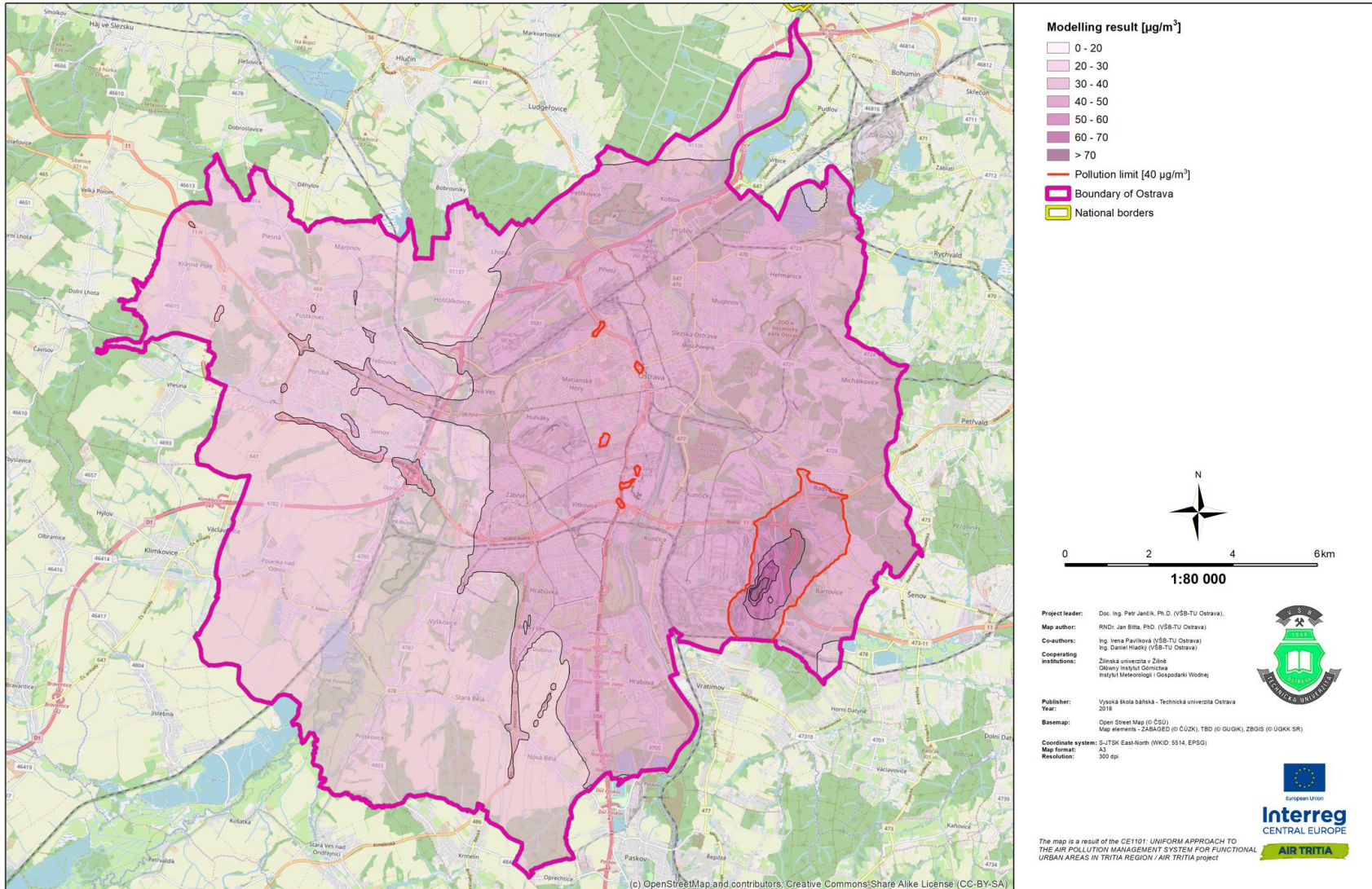




# IS IT POSSIBLE TO VERIFY, WHAT WILL BE RESULT OF THIS BIG INVESTMENT?

## AVERAGE ANNUAL CONCENTRATION OF PM<sub>10</sub> IN OSTRAVA

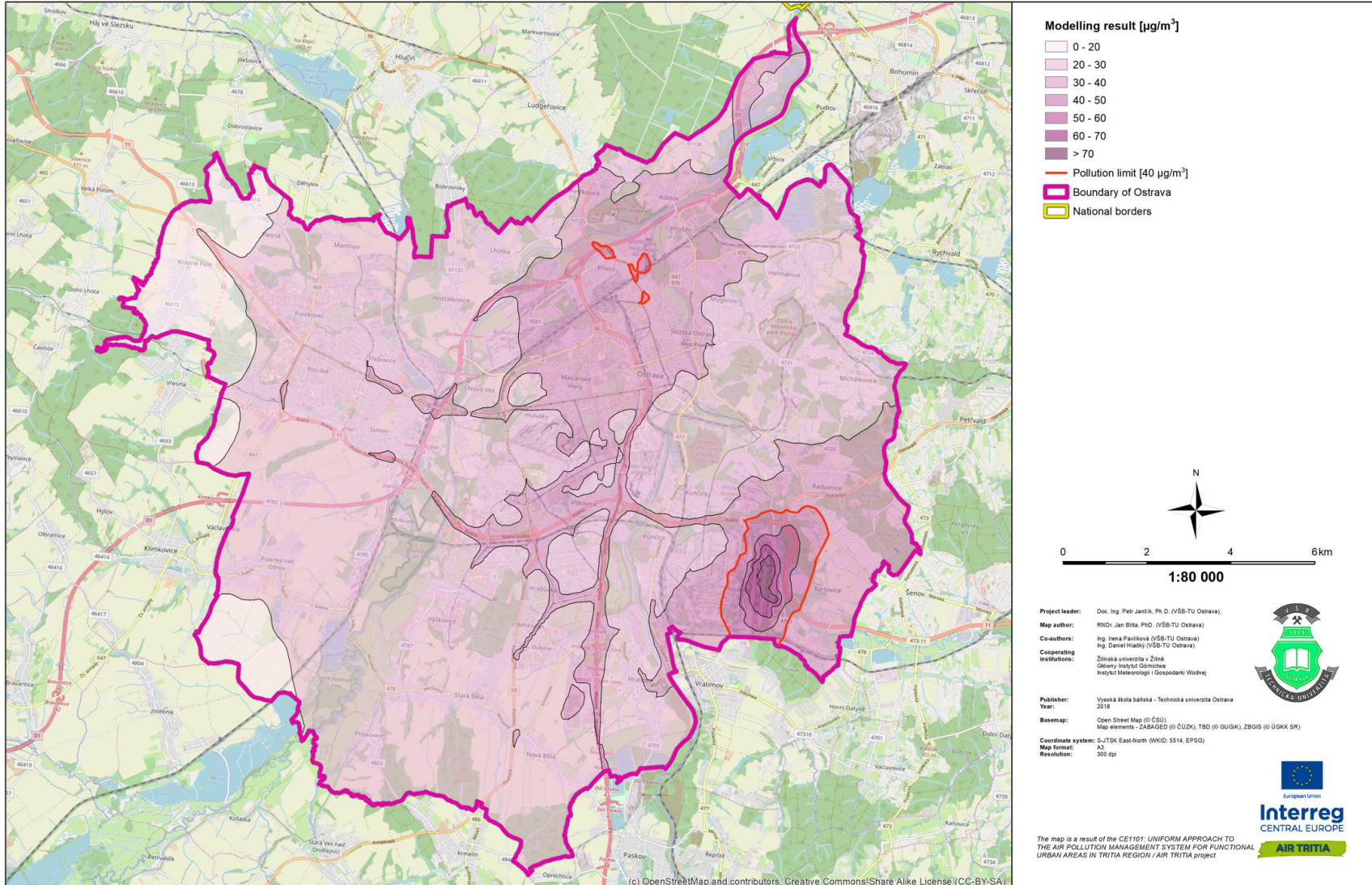
All pollution limiting provisions, model SYMOS'97 with correction by pollution monitoring, year 2007



# IS IT POSSIBLE TO VERIFY, WHAT WILL BE RESULT OF THIS BIG INVESTMENT?

## AVERAGE ANNUAL CONCENTRATION OF PM<sub>10</sub> IN OSTRAVA

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



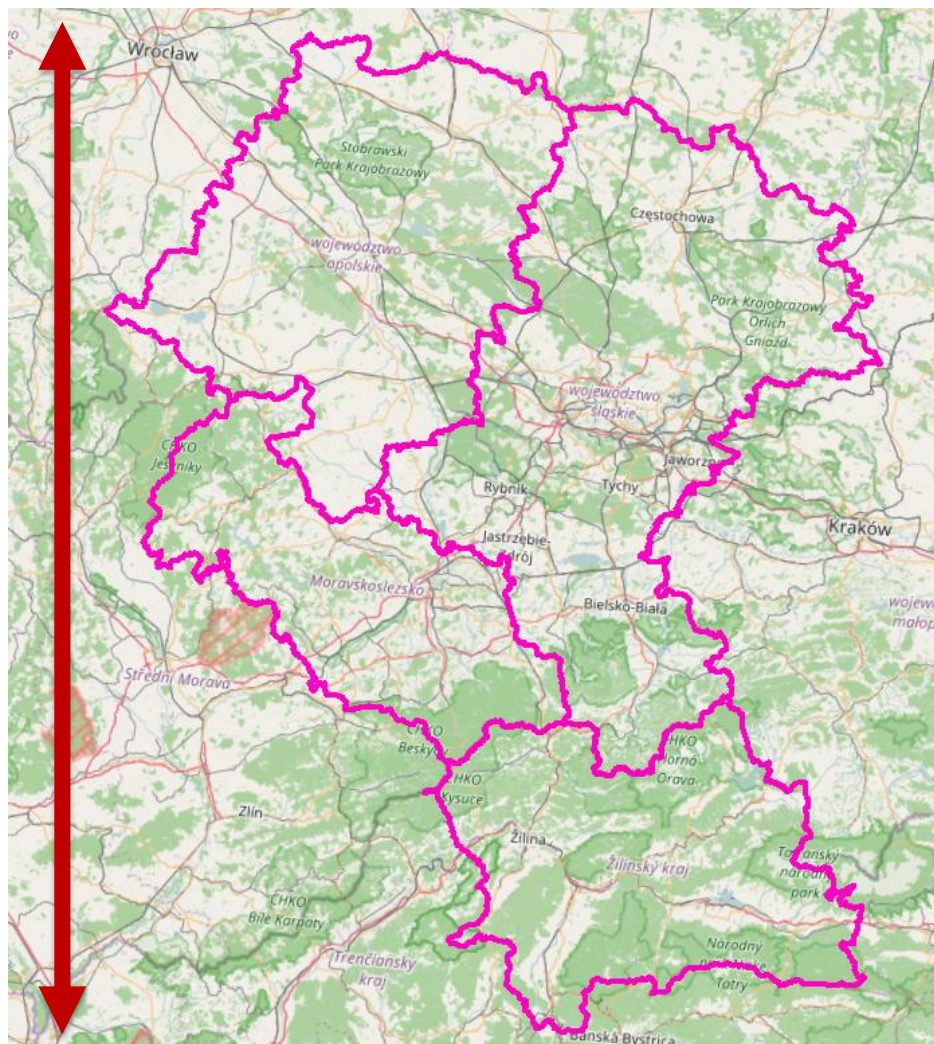
# WHAT IS POSSIBLE TO DO FOR AIR POLLUTION MANAGEMENT IN WHOLE AREA ?

1. Collect good and fresh data about situation (APM).
2. Collect good and fresh data about emission sources.
3. Made connection between them.
4. Made mathematical modelling with verified model of relations between sources and air quality.
5. Made modelling of many cases of potential improvement.
6. Evaluate those results to combine them with socioeconomic, health impact and costs data.
7. This way is possible to design some potential strategies for air quality improvement and to chose the optimal from them.
8. So we are doing in frame of project AIR TRITIA.
9. Result will be the easy accessible Air Pollution Management System for urban areas of big industrial region.



# AREA OF INTEREST

**220 km**



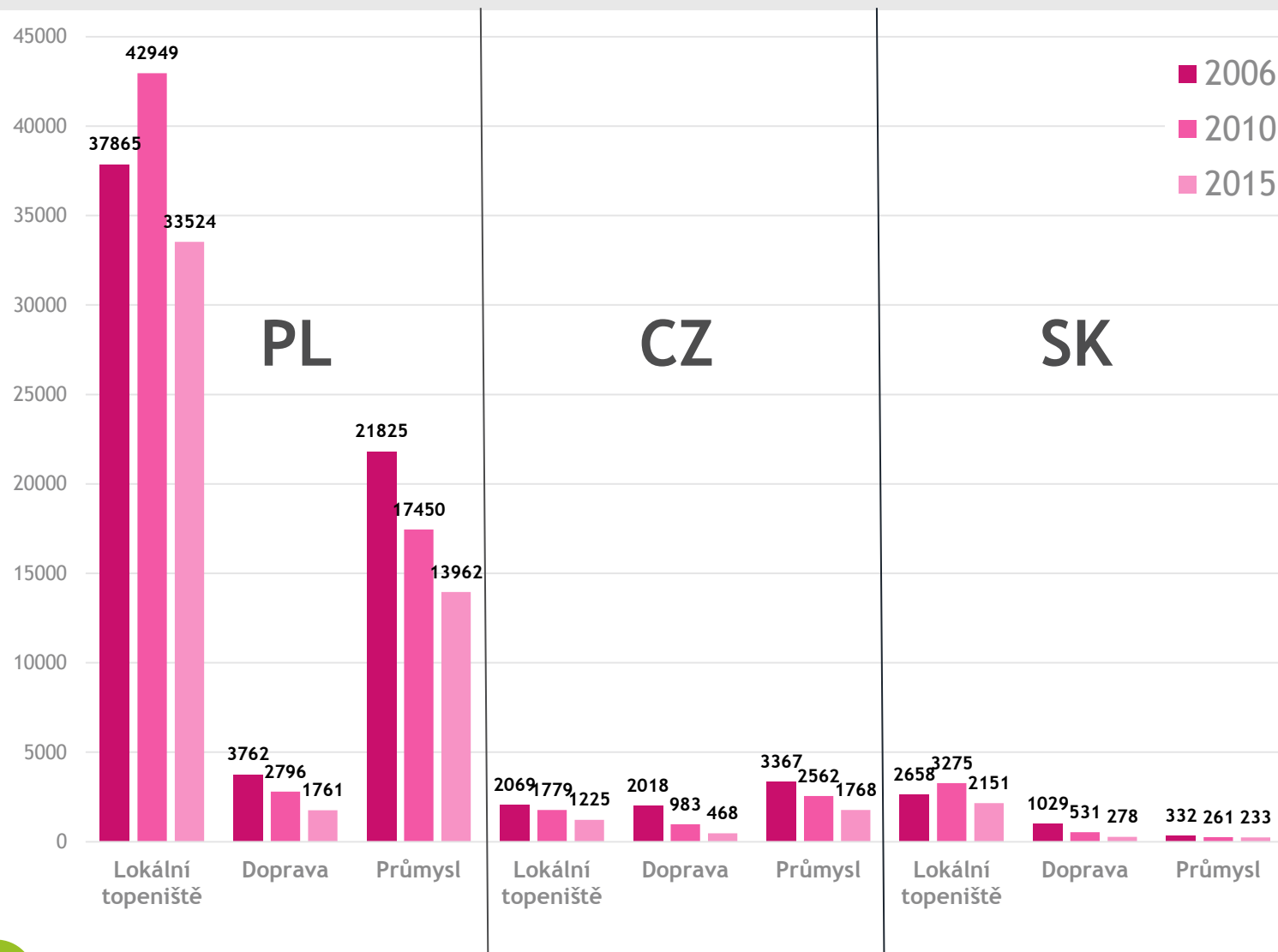
**34 000 km<sup>2</sup>**  
**7 550 000 citizens**

**280 km**

TAKING COOPERATION FORWARD



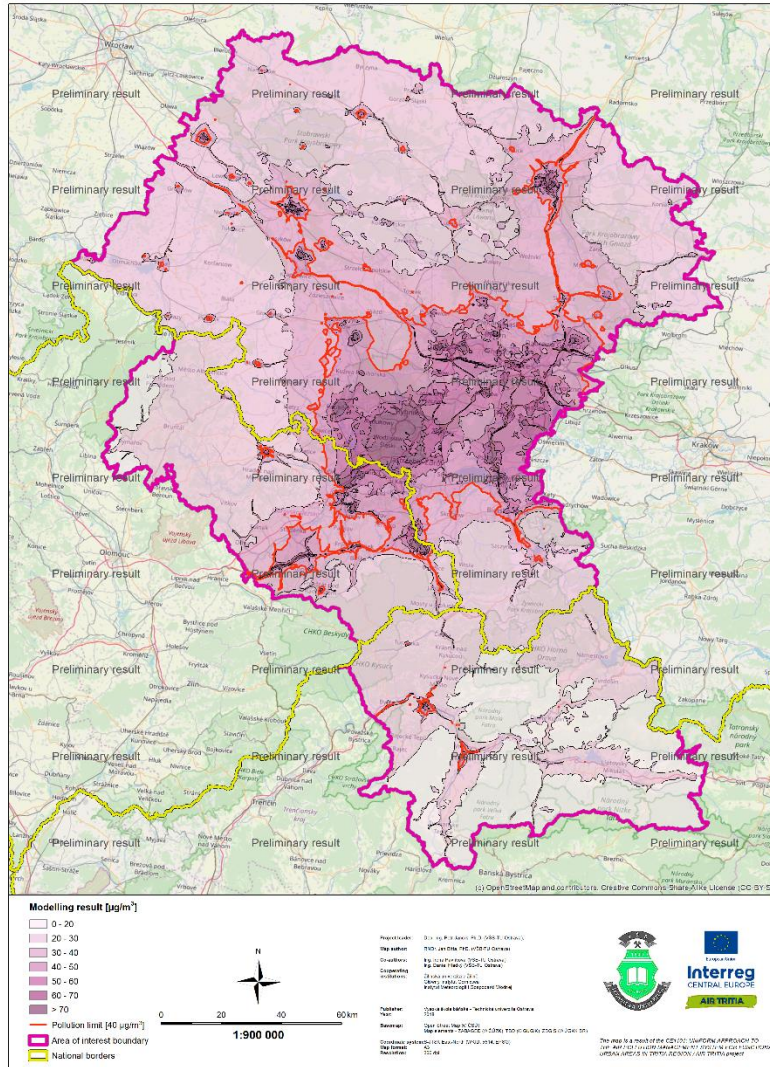
# EMMISSIONS OF PM<sub>10</sub>



# MATHEMATICAL MODELLING PRELIMINARY RESULTS

## AVERAGE ANNUAL CONCENTRATION OF PM<sub>10</sub> IN THE AREA OF INTEREST

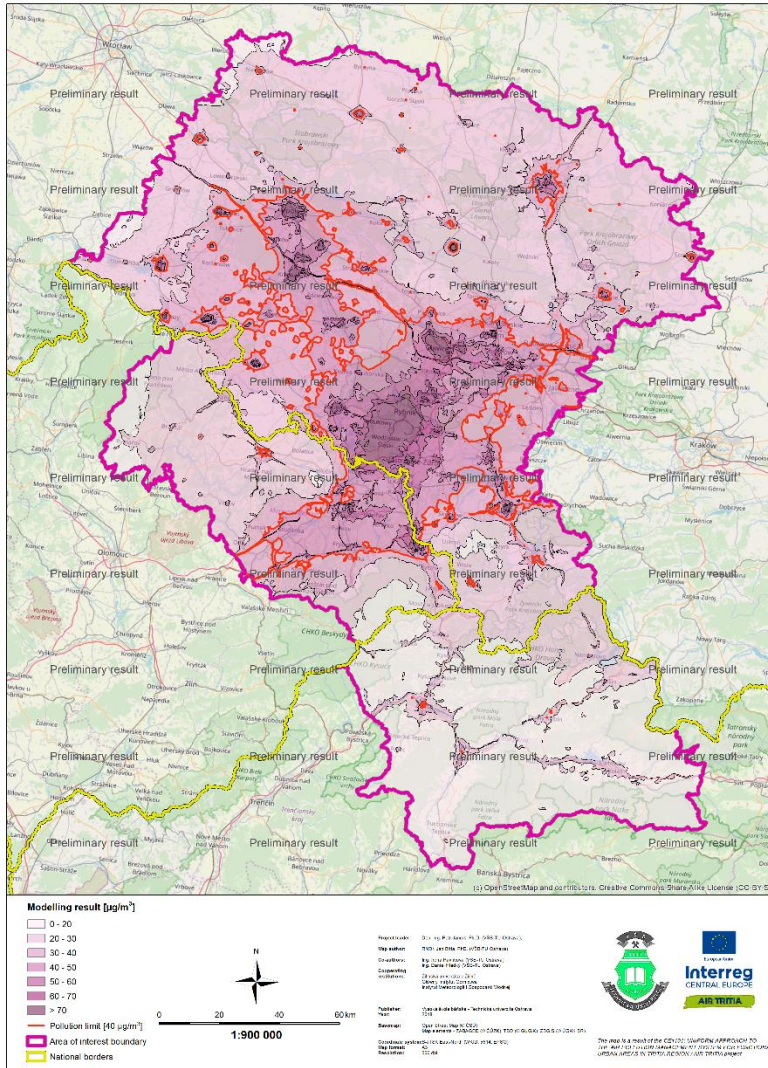
Total concentration, model SYMOS'97 with correction by pollution monitoring, year 2006



# MATHEMATICAL MODELLING PRELIMINARY RESULTS

## AVERAGE ANNUAL CONCENTRATION OF PM<sub>10</sub> IN THE AREA OF INTEREST

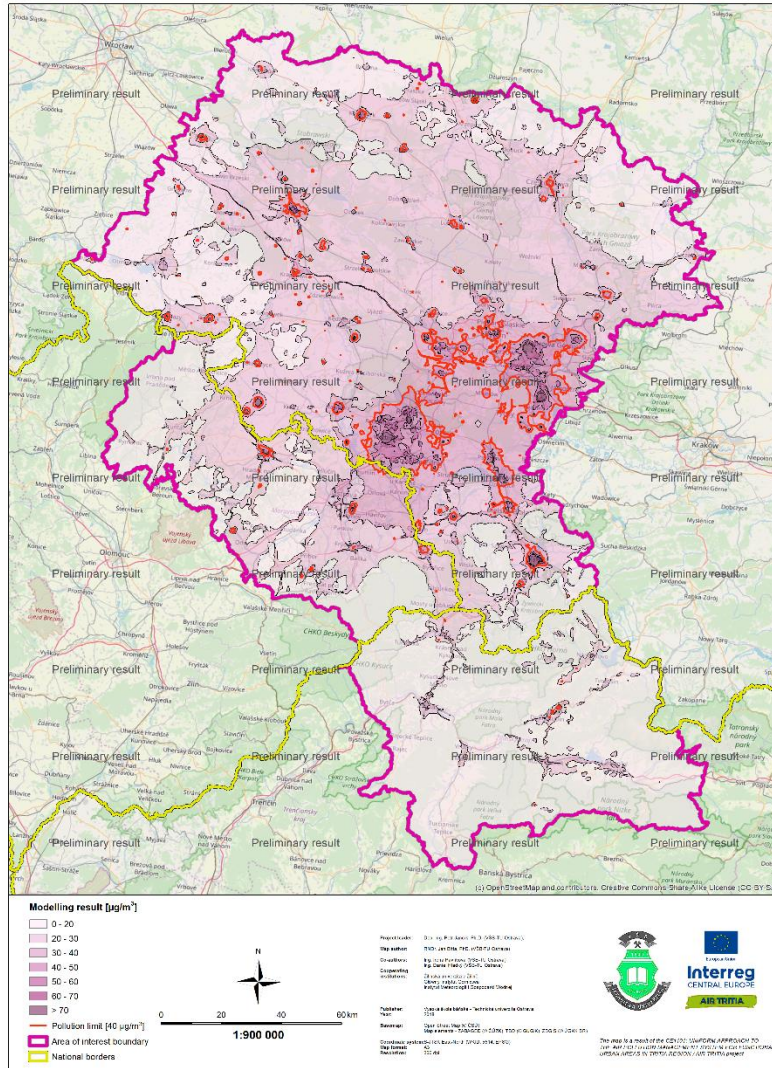
Total concentration, model SYMOS'97 with correction by pollution monitoring, year 2010



# MATHEMATICAL MODELLING PRELIMINARY RESULTS

## AVERAGE ANNUAL CONCENTRATION OF PM<sub>10</sub> IN THE AREA OF INTEREST

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

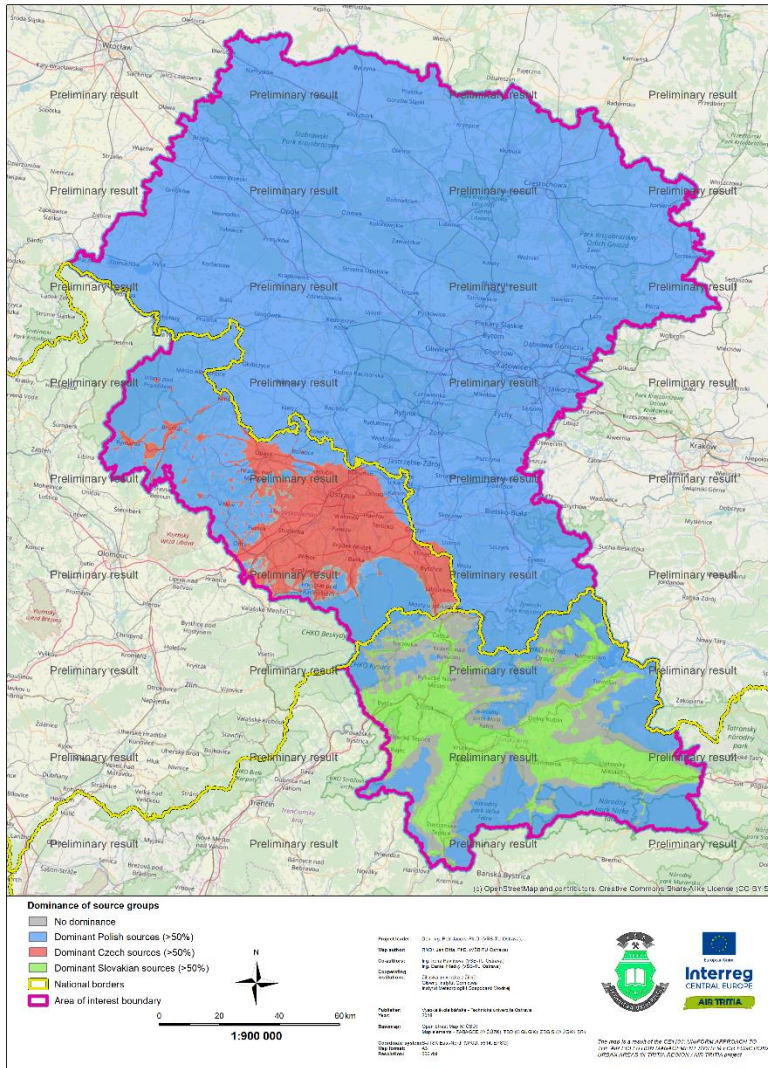




# MATHEMATICAL MODELLING PRELIMINARY RESULTS

## DOMINANCE BY COUNTRY OF ORIGIN FOR PM<sub>10</sub> IN THE AREA OF INTEREST

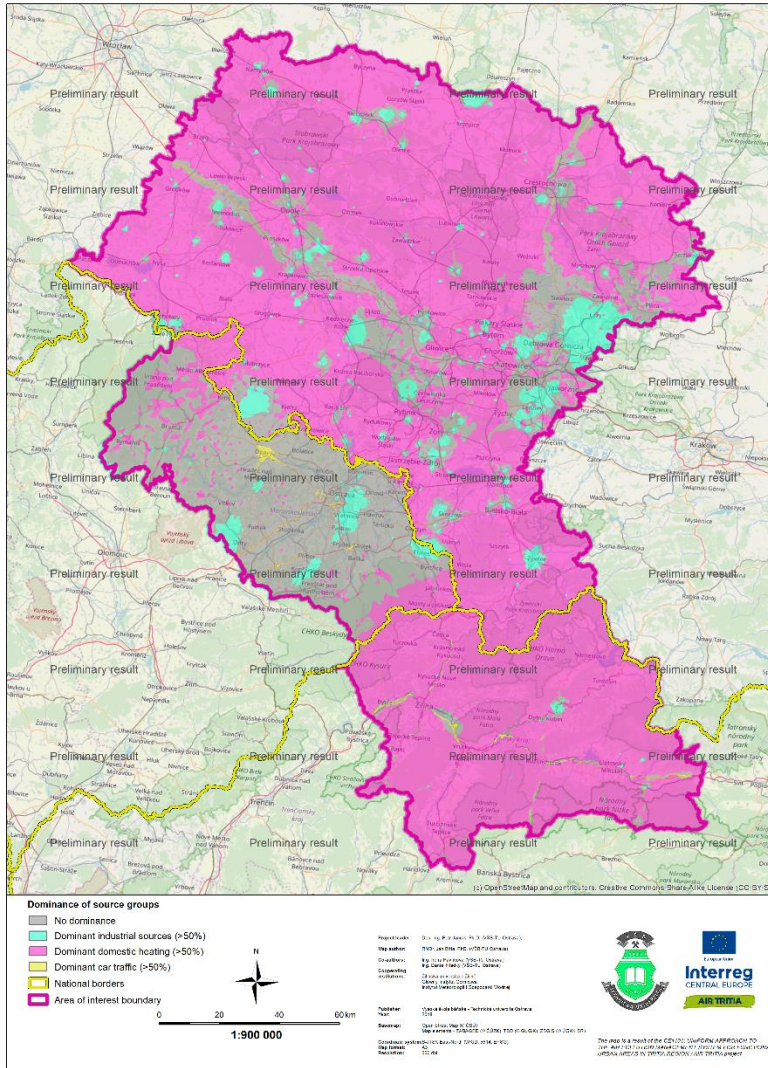
Model SYMOS'97, annual concentration, year 2010



# MATHEMATICAL MODELLING PRELIMINARY RESULTS

## DOMINANCE BY SOURCE GROUPS FOR PM<sub>10</sub> IN THE AREA OF INTEREST

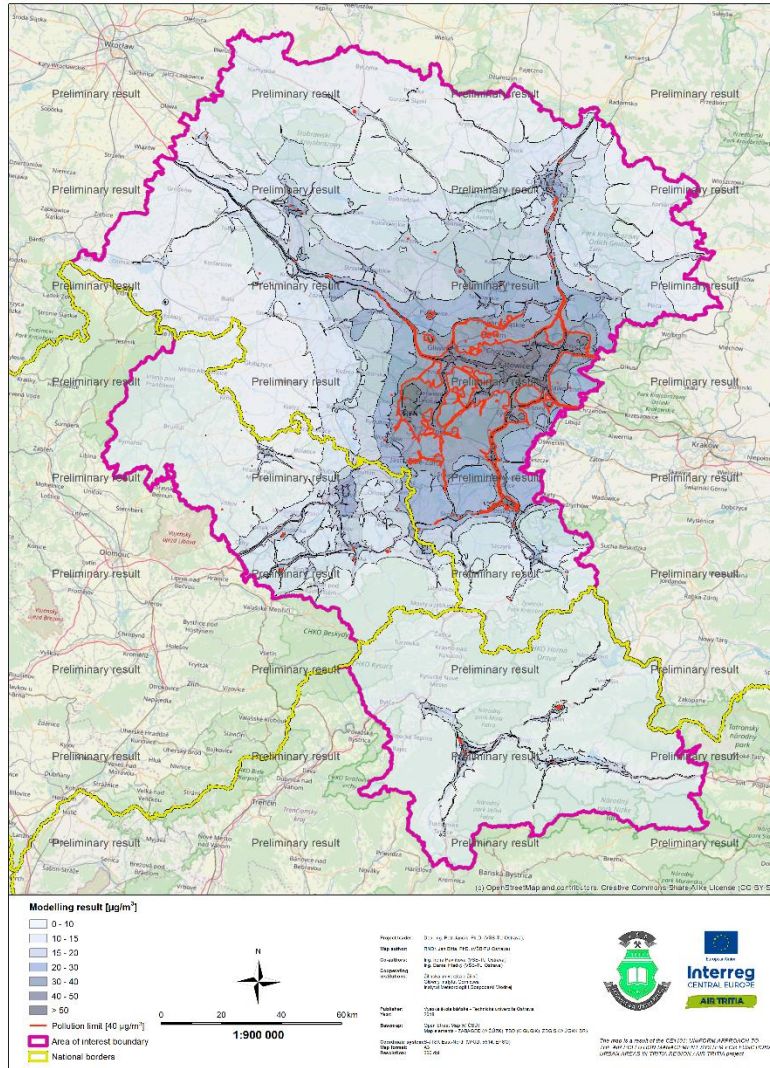
Model SYMOS'97, annual concentration, year 2015



# MATHEMATICAL MODELLING PRELIMINARY RESULTS

## AVERAGE ANNUAL CONCENTRATION OF NO<sub>2</sub> IN THE AREA OF INTEREST

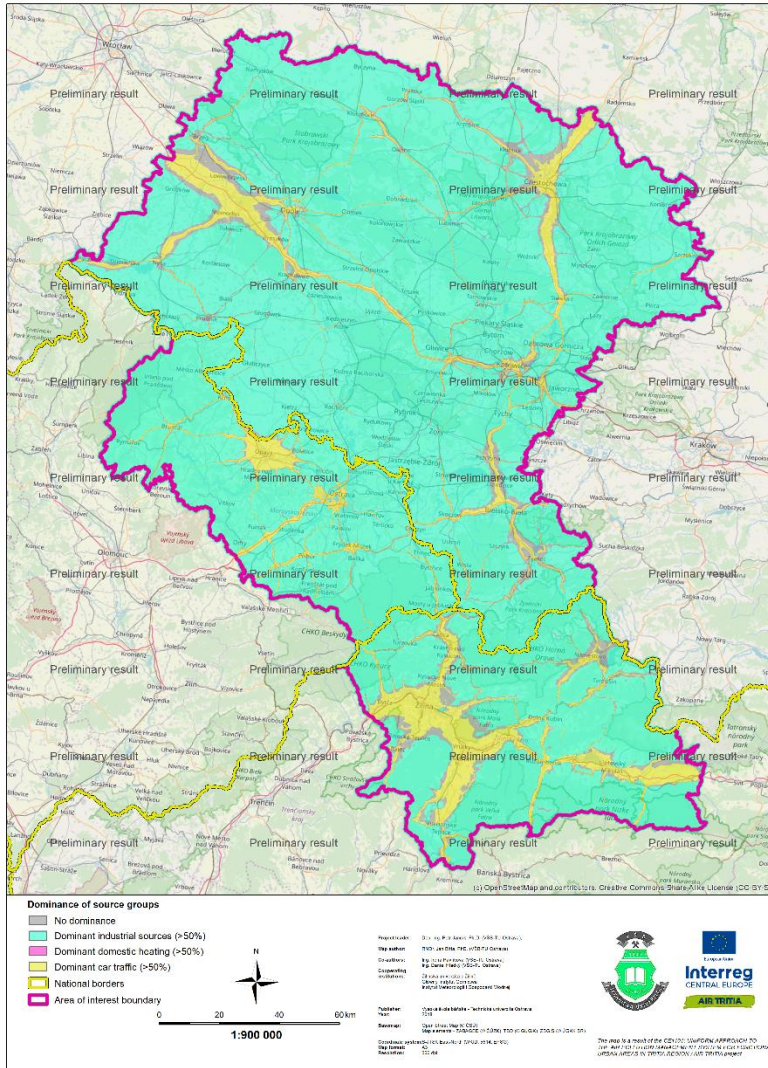
Total concentration, model SYMOS'97 with correction by pollution monitoring, year 2015



# MATHEMATICAL MODELLING PRELIMINARY RESULTS

## DOMINANCE BY SOURCE GROUPS FOR NO<sub>2</sub> IN THE AREA OF INTEREST

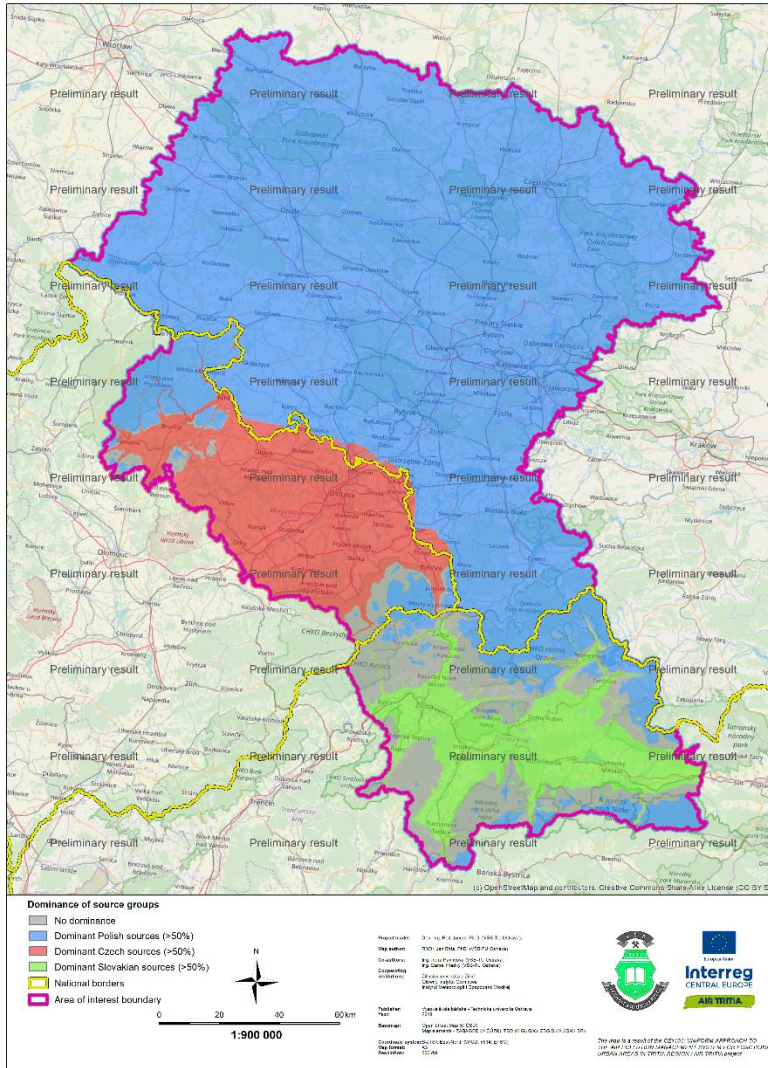
Model SYMOS'97, annual concentration, year 2015



# MATHEMATICAL MODELLING PRELIMINARY RESULTS

## DOMINANCE BY COUNTRY OF ORIGIN FOR NO<sub>2</sub> IN THE AREA OF INTEREST

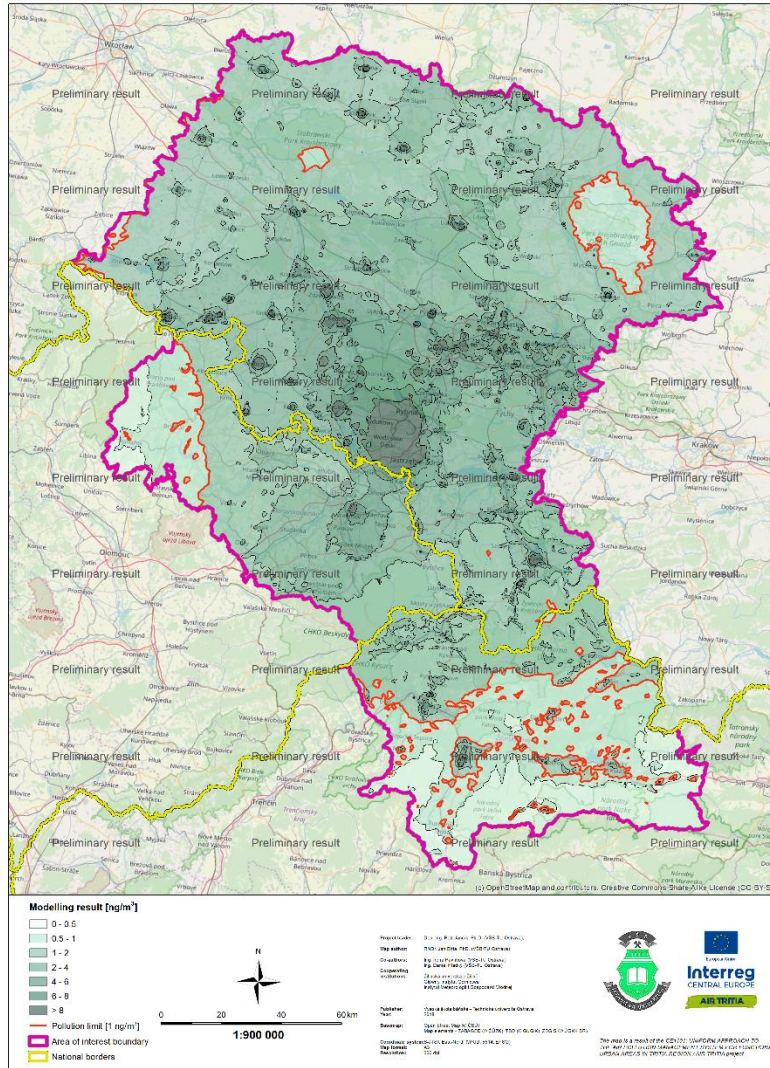
Model SYMOS'97, annual concentration, year 2015



# MATHEMATICAL MODELLING PRELIMINARY RESULTS

## AVERAGE ANNUAL CONCENTRATION OF B(A)P IN THE AREA OF INTEREST

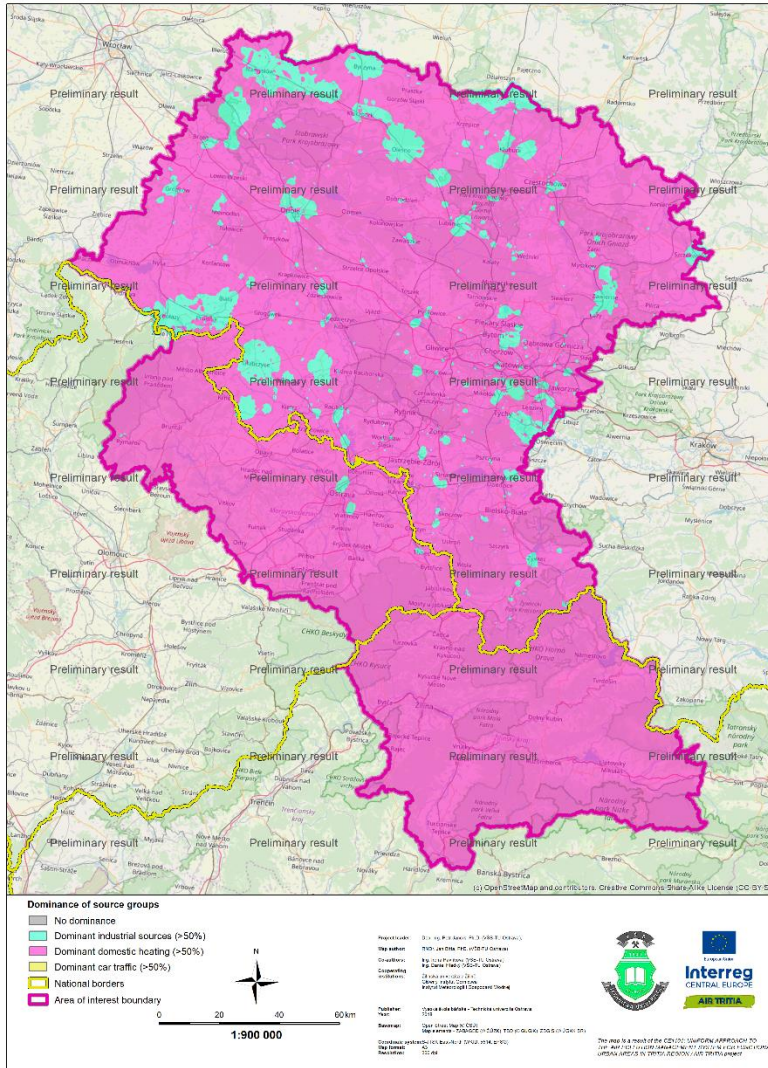
Total concentration, model SYMOS'97 with correction by pollution monitoring, year 2015



# MATHEMATICAL MODELLING PRELIMINARY RESULTS

## DOMINANCE BY SOURCE GROUPS FOR B(A)P IN THE AREA OF INTEREST

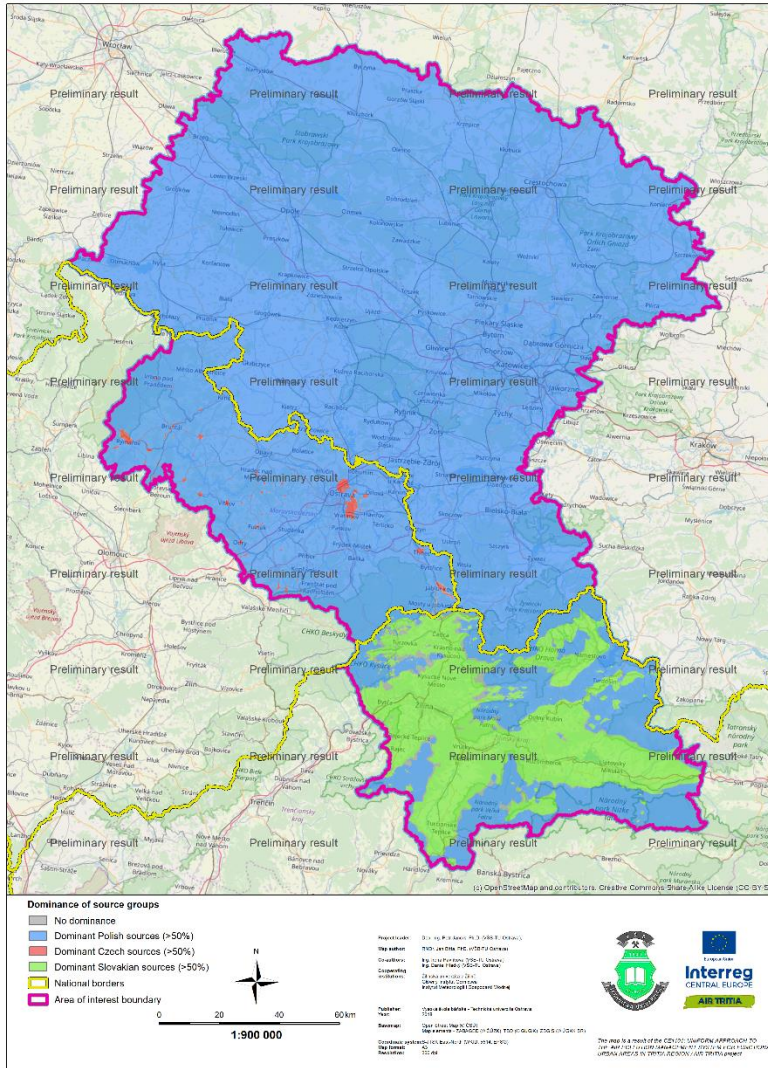
Model SYMOS'97, annual concentration, year 2015



# MATHEMATICAL MODELLING PRELIMINARY RESULTS

## DOMINANCE BY COUNTRY OF ORIGIN FOR B(A)P IN THE AREA OF INTEREST

Model SYMOS'97, annual concentration, year 2015

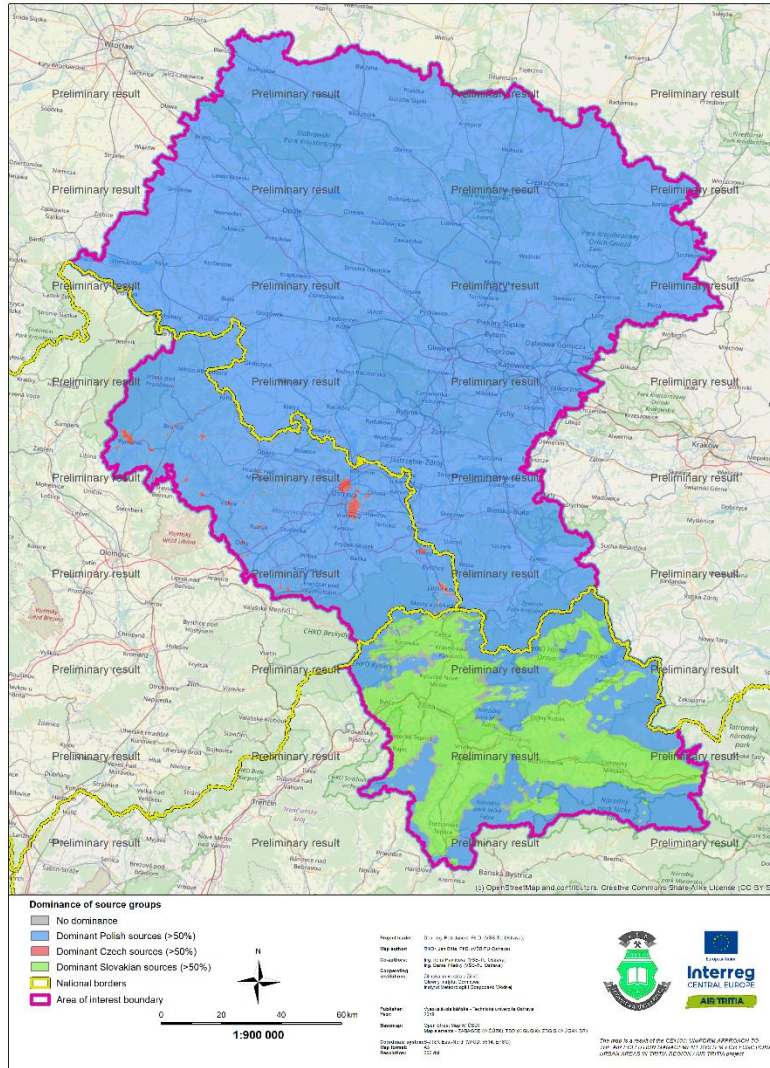




# MATHEMATICAL MODELLING PRELIMINARY RESULTS

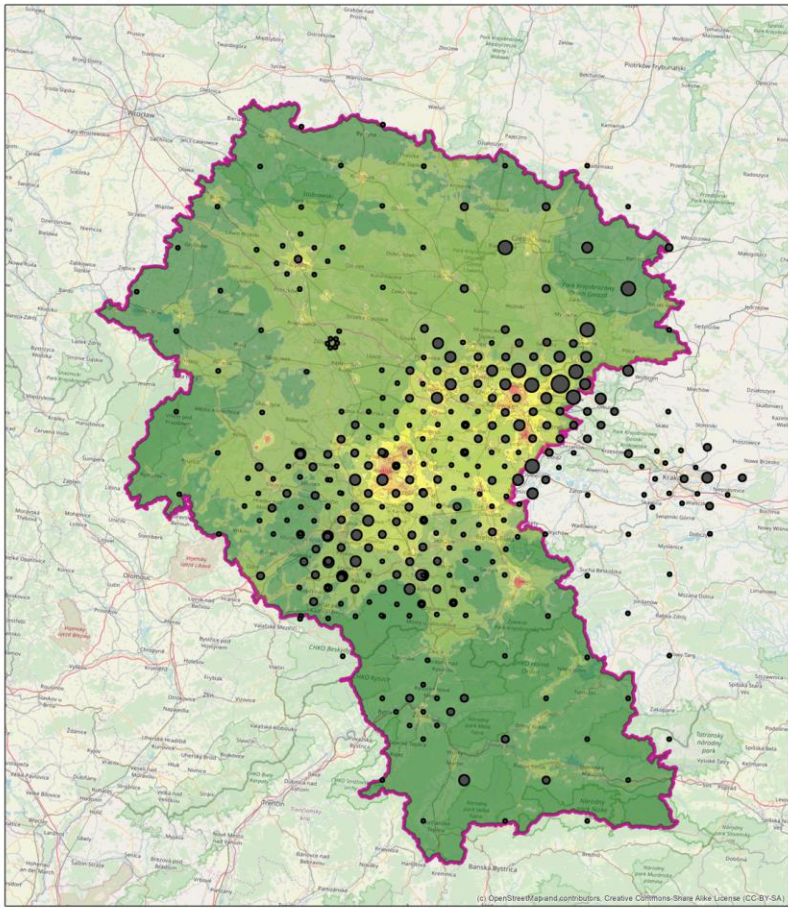
## DOMINANCE BY COUNTRY OF ORIGIN FOR B(A)P IN THE AREA OF INTEREST

Model SYMOS'97, annual concentration, year 2015



# MATHEMATICAL MODELLING PRELIMINARY RESULTS AND RESULTS OF MOSS SAMPLES NAA

**ELEMENTS IDENTIFIED BY NEUTRON ACTIVATION ANALYSIS IN FRAME OF AIR TRITIA**  
 Moss biomonitoring year 2015, 2016, 2017; Total concentrations model SYMOS'97, year 2015



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**Legend**



|   |   |   |
|---|---|---|
| <b>Measure concentrations of Fe [mg/kg]</b> | <b>Annual mean concentrations [<math>\mu\text{g}/\text{m}^2</math>]</b> | <b>Project leader:</b> Dr. Ing. Feri Jurčić, Ph.D. (USA-FY) Osijek; |
| ● 294.0 - 1710.0                            | 0 - 20  | <b>Map author:</b> Vladimir Šušterić (USA-FY) Osijek;               |
| ● 1710.0 - 3900.0                           | 20 - 30   | <b>Coauthors:</b> M. Štepec Partušić (USA-FY) Osijek;               |
| ● 3900.0 - 7200.0                           | 30 - 40   | <b>Coauthors:</b> M. Štepec Partušić (USA-FY) Osijek;               |
| ● 7200.0 - 13100.0                          | 40 - 50   | <b>Coauthors:</b> Žilina  |
| ● 13100.0 - 32000.0                         | 50 - 60   | <b>Coauthors:</b> Zilina  |
|   | 60 - 70   | <b>Coauthors:</b> Zilina  |
|   | > 70  | <b>Coauthors:</b> Zilina  |

**Map scale:** 1:1 000 000

**Map orientation:** N

**Scale bar:** 0 20 40 60 km

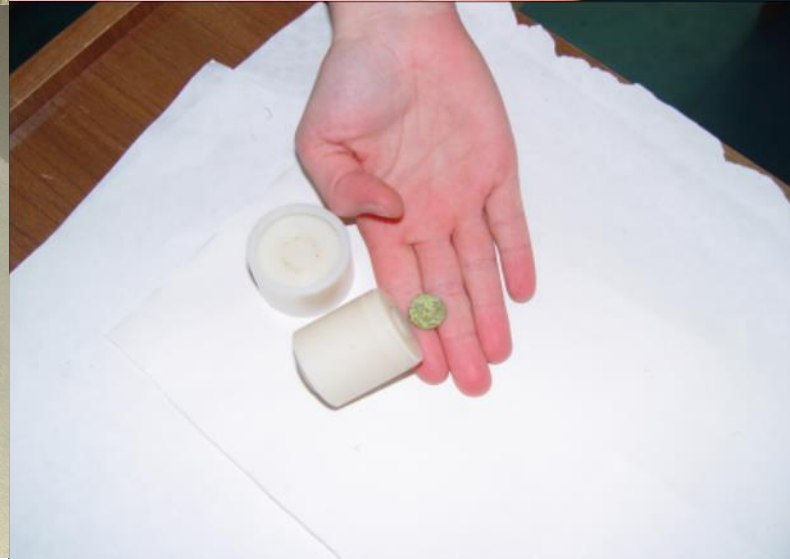
**Project info:**  
 Publication year: 2018  
 Publisher: Virovitički veleučilišni fakultet Osijek  
 Map data: Open Street Map (© OpenStreetMap contributors)  
 License: CC-BY-SA  
 Coordinate system: UTM (EPSG:3143) (UTM zone 31E, datum: ED50, projection: UTM)  
 Map scale: 1:1 000 000

**Logos:**  

Evaluation of model results by moss biomonitoring using neutron activation analysis



# MOSS SAMPLING AND PREPARING FOR ANALYSIS





# JINR (ОИЯИ)

## ■ 1956 - 2018

International Research Centre (1992)

### 18 member countries:

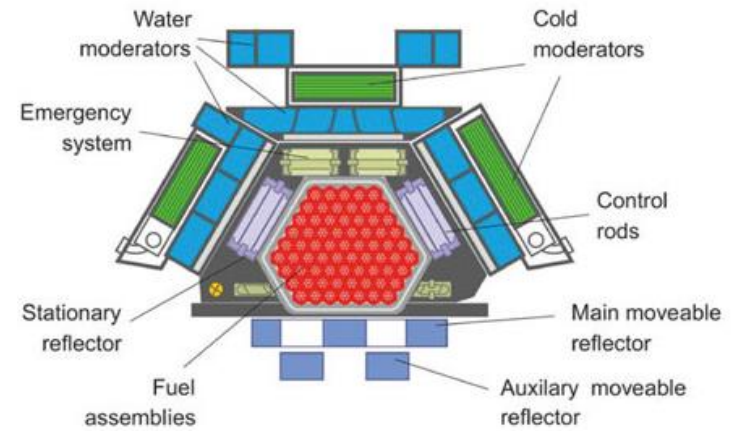
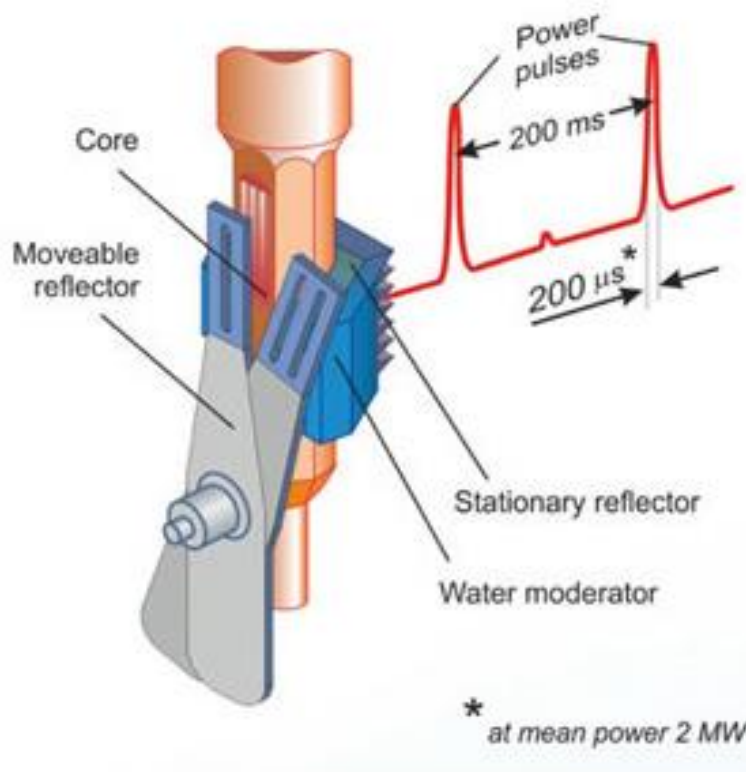
Azerbaijan, Armenia, Belarus, Bulgaria, Vietnam, Georgia, Kazakhstan, North Korea, Cuba, Moldova, Mongolia, Poland, Russia, Romania, Slovakia, Uzbekistan, Ukraine, Czech Republic

### 8 laboratories and University Centre:

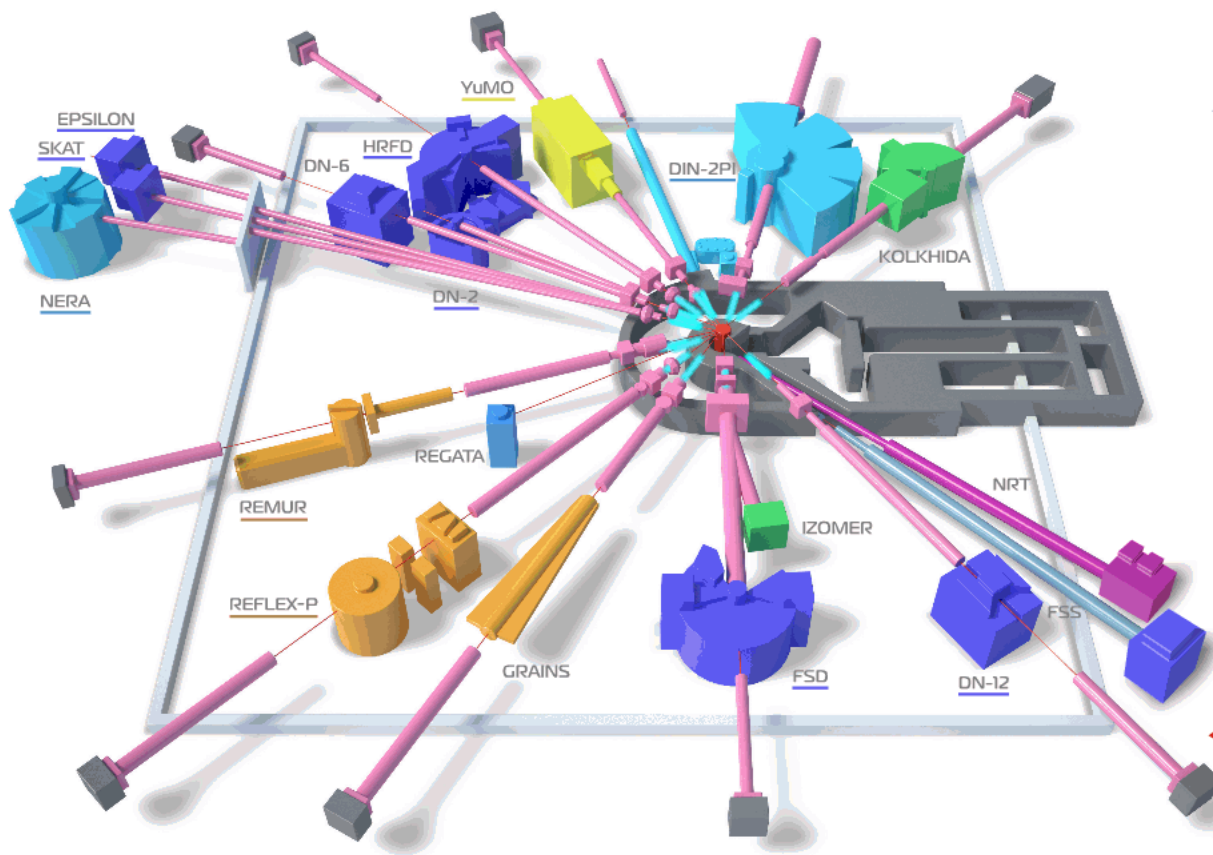
- Bogoliubov Laboratory of Theoretical Physics (BLTP)
- Veksler and Baldin Laboratory of High Energies (VBLHE)
- Laboratory of Particle Physics (LPP)
- Dzhelapov Laboratory of Nuclear Problems (DLNP)
- Flerov Laboratory of Nuclear Reactions (FLNR)
- Frank Laboratory of Neutron Physics (FLNP)
- Laboratory of Information Technologies (LIT)
- Laboratory of Radiation Biology (LRB) University Centre (UC)



## Pulse reactor IBR 2 in Frank Laboratory of Neutron Physics



## Experimental facilities



- 
**Diffraction**  
 DN-2, DN-12, DN-6, FSD, FSS, HRFD, SKAT, EPSILON
- 
**Small-angle scattering**  
 YuMO
- 
**Reflectometry**  
 GRAINS, REFLEX-P, REMUR
- 
**Inelastic scattering**  
 DIN-2PI, NERA
- 
**Nuclear Physics**  
 ISOMER, KOLKHIDA
- 
**Neutron Activation Analysis**  
 REGATA
- 
**Neutron imaging**  
 NRT

TAKING  
**COOPERATION**  
FORWARD



Ostrava, Ostrava University |  
19.11. 2018



**Technical and technological possibilities to reduce  
pollution from the steelworks - the story of Ostrava**



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<https://www.interreg-central.eu/Content.Node/AIR-TRITIA.html>