MUNI | RECETOX

Exposure to chemicals and their health risks in human population

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RECETOX, HEAR – Human Exposure Assessment and Risks

Introduction

Dissertation is focused on the new methods of evaluation of exposure to chemicals and primarily on prediction and assessment of possible health risks in human population. Emphasis will be placed on inhalation exposure models and their general utilization in the Smart City project concepts. Model will be employed to assess health risks connected to air pollution in Brno city. This model has potential to by implemented and used by city authorities to assess current air quality if proven useful and applicable for Brno.

Second part of thesis is focused on international cohort study aiming to evaluate pesticide levels in human urine. The goal of study is comparison of pesticide levels in humans living close to agriculturally active areas with pesticide levels in humans living farther from those areas. Ultimate objective is to prepare, execute and assess results of the study for Czech Republic.

This thesis will provide comprehensive study on approach to human exposure to chemical substances and risks connected with this exposure scenarios.
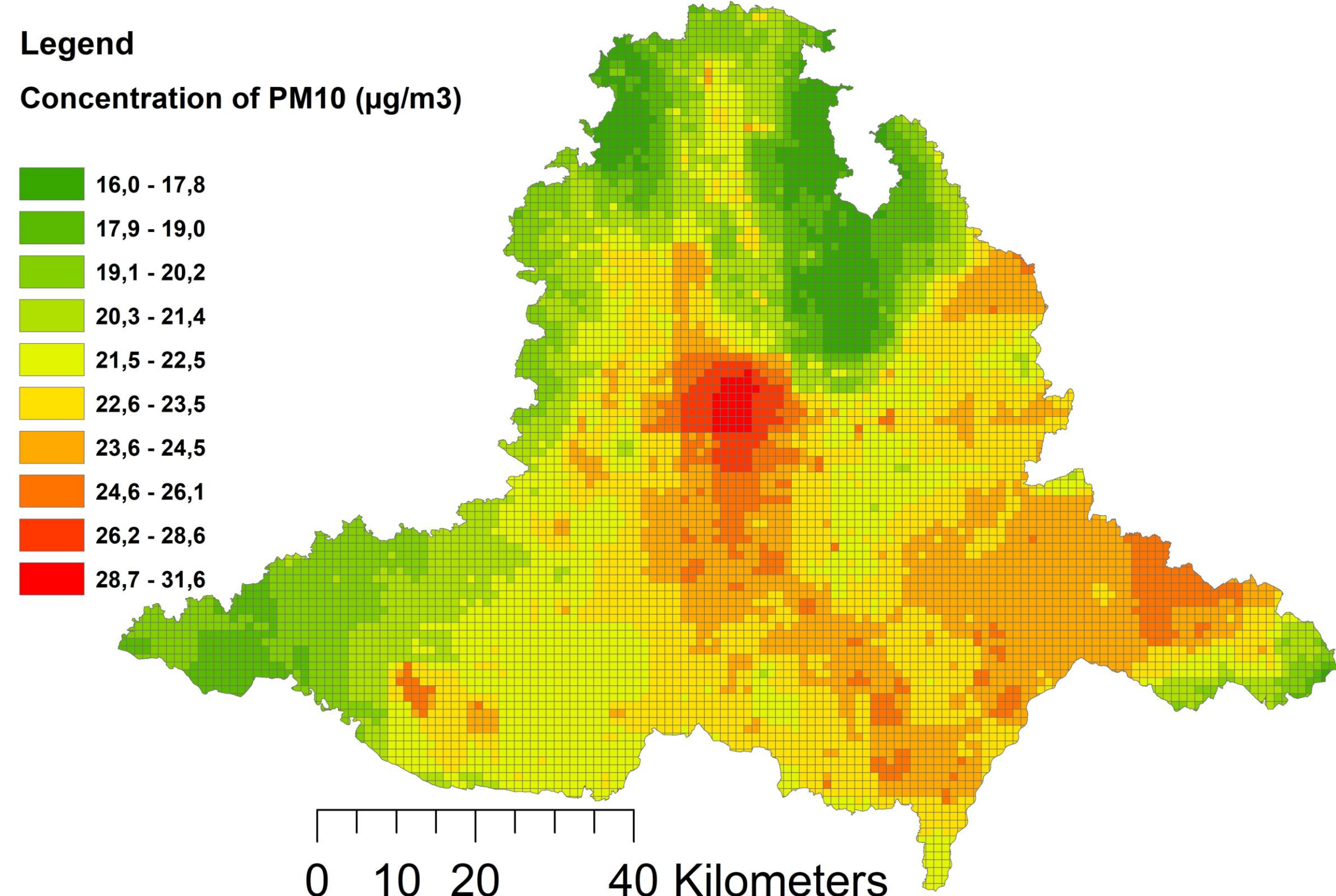
Modelling

Subject of modeling for Brno is WHO based software (AirQ+) for human health assessment. Purpose of this model is to estimate impact of air pollution on health of given population in long or short term. Regarding pollutants, AirQ+ can work with $PM_{2.5}$, PM_{10}, NO_2, black carbon and O_3. Calculations performed by AirQ+ are based on methodologies and concentration-response function (CRF) supplied by epidemiological studies. Required input data for successful impact assessment are pollution and studied population health data.

Modeling using AirQ+ for Brno city is focused on work with health data (provided by Institute of Health Information and Statistics of the Czech Republic - www.uzis.cz) collected in extended period of time together with air pollutant concentrations valid for Brno city. Available pollution data are in form of 1 and 5 year annual means for $PM_{2.5}$, PM_{10} and NO_2 (provided by Czech Hydrometeorological Institute database).
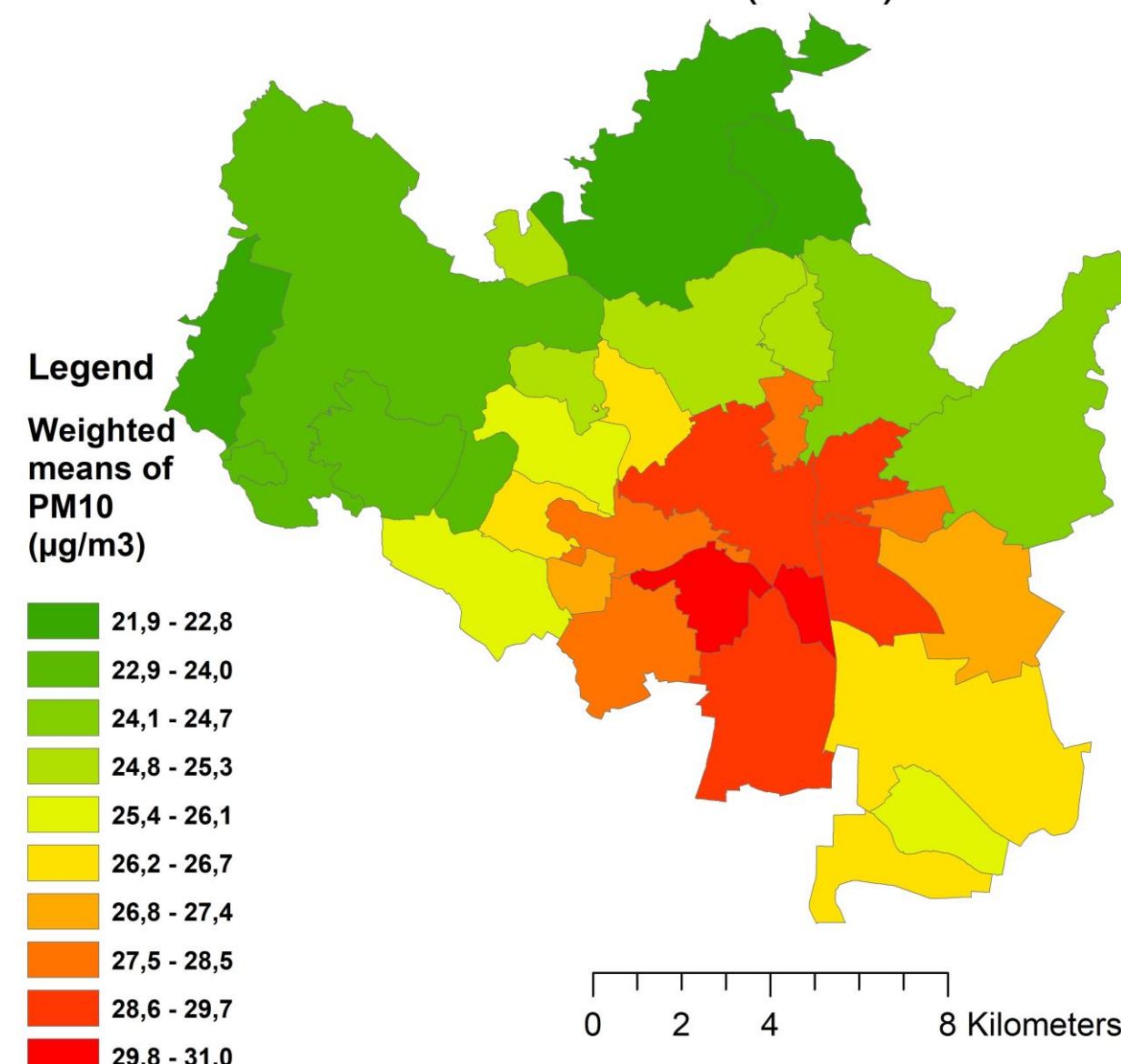
Overview of intented analysis of human health risk assessment for Brno city

Exposition	Observed period	Pollutant	Endpoint	ICD	Age group
Long-term	2012 - 2018	PM10, 5 year annual mean	Prevalence of bronchitis in children	J20, J40, J41, J42, J44, J450, J459, J47, J680	0 - 19
	2012 - 2018	PM10, 5 year annual mean	Incidence of chronic bronchitis in adults	J41, J42, J448	20+
	2012 - 2018	NO2, 5 year annual mean	Prevalence of bronchitic symptoms in asthmatic children	J45, J46 with J20, J40, J41, J42, J44, J450, J459, J47, J680	5 - 14
Short-term	2011 - 2018	PM2,5; annual mean	Hospital admissions, cardiovascular diseases (CVDs), includes stroke	I00 - I99	whole population
	2011 - 2018	PM2,5; annual mean	Hospital admissions, respiratory diseases	J00 - J99	whole population
	2010 - 2018	PM10, annual mean	Incidence of asthma symptoms in asthmatic children	J450, J459, J46	0 - 19
	2010 - 2018	O3, annual mean	Hospital admissions CDVs (excluding stroke) and respiratory diseases	I00-I99 without I60-I64	65+
	2010 - 2018	NO2, annual mean	Hospital admissions, respiratory diseases	J00 - J99	whole population

It seem appropriate to transfer AirQ+ CRFs into GIS software as it is much easier to create temporal and spatial analysis for Brno city, and pollution data are already in form of GIS based maps. Air quality impact assessment will be done for area of each Brno city postal code, each available pollutant, each year and each non-mortality related endpoint (based on provided health data). This work will be done under the SMURBS project (SMart URBan Solutions for air quality, disasters and city growth) aiming on smart solutions for cities and Earth observation methods. Another involved project is URBAN_X (External and Internal Human Exposure in Urban Exposome), focusing on health of urban population and factors affecting it.
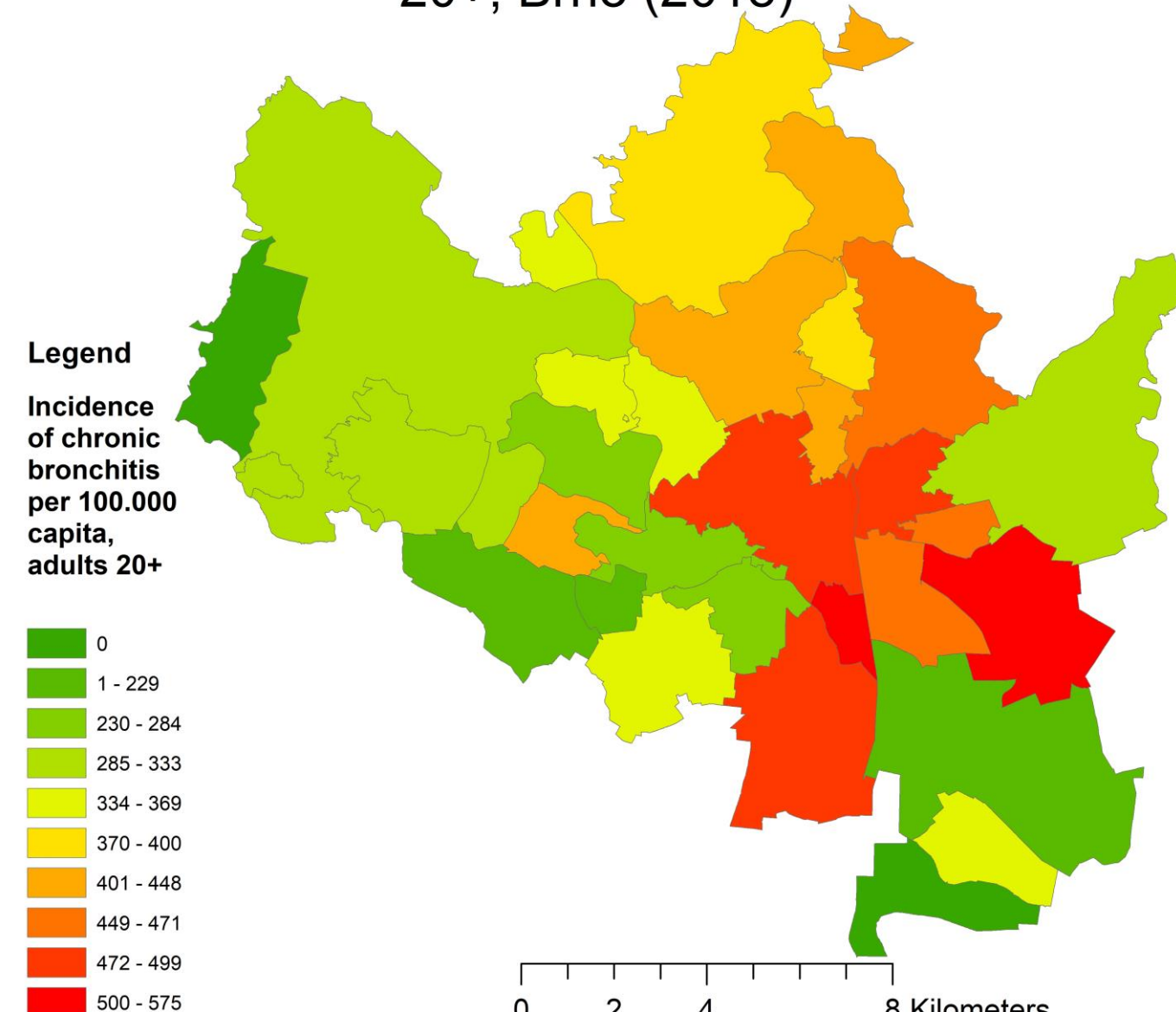
Map of annual means of PM10 for South Moravian Region (2018)

Legend
Concentration of PM10 (µg/m3)

- 16,0 - 17,8
- 17,9 - 19,0
- 19,1 - 20,2
- 20,3 - 21,4
- 21,5 - 22,5
- 22,6 - 23,5
- 23,6 - 24,5
- 24,6 - 26,1
- 26,2 - 28,6
- 28,7 - 31,6

0 10 20 40 Kilometers

Map of weighted means of PM10 for Brno (2018)

Legend
Weighted means of PM10 (µg/m3)

- 21,9 - 22,8
- 22,9 - 24,0
- 24,1 - 24,7
- 24,8 - 25,3
- 25,4 - 26,1
- 26,2 - 26,7
- 26,8 - 27,4
- 27,5 - 28,5
- 28,6 - 29,7
- 29,8 - 31,0

0 2 4 8 Kilometers

Incidence map of chronic brnonchitis in adults 20+, Brno (2018)

Legend
Incidence of chronic bronchitis per 100.000 capita, adults 20+

- 0
- 1 - 229
- 230 - 284
- 285 - 333
- 334 - 369
- 370 - 400
- 401 - 448
- 449 - 471
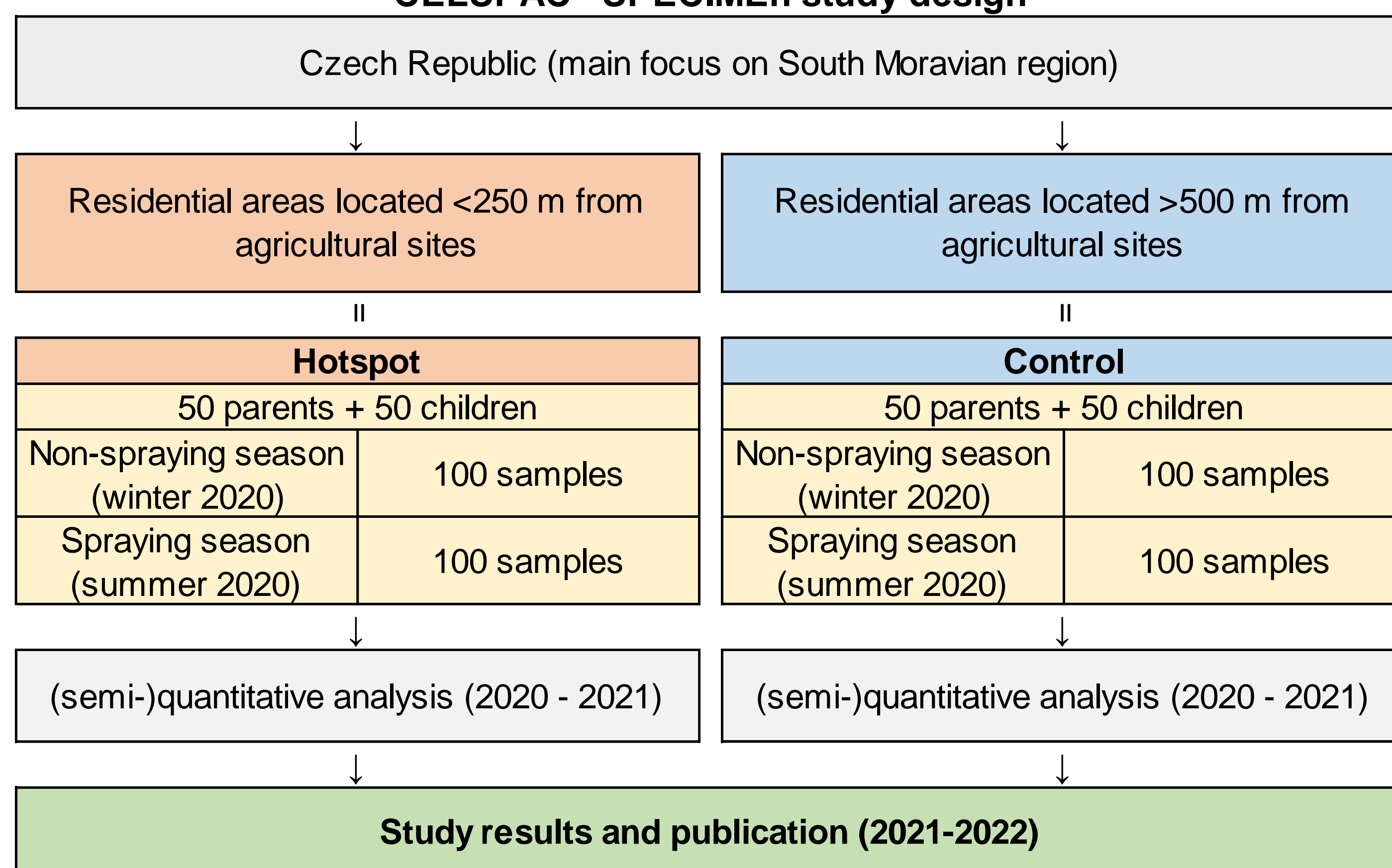- 472 - 499
- 500 - 575

0 2 4 8 Kilometers

Cohort study

The CELSPAC – SPECIMEn study (Central European Longitudinal Studies of Parents and Children - Survey on PEstiCIde Mixtures in Europe) is part of HBM4EU project (Human Biomonitoring for Europe). The main aim of this joint survey is to generate new exposure data across Europe on a broad combination of pesticides and to assess possible local contributions (i.e. hotspot areas) and within-person variation. The approach used is a so-called 'hotspot' design, focusing on residential areas close to sites where pesticides are applied. Pesticide suspect screening method will be applied, capable of (semi-)quantitatively detecting multiple pesticide (metabolites) in a single assay. The study will be conducted in Czech Republic, Hungary, Latvia, Netherlands and Spain.
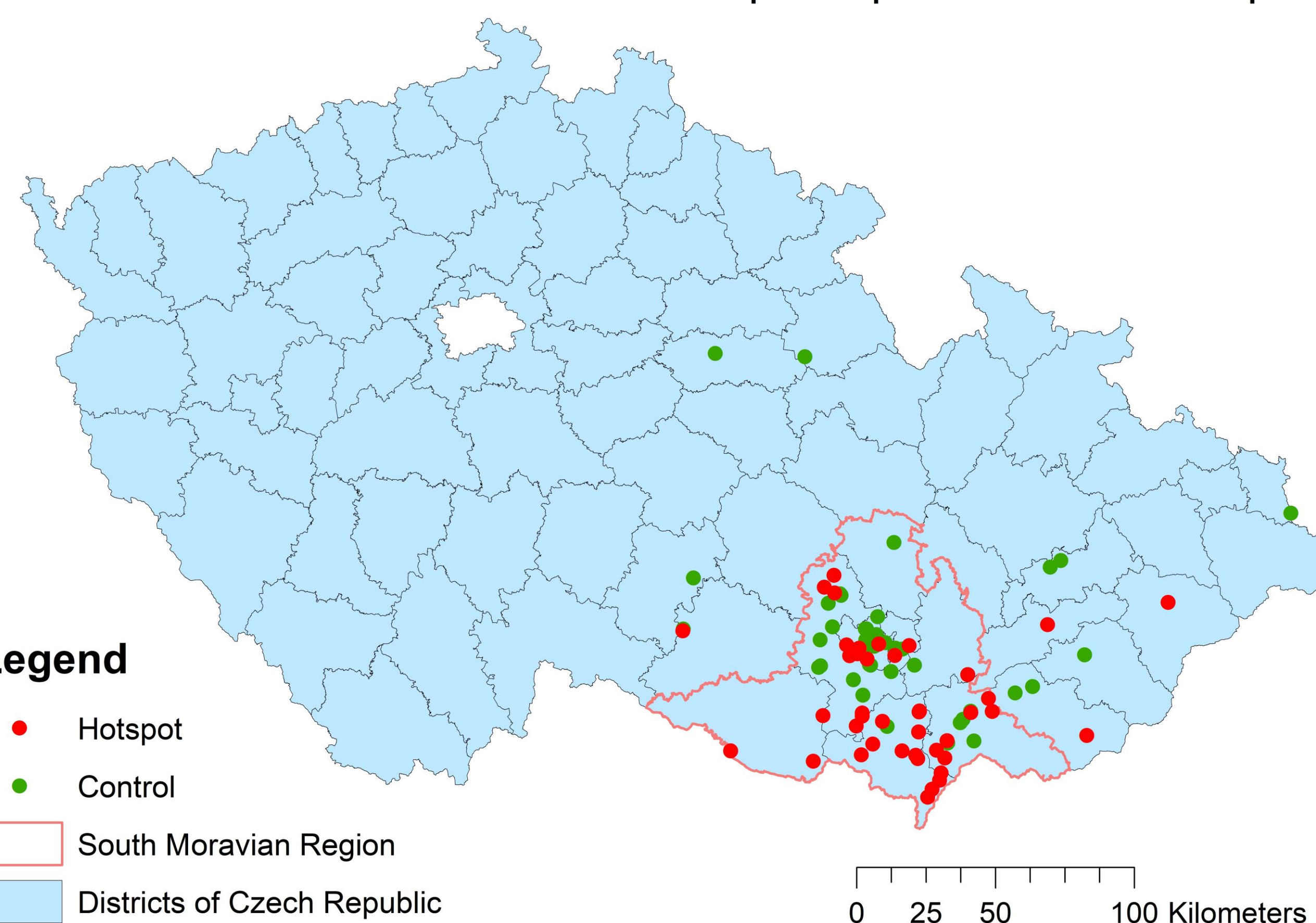
The main research questions for the joint hotspot-survey are:
Which combinations of pesticides are the most common in suspect screening?
Do patterns in pesticides detected in suspect screening differ between age groups and study populations in different countries?
Do patterns in pesticides detected in suspect screening differ between people living close to pesticide application sites and control group?
Do patterns in pesticides detected in suspect screening differ between seasons (spraying and non-spraying season)?

CELSPAC - SPECIMEn study design

Czech Republic (main focus on South Moravian region)	
↓	↓
Residential areas located <250 m from agricultural sites	Residential areas located >500 m from agricultural sites
ΙΙ	ΙΙ
Hotspot	**Control**
50 parents + 50 children	50 parents + 50 children

Non-spraying season (winter 2020)	100 samples	Non-spraying season (winter 2020)	100 samples
Spraying season (summer 2020)	100 samples	Spraying season (summer 2020)	100 samples

(semi-)quantitative analysis (2020 - 2021)	(semi-)quantitative analysis (2020 - 2021)
↓	↓

Study results and publication (2021-2022)

Distribution of CELSPAC - SPECIMEn participants in Czech Republic

Legend
- Hotspot
- Control
- South Moravian Region
- Districts of Czech Republic

0 25 50 100 Kilometers

Current progress and plans

Modelling
Air quality impact assessment model for Brno city is in phase of data preparation, transformation and additional data collection. Ultimate outcome will be scientific publication aiming on combined results of all involved partners within SMURBS project working with air quality and urban health aspects. Another publication will be focused in more detail on results from Brno city and possible implications directly for Brno.

Cohort study
As described above, cohort study is divided into two seasons: spraying and non-spraying. The main portion of fieldwork for non-spraying season begun in mid-January 2020. The last sample for non-spraying season was collected in mid-March 2020. Thus the non-spraying season was successfully finished with samples from 111 families, exceeding required number of participants. Spraying season will begin at the end of May 2020. Primary results of this study will be turned into scientific paper providing summary on pesticide levels in human urine across Europe. Second intended paper will provide closer look and possibly more context to human exposure to pesticides in Czech Republic.