

The exploration of spatio-temporal patterns

An example of the campylobacteriosis
in the Czech Republic

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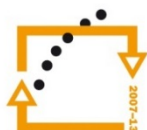
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MINISTERSTVO ŠKOLSTVÍ,
MLÁDEŽE A TĚLOVÝCHOVY

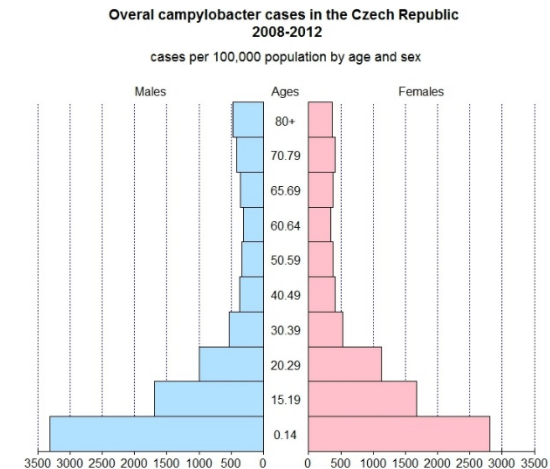


OP Vzdělávání
pro konkurenceschopnost

INVESTICE
DO ROZVOJE
VZDĚLÁVÁNÍ

Campylobacteriosis

- Campylobacter spp. (*C. jejuni*)
- Most frequent gastroenteritis in developed countries
- Often foodborne
- Children are the most vulnerable
- Seasonality
- Underreported



Data

- **EPIDAT** database
 - Mandatory records about infectious diseases and patients, manually fulfilled
 - Age, Sex, Date, Profession, Place of residence, infection, isolation, ...
 - 2008 - 2012
 - $\approx$ 100 000 records
 - (weakly) Anonymized
- Aggregation
 - Regular square network, municipal districts
- Statistical data
 - National census 2011
 - EUROSTAT population grid

Why Geographical Information Systems?

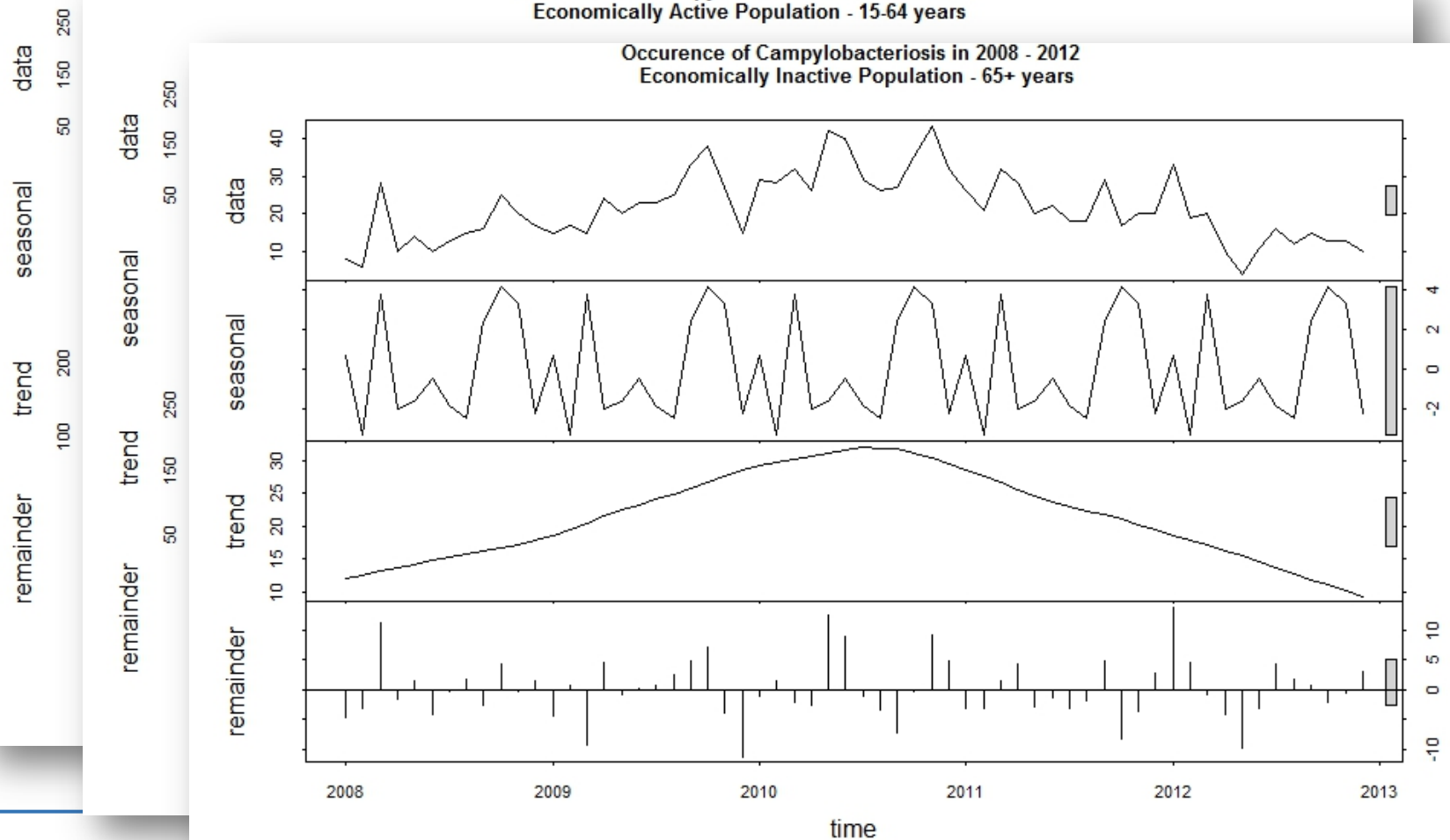
- Advanced methods for spatial analyses
- Spatial statistics
- Exploration of spatial pattern
- Visualization and presentation for non-geographers
(doctors, specialist)

Time

Occurrence of Campylobacteriosis in 2008 - 2012
Economically Inactive Population - 0-14 years

Occurrence of Campylobacteriosis in 2008 - 2012
Economically Active Population - 15-64 years

Occurrence of Campylobacteriosis in 2008 - 2012
Economically Inactive Population - 65+ years



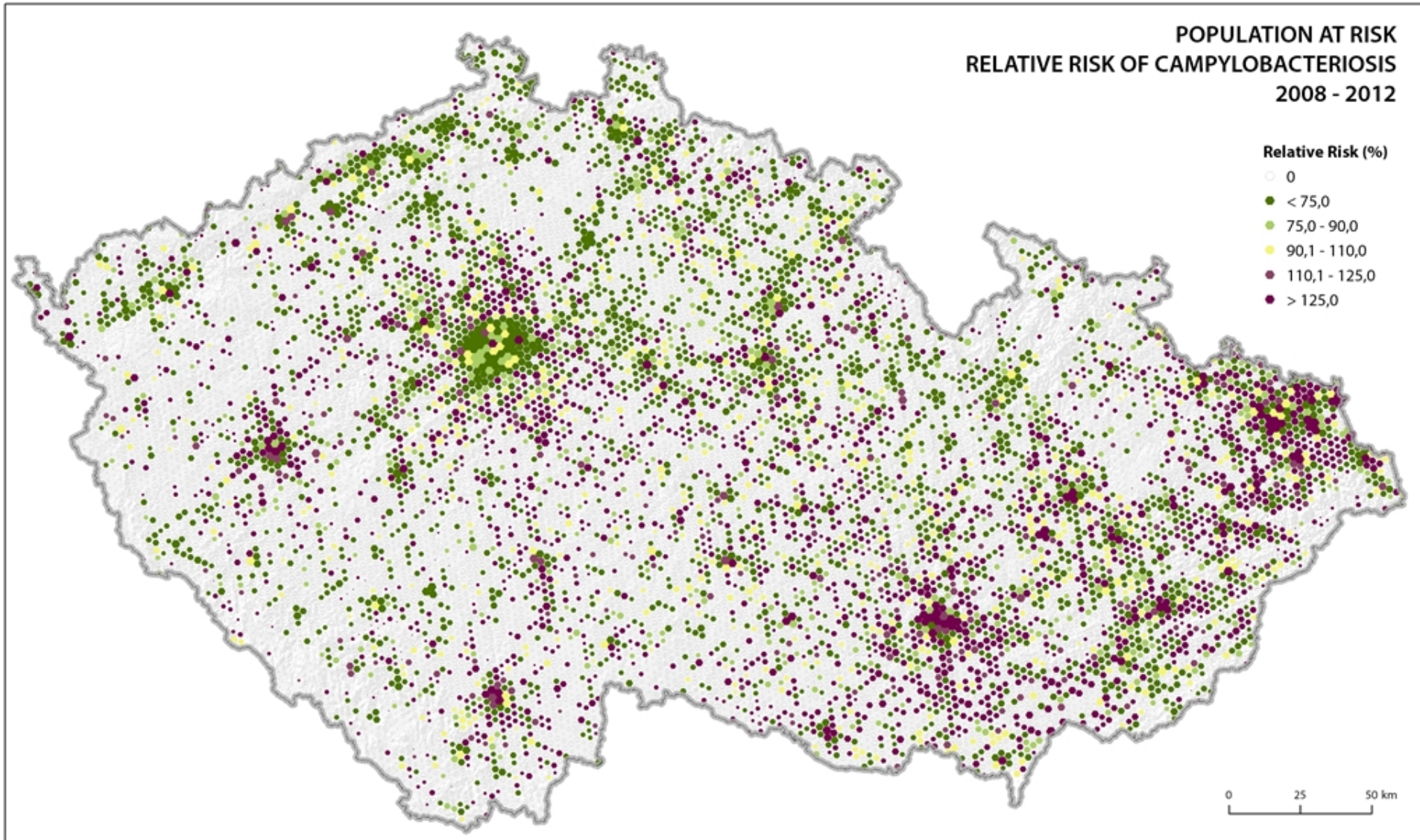
Spatial visualization

POPULATION AT RISK
RELATIVE RISK OF CAMPYLOBACTERIOSIS
2008 - 2012

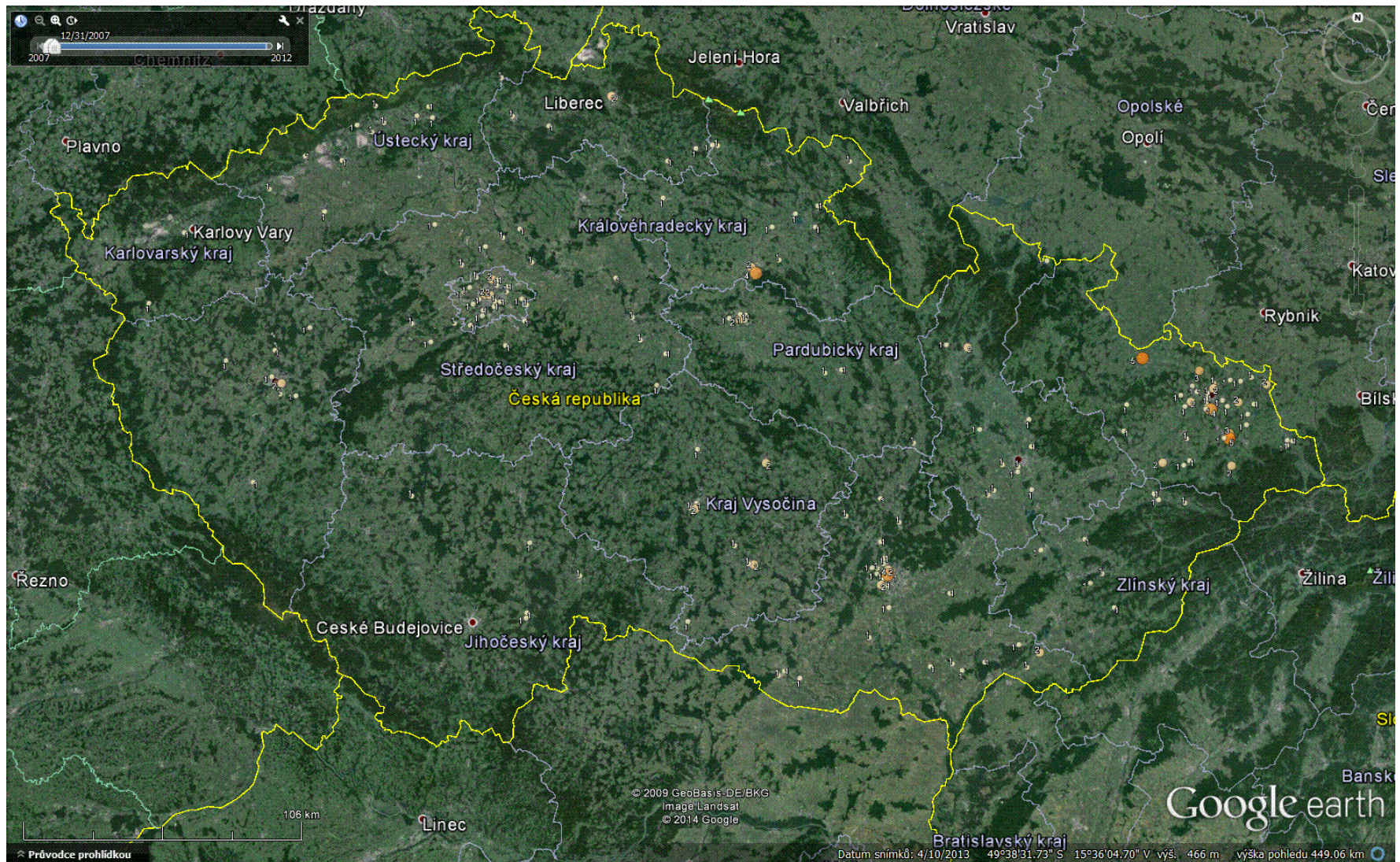
Relative Risk (%)

- 0
- < 75,0
- 75,0 - 90,0
- 90,1 - 110,0
- 110,1 - 125,0
- > 125,0

0 25 50 km

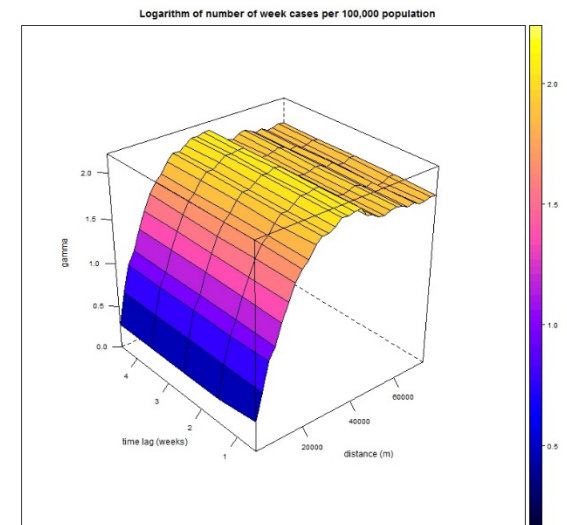
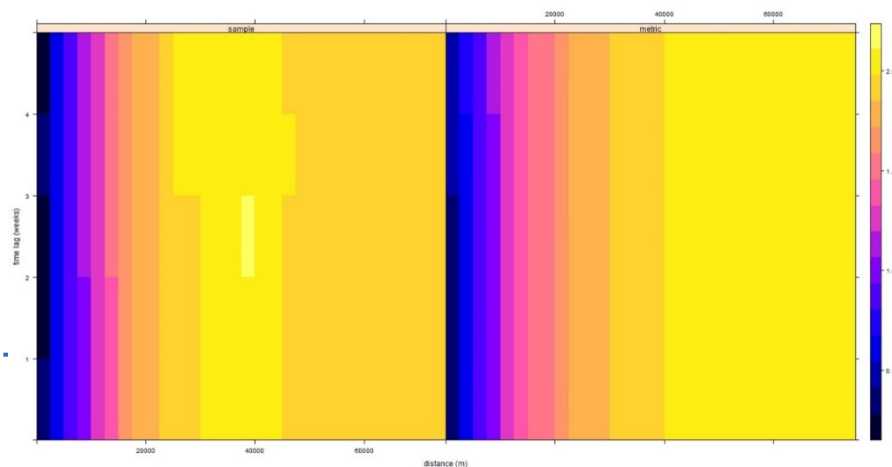


Spatio-temporal visualization

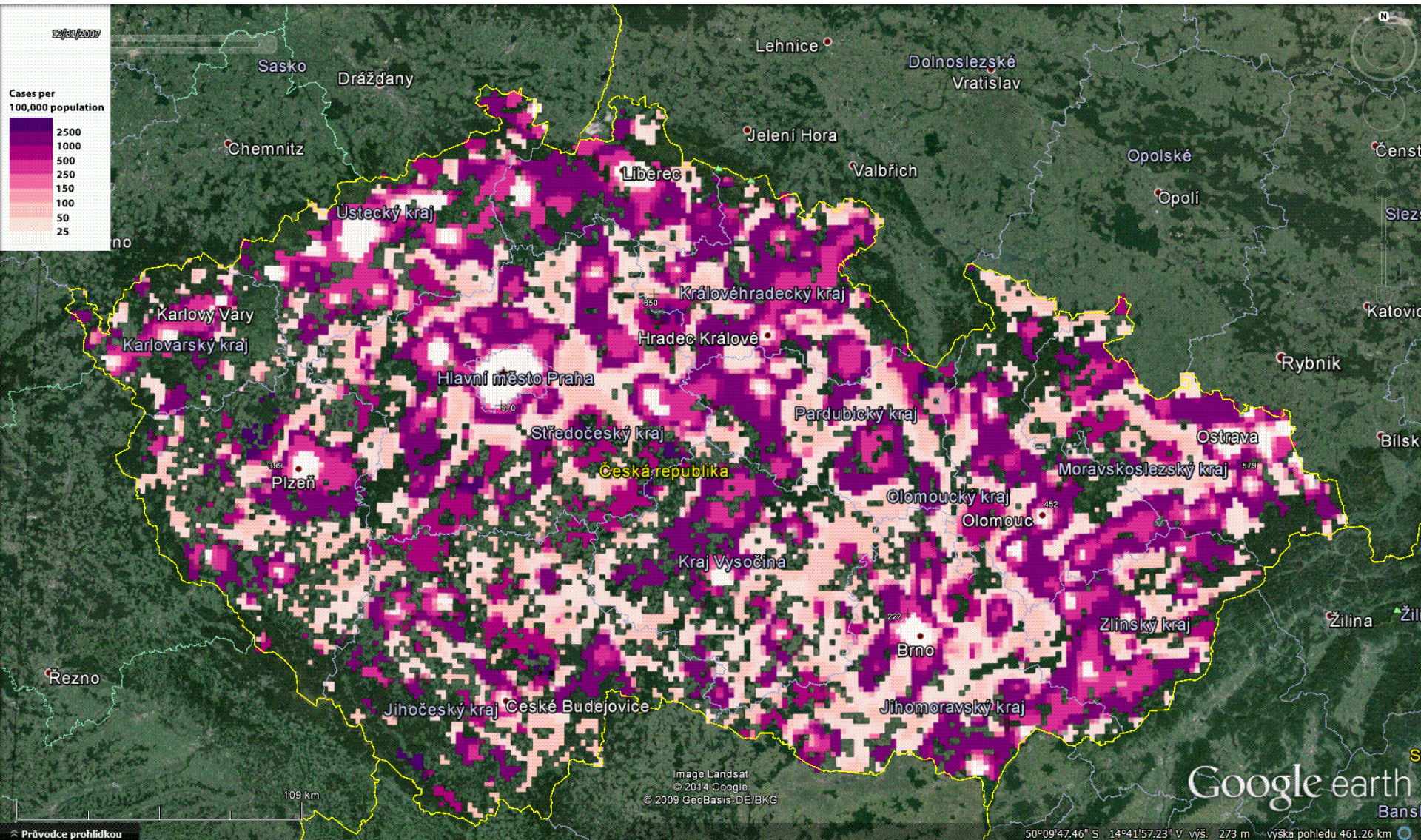


Spatio-temporal kriging

- Continuous incidence surface in populated places of the Czech Republic
- Exploration of the phenomenon's autocorrelation simultaneously in space and time
- Ordinary global spatio-temporal kriging



Spatio-temporal kriging





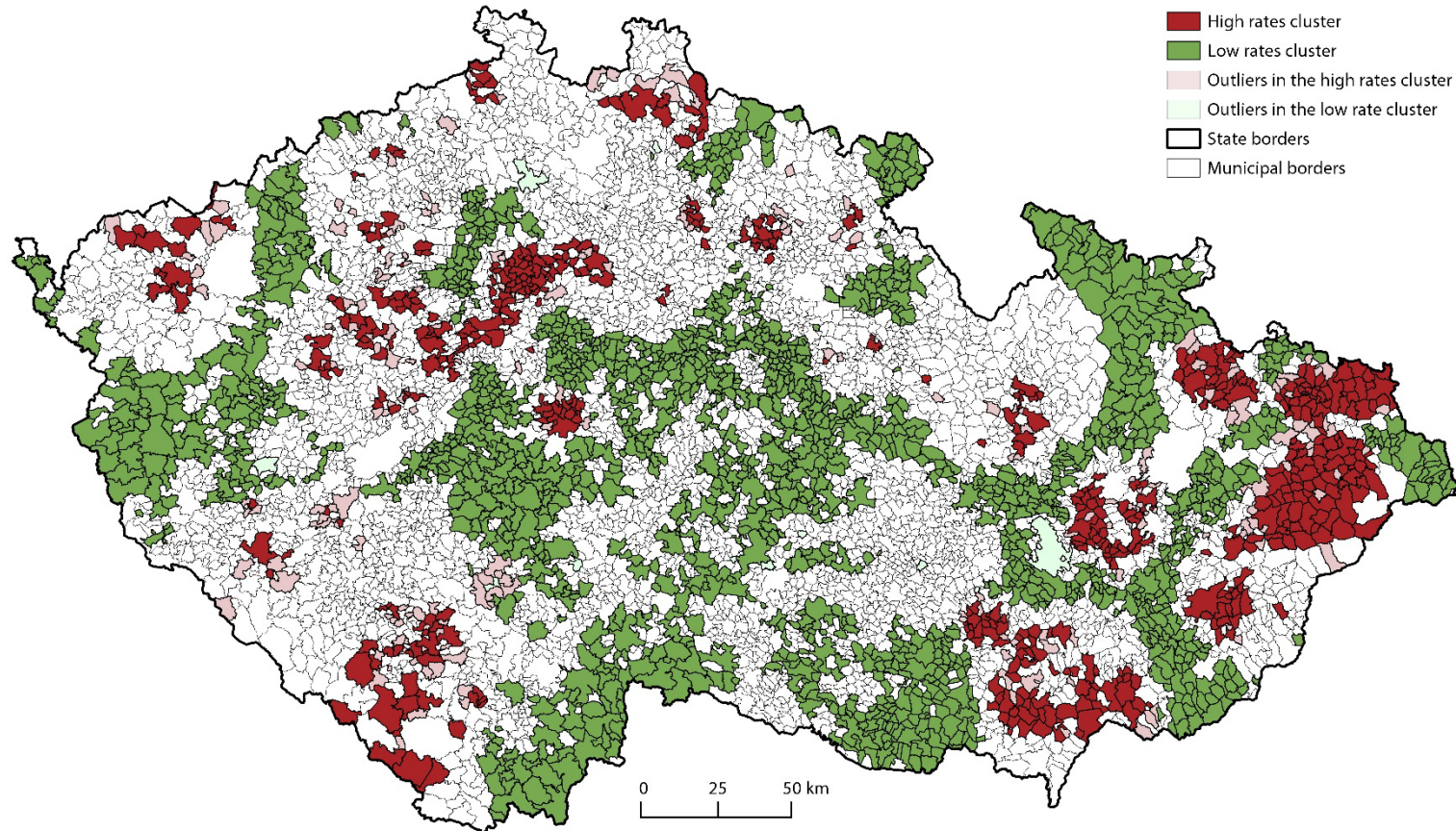
Spatio-temporal clustering

- Visual overview of the space-time pattern in Google Earth
- Spatial Scan Statistics
 - Identification of clusters of high and low rate areas together in the continuous geographical areas and time
- Age/sex stratified cases, age/sex stratified population, coordinates of centroids
- Weekly aggregated data

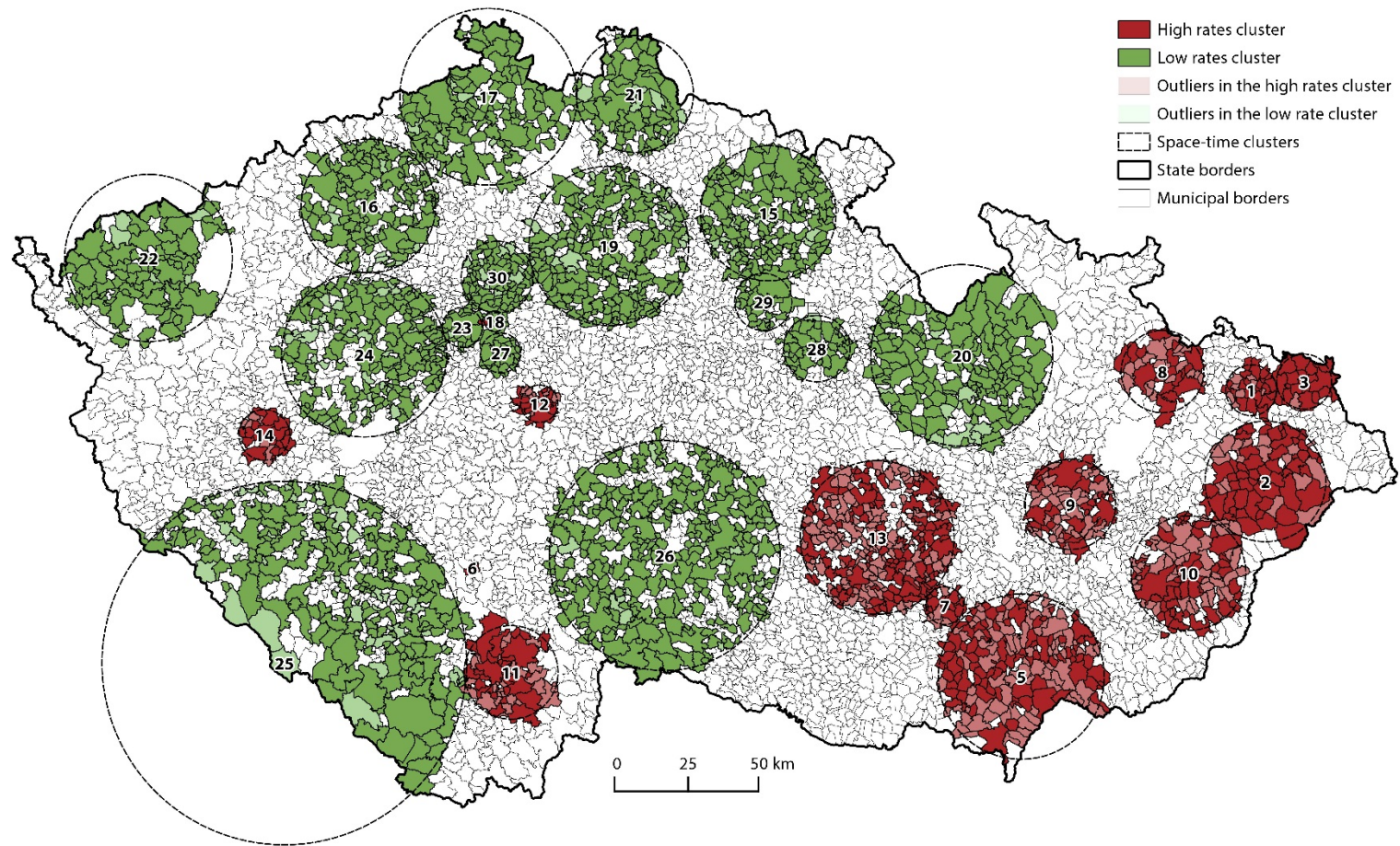
Spatio-temporal clustering

- Retrospective analysis based on Poisson probability model
- Clusters of maximum size of 3% of population, max. 50% of time or entire time period
- Non-parametric temporal adjustment
- Monte Carlo simulation, $p\text{-value} < 0.05$
- Comparison based on relative risk

Spatial clustering



Spatio-temporal clustering



Spatio-temporal clustering

Cluster	Type	Time period	Region	Count	Observed	Expected	Relative risk	Population
1*	H	2008/01/01 – 2012/12/31	Ostrava	31	5975	2861	2.16	292,978
2	H	2008/01/01 – 2012/12/31	North Wallachia - Lachia	70	5414	2788	2.00	277,236
3	H	2008/01/01 – 2012/12/31	Silesia	16	4773	2534	1.93	256,657
4	H	2008/01/01 – 2012/12/31	Prague - centre	1	1006	245	4.13	29,948
5	H	2008/05/13 – 2010/11/01	South Moravia	167	2274	1432	1.60	292,885
6	H	2008/01/01 – 2012/12/31	Dražič	1	72	2	41.92	214
7	H	2008/01/01 – 2012/12/31	Brno - centre	19	3951	2590	1.55	271,742
8	H	2008/01/01 – 2012/12/31	Opava	37	1714	877	1.97	87,203
9	H	2008/01/01 – 2012/12/31	Haná	66	3828	2526	1.54	256,721
10	H	2009/04/14 – 2011/09/05	South Wallachia	90	1596	932	1.72	196,522
11	H	2010/01/12 – 2010/02/22	Budweis	60	194	36	5.41	157,425
12	H	2008/01/01 – 2012/12/31	Benešov	15	640	313	2.05	31,115
13	H	2010/04/06 – 2010/10/04	Brno - surroundings	224	568	286	1.99	284,346
14	H	2011/05/03 – 2011/11/14	Pilsen	22	394	201	1.96	197,263



Conclusions

- Space – time aggregation and visualization for visual analytics
- Continuous incidence surface describing spatial and temporal progress of the disease
- Scan statistics identifying high and low rate clusters as well as their temporal support
- Visualization in Google Earth

THANK YOU FOR YOUR ATTENTION

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INVESTMENTS IN EDUCATION DEVELOPMENT