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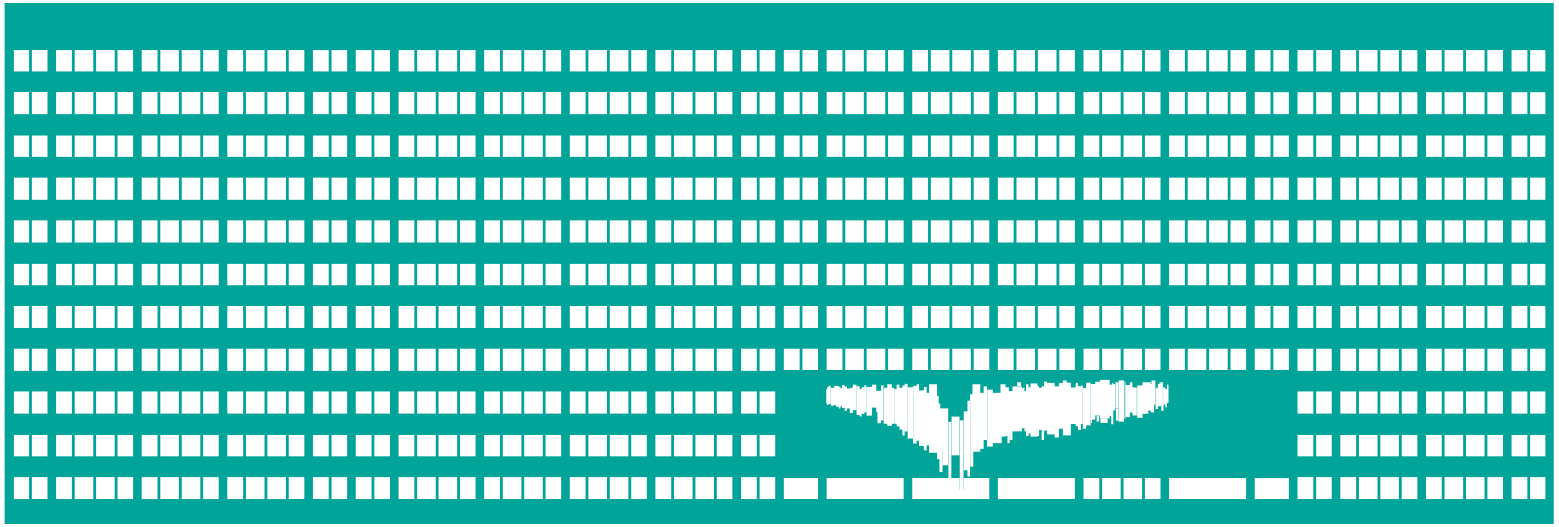

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Possibilities of using GIS and GIT in the field of TBD studies

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Who I am?

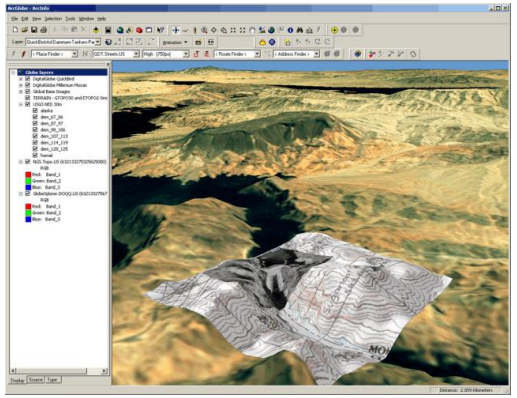
- geographer and geoinformatician
- Since 2008 I participate in the field of tick-borne diseases research with the Institute of Parasitology, Biology Centre AS CR, České Budějovice, Czech Republic and other organizations
- My role?
- Map creation and publication, field mapping, data acquisition, analysis, modeling etc.

Geoinformation Technology include:

- GIS – Geographical information system

- RS – Remote Sensing
- GNSS – Global navigate satellite systems (GPS)

- Mobile maps
- Digital Terrain Model (DTM)



- And many others

What can GIT offer for you?

- Analysis and selection of tick sampling sites
- Field research including GPS measurement + on-line or off-line mapping
- Data analysis + data visualisation (finding of hotspots, data interpolation etc.)
- Creation of the maps
- Deriving / acquiring data e.g. from satelite images (NDVI etc.)
- Construction of the model for TBD risk prediction
- Creation of on-line map portal with the results of your research for general public

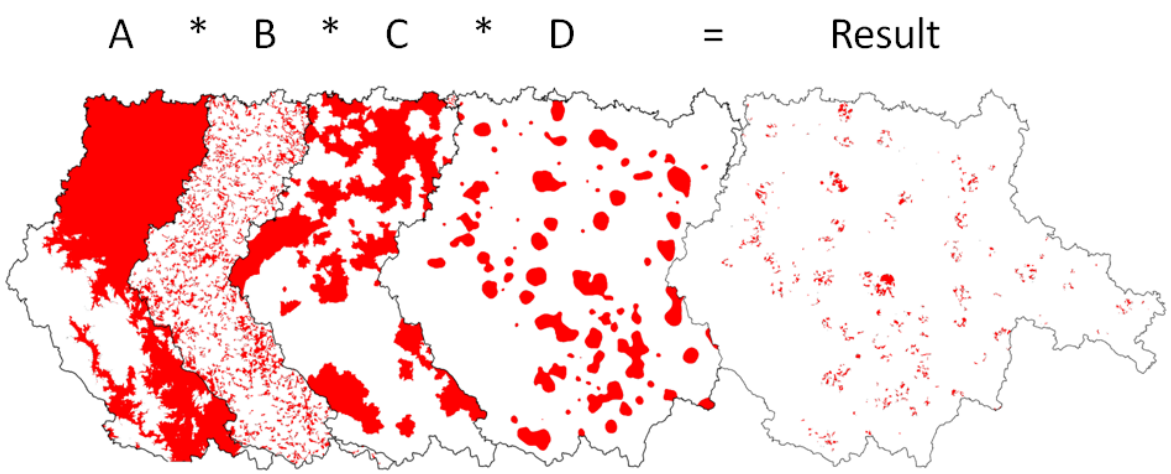
Practical examples of realised projects

- **Project „Ticks and tick-borne diseases in South Bohemia and Bavaria“ (2008 - 2011)**

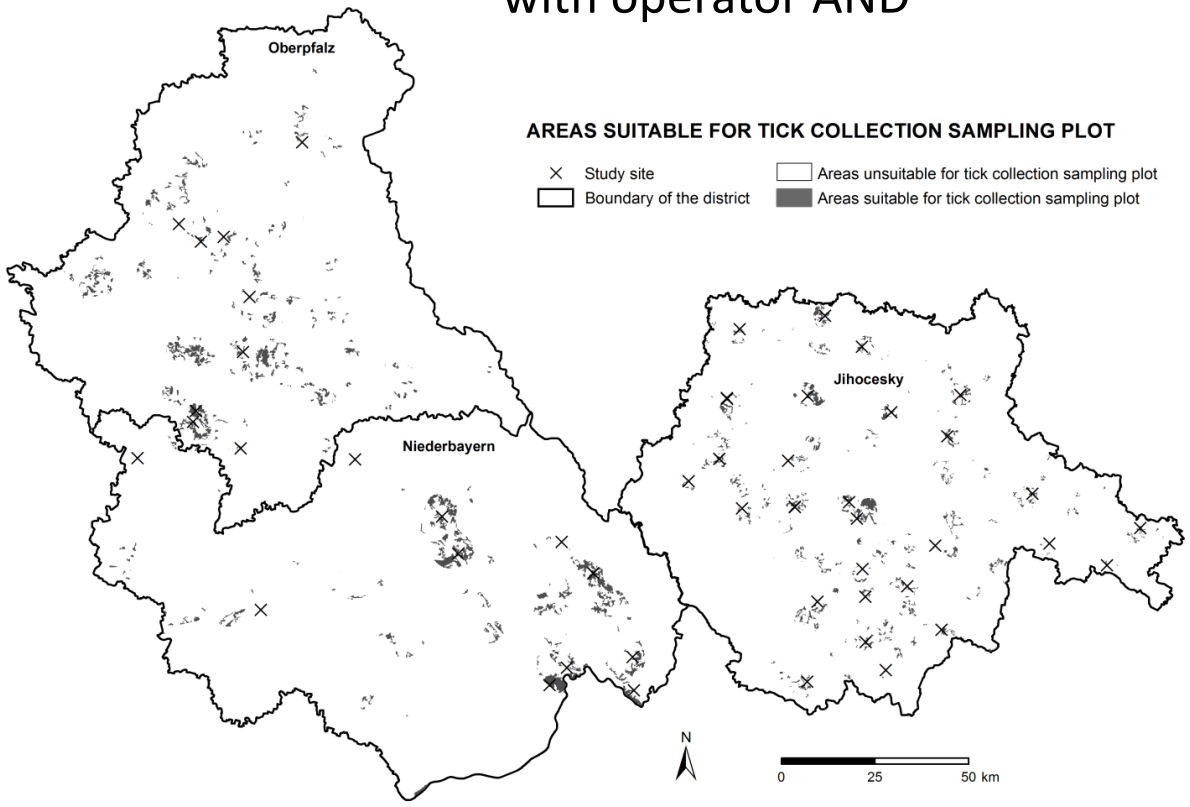
- **The aims of the project were**
- a) mapping the occurrence of ticks and causative agents of tick-borne encephalitis and Lyme borreliosis
- b) identification of the key factors that influence the distribution of the disease risk, based on the data acquired by mapping
- c) construction of a model for TBD risk prediction

- **First task**
- Find 50 study sites in South Bohemia and Bavaria based on some objective criterion

Analysis and selection of tick collection sites and field research



We used Boolean multicriteria evaluation (MCE) with operator AND



Criteria:
Vegation cover (CORINE)
Occurrence of cases of tick borne encephalitis
Altitude
Tourist and recreational attractivity

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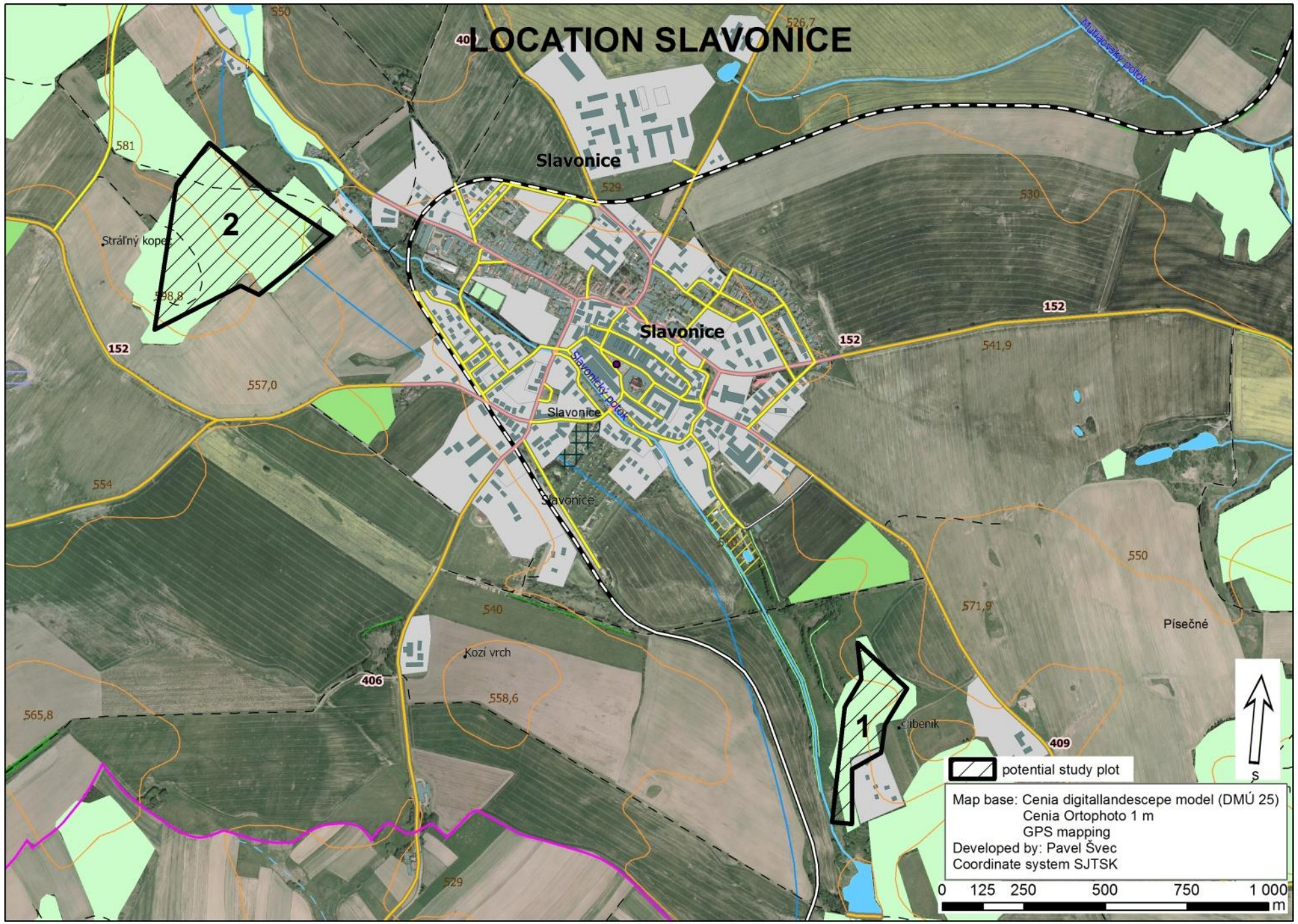

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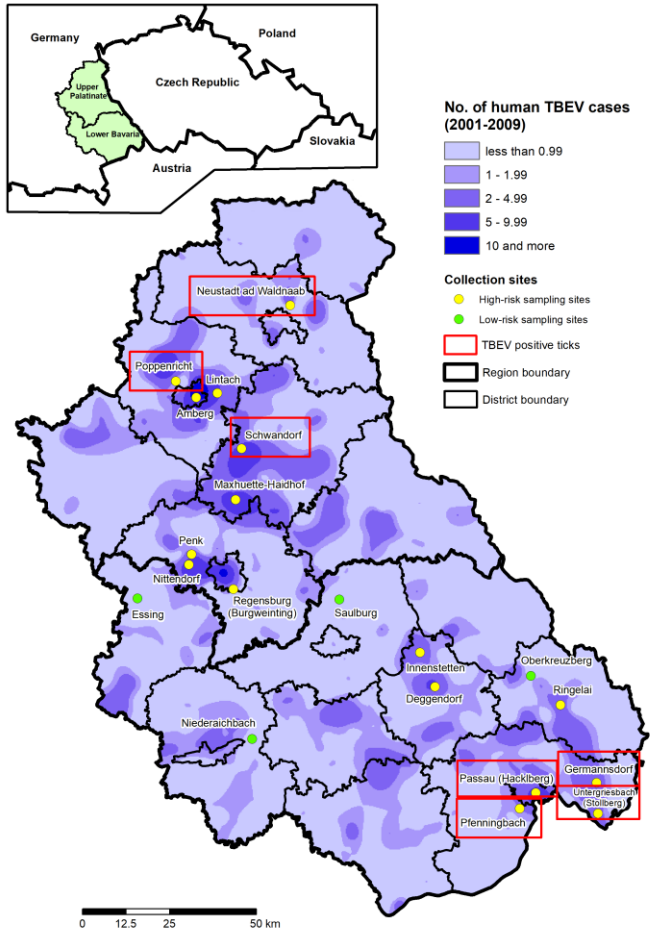
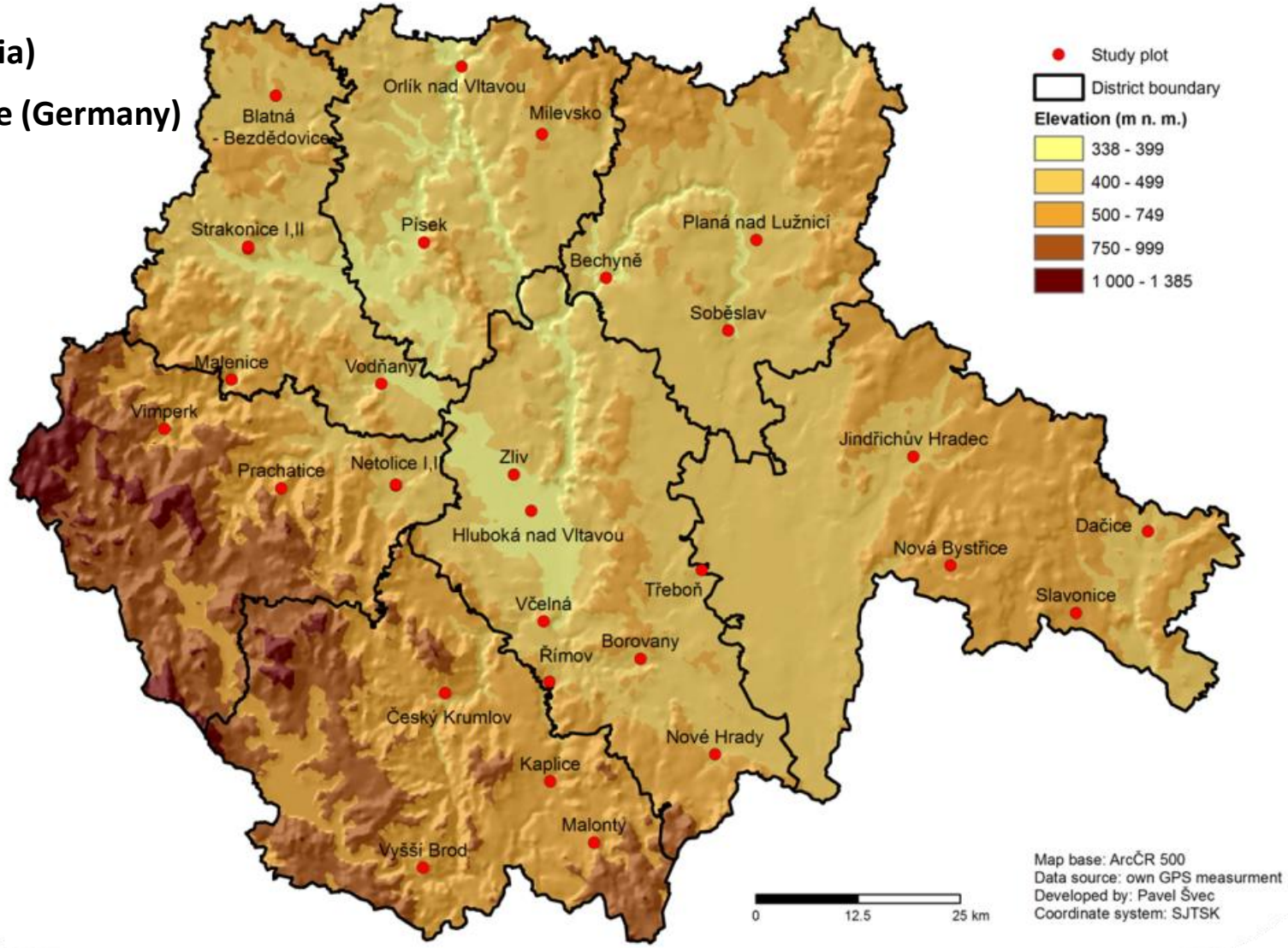
Tick sampling of study plots in the South Bohemian Region (2008)

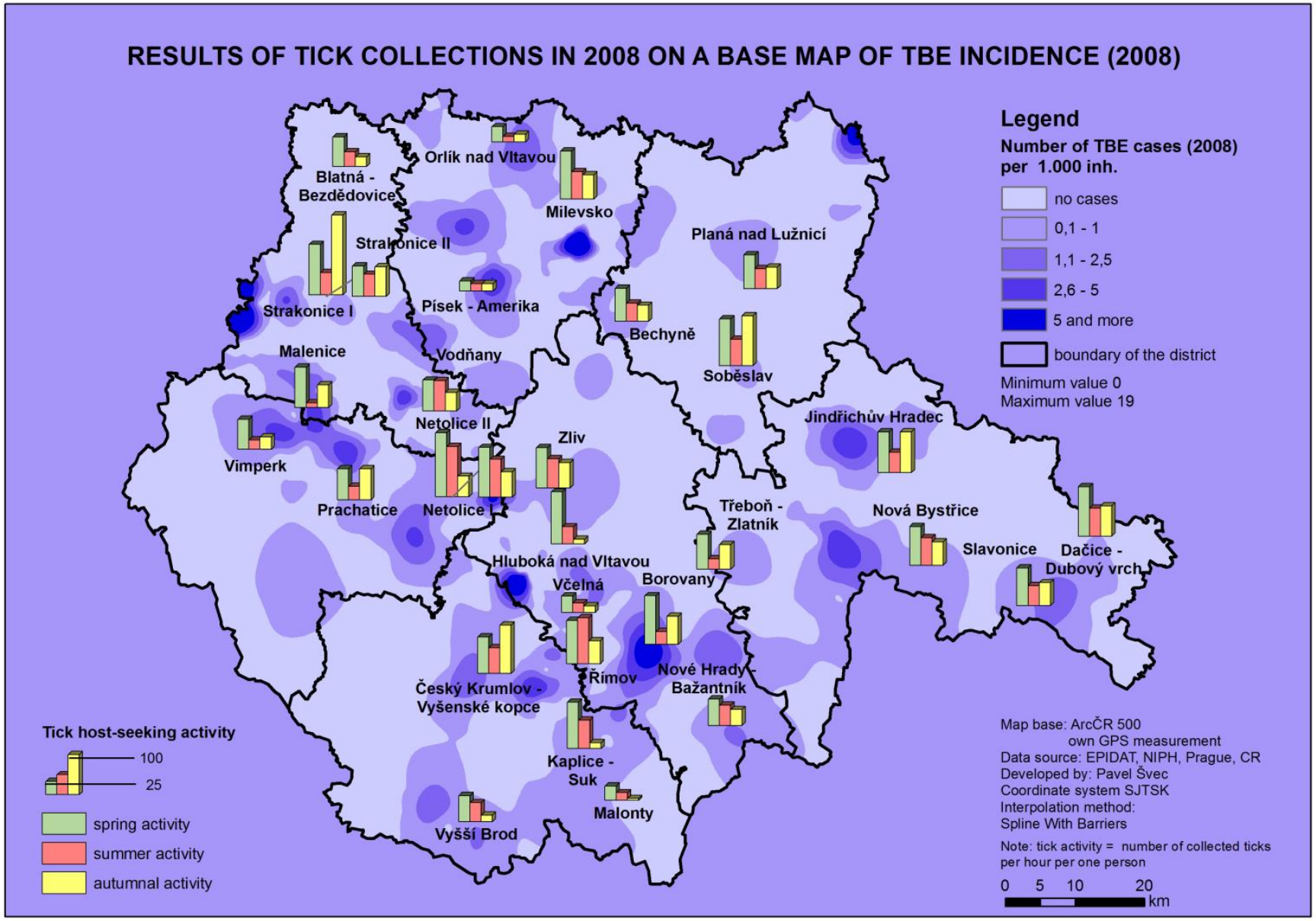
- **30 study plots in the South Bohemian Region (Czechia)**
- **20 study plots in Lower Bavaria and Upper Palatinate (Germany)**





Zubriková D, Wittmann M, Hönig V, Švec P, Víchová B, Essbauer S, Dobler G, Grubhoffer L, Pfister K. **Prevalence of tick-borne encephalitis virus and Borrelia burgdorferi sensu lato in Ixodes ricinus ticks in Lower Bavaria and Upper Palatinate, Germany**. Ticks Tick Borne Dis. 2020 May;11(3):101375. doi: 10.1016/j.ttbdis.2020.101375. Epub 2020 Jan 15. PMID: 31983627.

Švec, P., Hönig, V., Daniel, M., Danielová, V., Grubhoffer, L., 2009. **Využití GIS pro mapování klíšťat a klíšťaty přenášených patogenů v Jihočeském kraji.** Geografie, 114, č. 2009/3, s. 157-168.



Sampling done using the „flagging“ method

Ticks were sampled in spring, summer, autumn. Total 28,257 ticks (20,057 in the South Bohemian Region)

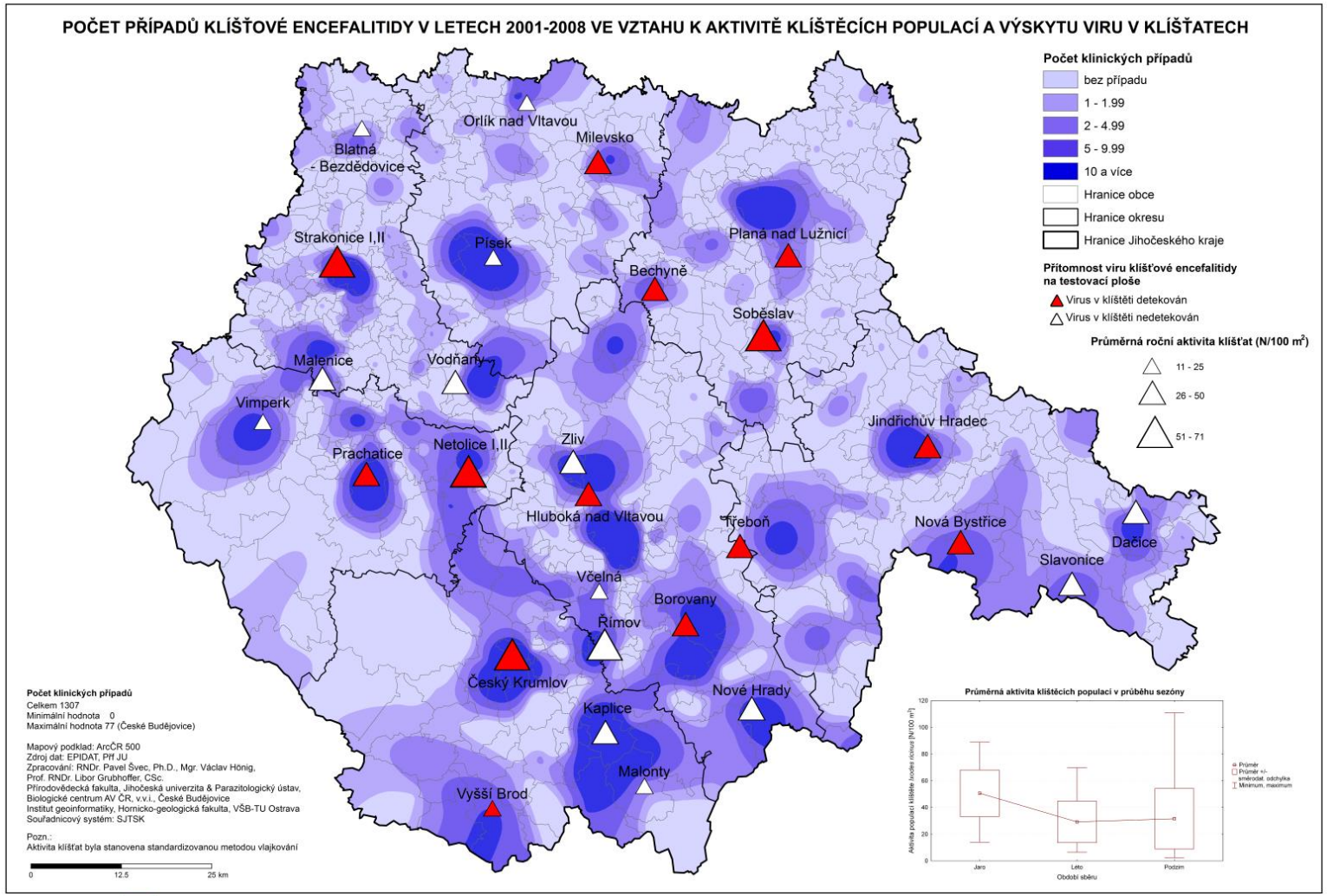
The tick activity was highly variable 1-110 nymphs/100 m²

Laboratory testing for TBEV and LB spirochetes

Zubriková D, Wittmann M, Hönig V, Švec P, Víchová B, Essbauer S, Dobler G, Grubhoffer L, Pfister K. **Prevalence of tick-borne encephalitis virus and Borrelia burgdorferi sensu lato in Ixodes ricinus ticks in Lower Bavaria and Upper Palatinate, Germany**. Ticks Tick Borne Dis. 2020 May;11(3):101375. doi: 10.1016/j.ttbdis.2020.101375. Epub 2020 Jan 15. PMID: 31983627.

Honig, V., Švec, P., Halas, P., et al. 2015: **Ticks and tick-borne pathogens in South Bohemia (Czech Republic) – Spatial variability in Ixodes ricinus abundance, Borrelia burgdorferi and tick-borne encephalitis virus prevalence.** Ticks and Tick-borne Diseases. Vol. 6., No. 5., 559-567.

- **LB spirochetes were present in all locations – prevalence of LB spirochetes from 2 to 20%**
- **TBEV was not present in all locations – prevalence of TBE virus from 0 to 1.22% (see map)**



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Construction of the model for TBD risk prediction

- 3 different approaches (map algebra, regression and classification trees, generalized least squares method)
- The final model is based on the method of the generalized least squares and is statistically significant
- In the **tick activity model** a **Poisson regression** model was used
- **Logit** model was used for **prediction of tick infection by TBEV and LB spirochetes**
- **Model is based on combination of information from field survey (laboratory testing results), remote sensing (NDVI, LST) and spatial data from GIS (elevation, number of tick-borne disease cases)**
- Models were designed and tested in STATISTICA 9, subsequently applied in the ArcGIS (Raster calculator)

Table 1. Environmental and other accessory data used for model construction and testing *.

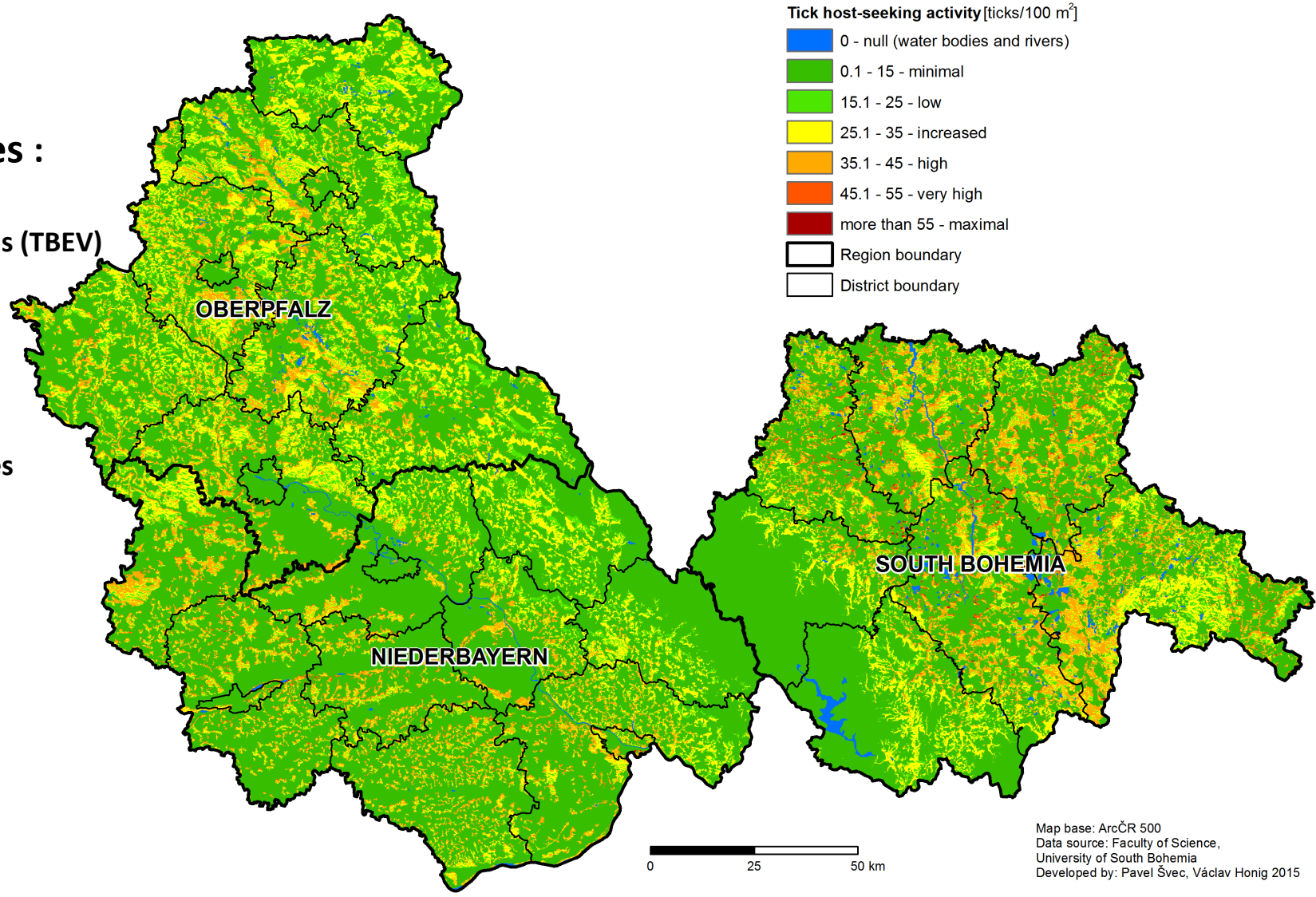
Type of Data	Data	Description	Source Czech Rep.	Source Bavaria
Epidemiological	number LB cases number TBE cases	disease cases per municipality	National Institute of Public Health, Prague	RKI, Berlin; local public health authorities
Demographic	number of inhabitants	number of inhabitants per municipality	Czech Statistical Office	Federal Statistical Office Germany
Physical-geographical	altitude slope exposition	digital elevation model	ArcCR500, ArcDATA, Prague	Vektor 500, ATKIS® Basis DLM, Bayerische Vermessungsverwaltung
Climatic	land surface temperature (LST)	MODIS Land Surface Temperature, 1000 m raster	NASA, LP DAAC	NASA, LP DAAC
Vegetation cover	NDVI	MODIS NDVI, 250 m raster	NASA, LP DAAC	NASA, LP DAAC
	forest type	CORINE landcover 2006, 100 m raster	EEA	EEA

* LB—Lyme borreliosis; TBE—tick-borne encephalitis; NDVI—normalized difference vegetation index; RKI—Robert Koch Institute; NASA, LP DAAC—National Aeronautics and Space Administration, Land Processes Distributed Active Archive Center; EEA—European Environment Agency.

- **Models divided into three categories :**
  - **1) Activity of ticks (ticks/100 m^2)**
  - **2) Occurrence of tick-borne encephalitis virus (TBEV)**
  - **numbers of cases,**
  - risk of being attacked by an infected tick,
  - activity of infected ticks

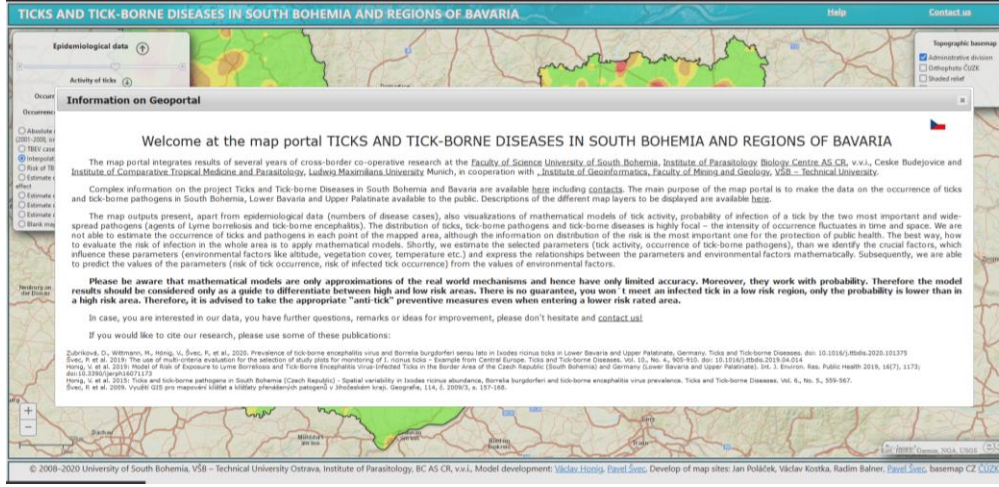
  - **3) Occurrence of Lyme borreliosis spirochetes**
  - numbers of cases,
  - risk of being attacked by an infected tick,
  - activity of infected ticks

- **Available for:**
- **spring**
- **summer,**
- **autumn**
- **no season**

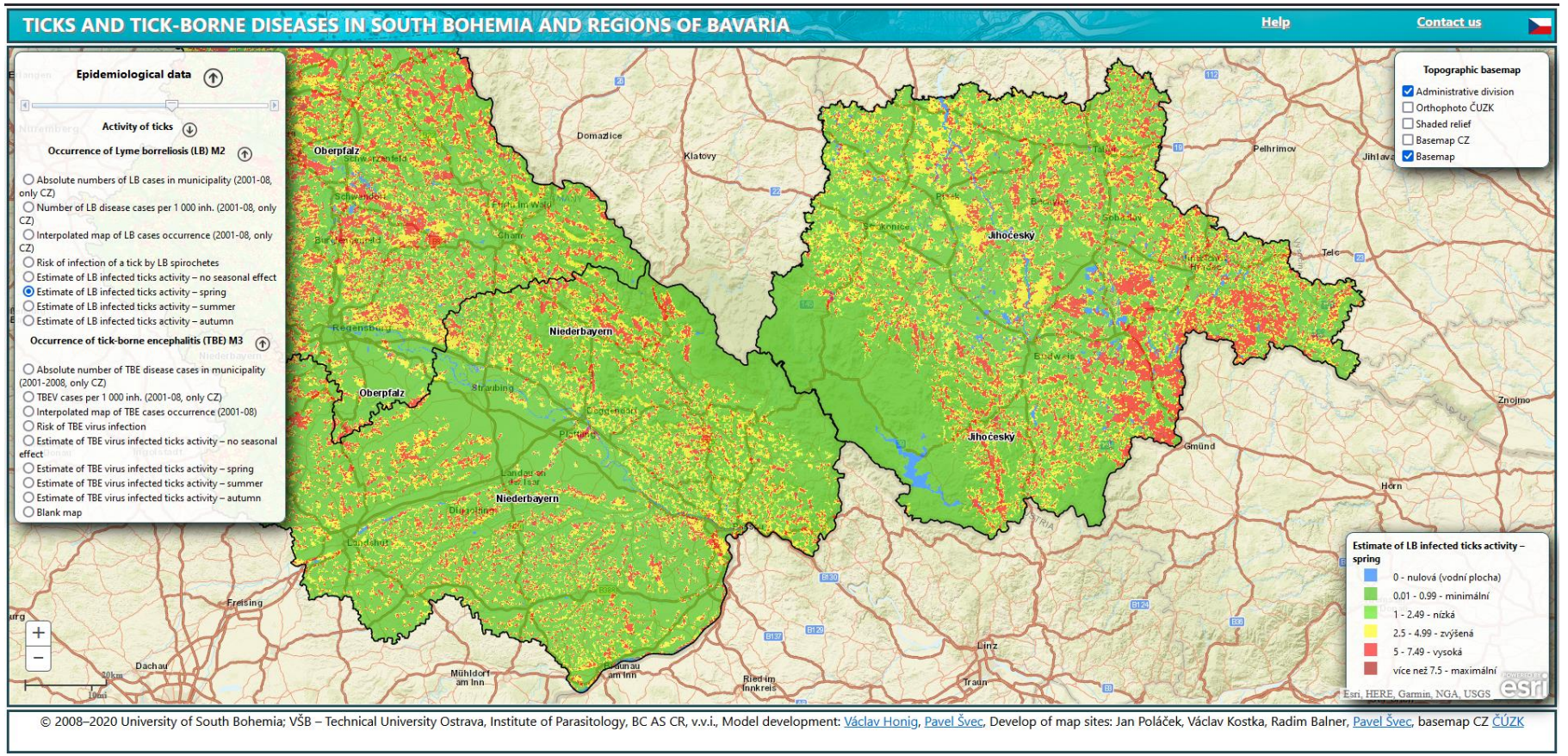


Honig, V., Švec, P., Marek, L., et al. 2019: **Model of Risk of Exposure to Lyme Borreliosis and Tick-Borne Encephalitis Virus-Infected Ticks in the Border Area of the Czech Republic (South Bohemia) and Germany (Lower Bavaria and Upper Palatinate).** ***Int. J. Environ. Res. Public Health*** 2019, *16*(7), 1173; doi:10.3390/ijerph16071173

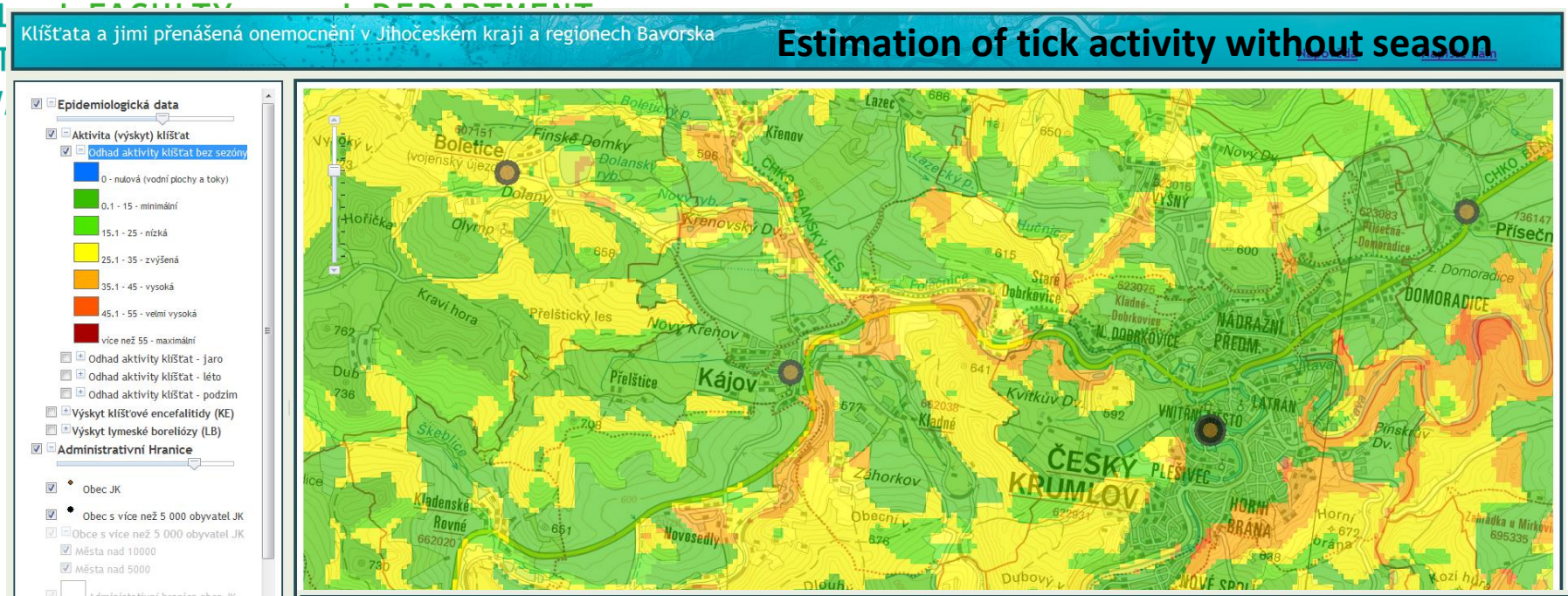
Creation of map portal



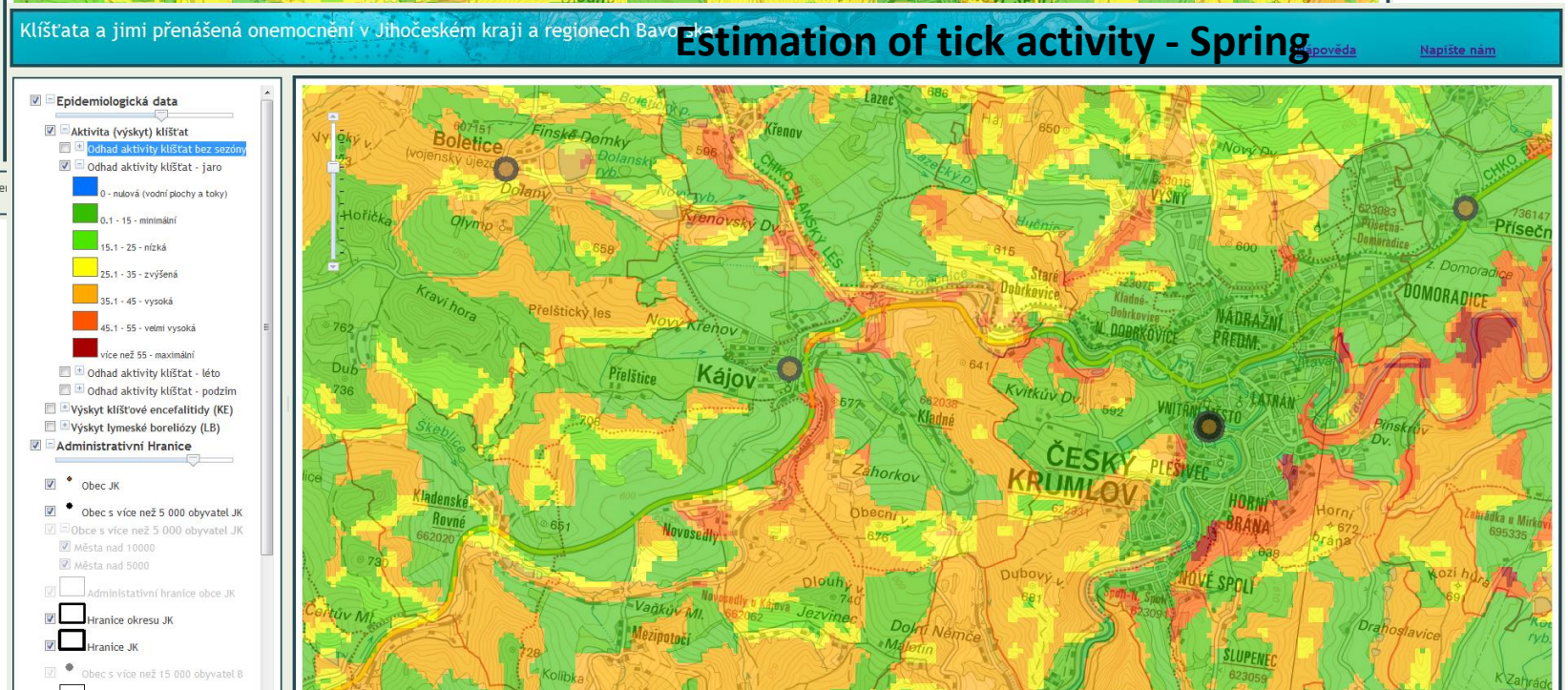
- Project results are open to the general public at: gis.vsb.cz/klistata
- Map portal uses a ArcGIS Server platform + ArcGIS on-line
- The main part of the application shows epidemiological data



Estimation of tick activity without season



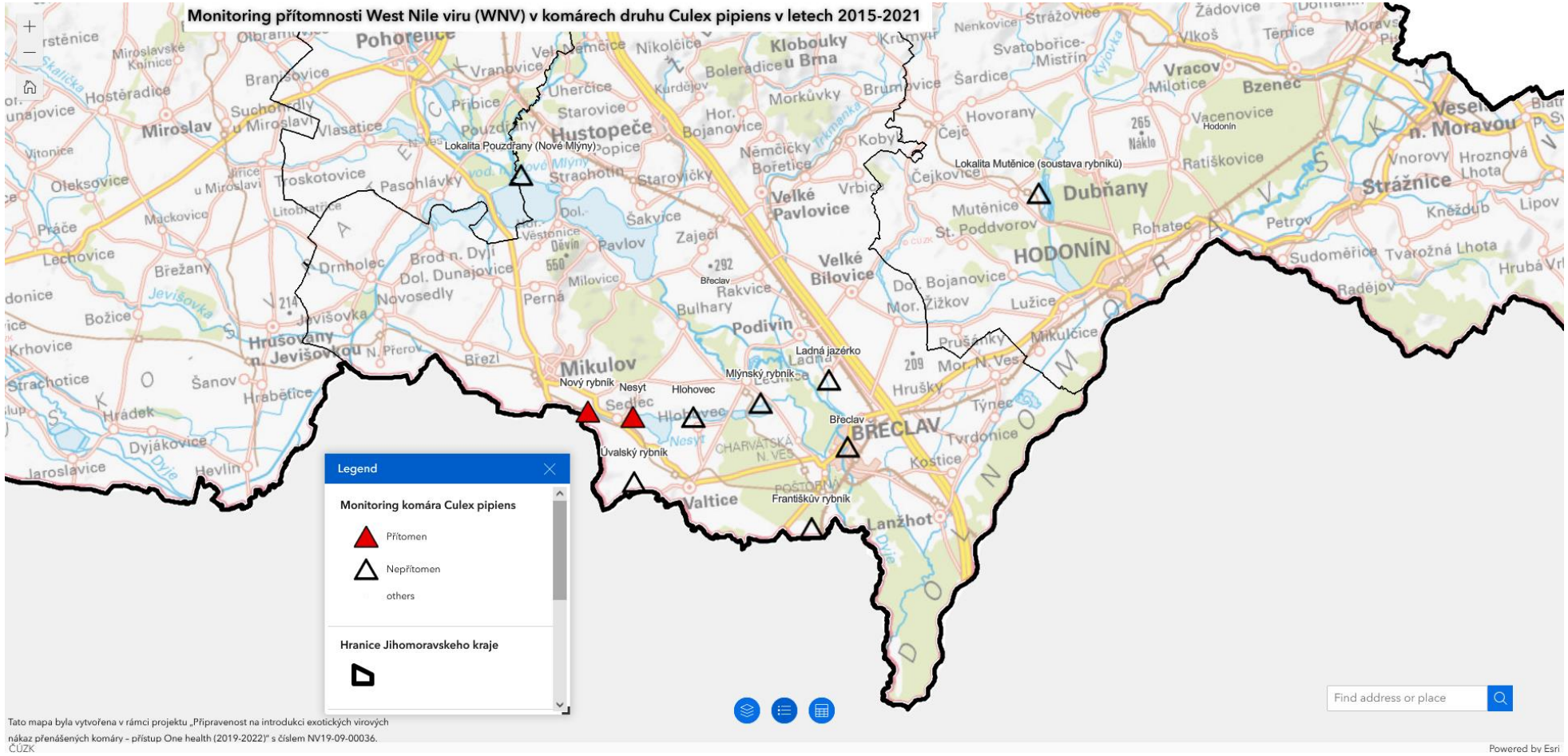
Estimation of tick activity - Spring



Another examples

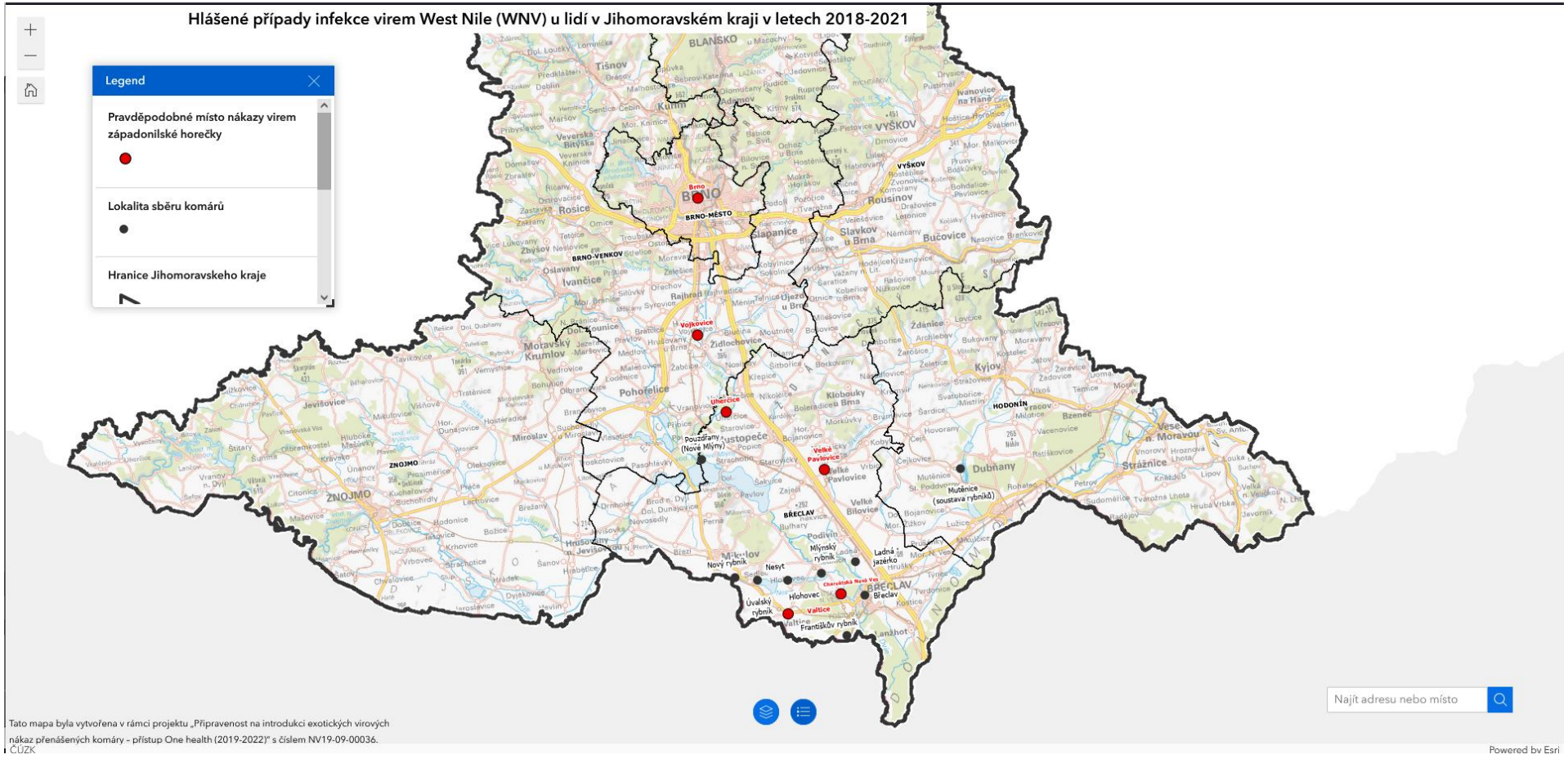
- Preparedness for introduction of exotic mosquito-borne viral fevers - One Health approach
- Mosquito-borne viral pathogens
- The project involved entomological surveillance of mosquitoes of public health importance including introduction of dangerous invasive species (mainly 'Asian tiger mosquito' *Aedes albopictus*)

Monitoring the presence of West Nile virus (WNV) in Culex pipiens mosquitoes in the years 2015-2021



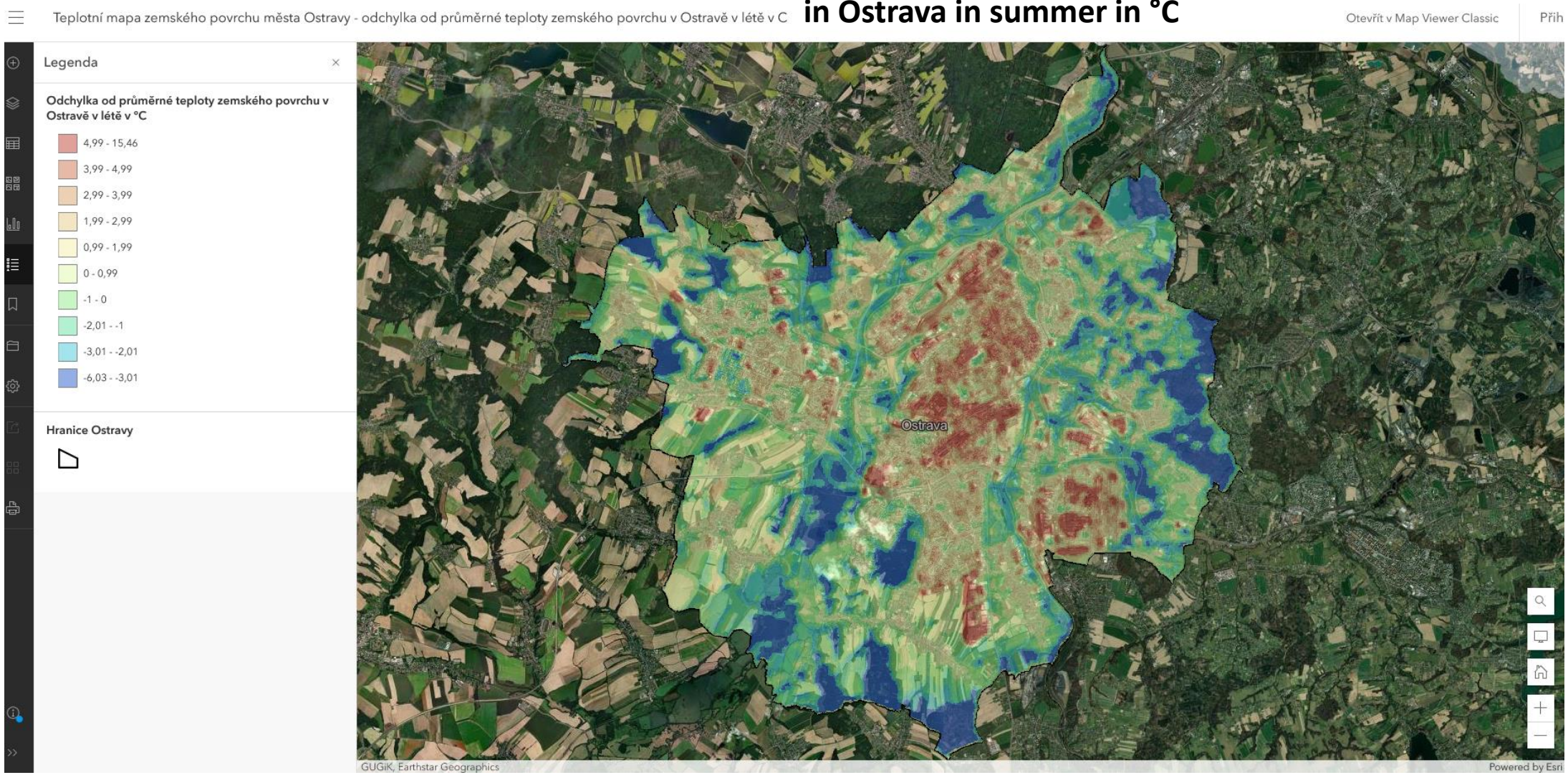
- https://experience.arcgis.com/experience/85ceea8ab8af47a880ea27c9834789c0/

Reported cases of West Nile virus (WNV) infection in people in the South Moravian Region in 2018-2021 (autochthonous cases only)



- https://experience.arcgis.com/template/bd2f1b94ee594aa0854e7bec249d5255/

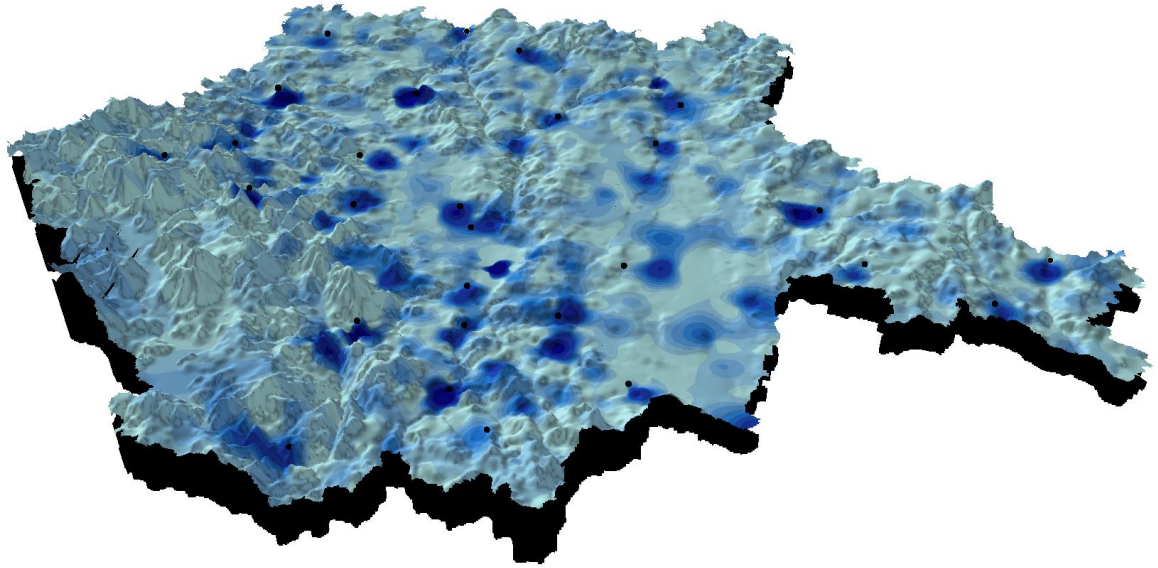
Temperature map of land surface of the city of Ostrava - deviation from the average temperature of the earth's surface in Ostrava in summer in °C



- https://vsb-tuo.maps.arcgis.com/apps/mapviewer/index.html?webmap=a9fc5ff2a1ee4904ad6f7202716f13c0

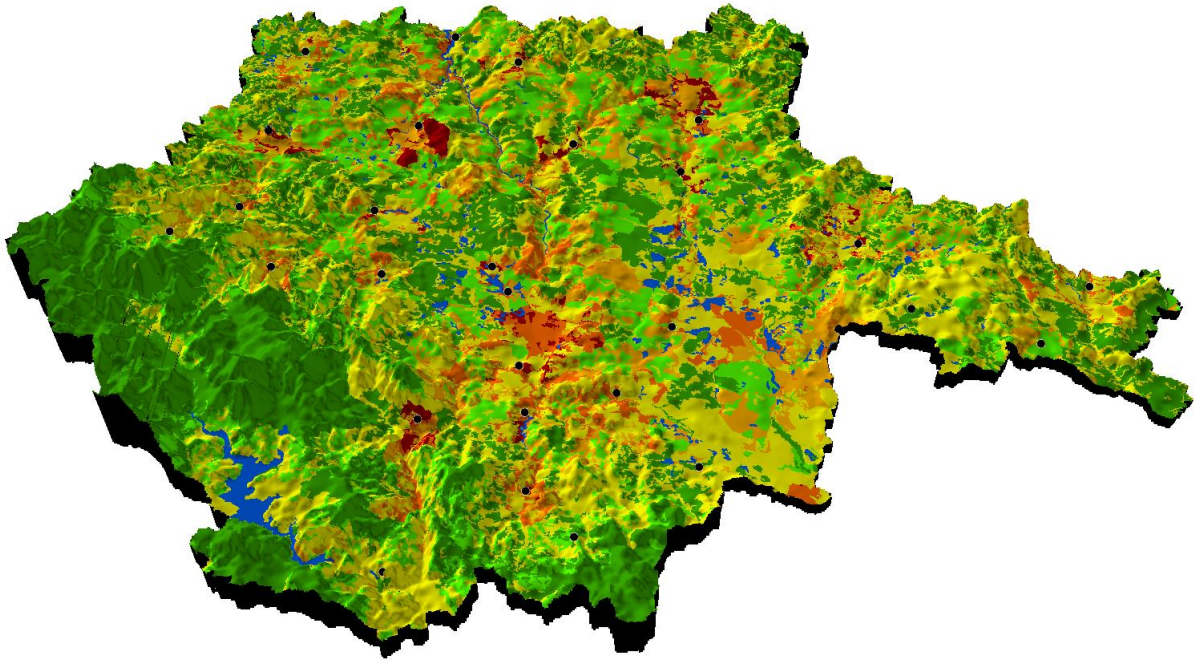
Visualization

Number of cases of TBE in 3D
(visualization on 3D terrain model)

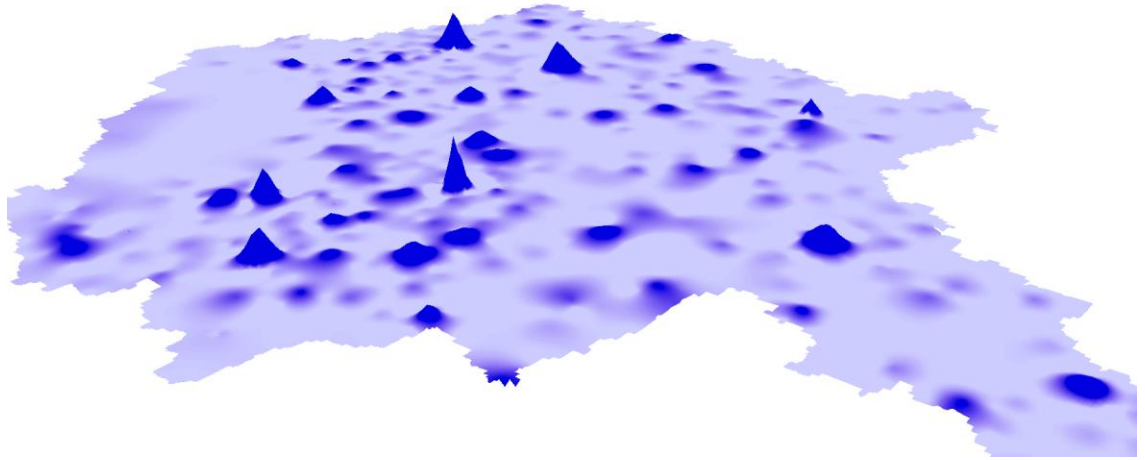


Model risk of TBE in 3D

(visualization on 3D terrain model)



Number of cases of TBE in 3D



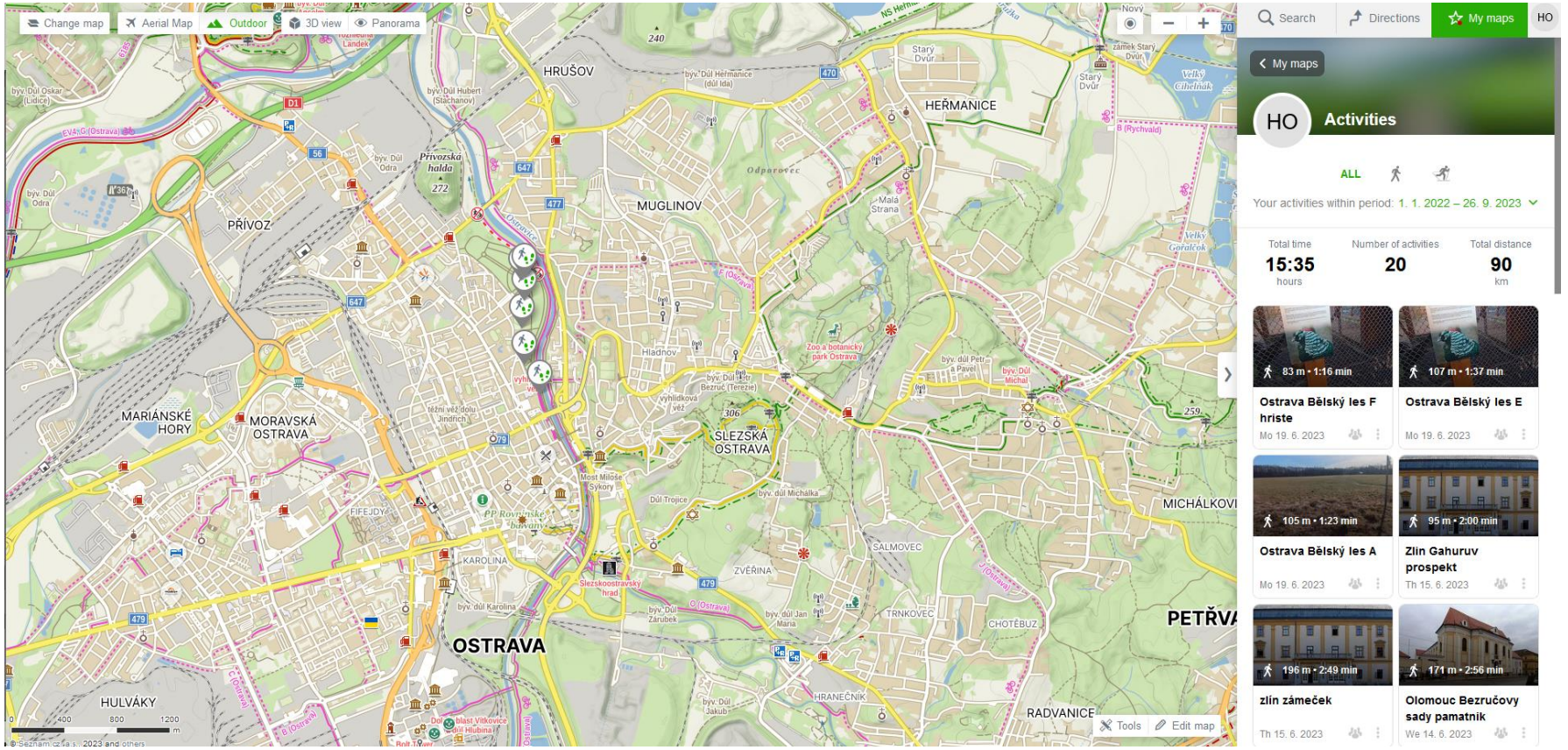
On-line mapping example

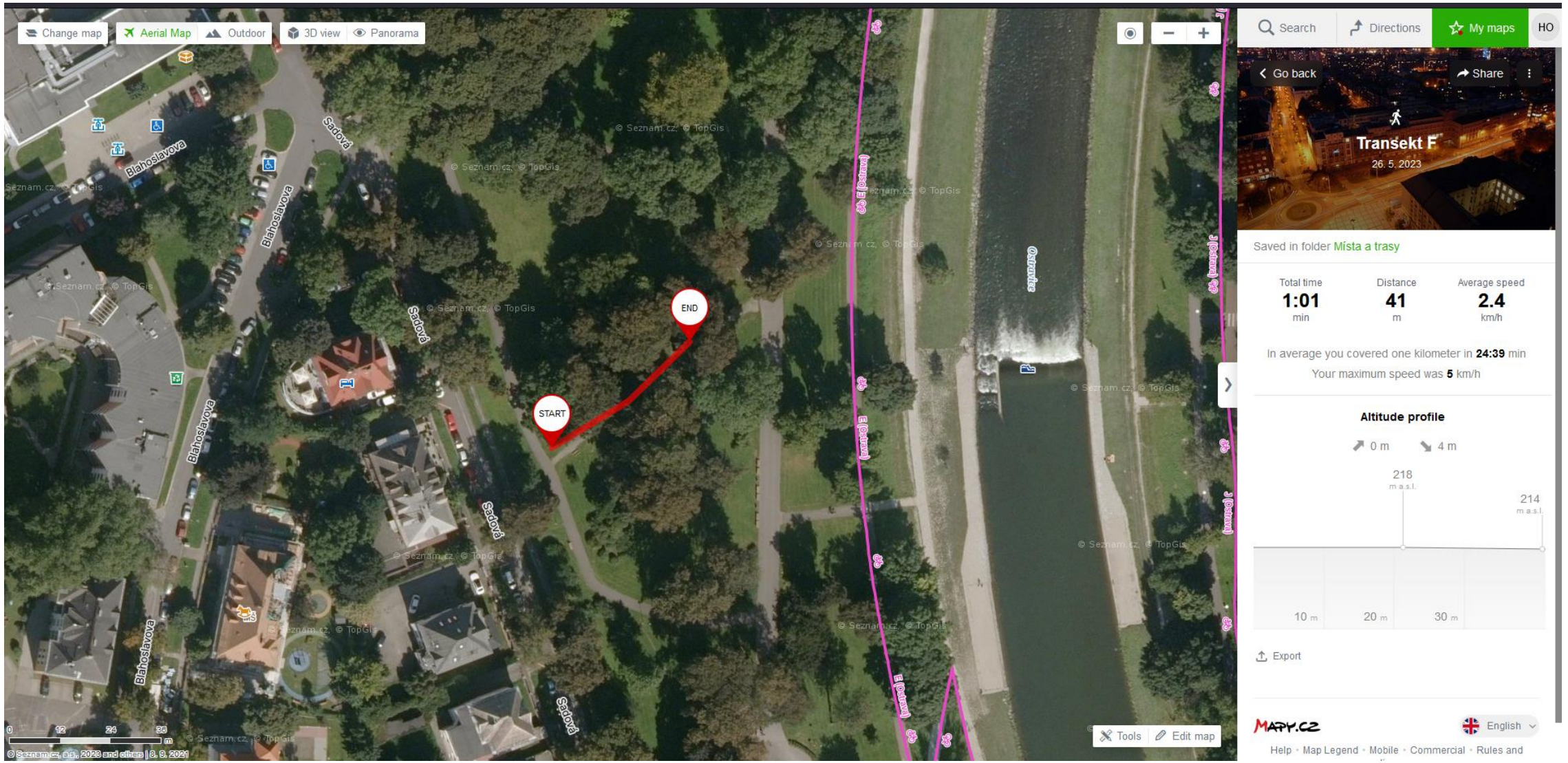
Catch a tick – live mapping example

https://vsb-tuo.maps.arcgis.com/apps/mapviewer/index.html?webmap=8dc3ed01e5084cf2a0e65384117d698e

Ongoing project „Ticks in the city“

- Easily GPS mapping with Mapy.cz





https://en.mapy.cz/s/joromodede

Advantages and perspectives on the use of GIT in the field of TBD (healthcare) from the point of view of a geographer and geoinformatics (Conclusions)

- An **objective approach to the studied issue - It allows finding spatial relationships and linkages**
- The possibility of finding connections that are not possible with the classic approach
- **Creation of maps** of prevalence, incidence, etc.
- Use of statistical methods
- The possibility of **publishing the results of medical data in the form of digital or web (online) maps**
- Involvement in **multidisciplinary scientific teams**, including possible field work
- **GIT is still underestimated in the field of TBD** (health care) from my point of view – but it changes slowly
- GIS offers many possibilities and instruments in the field of epidemiology (and other fields of biological and medical sciences) which can be used for searching of relationships

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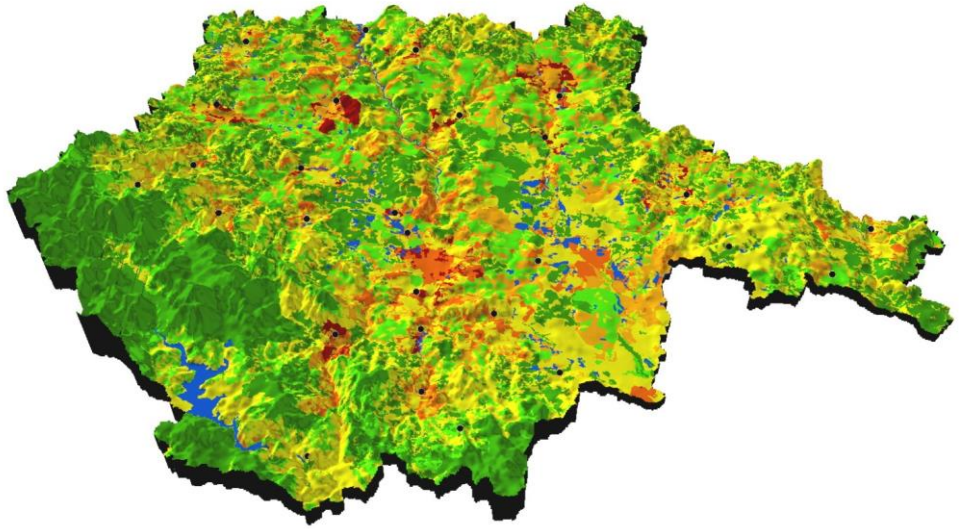
Questions?



Thank you for your attention

doc. RNDr. Pavel Švec, Ph.D.

Would you like to collaborate with me? Do not hesitate to contact me :o)
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