

Geografické informačné systémy, geopriestorové technológie – súčasť modernej geografie

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https://uge-share.science.upjs.sk/webshared/Seminar_GIS/

Obsah kurzu

1. Princípy GIS-u, aplikácie (Hofierka/Gallay)
2. Princípy DPZ, aplikácie (Gallay/Onačillová)
3. Online mapy a nástroje, Google Earth Engine, ukážky dát DPZ, aplikácie (Tokarčík/Onačillová/Gábor)
4. Drony, praktická ukážka, ukážka spracovania dát, aplikácie (Kaňuk/Ujlakiová/Bogľarský)
5. QGIS, tvorba mapy (Šašak/Nováková/Tokarčík)
6. Tangible landscape, Virtual Reality v geografii (Šupinský/Gallay)

Obsah dnešnej prednášky

Úvod: geoinformatika, geopriestorové informácie a GIS

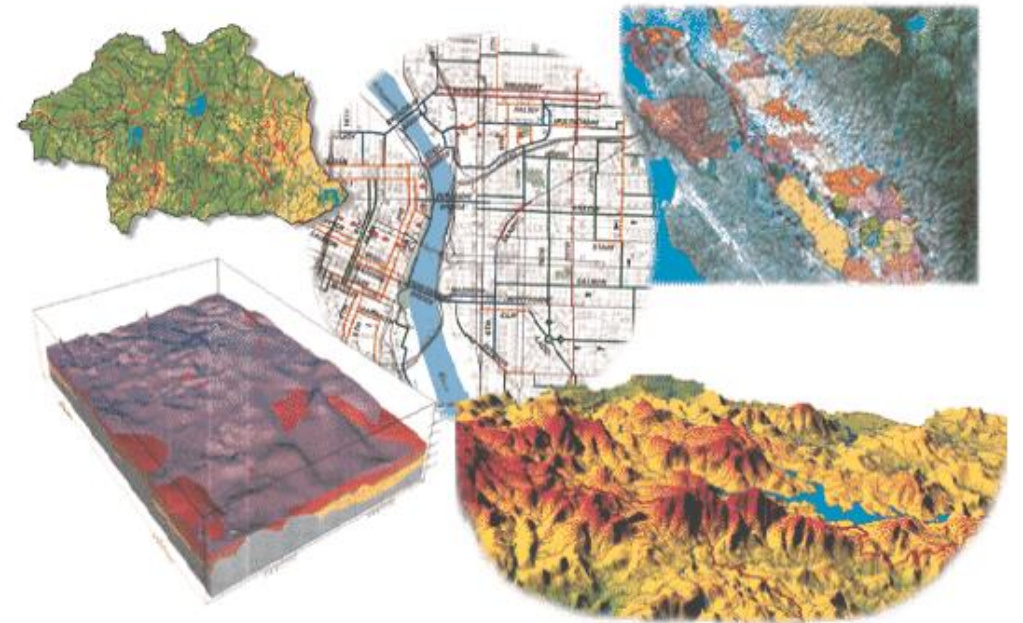
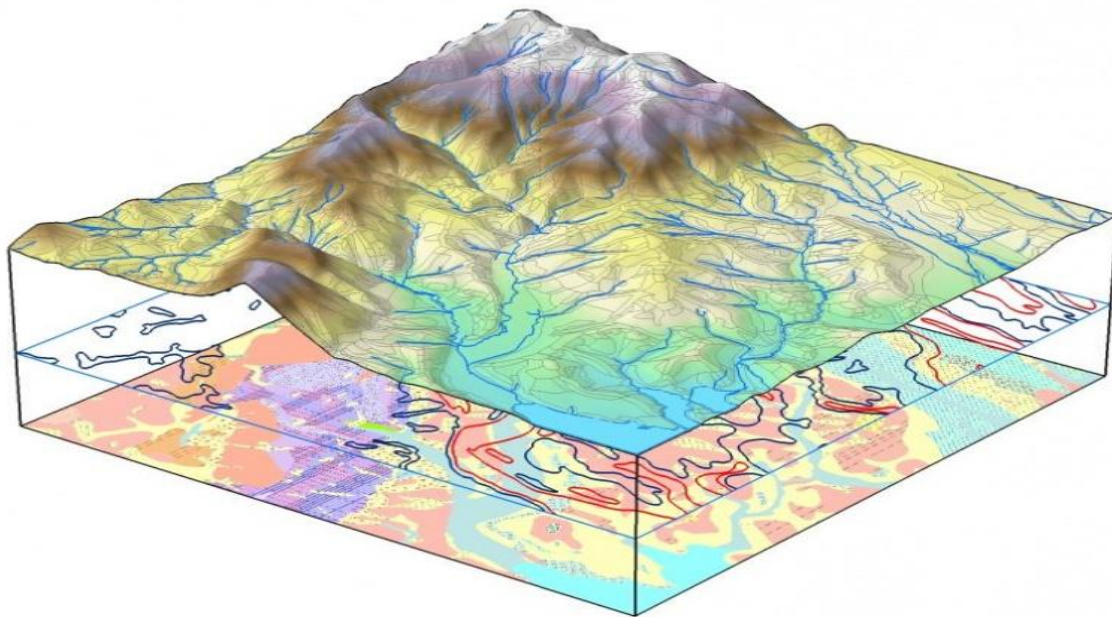
Geopriestorové technológie – nástroj na spracovanie geopriestorovej informácie

Príklady projektov, aplikácie

GIS a Geoinformatika

S rozvojom počítačov a IT v 60. rokoch 20. storočia vzniká aj geografický informačný systém (GIS), ktorého úlohou je nahradiť papierové mapy a spracovávať geopriestorové dáta. Postupne vzniká špecializácia, nový vedný odbor „Geoinformatika“ (angl. Geographic Information Science). Je to vedecká disciplína, ktorá sa venuje teoretickým a metodickým aspektom spracovania geopriestorových/geografických informácií pomocou geografického informačného systému (GIS).

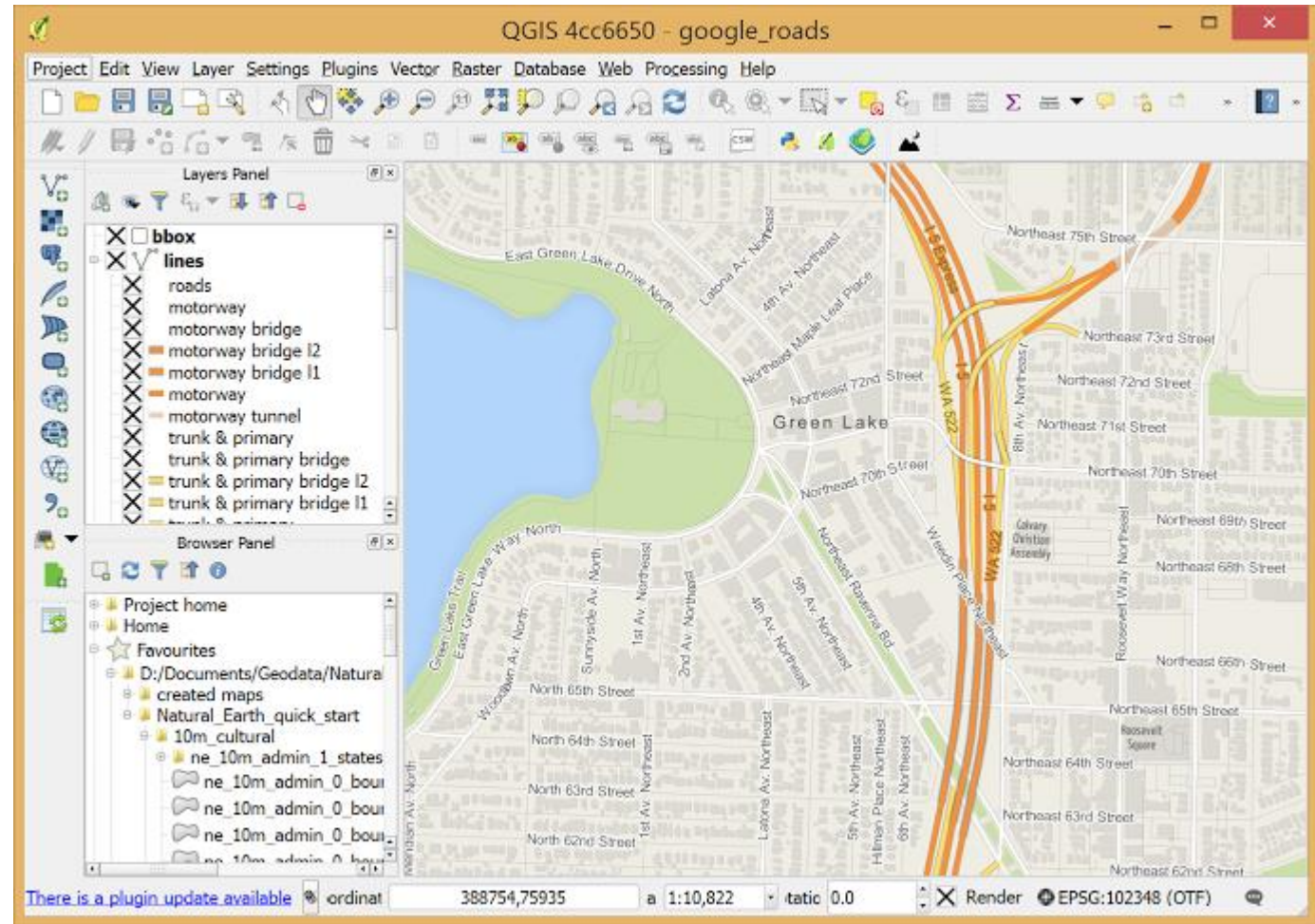
GIS je nástrojom a zároveň produktom geoinformatického výskumu.



Geopriestorové informácie

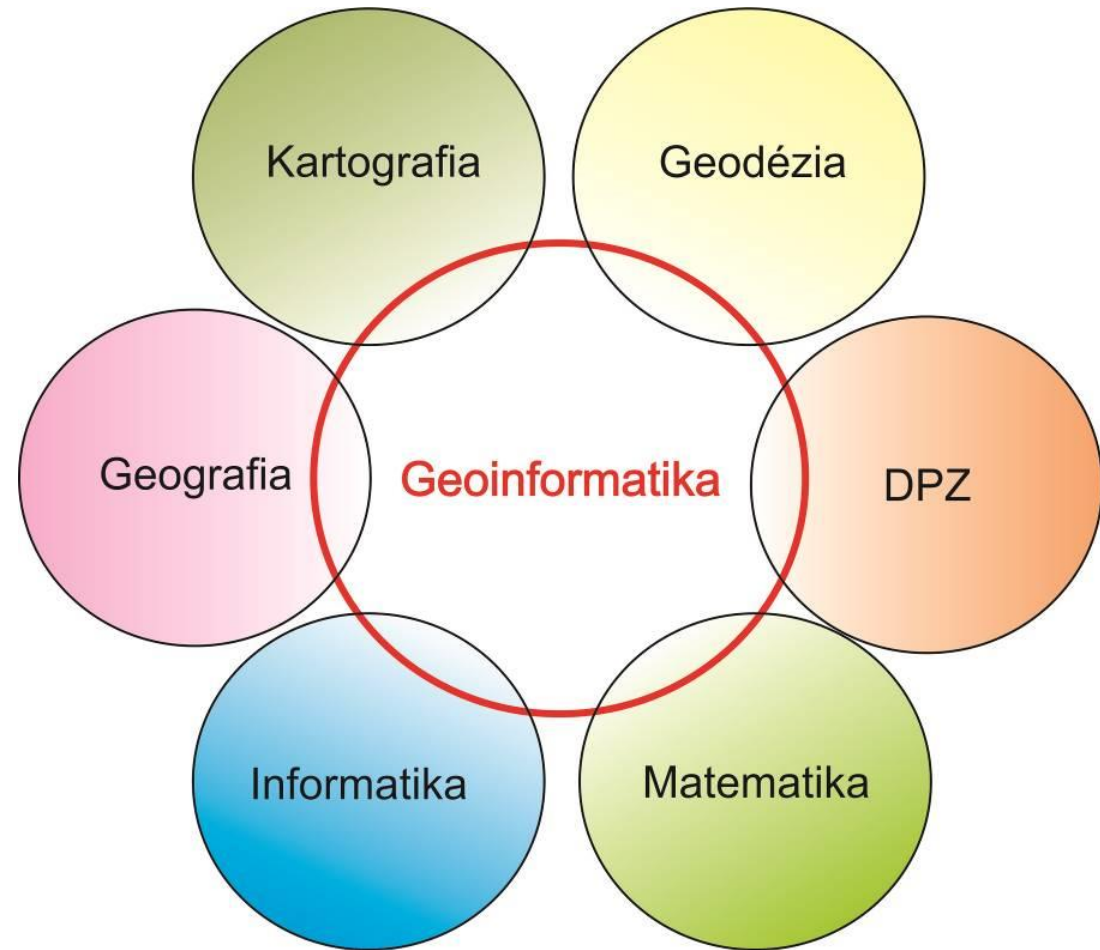
geopriestorové/geografické informácie:

- vlastnosti geografických informácií -
polohový aspekt (x,y), kvalitatívny al.
kvantitatívny atribút, časová premenlivosť
- až 80% všetkých informácií s ktorými sa
ľudia stretnú má polohový aspekt a teda
sú spracovateľné GIS-om



Geoinformatika

- nový, vysoko interdisciplinárny vedný odbor
- produkty a aplikácie sa objavujú aj v bežnom živote
- geografická (geopriestorová informácia)=poloha + atribút (vlastnosť krajiny)
- vývoj aplikácií vyžaduje interdisciplinárny prístup a zložené tímy



Chápanie GIS-u v praxi

Chápanie GIS-u v praxi (postupný nárast zložitosti a náročnosti):

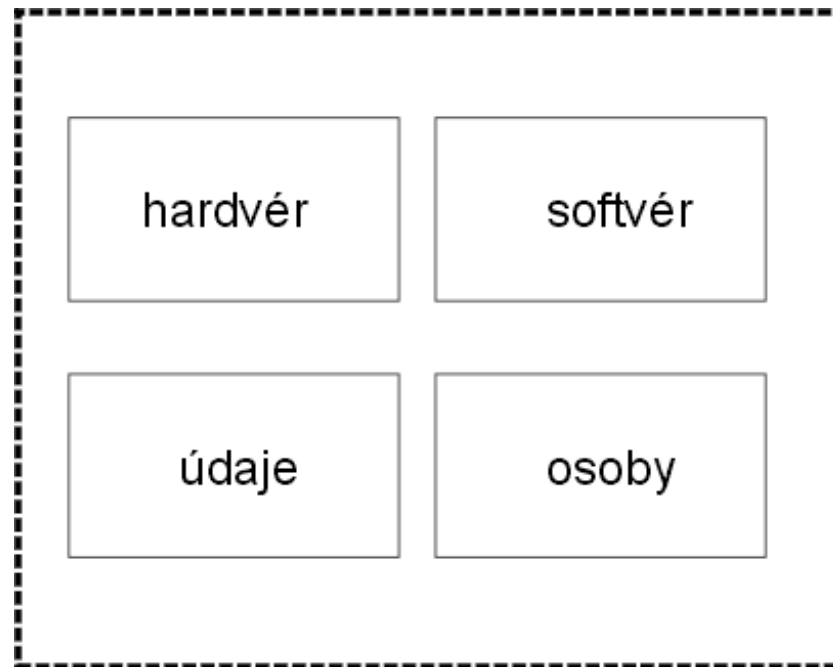
- súbor digitálnych máp alebo tematických vrstiev zameraných na určité objekty (cca 60-80% aplikácií v praxi)
- počítačový nástroj na riešenie geopriestorových problémov (napr. navigácia),
- systém na podporu priestorového rozhodovania,
- nástroj výskumu a modelovania

Ako pracovať s GIS-om?

Základné body postupu

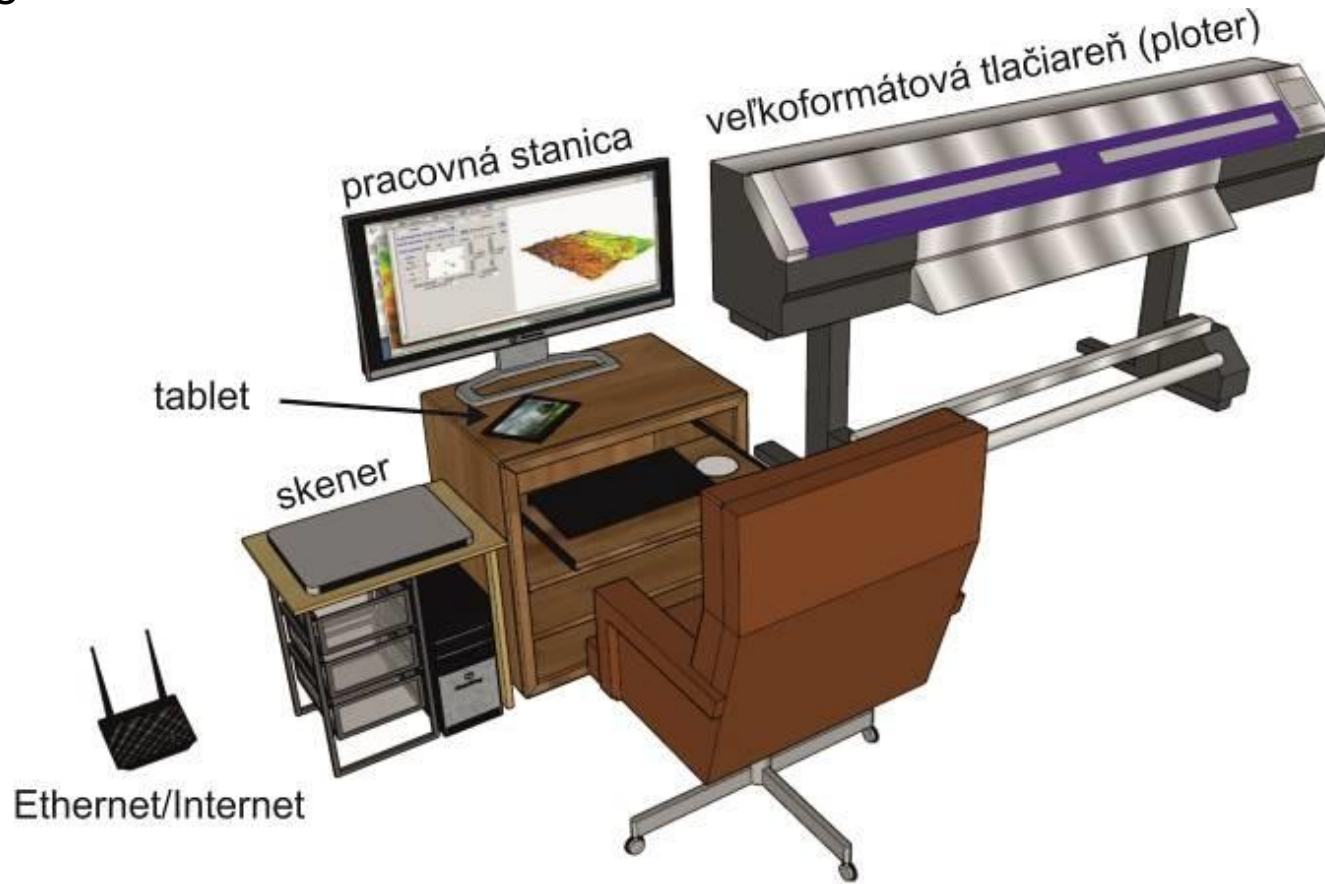
1. Vhodný softvér (komerčné: ArcGIS, MapInfo, open-source: GRASS, QGIS)
2. Zber dát: a) priamo v teréne, b) digitalizáciou existujúcich máp
3. Vstup dát do GIS-u, georeferencovanie (súradnicové priradenie)
4. Priestorové analýzy – hľadanie priestorových súvislostí
5. Kartografický výstup – tvorba tematickej mapy

Geografický informačný systém



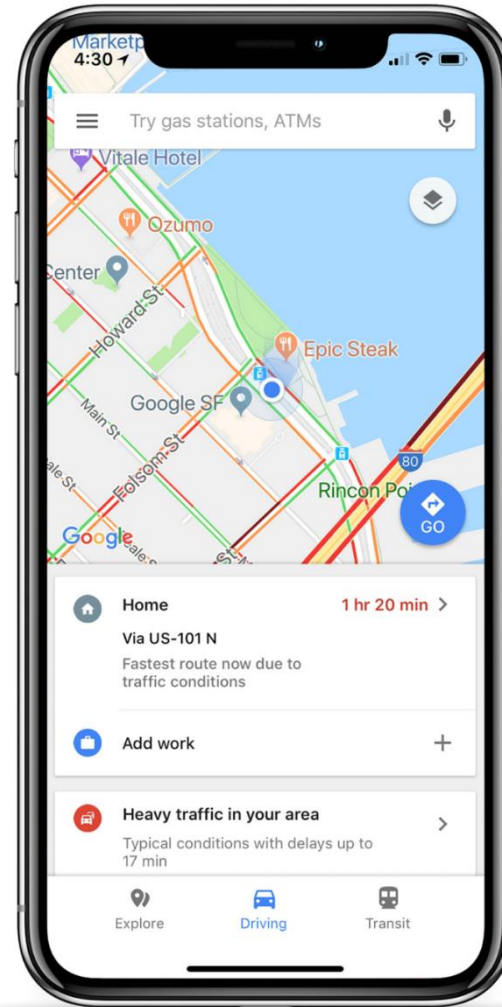
Geografický informačný systém - hardvér

Typická konfigurácia
80.-90. rokov



Geografický informačný systém - hardvér

Typický hardvér 2020 😊



Geografický informačný systém - softvér

The image displays the GRASS GIS 7.0.0beta2 interface. The main window is titled "GRASS GIS 7.0.0beta2 Map Display: 1 - Location: SVK@dmr10k" and shows a 2D view of a terrain map with a color scale from blue (low elevation) to red (high elevation). A scale bar indicates 100 km. The "Raster" menu is open, showing various processing options. The "Hydrologic modeling" sub-menu is selected, listing tools such as "Carve stream channels", "Flow accumulation", and "Watershed analysis".

The "Raster" menu options include:

- Develop raster map
- Manage colors
- Query raster maps
- Map type conversions
- Buffer rasters [r.buffer]
- Concentric circles [r.circle]
- Closest points [r.distance]
- Mask [r.mask]
- Raster map calculator [r.mapcalc]
- Neighborhood analysis
- Overlay rasters
- Solar radiance and shadows
- Terrain analysis
- Transform features
- Hydrologic modeling
 - Carve stream channels [r.carve]
 - Fill lake [r.lake]
 - Depressionless map and flowlines [r.fill.dir]
 - Flow accumulation [r.terraflow]
 - Flow lines [r.flow]
 - Watershed analysis [r.watershed]
 - Watershed subbasins [r.basins.fill]
 - Watershed basin creation [r.water.outlet]
- Extraction of stream networks [r.stream.extract]
- SIMWE Overland flow modeling [r.sim.water]
- SIMWE Sediment flux modeling [r.sim.sediment]
- Topographic index map [r.topidx]
- TOPMODEL simulation [r.topmodel]
- USLE K-factor [r.uslek]
- USLE R-factor [r.usler]

The "Map layers" panel shows the current map layers, including "r.terraflow -- Flo". The "Map Display: 2" window shows a 3D view of the same terrain, with a color scale from 0 to 100. The "Domicq" location is labeled on the map. The status bar at the bottom shows coordinates: -323331.31; -1263451.88.

GRASS GIS 7.0.0beta2
© 1999-2014 by the GRASS Development Team
Official GRASS site: <http://grass.osgeo.org>

Geografický informačný systém - softvér

The screenshot shows the official GRASS GIS website. At the top, there is a navigation bar with links for Home, Download, Documentation, Gallery, Support, Donations, Development, and Get involved!. The main content area is divided into several sections:

- Search:** A search bar with a 'Submit' button.
- Latest News:** A section with two news items:
 - Jan 23, 2020: GRASS GIS issues now on GitHub! GRASS GIS bug reporting and feature request on GitHub now! [More]
 - Dec 12, 2019: GRASS GIS 7.8.2 released GRASS GIS 7.8.2 released with updated PROJ 6 and GDAL 3 support [More]
- Next event:** FOSSDEM 2020, Brussels, with a gear icon.
- Home:** A central section with the following text:

GRASS GIS, commonly referred to as GRASS (Geographic Resources Analysis Support System), is a **free** and open source **Geographic Information System** (GIS) software suite used for geospatial data management and analysis, image processing, graphics and maps production, spatial modeling, and visualization. GRASS GIS is currently used in academic and commercial settings around the world, as well as by many governmental agencies and environmental consulting companies. It is a founding member of the **Open Source Geospatial Foundation** (OSGeo).

Visit [GRASS GIS on GitHub](#)

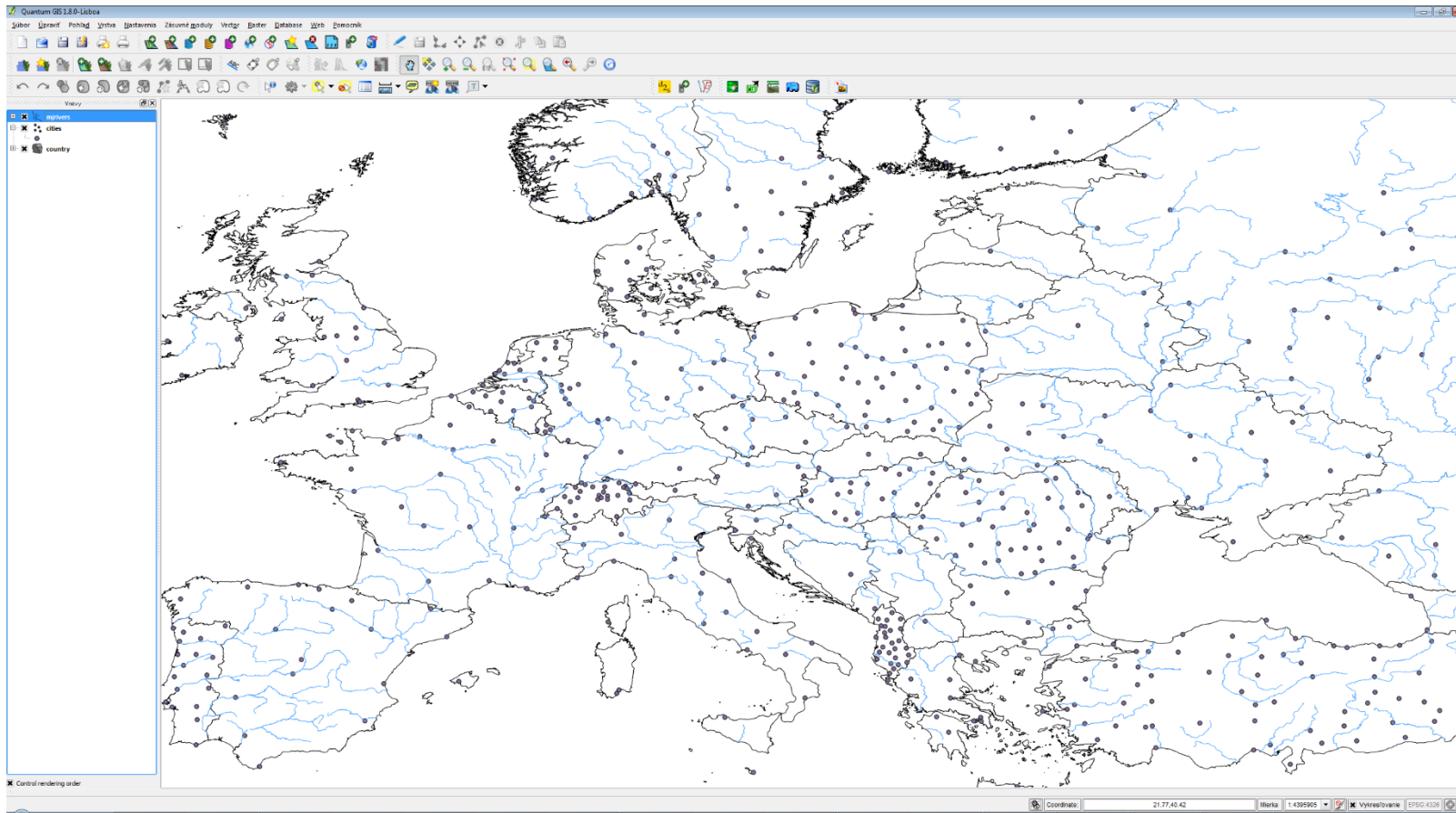
Latest stable release: **GRASS GIS 7.8.2** with Python 3, PROJ 6 and GDAL 3 support

Buttons for Mac OS X, Windows, and Linux, with links for [... and Addons](#) and [Source Code](#).
- Newcomers: How to start with GRASS GIS?**
 - [About GRASS GIS](#)
 - Read the [First Day Documentation](#)
 - Go through [Tutorial and Courses](#) in various languages
 - Learn more with the [GRASS GIS migration hints](#)
- Code quality check:** build passing
- Module of the Day:** [rast.list](#) Lists registered maps of a space time raster dataset.
- Screenshots (click for more):** A collage of screenshots showing the GRASS GIS interface, including a map of Copernicus Sentinel 2B, a Bivariate Scatterplot, and a map of Ptiluga National Park, Australia.

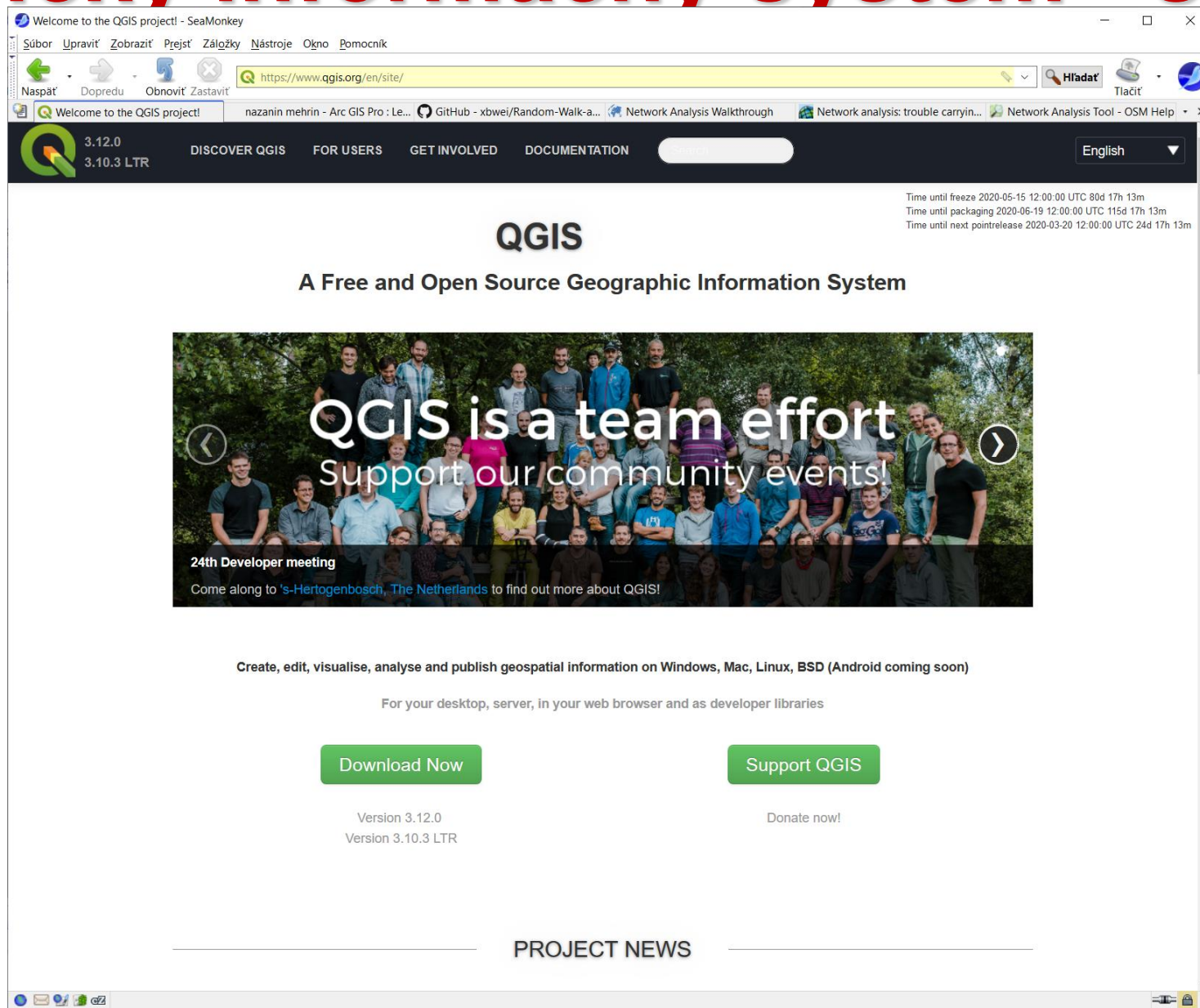
At the bottom, there is a footer that reads: "You are at the official GRASS GIS site (United States) - [mirror sites](#)"

GIS softvér

QGIS (www.qgis.org)
plugin GRASS GIS



Geografický informačný systém - softvér



Welcome to the QGIS project! - SeaMonkey

Úbor Upravit' Zobrazit' Prejst' Záložky Nástroje Okno Pomocník

https://www.qgis.org/en/site/ Hľadat Tlačit

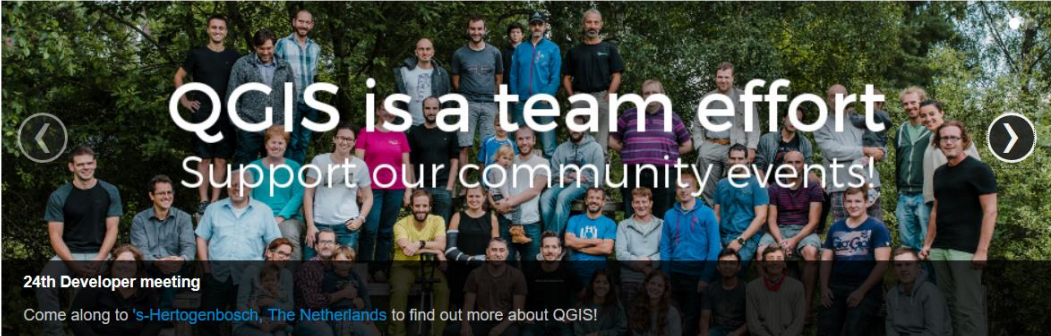
3.12.0
3.10.3 LTR

DISCOVER QGIS FOR USERS GET INVOLVED DOCUMENTATION English

Time until freeze 2020-05-15 12:00:00 UTC 80d 17h 13m
Time until packaging 2020-06-19 12:00:00 UTC 115d 17h 13m
Time until next pointrelease 2020-03-20 12:00:00 UTC 24d 17h 13m

QGIS

A Free and Open Source Geographic Information System



QGIS is a team effort
Support our community events!

24th Developer meeting
Come along to 's-Hertogenbosch, The Netherlands to find out more about QGIS!

Create, edit, visualise, analyse and publish geospatial information on Windows, Mac, Linux, BSD (Android coming soon)

For your desktop, server, in your web browser and as developer libraries

Download Now

Support QGIS

Version 3.12.0
Version 3.10.3 LTR

Donate now!

PROJECT NEWS

GIS softvér

Firma ESRI: ArcGIS, www.esri.com

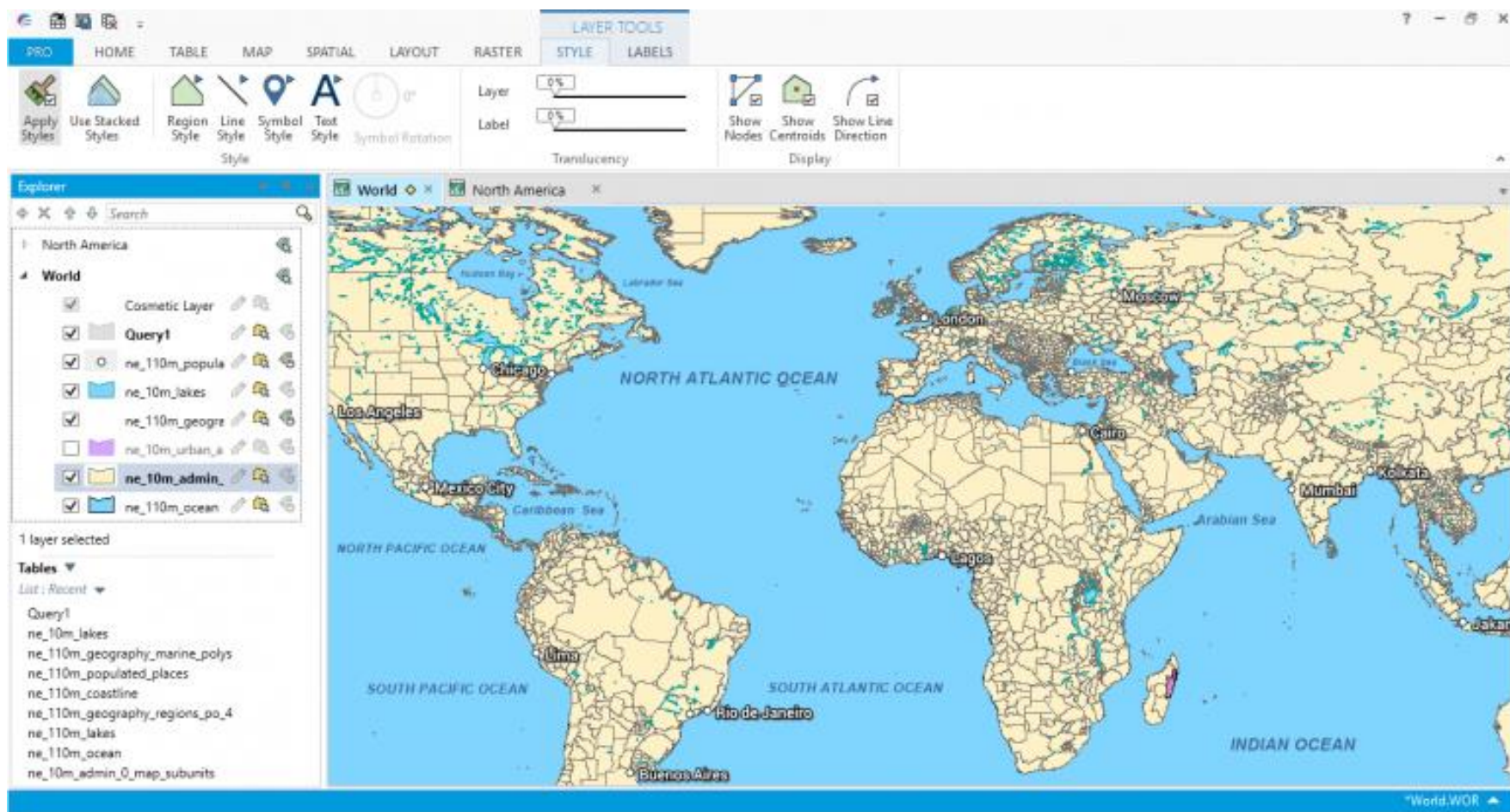
The screenshot displays the ArcMap interface for a project named 'Cambridge_1960.mxd'. The main map area shows an aerial view of Cambridge with overlaid GIS data layers. A 'Table Of Contents' on the left lists various layers, including '1969 or later', 'Public_Housing_Units', 'Vertices', 'City Boundary', 'Centerline Vertices', 'Rail Vertices', 'Parcel Vertices', 'Major Roads', 'CityBoundary', 'Water', 'Lines', 'Cambridge_Blocks', 'Cambridge_Tracks', 'Centerline', 'Rail', 'Parcels', 'Cambridge 1903', 'Cambridge_100.sid', and 'Cambridge Census M.'. The 'Cambridge_Blocks' layer is currently selected and highlighted in green on the map. A 'Table' window is open in the bottom right, displaying the following data:

NHGISST	NHGISCTY	TRACT_BLOC	TRACT	BLOCK
250	0170	MC000307	MC0003	07
250	0170	MC000308	MC0003	08
250	0170	MC000309	MC0003	09
250	0170	MC000310	MC0003	10
250	0170	MC000311	MC0003	11
250	0170	MC000312	MC0003	12
250	0170	MC000313	MC0003	13
250	0170	MC000314	MC0003	14

The table window also shows navigation controls and indicates that 0 out of 864 records are selected. The status bar at the bottom of the map shows coordinates: 766672.628 2957698.395 Feet.

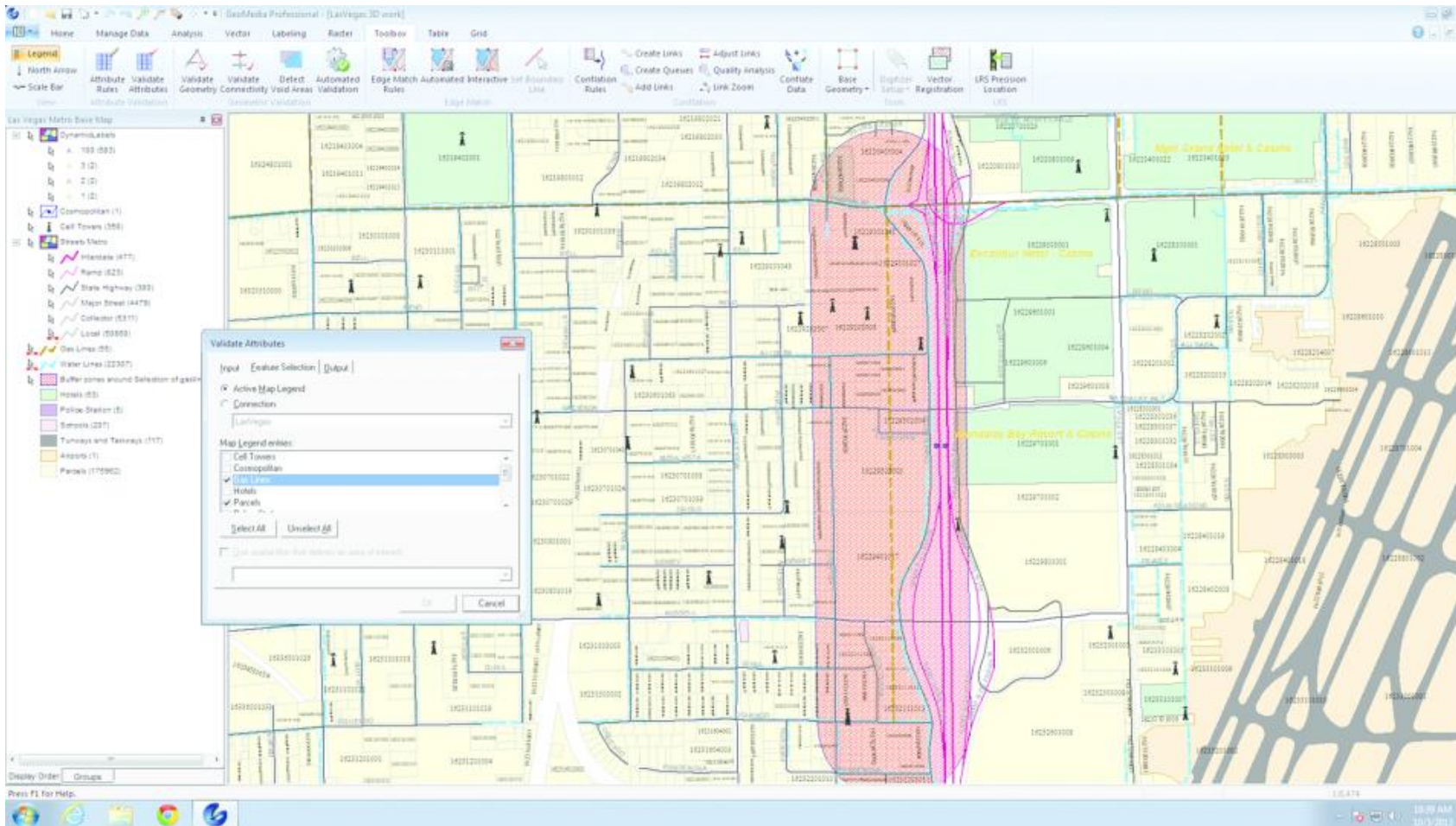
GIS softvér

MapInfo Professional - <http://www.mapinfo.com>



GIS softvér

Firma Hexagon Geospatial (predtým Intergraph):
GeoMedia (<https://www.hexagongeospatial.com>)



CAD softvér

MicroStation: <http://www.bentley.com/>



Iné: AutoCAD, Kokeš,...

GIS vs. CAD

GIS: obsahuje silný balík nástrojov na geopriestorové analýzy, t.j. nástroje na hľadanie nových informácií a poznatkov z existujúcich dát (riešenie problémov)

CAD: zamerané na „kreslenie“, t.j. tvorbu digitálnych máp, zvyčajne bez databázovej zložky a takmer vždy bez nástrojov na geopriestorovú analýzu

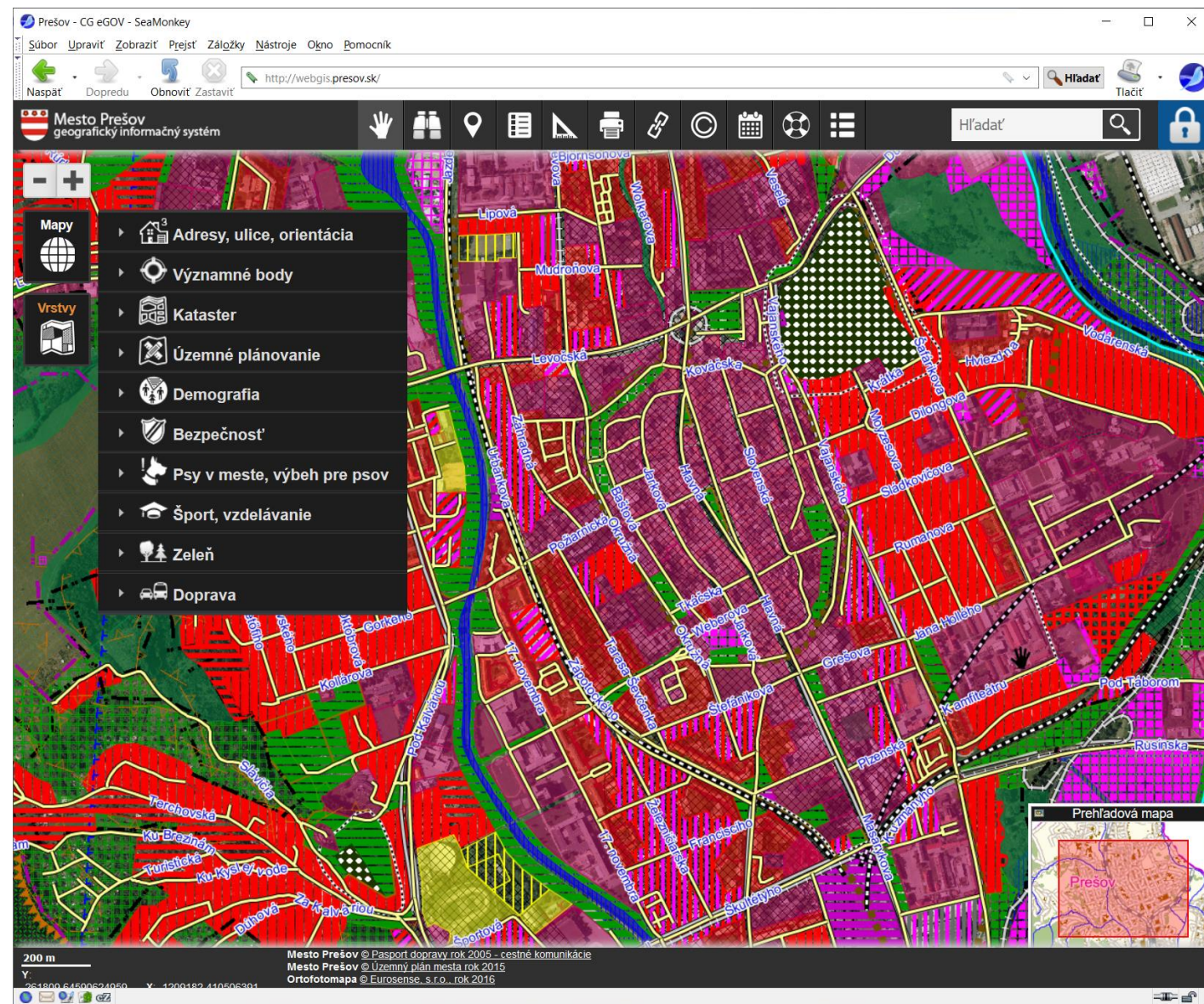
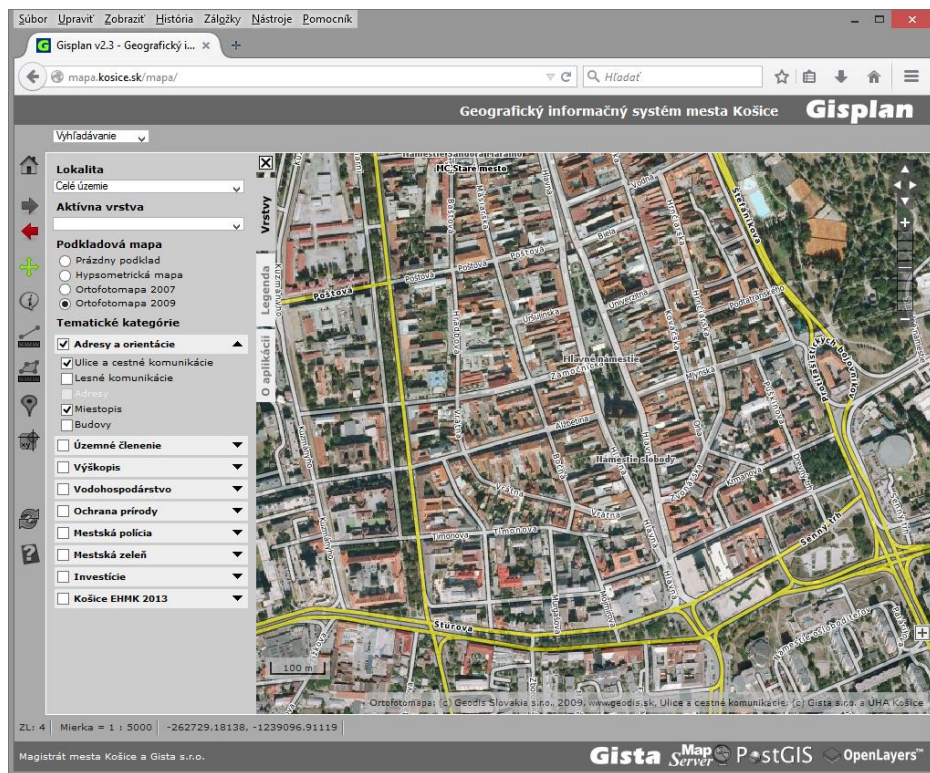
Softvérové riešenia

ArcGIS Windows desktop:

- od prehliadačky dát (ArcReader) po ArcGIS Desktop Advanced s plnou funkcionalitou, resp. ArcGIS Pro
- ArcGIS Enterprise (serverové riešenie)
- ArcGIS sw pre mobilné zariadenia
- možnosť rôznych špecializovaných rozšírení (extensions), napr. zber dát v teréne mobilnými telefónmi
- ArcGIS online – webová aplikácia na zdieľanie spoločne vytváraných dát

Softvérové riešenia

V súčasnosti sa využívajú webové riešenia kombinujúce GIS, databázu, mapový server a web server.



Softvérové riešenia

Participačný GIS:

na Slovensku a v Česku projekt
„Pocitové mapy“

Používateľ cez web prehliadač
identifikuje lokality a vkladá svoje
názory. Výsledok sa vyhodnocuje
ako anketa.

Pocitová mapa Prešova - SeaMonkey
ŠuĽbor Upraviť Zobrazit' Prejsť Záložky Nástroje OĽno Pomocník
https://www.pocitovamapa.sk/presov-2018/#1
Naspäť Dopredu Obnovit' Zastavit'
Domov Zložky Najobľubenejšie SeaMonkey SeaMonkey v slovenčine mozilla.org mozillaZme mozdev.org
Pocitové mapy Pocitová mapa Prešova
Vyhľadat ulicu
Podkladová mapa
NIŽNÁ ŠEBAST
Lubotice
ŠALGOVIK
PREŠOV
SOLIVAR
SOLNÁ BAŇA
Malkovská hôrka
Kyslá
Lea.flet | www.pocitovemapy.cz | ©Seznam.cz a.s. | ©OpenStreetMap MAPY.CZ

Ktoré verejné priestory radi navštevujete vzhľadom na celkovú kvalitu priestoru?

Pridať miesto

Pridaných miest: 0

Miesta môžete zmazať, keď na ne kliknete.
Kliknutím na mapu môžete pridať naraz aj viac miest.

DALŠÍ KROK

Krok 1/8

atrium ARCHITEKTI
UzemnePlany.sk
[VerejnéPriestory] Zasahy

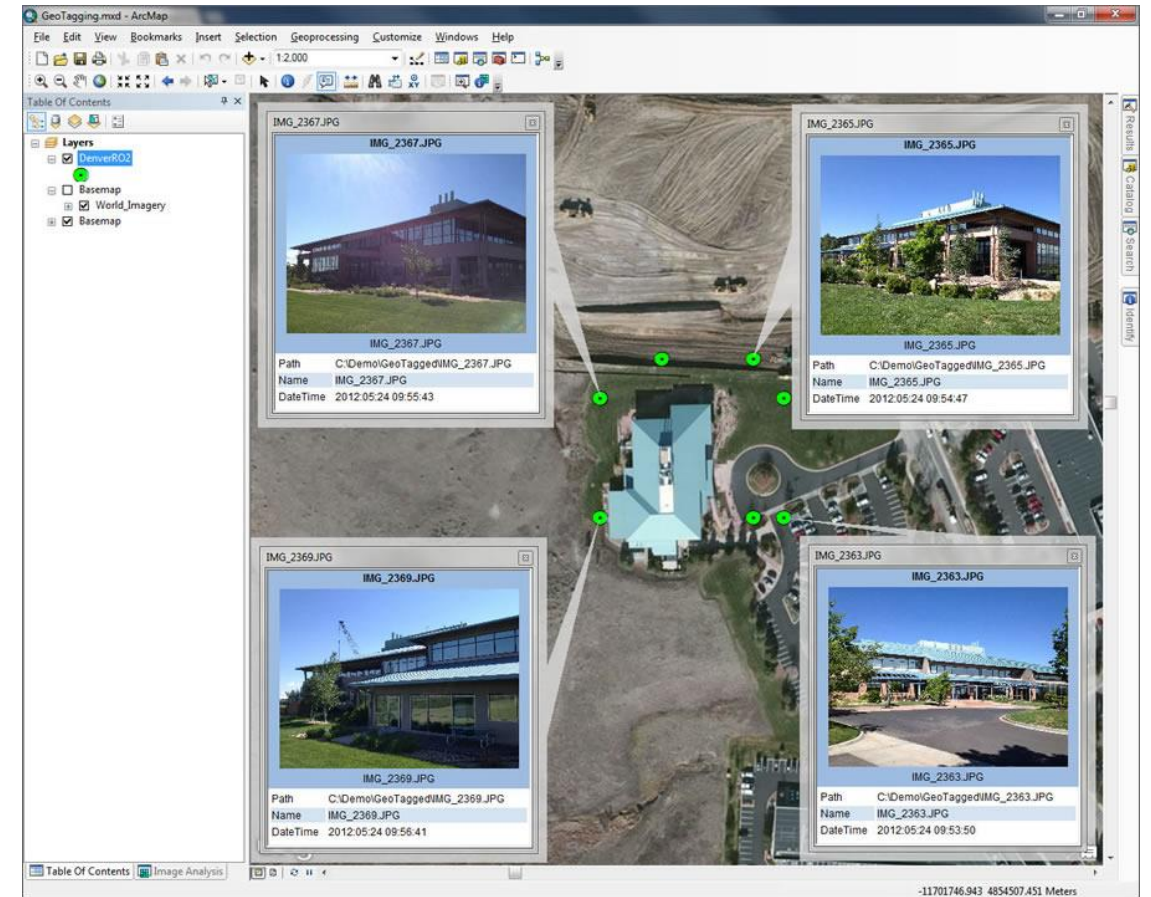
Zber dát pre GIS

GNSS (GPS, GLONASS, Galileo)



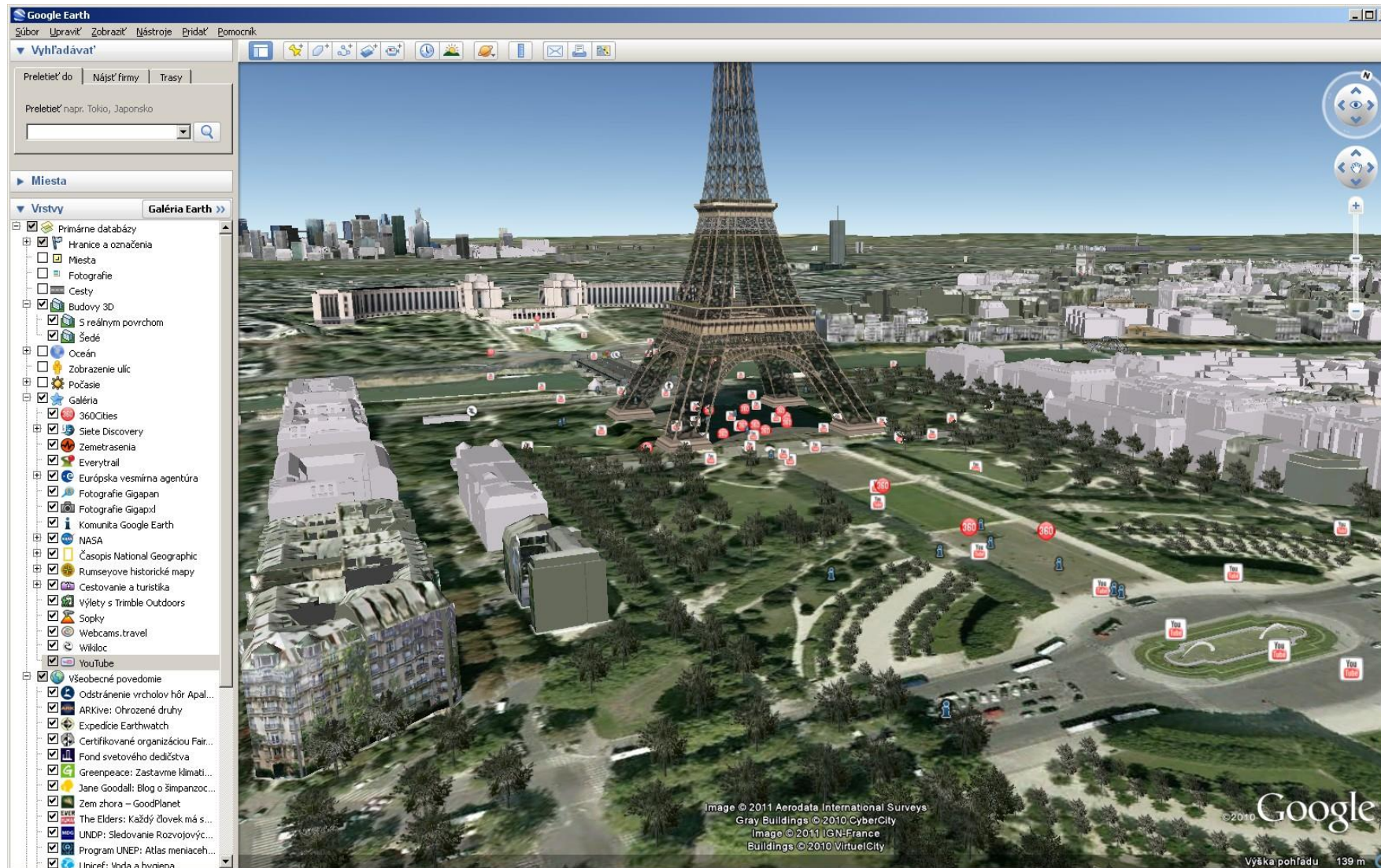
Geopriestorové technológie

Geotagging – geolokalizované fotografie



Geopriestorové technológie

Google Maps a Google Earth



Geopriestorové technológie

PV potential estimation utility - SeaMonkey

Úbor Upraviť Zobrazit' Prejsť Záložky Nástroje Okno Pomocník

http://re.jrc.ec.europa.eu/pvgis/apps4/pvest.php#

Domov Zložky Najobľúbenejšie SeaMonkey SeaMonkey v slovenčine mozilla.org mozillaZine mozdev.org

JRC CM SAF Photovoltaic Geographical Information System - Interactive Maps

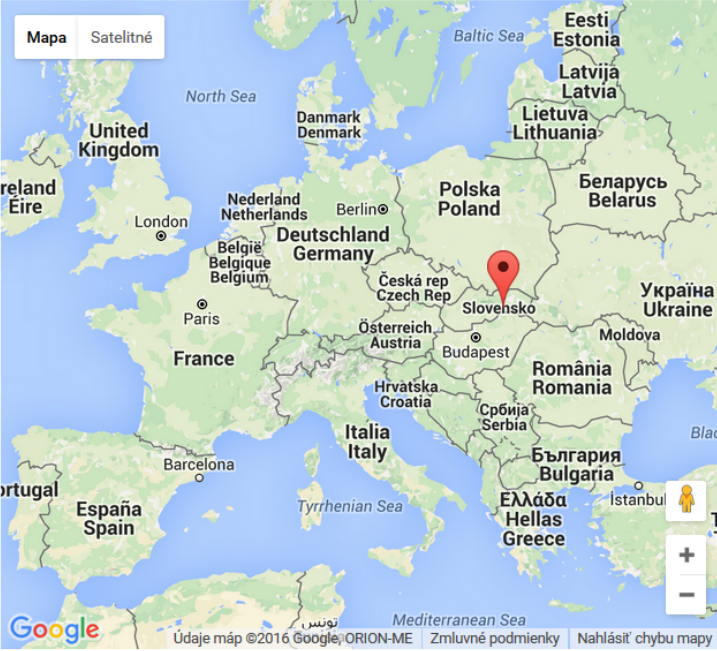
EUROPA > EC > JRC > IE > RE > SOLAREC > PVGIS > Interactive maps > europe Contact Important legal notice

e.g., "Ispra, Italy" or "45.256N, 16.9589E" cursor position: 47.880, 24.961 selected position: 48.699, 20.742

Europe Africa-Asia Search

Latitude: Longitude: Go to lat/lon

Mapa Satelitné



Google Údaje máp ©2016 Google, ORION-ME Zmluvné podmienky Nahlásiť chybu mapy

Solar radiation Temperature Other maps -18 -14 -10 -6 -2 2 6 10 14 [°C]

PV Estimation Monthly radiation Daily radiation Stand-alone PV

Performance of Grid-connected PV

Radiation database: Climate-SAF PVGIS [What is this?]

PV technology: Crystalline silicon

Installed peak PV power 1 kWp

Estimated system losses [0;100] 14 %

Fixed mounting options:

Mounting position: Free-standing

Slope [0;90] 35 ° Optimize slope

Azimuth [-180;180] 0 ° Also optimize azimuth

(Azimuth angle from -180 to 180. East=-90, South=0)

Tracking options:

Vertical axis Slope [0;90] 0 ° Optimize

Inclined axis Slope [0;90] 0 ° Optimize

2-axis tracking

Horizon file Prehľadávať... Nie je zvolený súbor.

Output options

Show graphs Show horizon

Web page Text file PDF

Calculate [help]

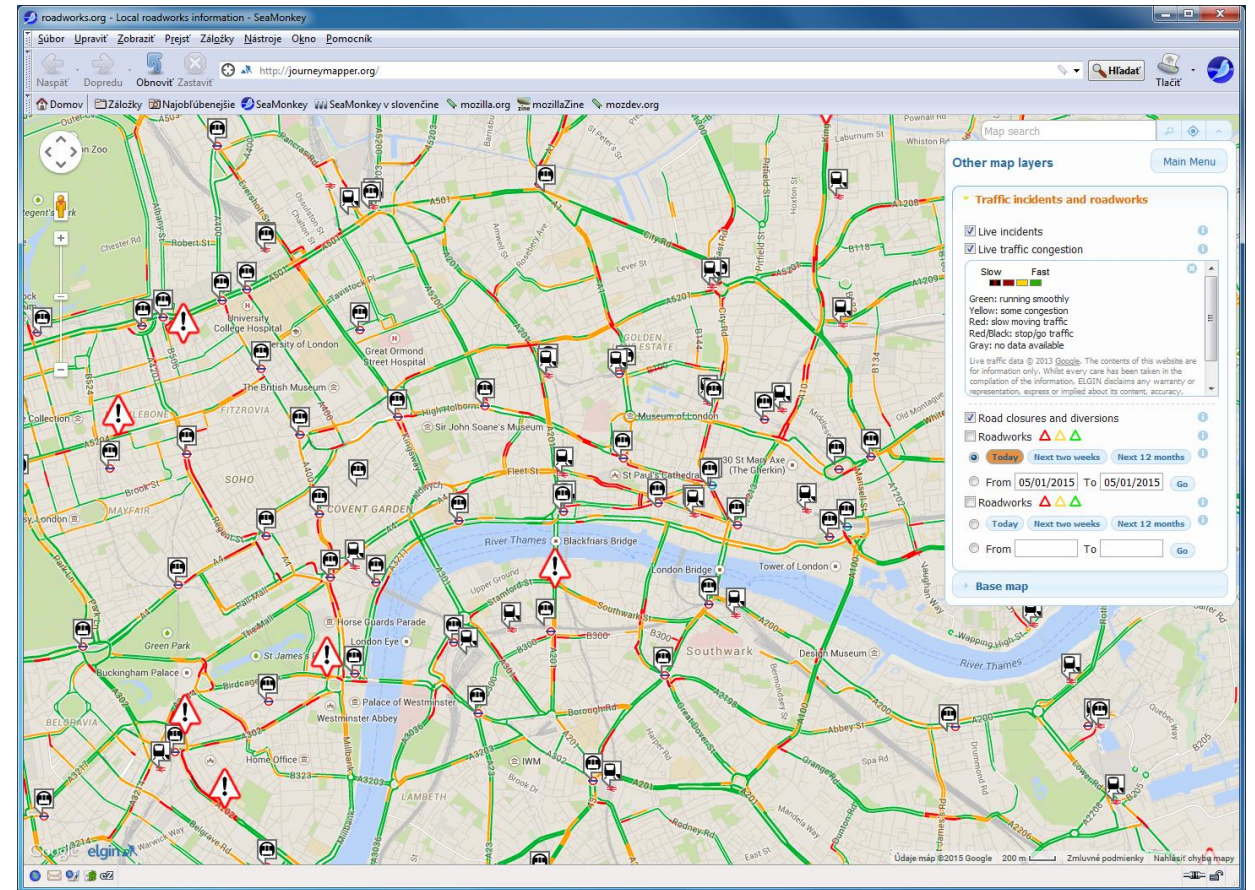
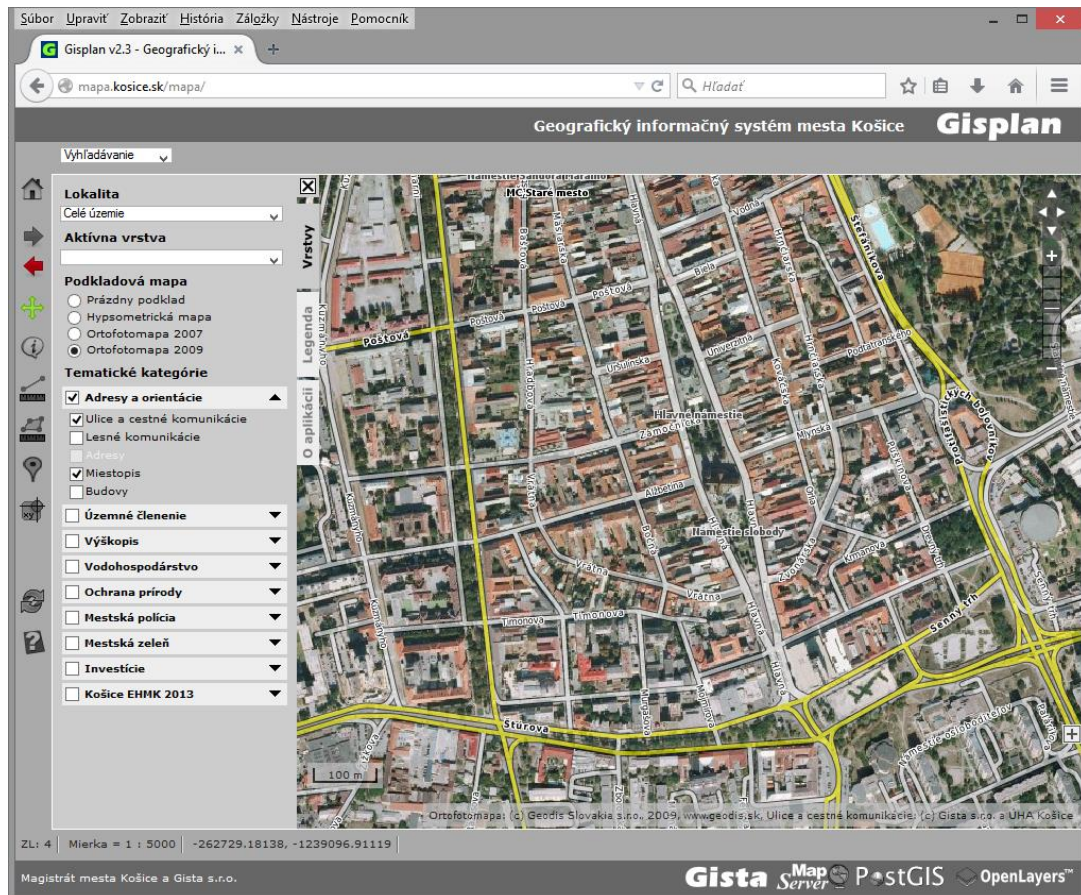
Geopriestorové technológie

The screenshot displays the Flightradar24 website interface. At the top, there is a browser window with the URL <https://www.flightradar24.com/48.54.19.52/7>. The website header includes the Flightradar24 logo, navigation links (Apps, Add coverage, Data / History, Social, Press, About), and a user profile section (Premium, UTC 12:21). The main content area features a map of Europe with numerous yellow aircraft icons and flight paths. On the left side, there is a sidebar with the following sections:

- Aircraft:** 204 / 7745
- Airport delays:** A table listing airport arrival and departure times.
- Tweets:** A section for social media updates related to flight tracking.
- Download on the App Store / Google play:** Links to mobile applications.
- Like 429k / Follow 3.1k:** Social media engagement metrics.
- Pick up your rental car direct from Brisbane - Ascot:** An advertisement for AirportRentals.com.

At the bottom of the page, there are two promotional banners: "Remove all ads and enjoy extra features" and "Get Flightradar24 for your phone/tablet". The footer includes a copyright notice: "Map data ©2015 Basasoft, GeoBasis-DE/BKG (©2009), Google | 50 km" and a "Terms of Use" link.

Geopriestorové technológie



Geopriestorové technológie

Mobilné aplikácie, drony (UAV)



Princípy GIS-u

Reprezentácia reality v GIS-e

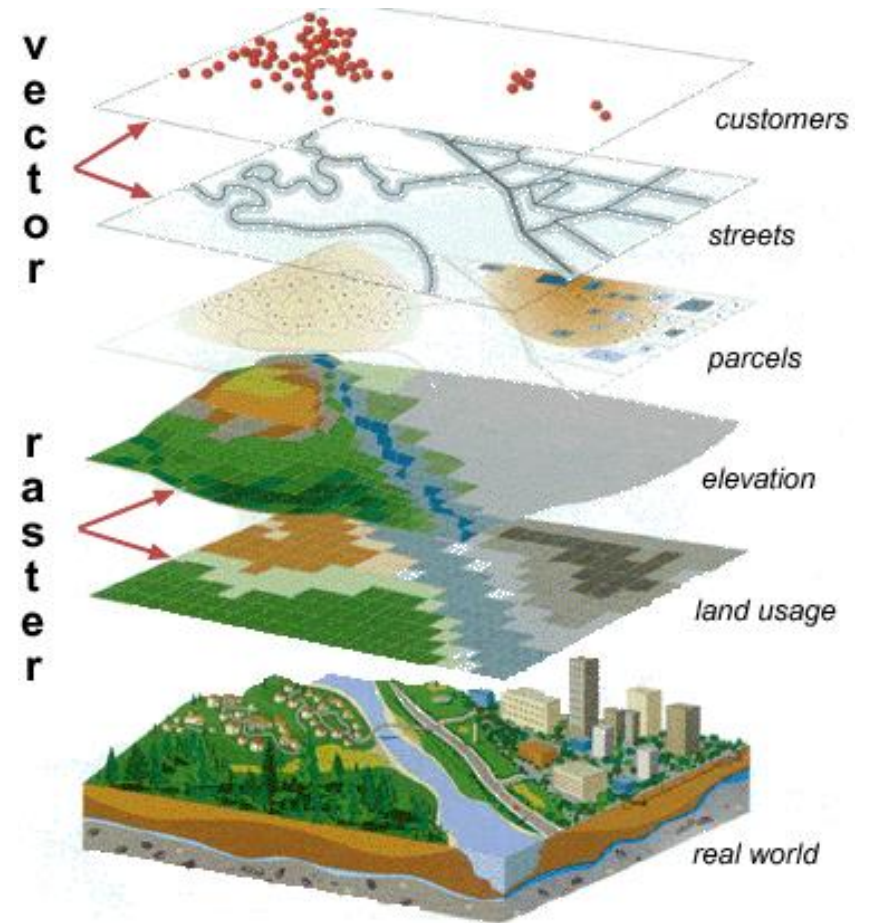
Realita vs. pamäť počítača

Konceptuálne modely reality

- diskkrétne objekty (spočítateľné)
- spojité fyzikálne polia

Digitálna reprezentácia v GIS-e

- dátové modely v GIS-e (raster/grid a vektor)
- vrstvy (layers) reprezentujúce prvky krajiny (cesty, rieky, reliéf)



Vrstvy v GIS-e

Cambridge_1960.mxd - ArcMap - ArcInfo

File Edit View Bookmarks Insert Selection Geoprocessing Customize Windows Help

1:4,500

Table Of Contents

- 1969 or later
- Public_Housing_Units
- Vertices
 - City Boundary Vert
 - Centerline Vertices
 - Rail Vertices
 - Parcel Vertices
- Major Roads
- CityBoundary
- Water
- Lines
 - Cambridge_Blocks
 - Cambridge_Tracks
 - Centerline
 - Rail
 - Parcels
- Cambridge 1903
- Cambridge_100.sid
- Cambridge Census M.

Table

Cambridge_Blocks_1960

NHGISST	NHGISCTY	TRACT_BLOC	TRACT	BLOCK
250	0170	MC000307	MC0003	07
250	0170	MC000308	MC0003	08
250	0170	MC000309	MC0003	09
250	0170	MC000310	MC0003	10
250	0170	MC000311	MC0003	11
250	0170	MC000312	MC0003	12
250	0170	MC000313	MC0003	13
250	0170	MC000314	MC0003	14

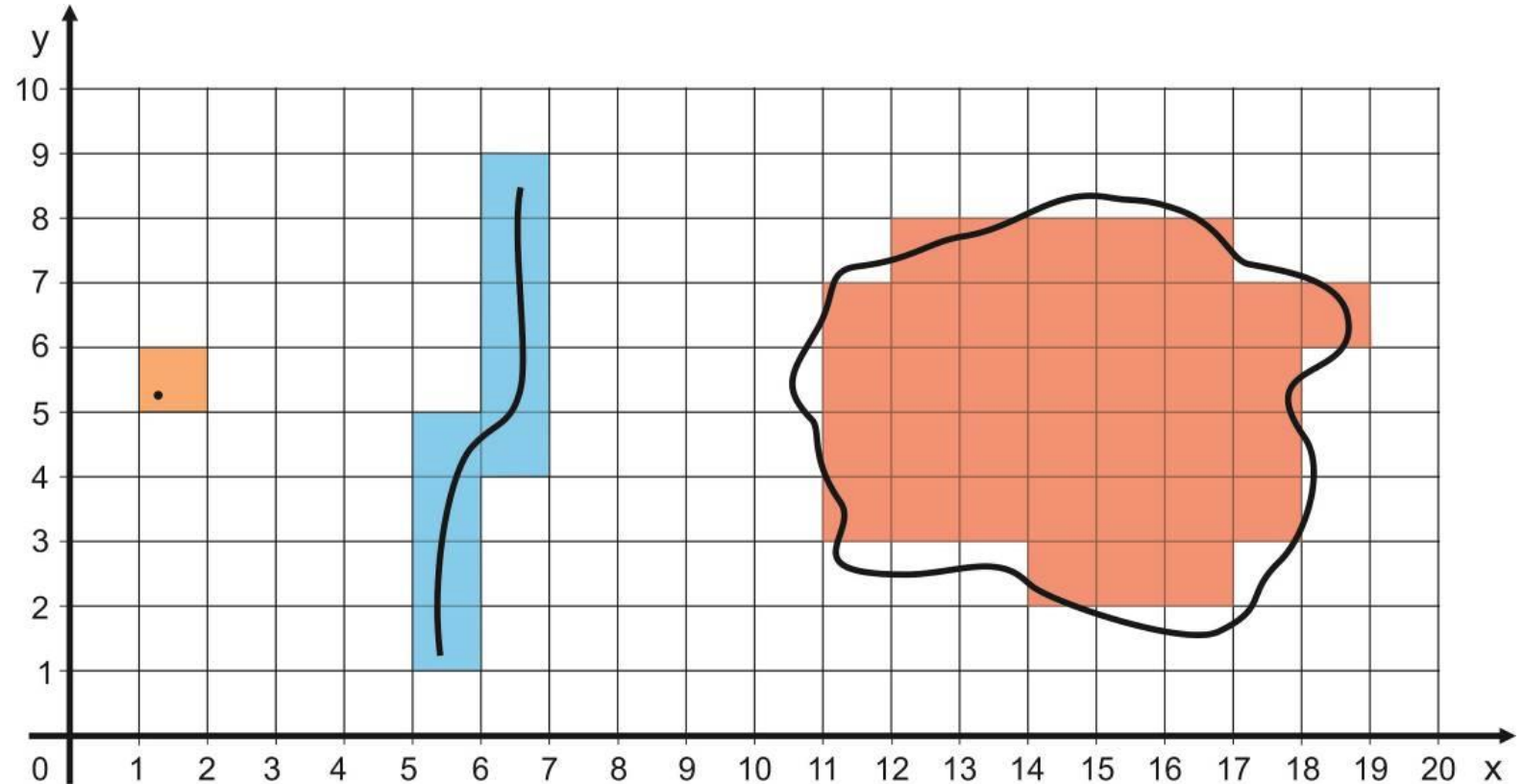
1 (0 out of 864 Selected)

Cambridge_Blocks_1960 Cambridge_Tracks_1960

766672.628 2957698.395 Feet

Rastrový dátový model

- základnou jednotkou je bunka
- rozlíšenie (veľkosť bunky) – rozmery v skutočnosti, napr. 1-500 m
- raster je matica hodnôt



Matica hodnôt rastru

ncols 945

nrows 1337

xllcorner -461006

yllcorner -1181642

cellsize 2.000000

NODATA_value -9999

440.07 439.81 439.52 439.2 438.86 438.49 438.1

437.69 437.26 436.82 436.36 435.91 435.46

435.02 434.59 434.18 433.8 433.45 433.14

432.86 432.63 432.44 432.28 432.16 432.08

432.03 432 432 432.03 432.06 432.12 432.19

432.27 432.37 432.48 432.61 432.76 432.93

433.12 433.35 433.6 433.88 434.2 434.54

434.92 435.32 435.75 436.2 436.66 437.14

437.63 438.11 438.6 439.07 439.54 439.99

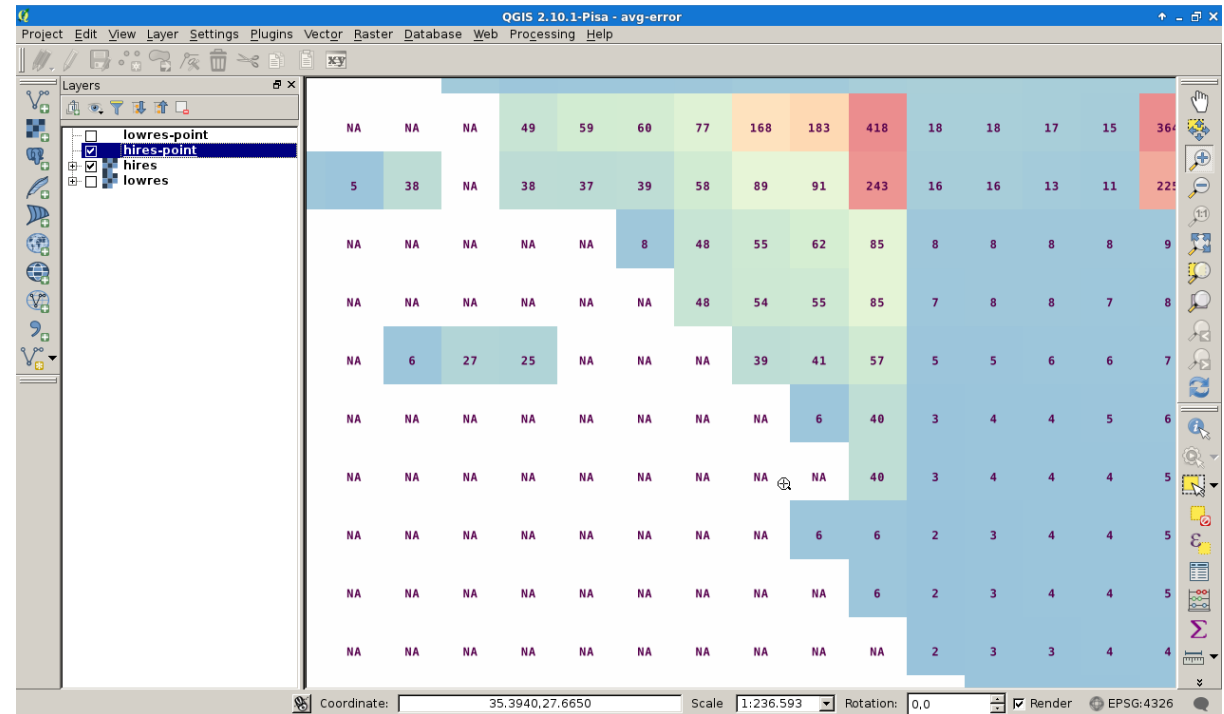
440.42 440.82 441.21 441.56 441.89 442.2

442.48 442.73 442.96 443.17 443.37 443.54

443.7 443.85 443.99 444.12 444.25 444.37

444.48 444.59 444.7 444.8 444.89 444.99

445.07 445.15 445.22



Rastrový dátový model

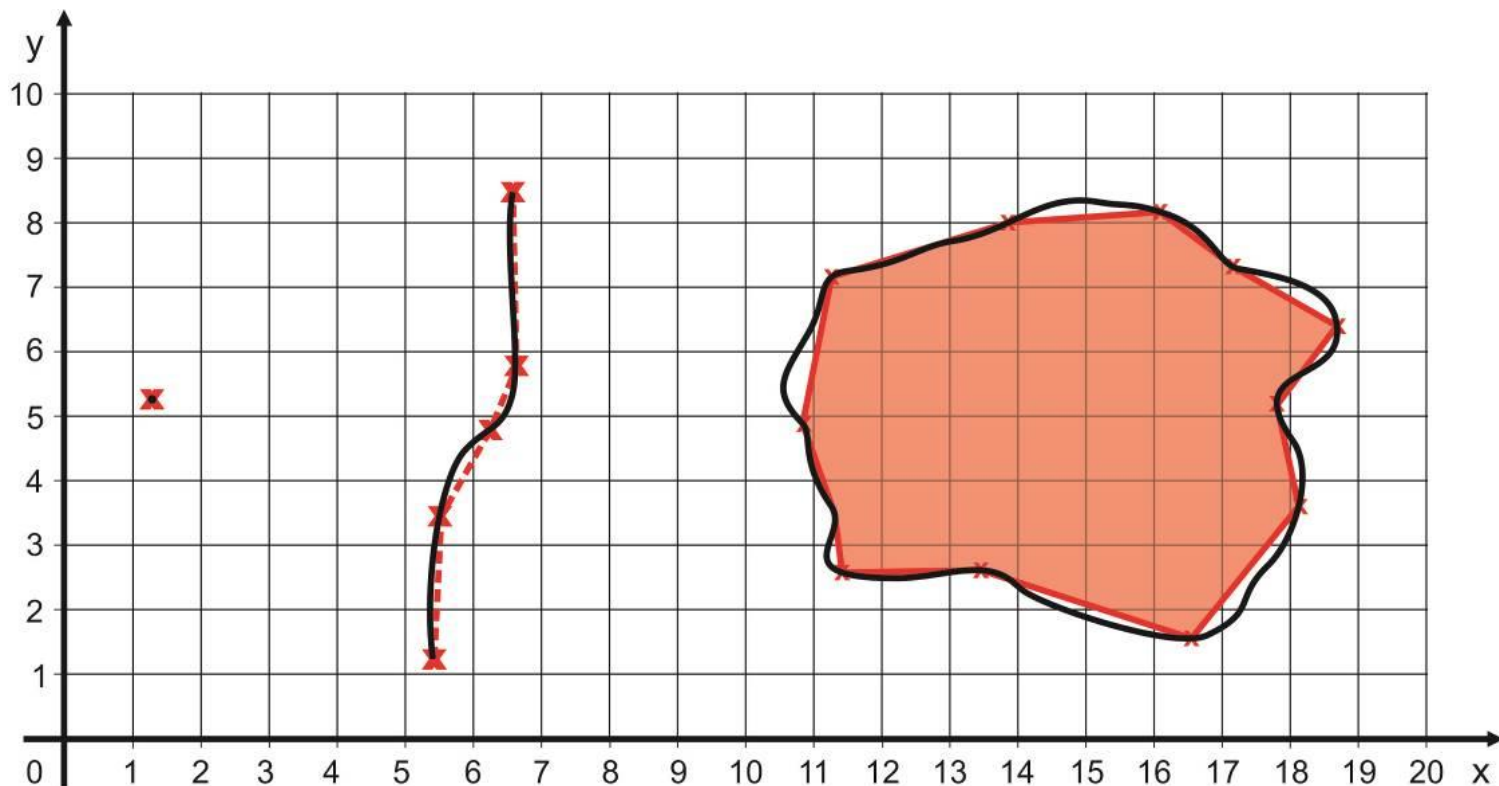


Vektorový dátový model

Body – body

Línie – séria bodov spojených úsečkami

Plochy – uzavretá séria bodov (vrcholov) navzájom spojenými úsečkami. Plochy sa tiež nazývajú **polygónmi**.

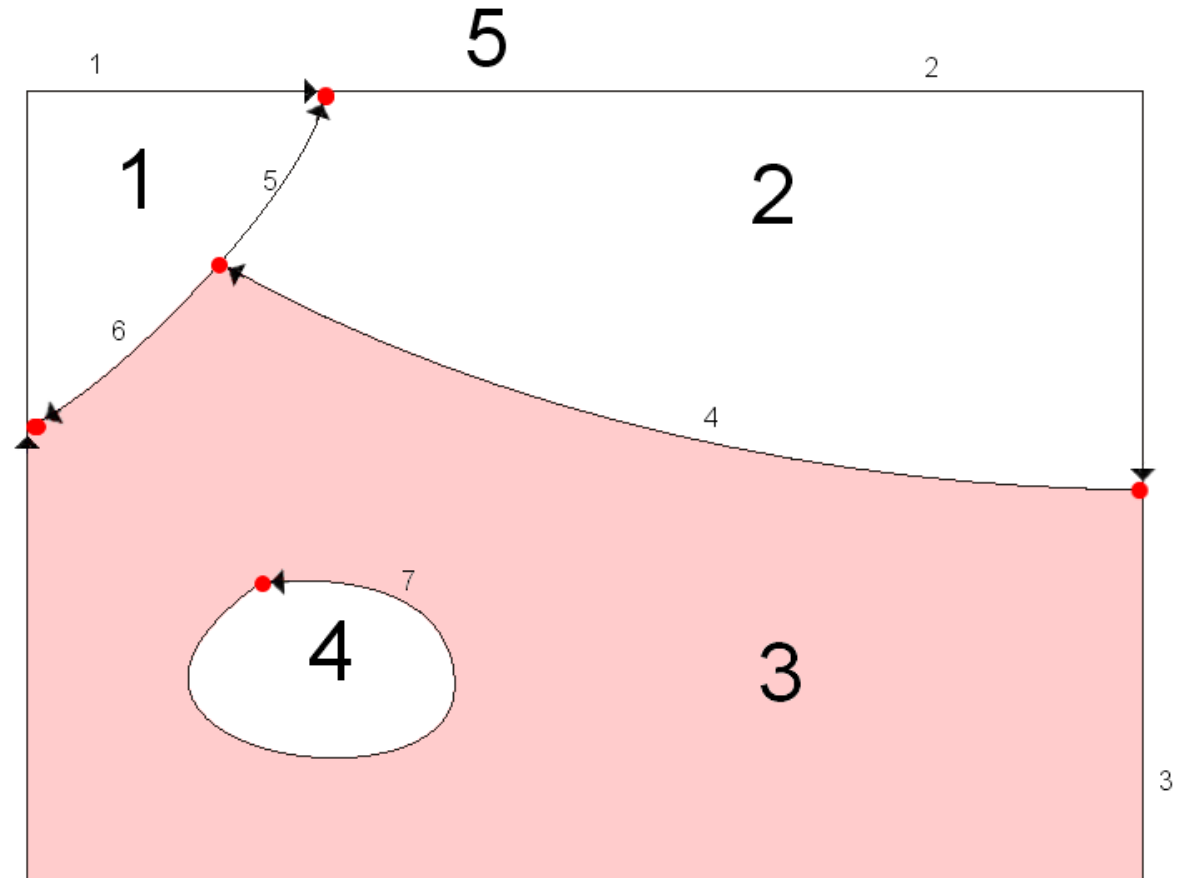


Topologické väzby pri vektorovom modeli

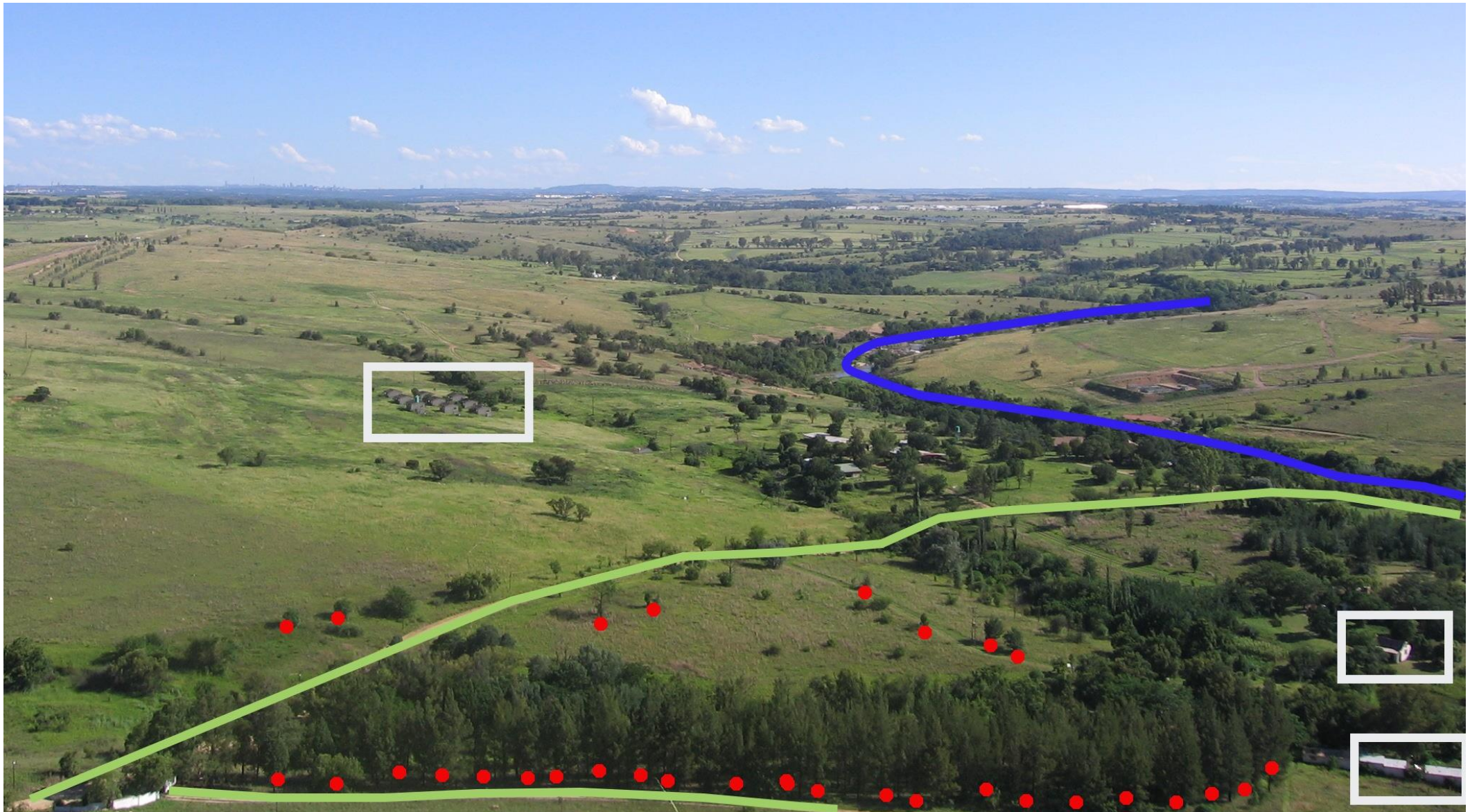
Číslo polygónu	Zoznam línií
1	1,5,6
2	2,4,5
3	3,4,6,7
4	7
5	

Číslo línie	Polygón vľavo	Polygón vpravo
1	5	1
2	5	2
3	5	3
4	3	2
5	1	2
6	3	1
7	3	4

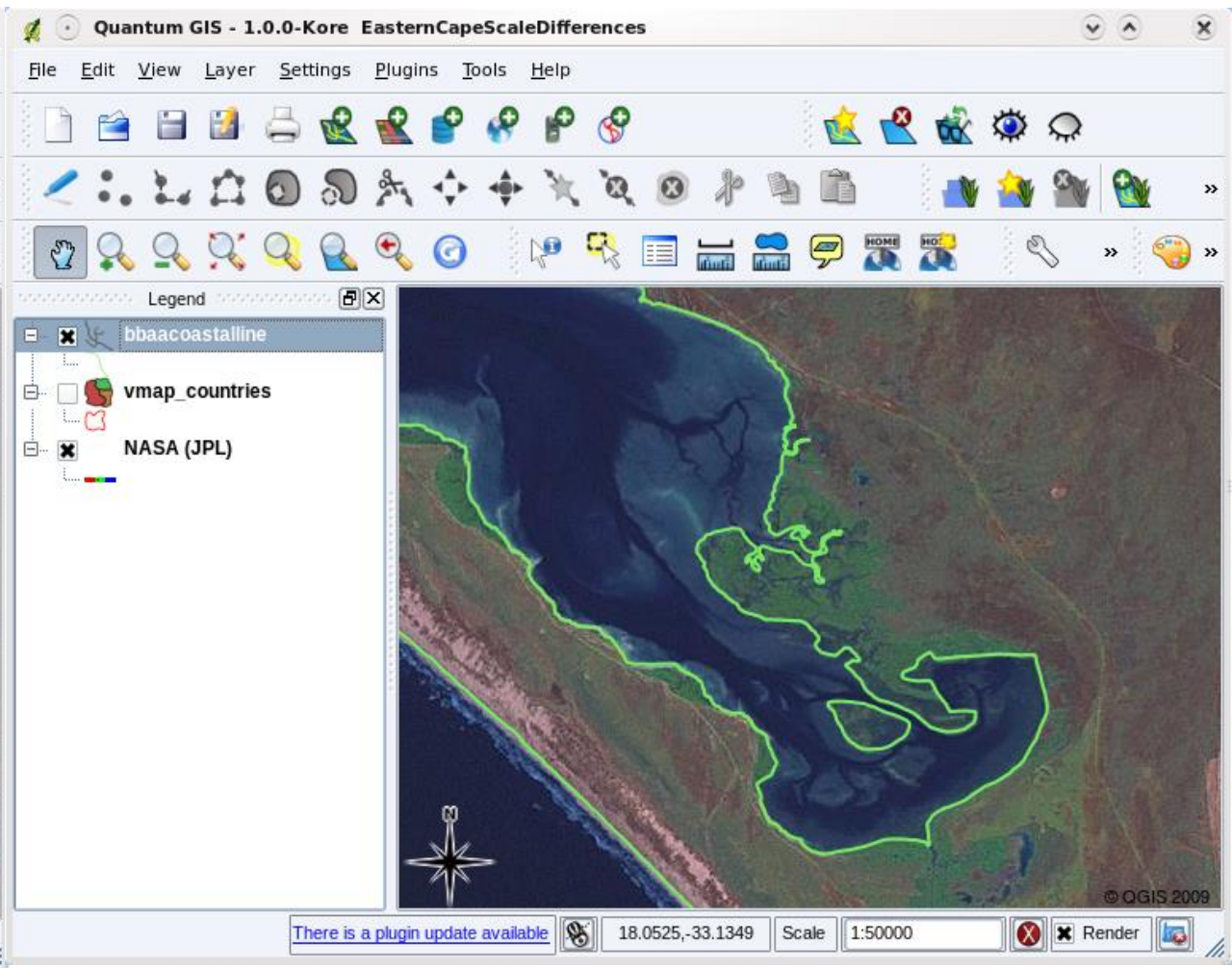
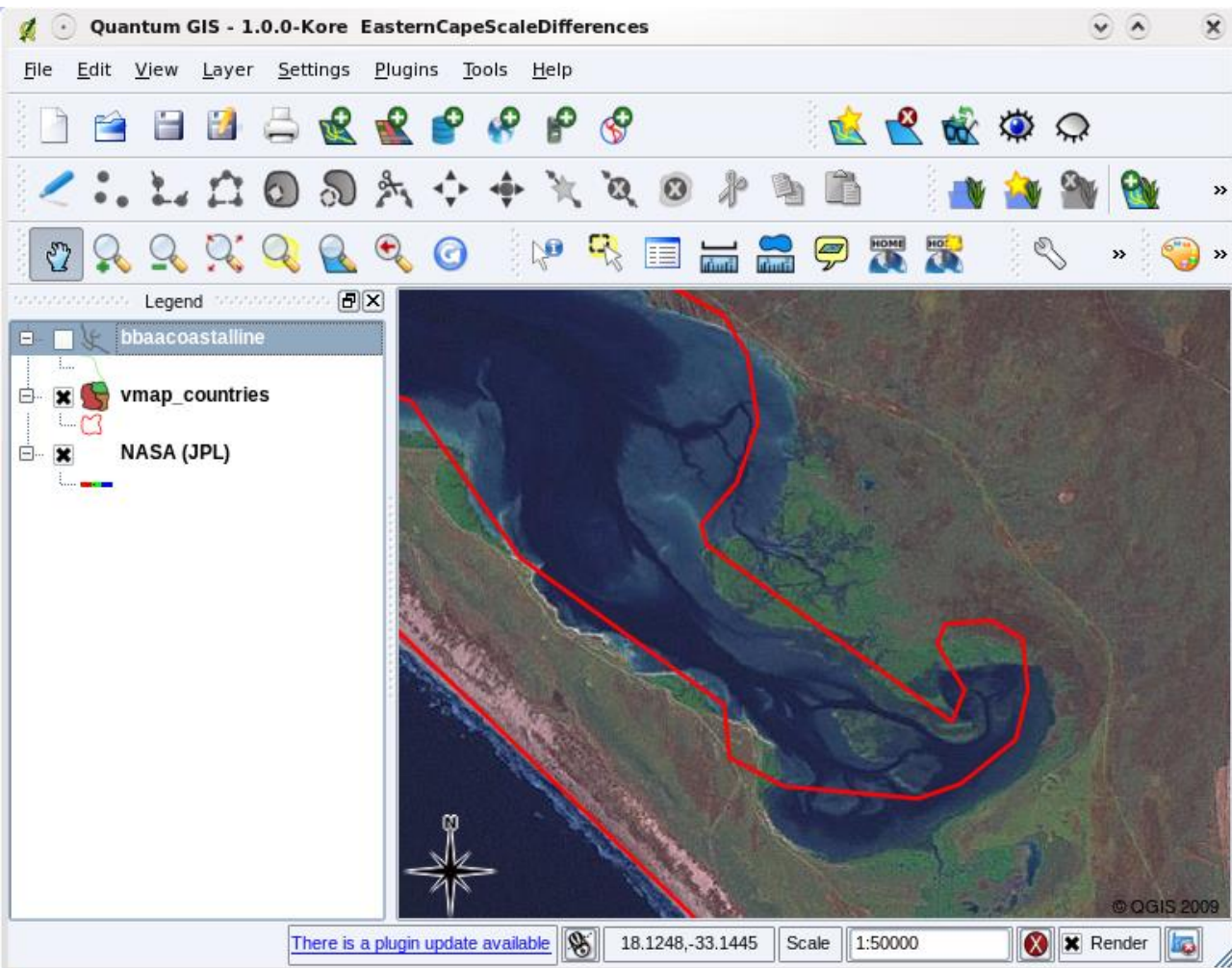
Číslo línie	Súradnice bodov
1	(0,7), (0,10), (3,10)
2	(3,10), (13, 10), ...
3	...
4	...
5	...
6	...
7	...



Reprezentácia krajiny – vektorový model



Vektorizácia – tvorba vektorovej vrstvy dát



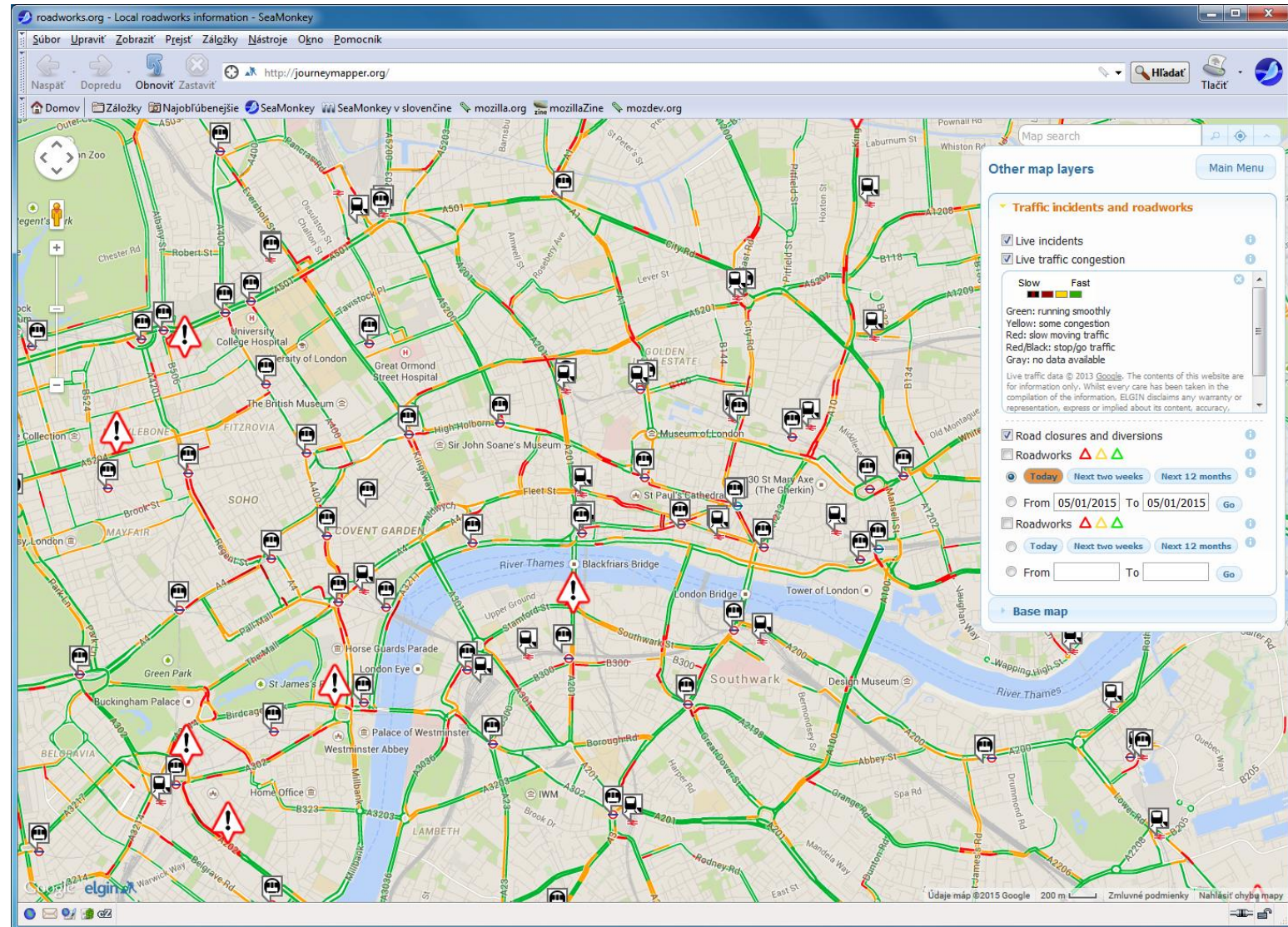
Vektorový model

Existujú 3 základné vektorové dátové modely:
špagetový, topologický a hierarchický

- **špagetový** – informácie o každom objekte samostatne
- **topologický a hierarchický** - analyzujú sa väzby, vzťahy medzi objektami a táto topologická informácia je uložená aj v databáze

Sieťová analýza v GIS-e

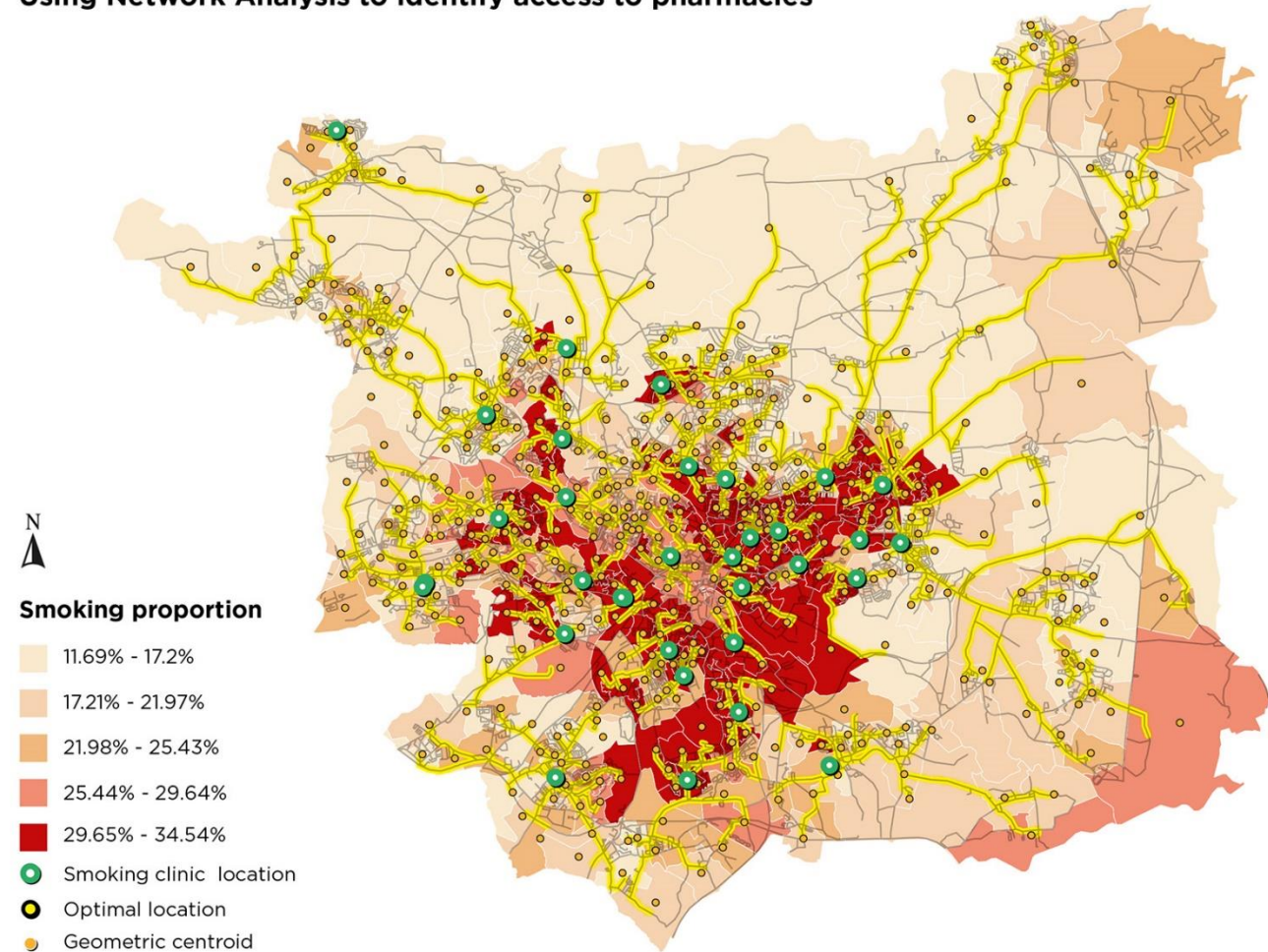
Teória grafov, topológia



Siet'ová analýza v GIS-e

Teória grafov, topológia

Using Network Analysis to identify access to pharmacies



Raster vs. vektor

Rastrový model – spojité dáta, prírodné javy, častá redundancia dát, avšak veľká dostupnosť napr. cez DPZ

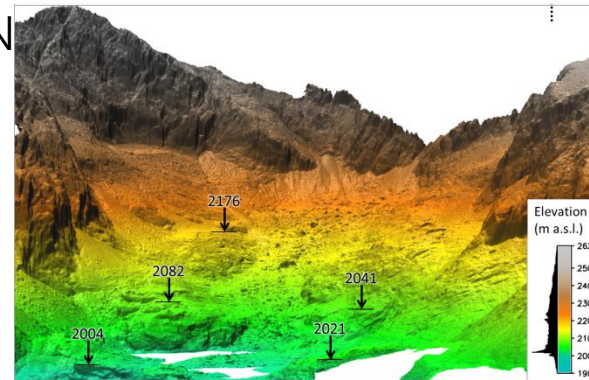
Vektorový model – diskkrétne objekty (cesty, budovy, objekty s ostrými hranicami), prácna príprava topológie

Aplikácie na Ústave geografie PF UPJŠ

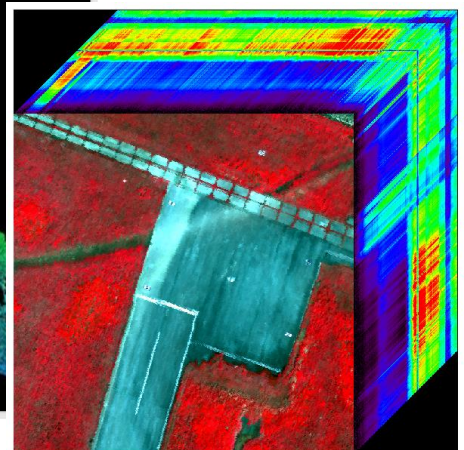
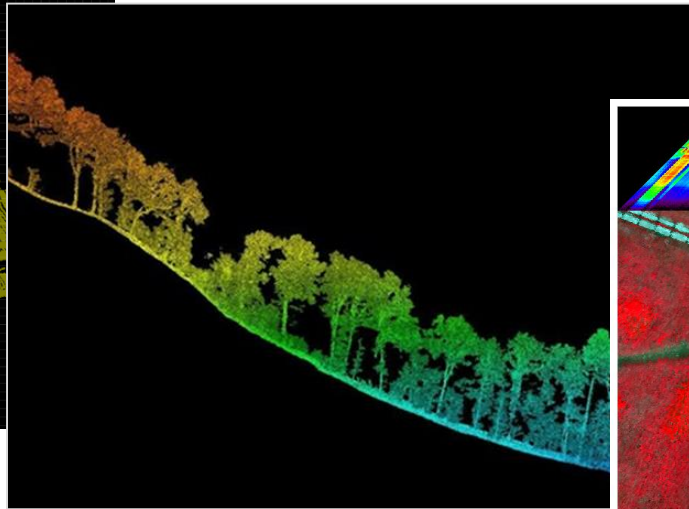
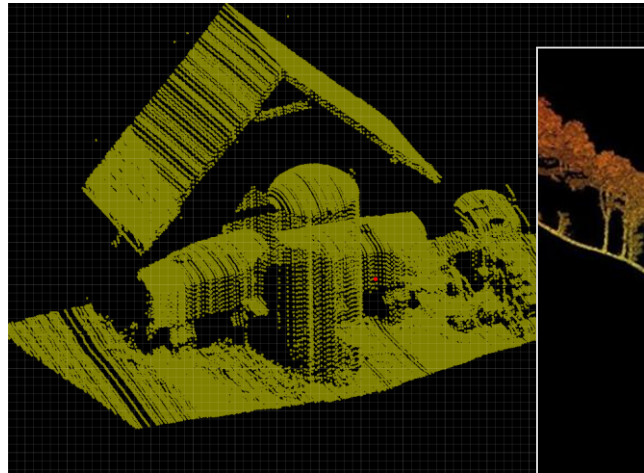
Laboratórium geografických informačných systémov a diaľkového prieskumu Zeme

Prístrojové a softvérové vybavenie

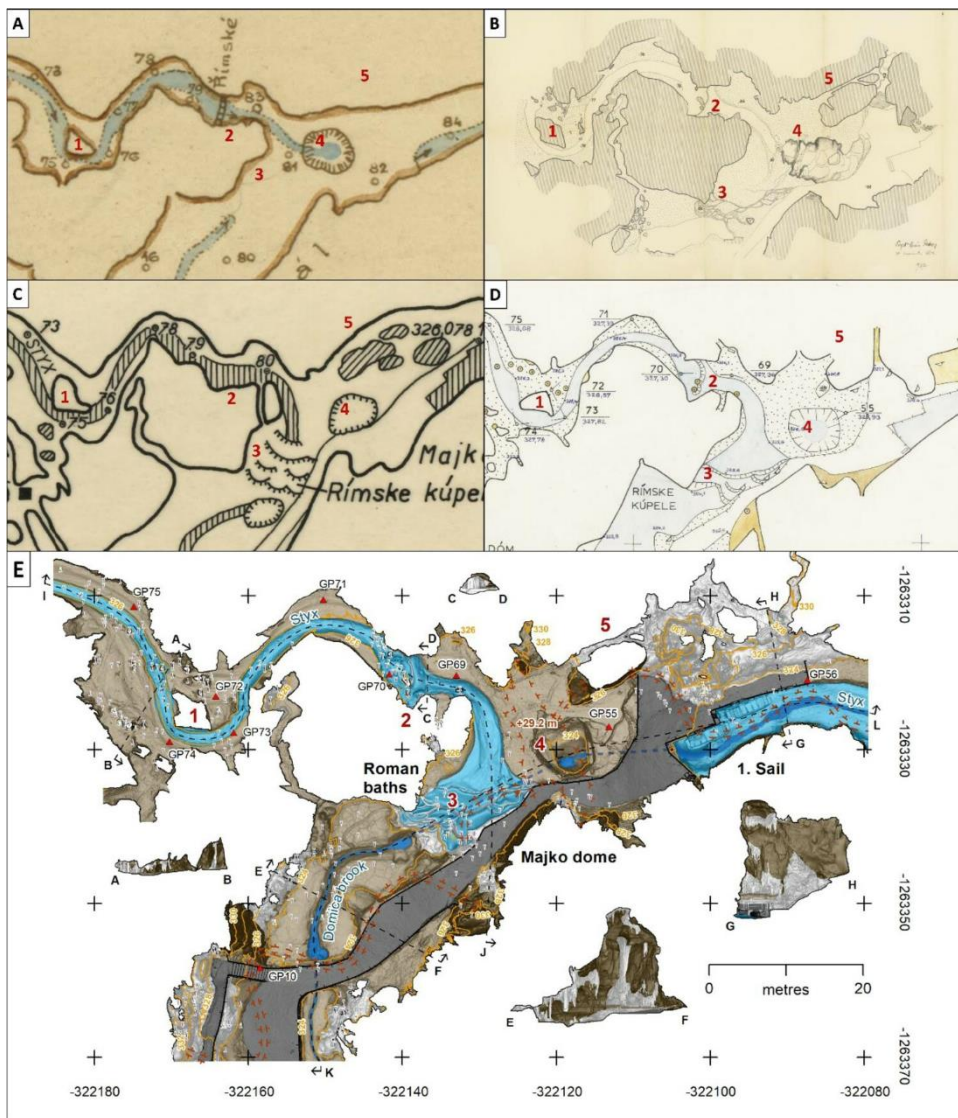
- pozemný laserový skener VZ-1000 od firmy Riegl s integrovaným fotoaparátom NIKON D-700;
- GNSS systém EPP Set – Hiper II od spoločnosti TOPCON
- GPS Trimble Juno SB s podporným softvérom (20 x)
- geodetická elektronická totálna stanica Leica TC 605;
- ploter HP DesignJet Z2100 Photo;
- ArcGIS for Server Enterprise Advanced 10, GRASS, Bentley Academic Select (50 sw balíkov), GPS Pathfinder, Quantum GIS 3



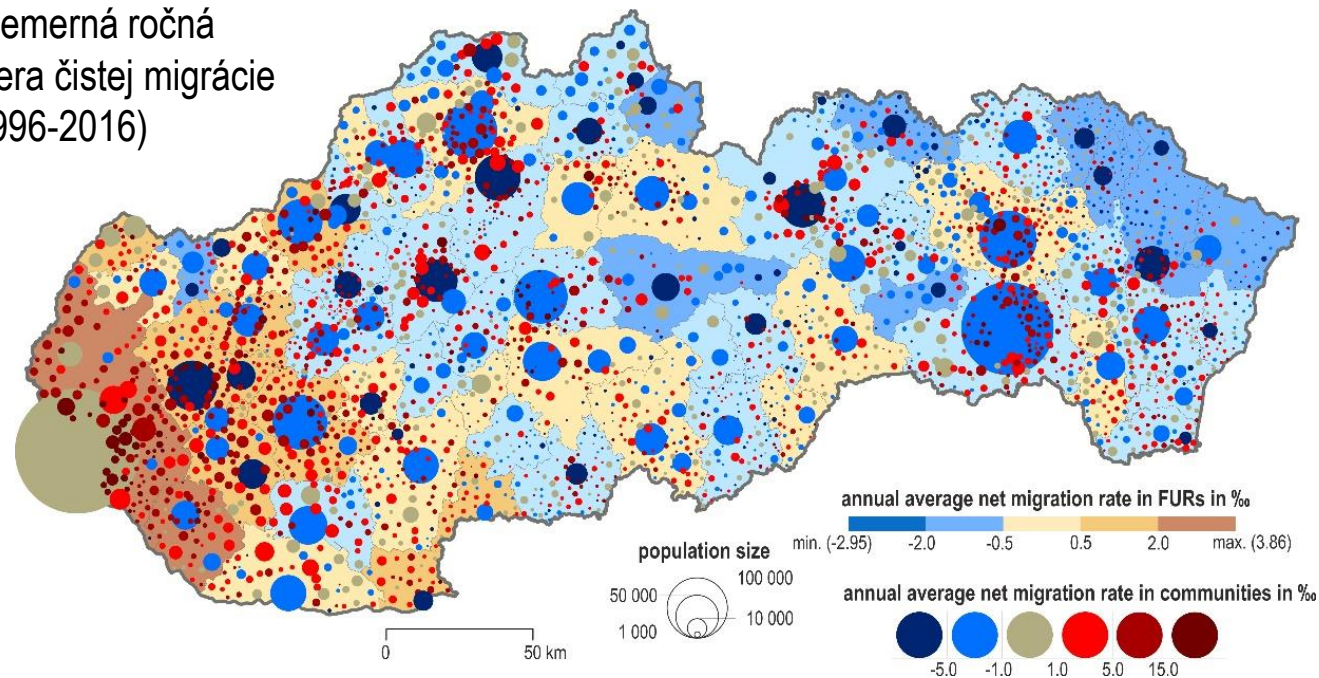
- UAV platformy: Aeroscout Scout B1-100; DJI Agras, DJI Matrice 210 , DJI PHANTOM 4, DJI PHANTOM 4
- senzory: Riegl VUX-1, AISA KESTREL 10, Parrot Sequoia, SONY A6000
- fotogrametrická pracovná stanica PHOTOMOD v5.2 RACURS
- softvér: RiAcquire, RiScanPro, CaliGEO Pro, Photoscan, LAStools



Tvorba máp



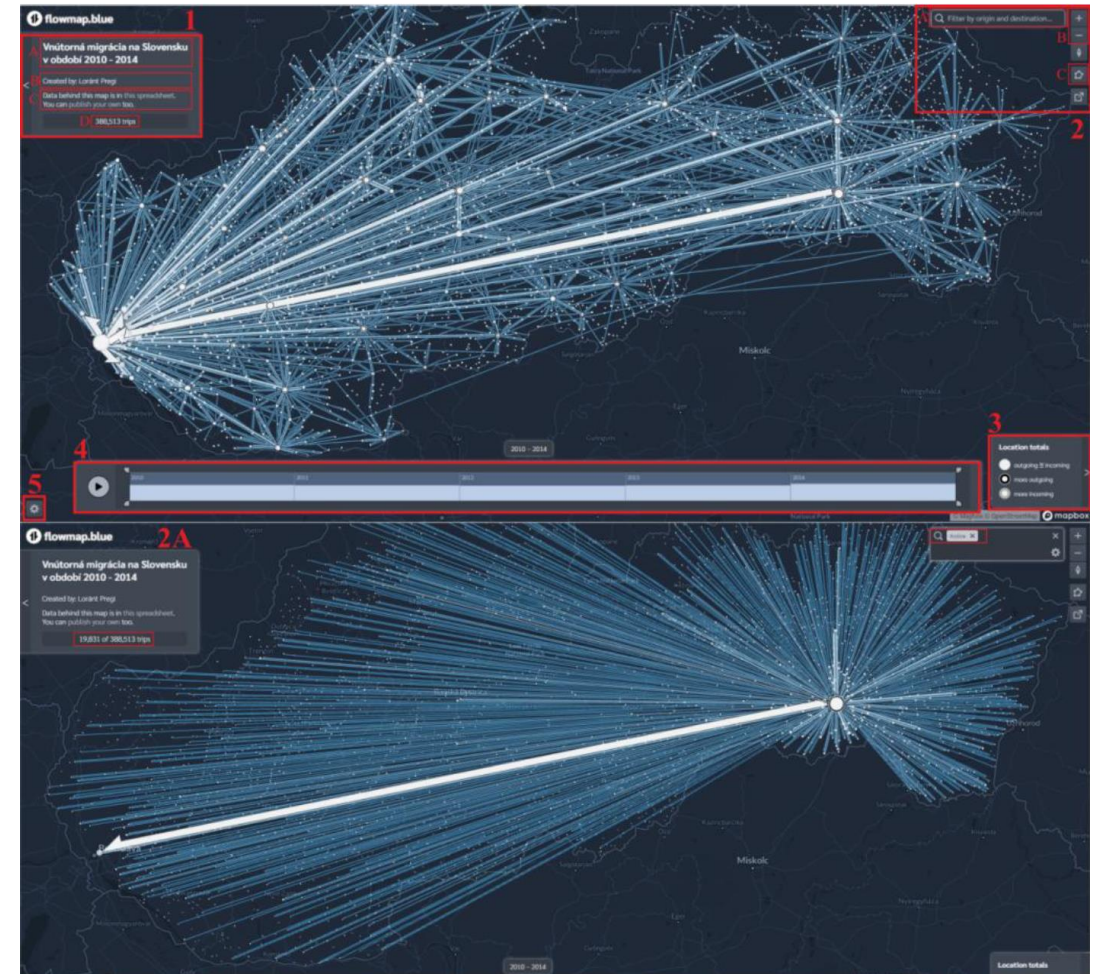
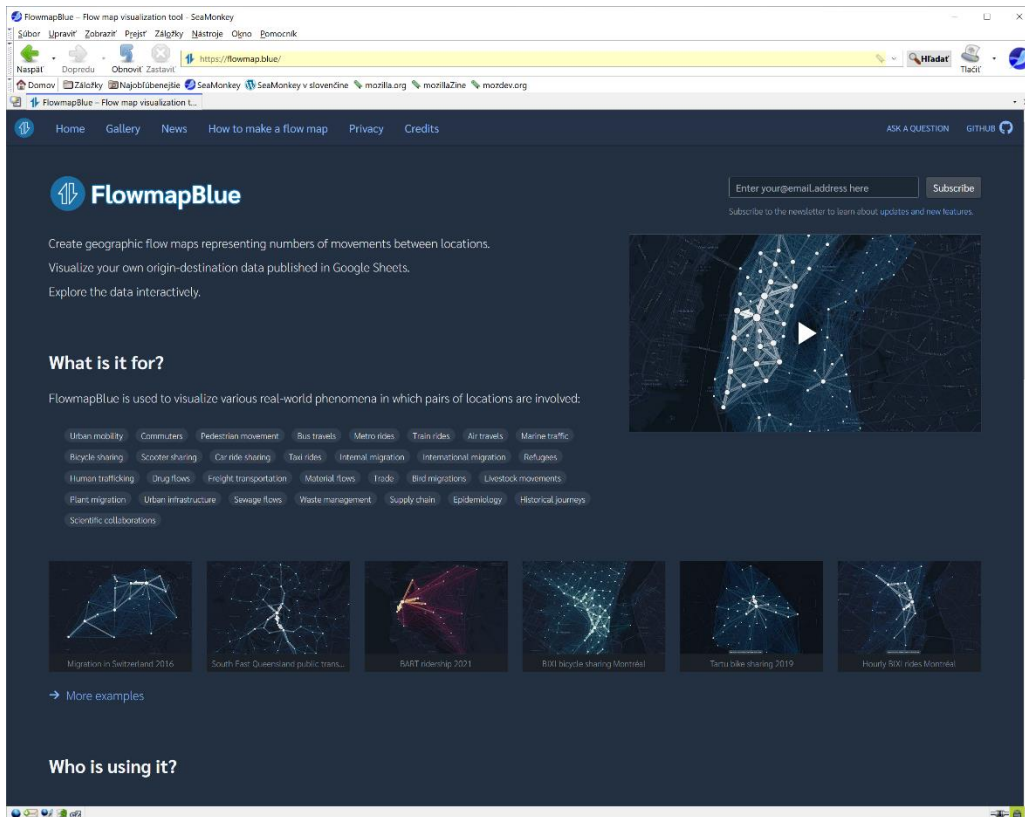
Priemerná ročná
 miera čistej migrácie
 (1996-2016)



NOVOTNÝ, L. (2019). Impact of Migration on Rural Regions in Post-socialist Slovakia. In: Baňski, J. ed. Three Decades of Transformation in the East-Central European Countryside. Cham (Springer), pp. 165-189.

ŠUPINSKÝ, J., KAŇUK, J., NOVÁKOVÁ, M., HOCHMUTH, Z. (2022). LiDAR point clouds processing for large-scale cave mapping: a case study of the Majko dome in the Domica cave. *Journal of Maps*, 1-8.

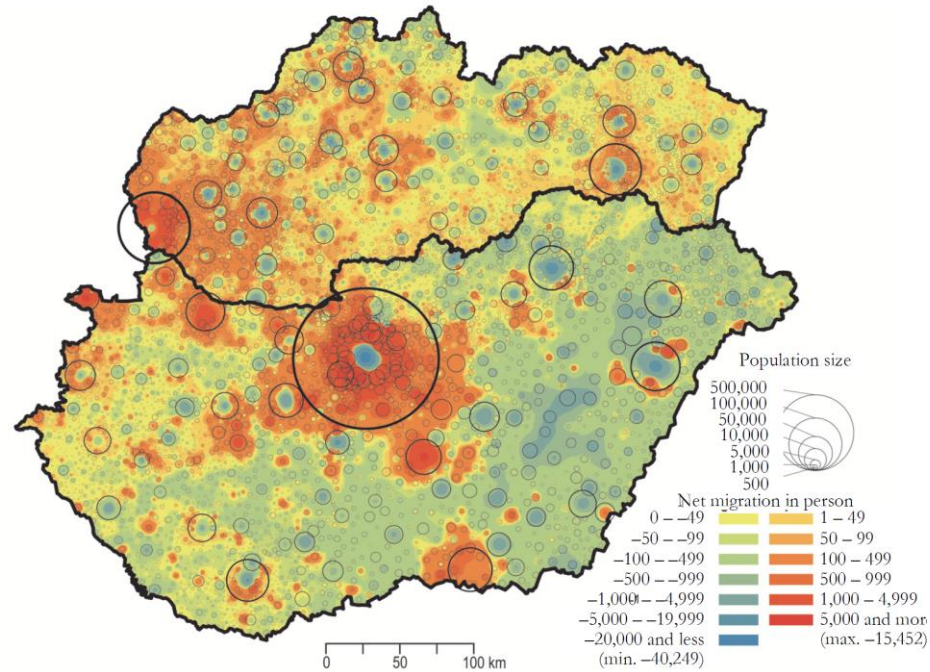
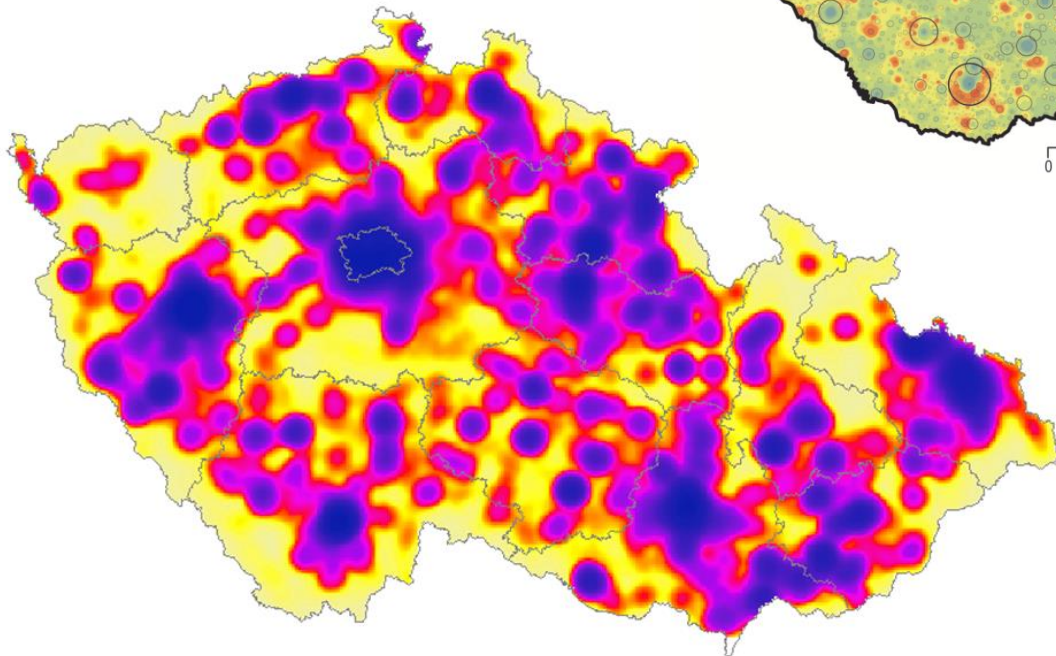
Flowmap.blue – online kartografia



PREGI, L., NOVOTNÝ, L., GÁBOR, Š. (2022).
Vizualizácia priestorových procesov pomocou
online mapovej aplikácie Flowmap.blue.
Kartografické listy, 30(1), 21-38.

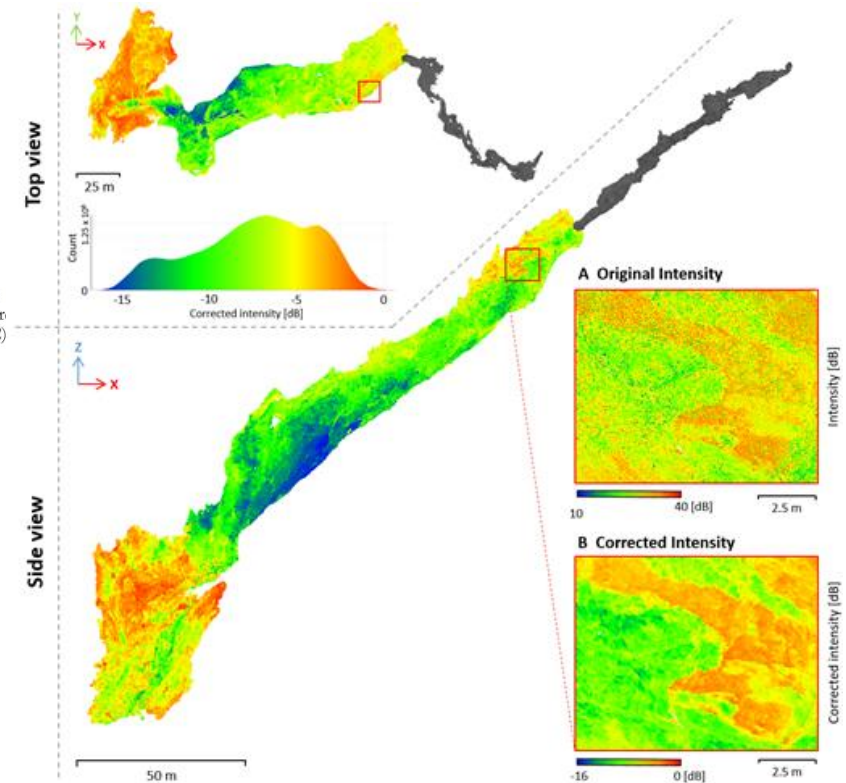
Geopriestorové analýzy

NOVOTNÝ, L., PREGI, L. (2018).
 Visualization of migration using spatial
 interpolation method in Hungary and
 Slovakia. *Regional Statistics*, 8(2),
 184–188.



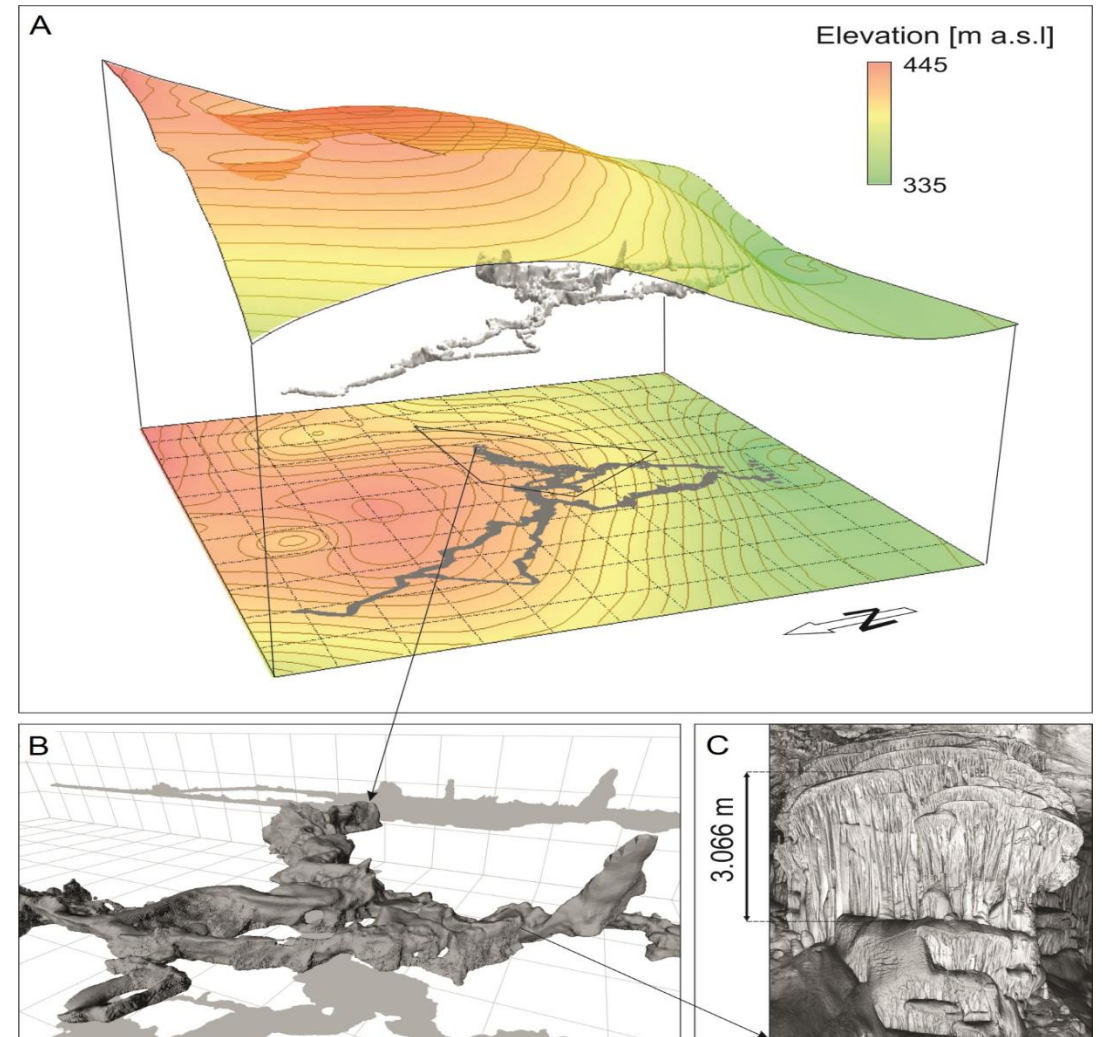
GALLAY, M., KAŇUK, J.,
 HOFIERKA, J. (2015). Capacity
 of photovoltaic power plants in
 the Czech Republic. *Journal of
 Maps*, 11(3), 480-486.

NOVÁKOVÁ, M., GALLAY, M., ŠUPINSKÝ, J., FERRÉ,
 E., ASTI, R., DE SAINT BLANQUAT, M., BAJOLET, F.,
 SORRIAUX, P. (2022). Correcting laser scanning
 intensity recorded in a cave environment for high-
 resolution lithological mapping: A case study of the
 Gouffre Georges, France. *Remote Sensing of
 Environment*, 280, 113210.

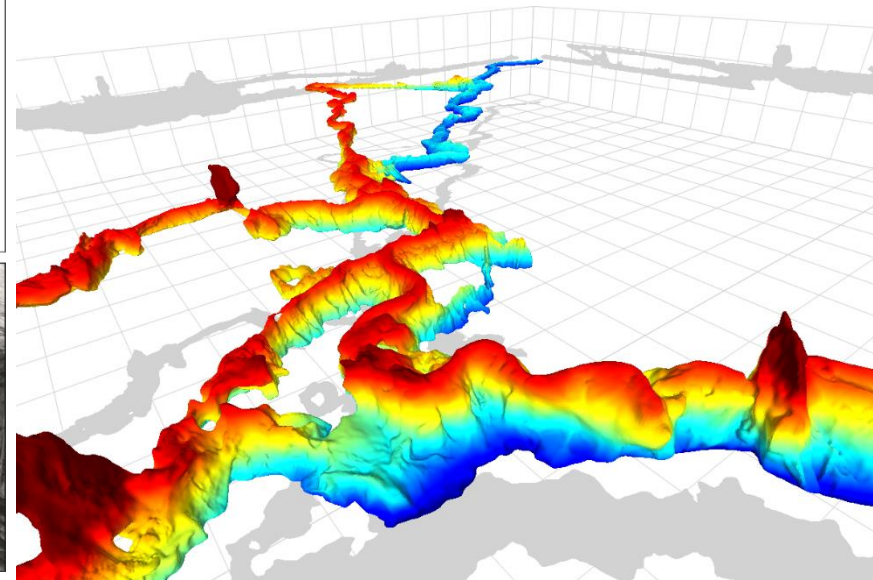
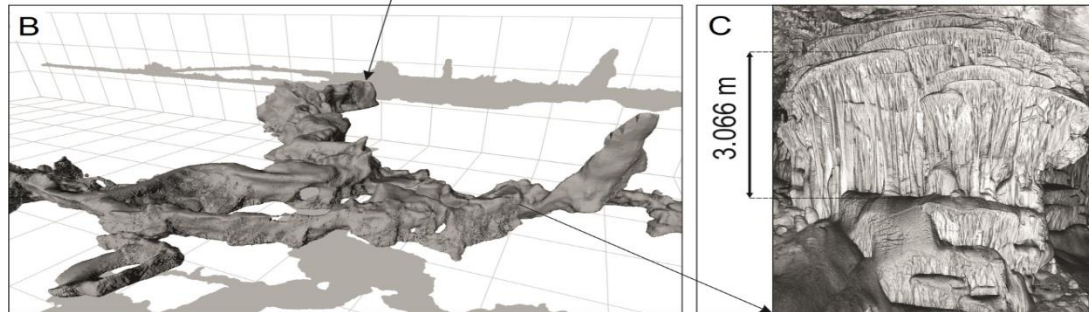
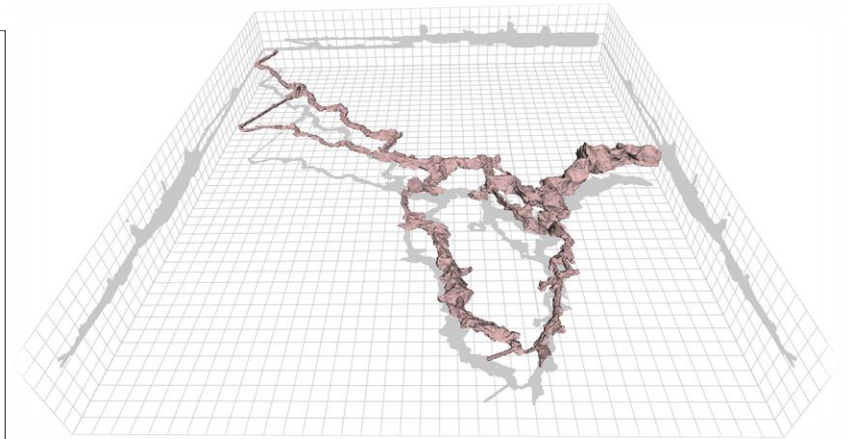
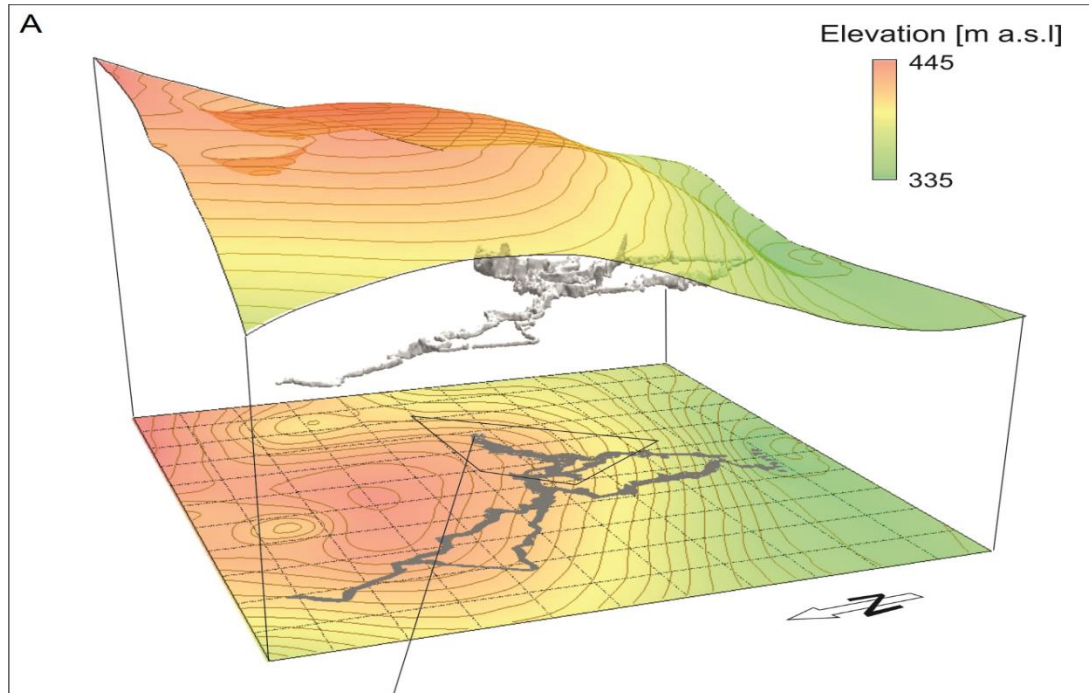


Laserové skenovanie

- 3D mračná bodov z laserového skenovania úplne zásadne zmenili spôsob, akým sa získavajú dáta o krajine. Máme k dispozícii bezprecedentné množstvo vysokopresných dát. To umožňuje výskum krajiny vo vysokom rozlíšení a **v 3D**



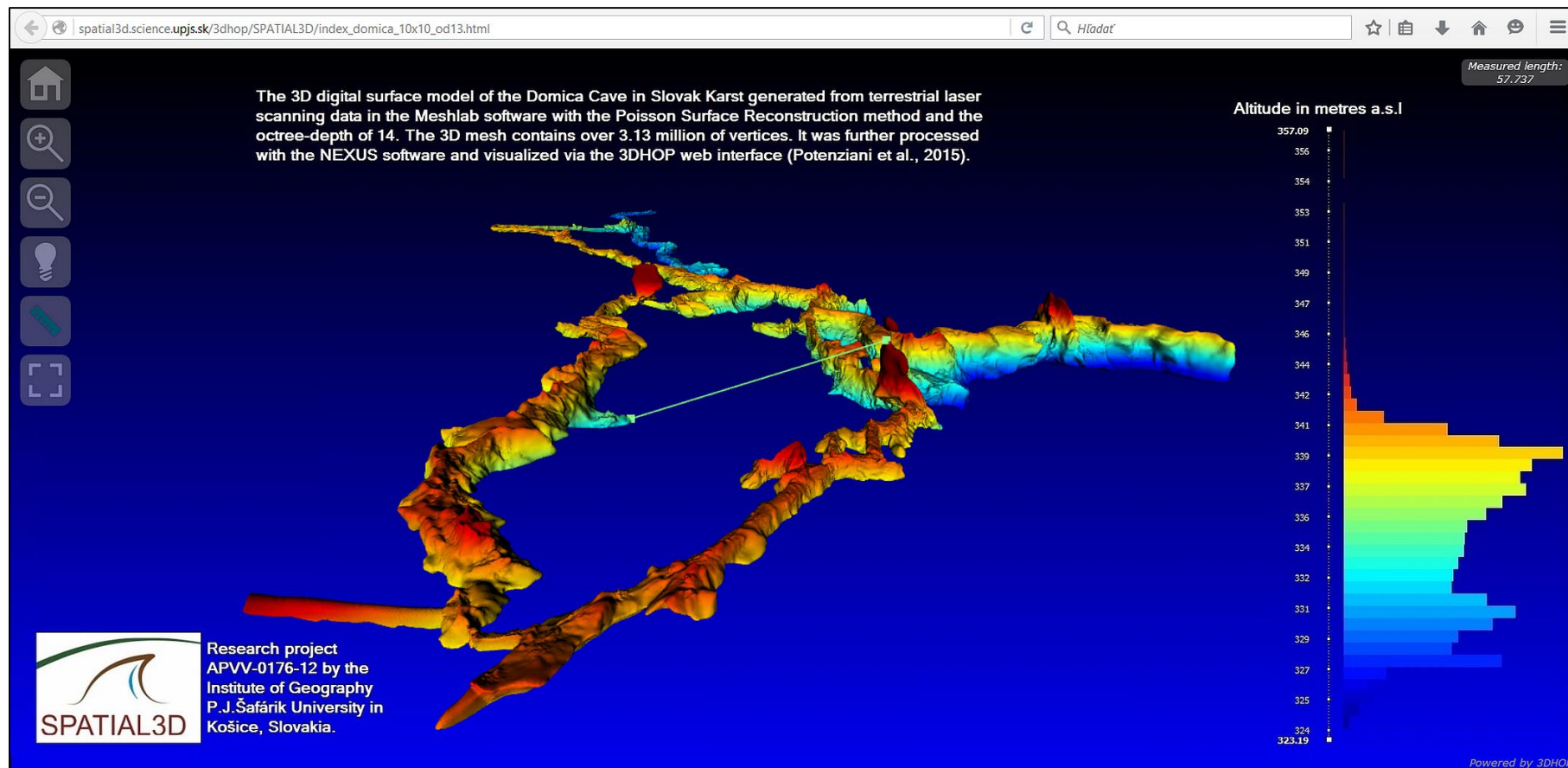
Terestrické laserové skenovanie jaskýň



Terestrické laserové skenovanie v jaskyni Domica

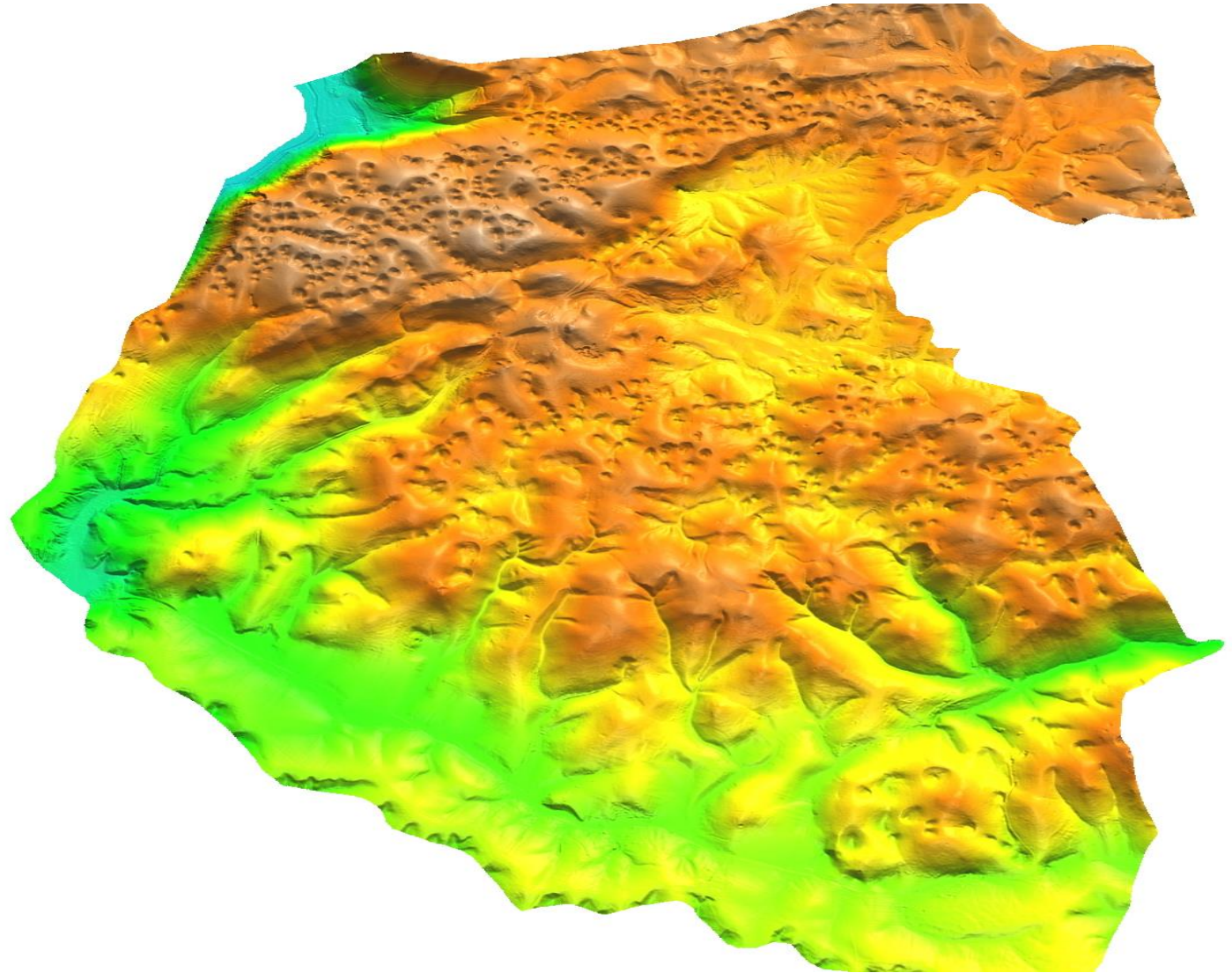
http://spatial3d.science.upjs.sk/3dhop/SPATIAL3D/index_domica_10x10_od13.html

Interaktívna web vizualizácia



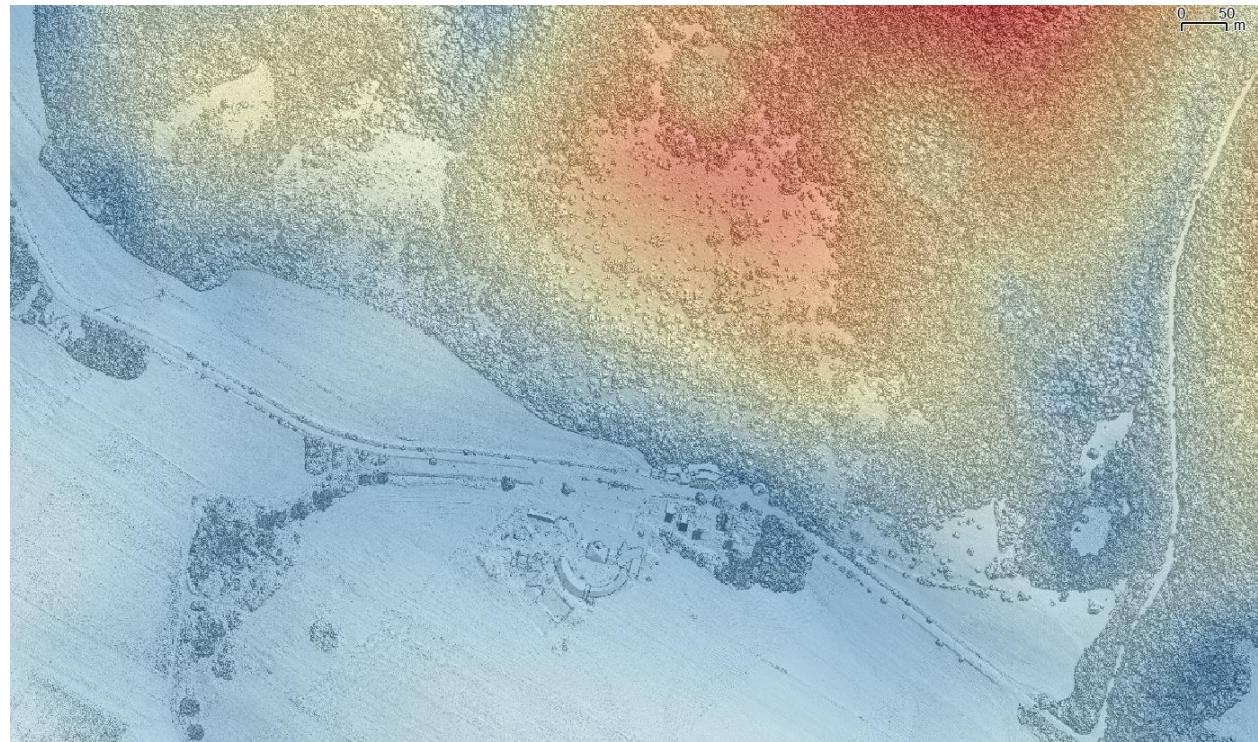
Digitálny model reliéfu z let. laser. skenovania

HOFIERKA, J., GALLAY, M., ŠAŠAK, J.,
BANDURA, P. (2018). Identification of karst
sinkholes in a forested karst landscape using
airborne laser scanning data and water flow
analysis. *Geomorphology*, 308, 265-277.

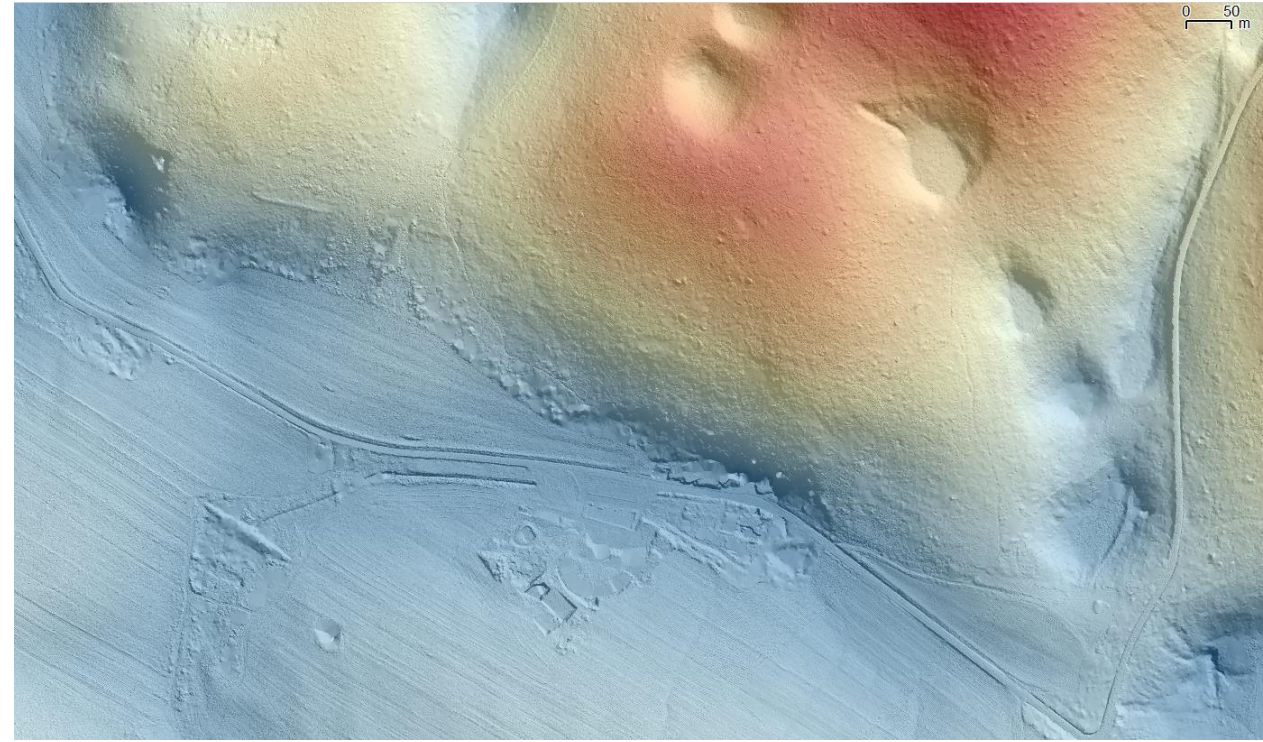


Laserové skenovanie na mapovanie georeliéfu a povrchu vegetácie

DSM (aj povrch vegetácie)

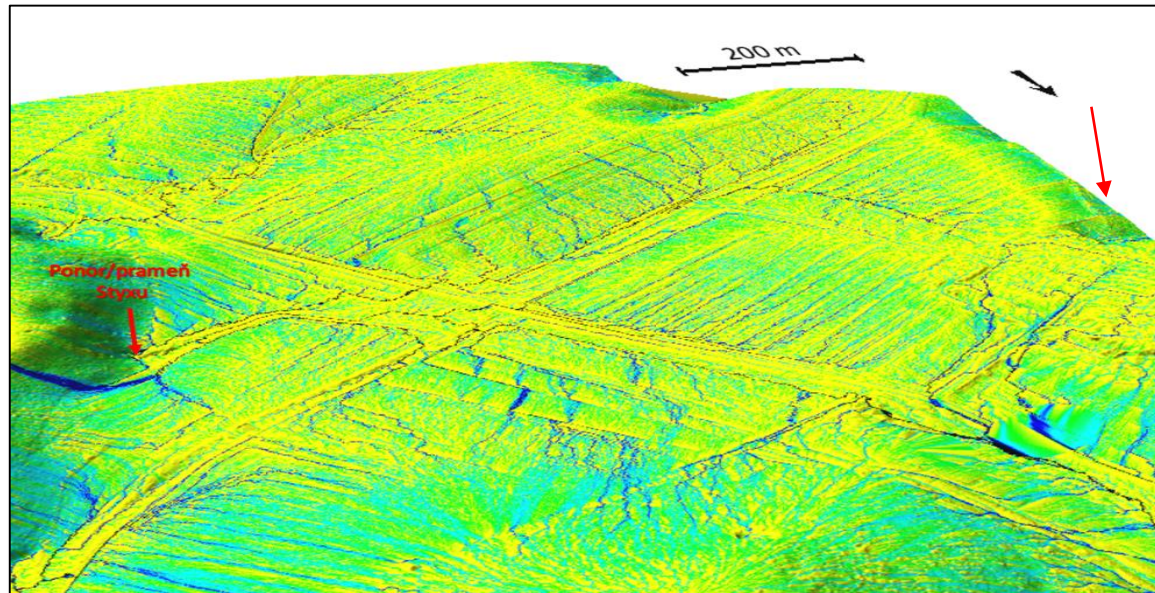


DMR (len georeliéf)

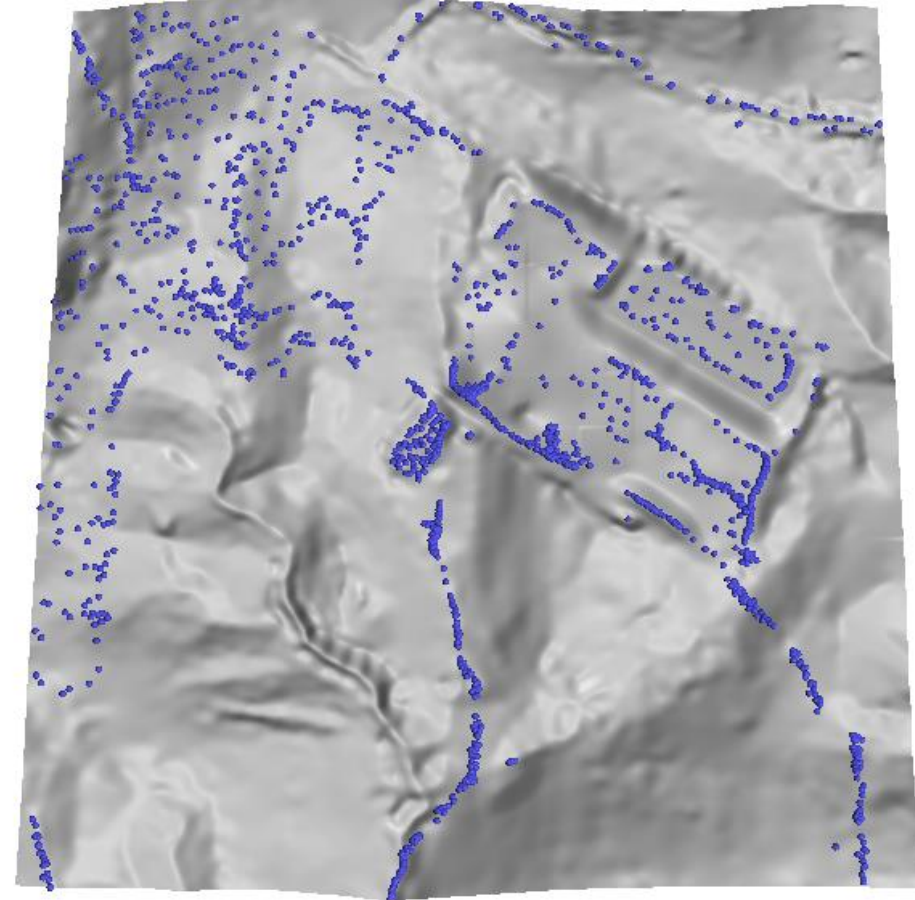
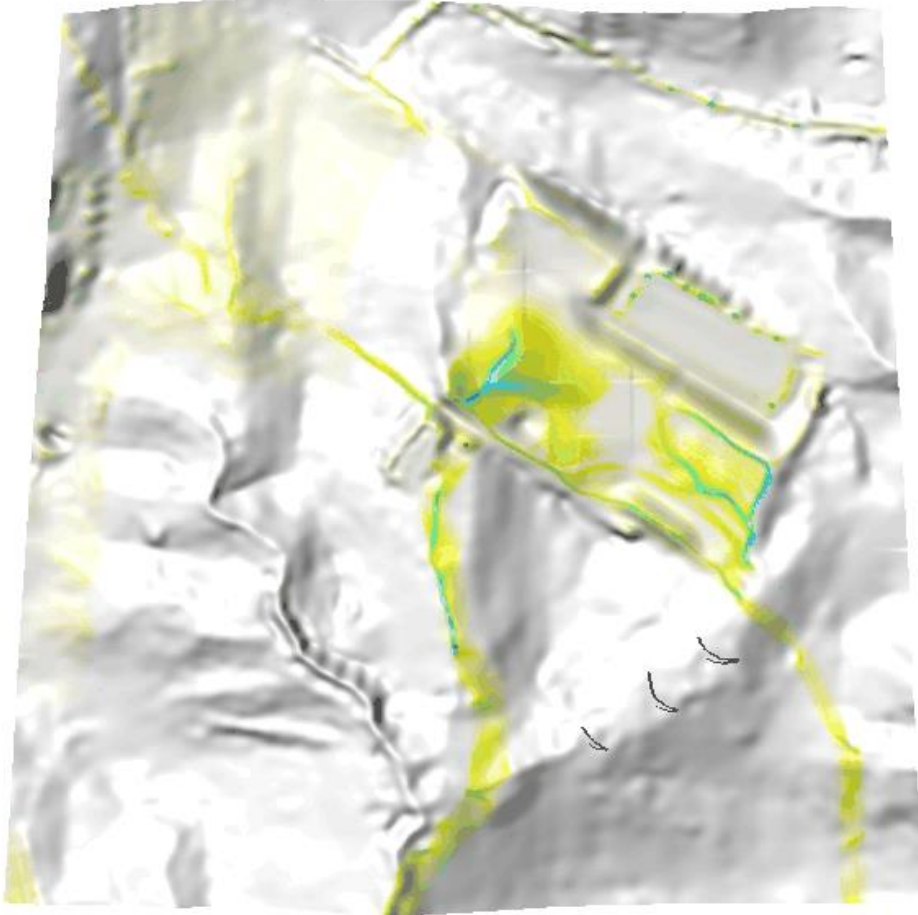


Použitie UAS pri monitorovaní javov

- Povrchové tečenie vody simulované podľa silnej zrážky zo 17. 2. 2016.
- Voda mizne v závrte, kde sa začína jaskynný systém Domice (Styx).
- Fotografia získaná z dronu DJI Phantom.



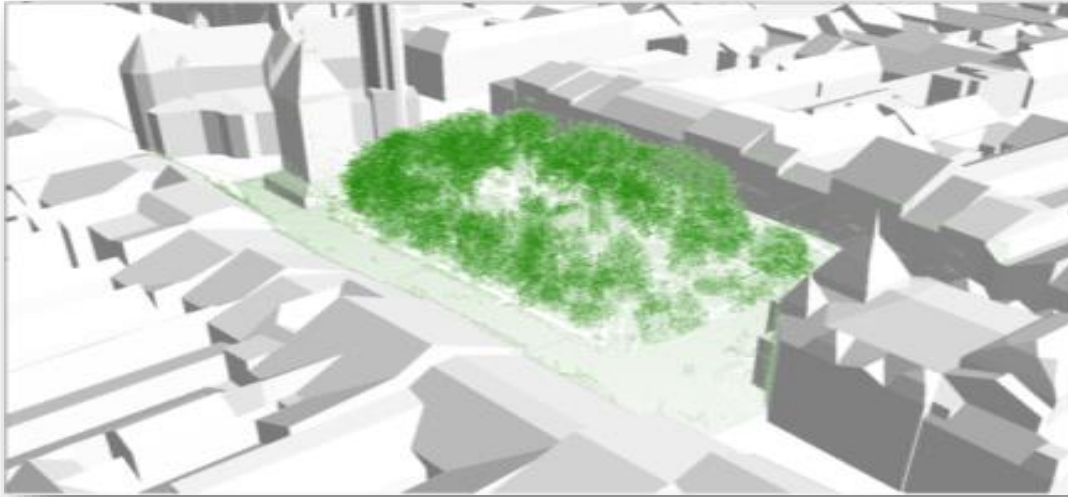
Modelovanie povrchového toku vody



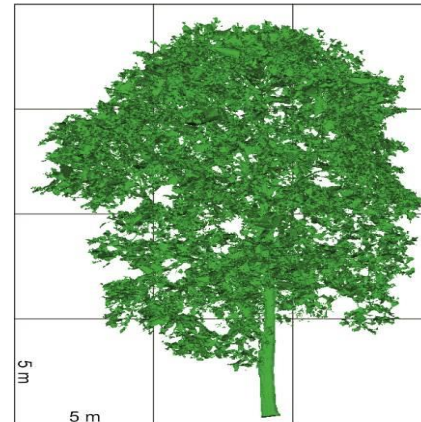
Mitasova, H., Thaxton, C., Hofierka, J., McLaughlin, R., Moore, A., Mitas, L. (2004). Path sampling method for modeling overland water flow, sediment transport and short term terrain evolution in Open Source GIS. In: Miller, C. T., Farthing, M. W., Gray, W. G., Pinder, G. F. (eds.) Computational Methods in Water Resources. Developments in Water Science 55 (Part 2). Proceedings of the 15th International Conference on Computational Methods in Water Resources (CMWR XV), June 13–17, 2004, Chapel Hill, North Carolina, USA, Elsevier, 1479-1490.

Laserové skenovanie stromovej vegetácie v meste

ALS



TLS

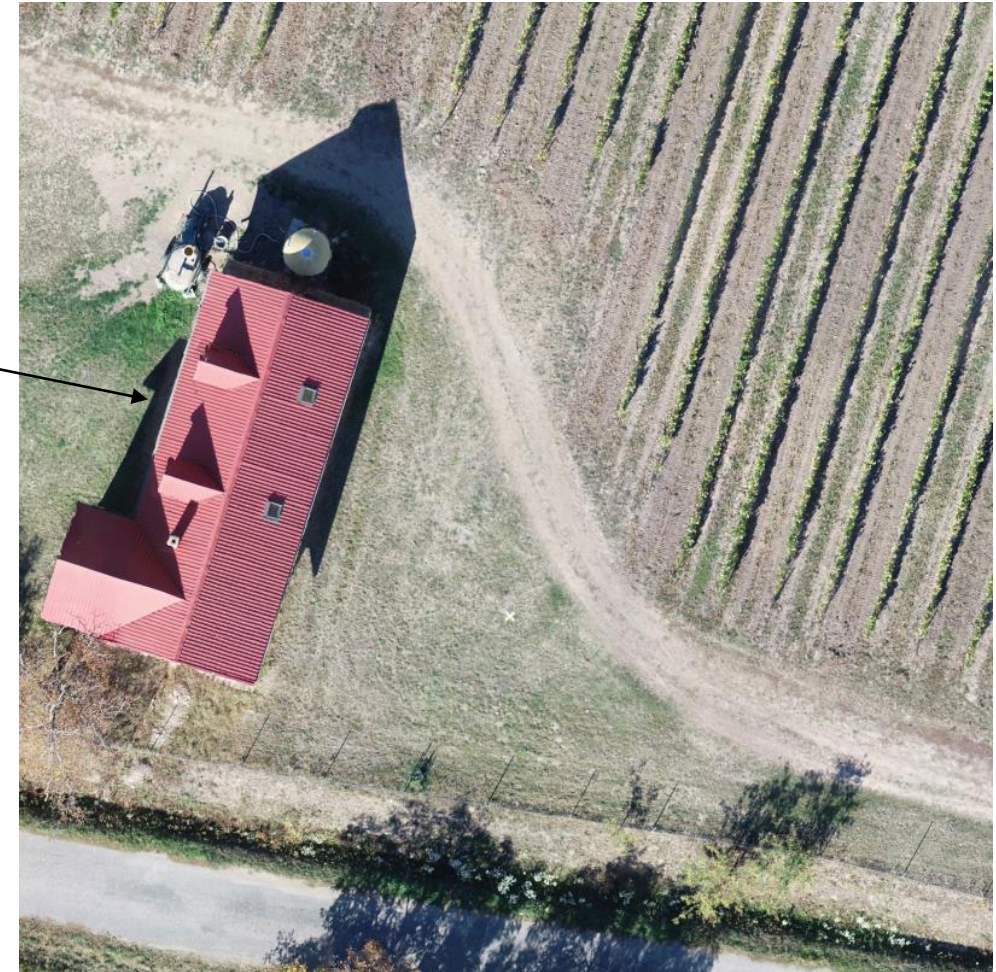
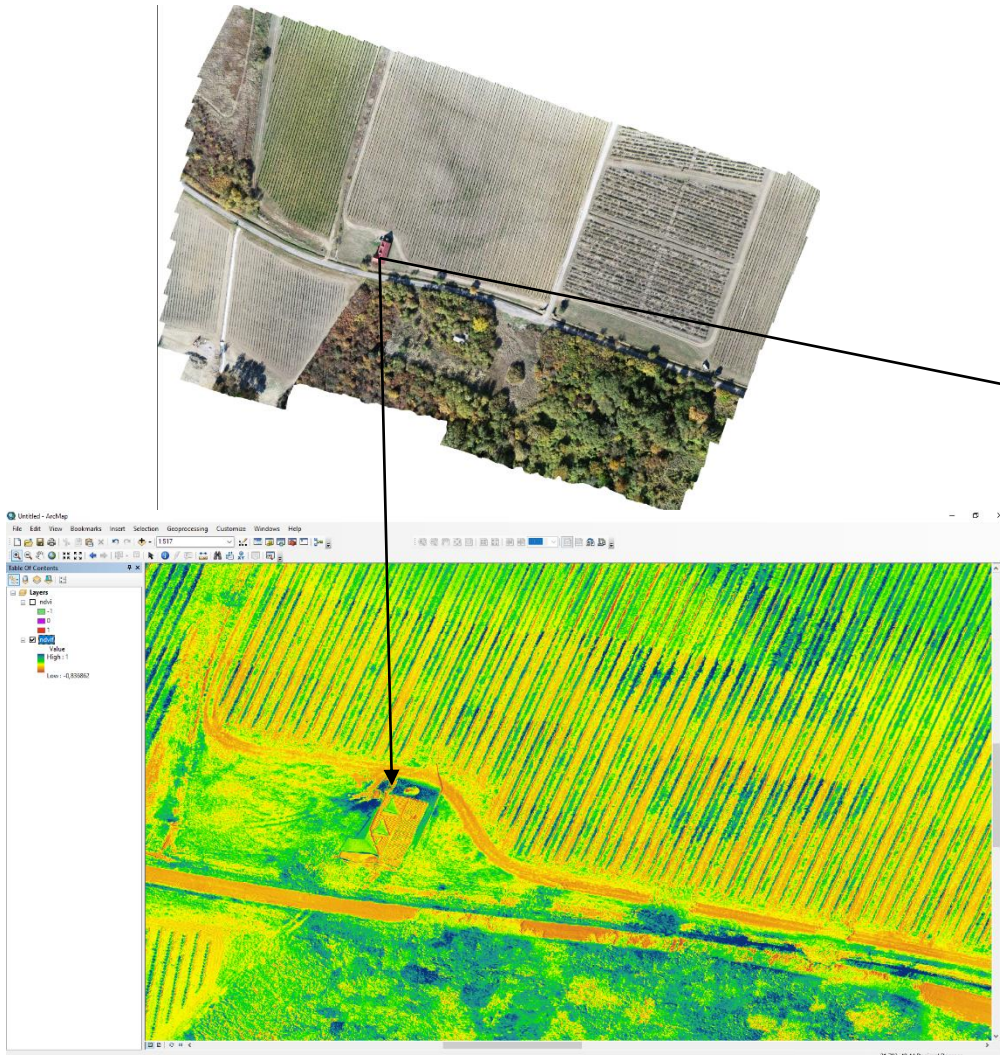


Bezpilotné letecké systémy - UAS

- Rozvoj UAS umožňuje veľmi efektívny a rýchly zber dát metódami DPZ
- Tvorba ortofotosnímkov s vysokým rozlíšením, ale aj 3D mračien bodov pomocou metódy Structure from motion (SfM)
- Cenovo dostupné a flexibilné riešenie
- Nosič umožňuje použitie rôznych senzorov, od optických kamier po laserové skenery



UAS s RBG a multispektrálnou kamerou Parrot Sequoia



Vizualizácia dát

Website: <https://uge.science.upjs.sk/webshared/Pivnica/Pivnica.html>



Vizualizácia a interakcia s dátami online Potree

JSON DXF

Objects

- Point Clouds
 - TLS_Vinica
 - ALS_Tokaj
 - TLS_Pivnica
 - TLS_Pivnica_exterier
 - VUX_Vinica
 - SFM_Vinica
- Measurements
 - Profile
- Annotations
- Other
 - Camera

Properties

x	y	z
-231,347.030	-1,272,136.652	174.194
-231,290.452	-1,272,161.642	177.570

Width:

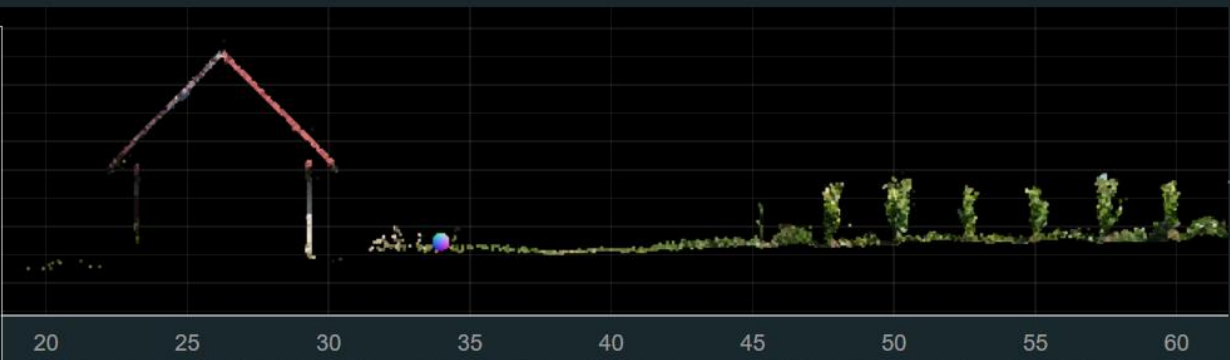


Hon Mako

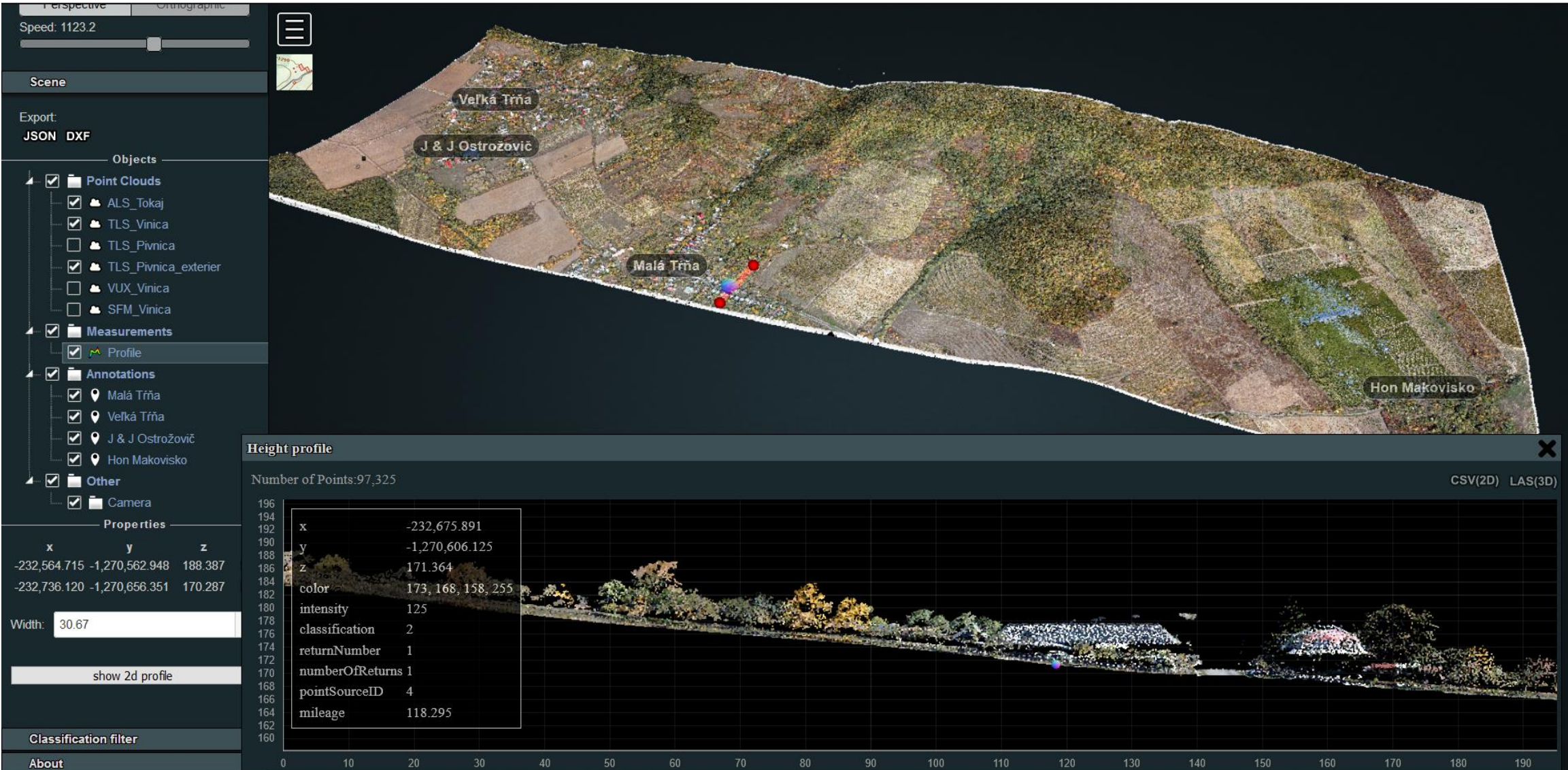
Height profile ✕

Number of Points: 15,163 CSV(2D) LAS(3D)

183	x	-231,316.125
182	y	-1,272,150.750
181	z	175.448
180	color	173, 169, 121, 255
179	intensity	31484
178	classification	0
177	returnNumber	1
176	numberOfReturns	1



Vizualizácia a interakcia s dátami online Potree



The screenshot displays the Potree software interface. The main window shows a 3D point cloud visualization of a landscape. The interface includes a left sidebar with a scene tree, a top toolbar with a speed slider (set to 1123.2), and a bottom toolbar with a 'show 2d profile' button.

The scene tree on the left is organized as follows:

- Scene
 - Export: JSON DXF
 - Objects
 - Point Clouds
 - ALS_Tokaj
 - TLS_Vinica
 - TLS_Pivnica
 - TLS_Pivnica_exterior
 - VUX_Vinica
 - SFM_Vinica
 - Measurements
 - Profile
 - Annotations
 - Malá Trňa
 - Veľká Trňa
 - J & J Ostrožovič
 - Hon Makovisko
 - Other
 - Camera
 - Properties

x	y	z
-232,564.715	-1,270,562.948	188.387
-232,736.120	-1,270,656.351	170.287

The main visualization area shows a 3D point cloud of a landscape with several annotations:

- Veľká Trňa
- J & J Ostrožovič
- Malá Trňa
- Hon Makovisko

A 'Height profile' window is open at the bottom, showing a 2D profile of the terrain. The window title is 'Height profile' and it includes a close button (X). The number of points is 97,325. The profile shows a cross-section of the terrain with a grid overlay. The x-axis ranges from 0 to 190, and the y-axis ranges from 160 to 196. A data table is visible in the profile window:

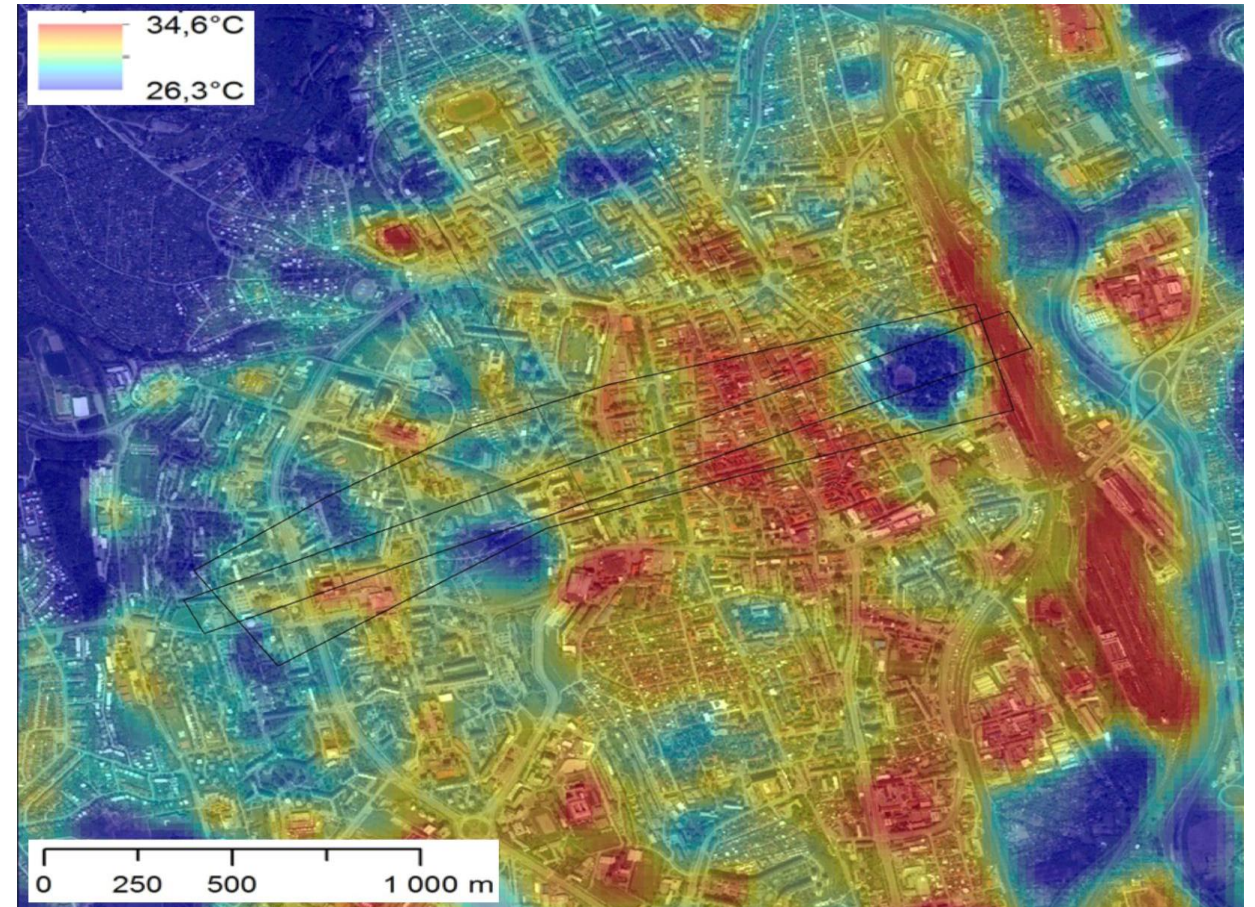
x	y	z	color	intensity	classification	returnNumber	numberOfReturns	pointSourceID	mileage
-232,675.891	-1,270,606.125	171.364	173, 168, 158, 255	125	2	1	1	4	118.295

The bottom toolbar includes a 'show 2d profile' button and a 'Classification filter' section.

Mestské tepelné ostrovy a povrchová teplota

- zamerané na výskum efektov mestského tepelného ostrova Košíc pomocou dát DPZ a simulácií v GIS-e
- LoD2 3D model mesta
- TLS, ALS, Sentinel 2A, Landsat 8
- vplyv vegetácie a tepelných vlastností materiálov povrchu mesta

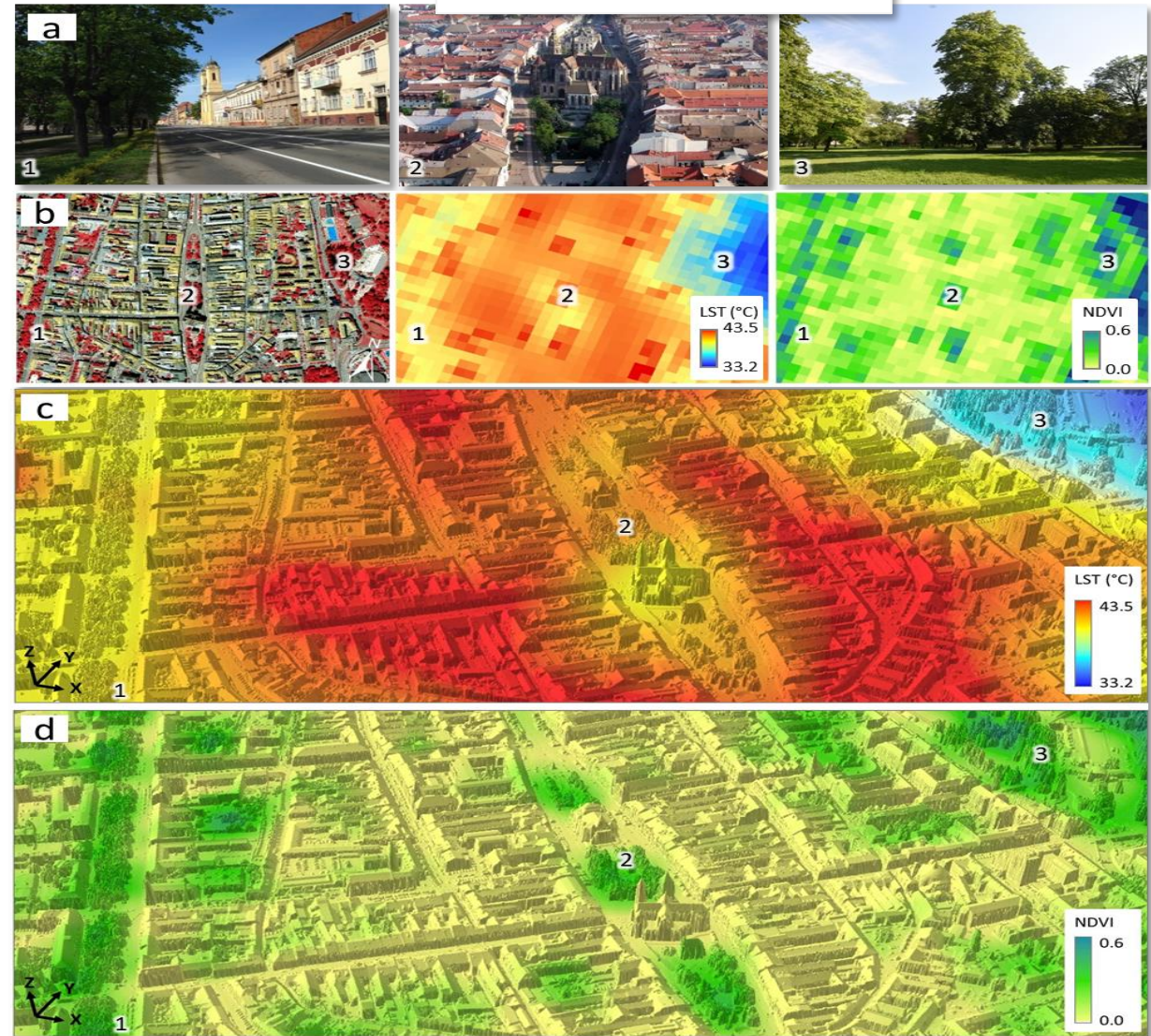
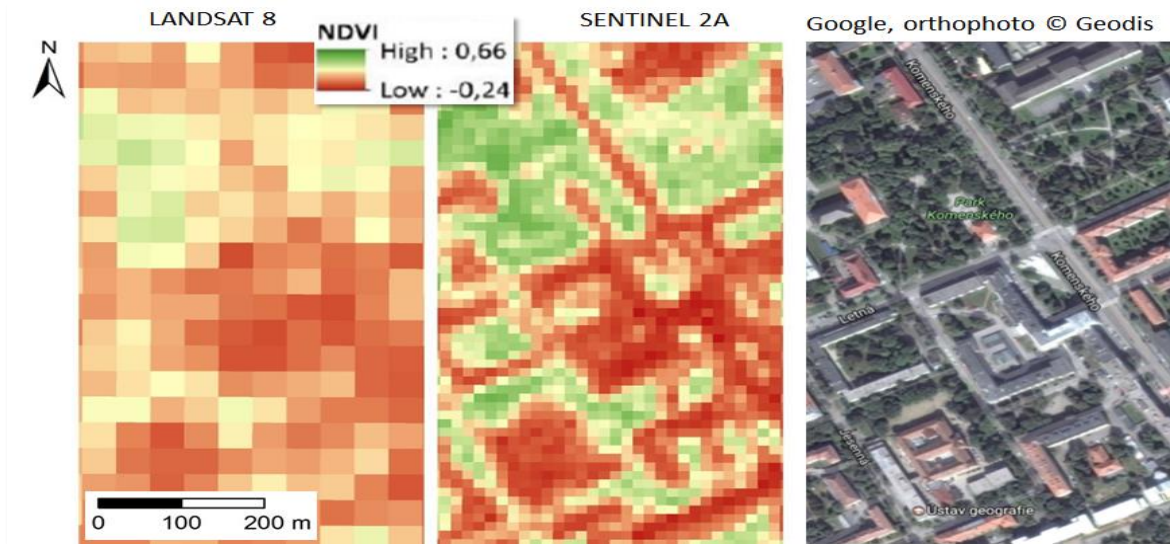
Teplota povrchu odvodená z Landsat8



Sentinel 2A a Landsat 8

- Multispektr. dáta Sentinel 2A – NDVI, albedo, emisivita
- Povrchová teplota zeme Landsat 8

Košice: centrum mesta



Google Earth Engine

- Online platforma, ktorá umožňuje realizovať geopriestorové analýzy pomocou online nástrojov firmy Google
- Obsahuje aj Code Editor na písanie a spúšťanie skriptov
- Explorer umožňuje prezerať dáta a vykonávať jednoduché analýzy.

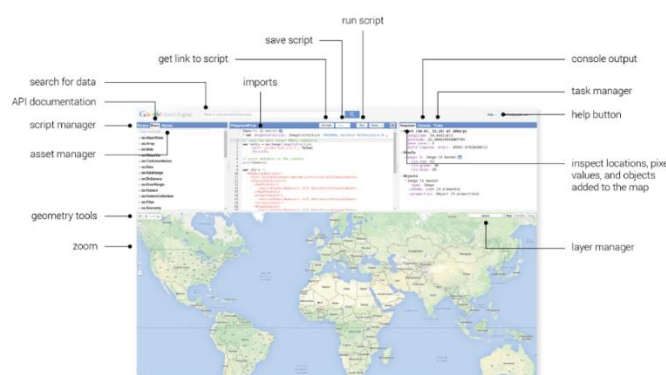
Platform – Google Earth Engine x +

earthengine.google.com/platform/

Google Earth Engine Platform Datasets Noncommercial Commercial Timelapse Case Studies FAQ Sign Up

Code Editor

The Earth Engine Code Editor at code.earthengine.google.com is a web-based IDE for the Earth Engine JavaScript API. It requires log in with a Google Account that's been enabled for Earth Engine access. Code Editor features are designed to make developing complex geospatial workflows fast and easy. The Code Editor has the following elements (illustrated in the figure):

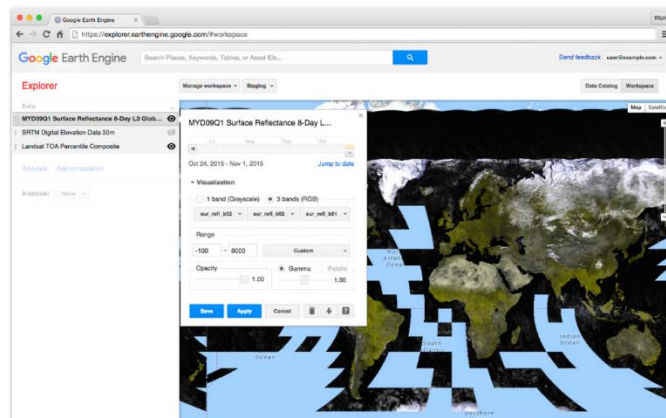


Labels in the Code Editor screenshot:

- search for data
- API documentation
- script manager
- asset manager
- geometry tools
- zoom
- get link to script
- imports
- save script
- run script
- console output
- task manager
- help button
- inspect locations, pixel values, and objects added to the map
- layer manager

Explorer

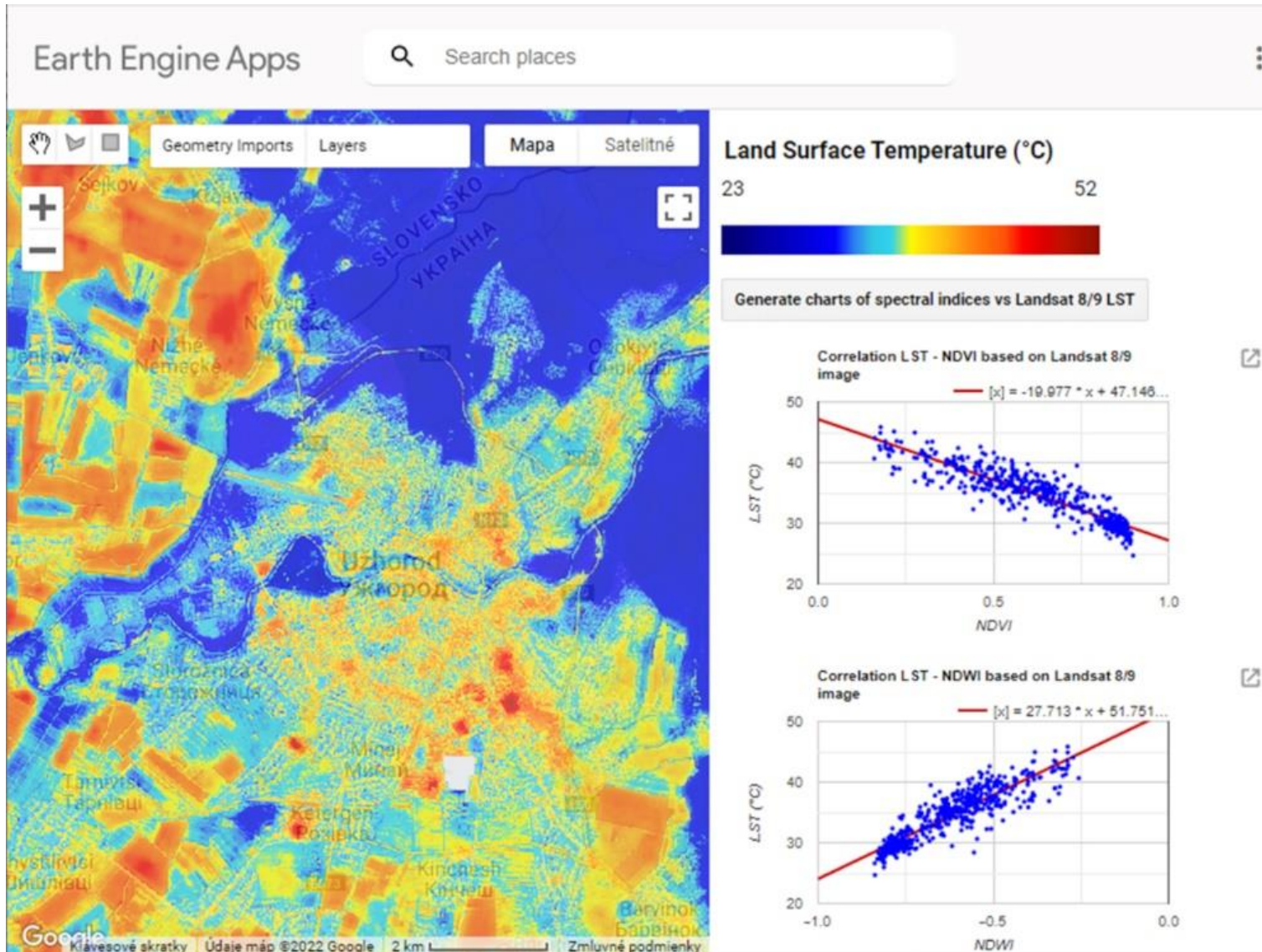
The [Explorer](#) is a simple web interface to the Earth Engine API. It allows anyone to visualize the data in the public data catalog. Signed in Earth Engine users can also import data, run simple analyses, save, and export the results.



Labels in the Explorer screenshot:

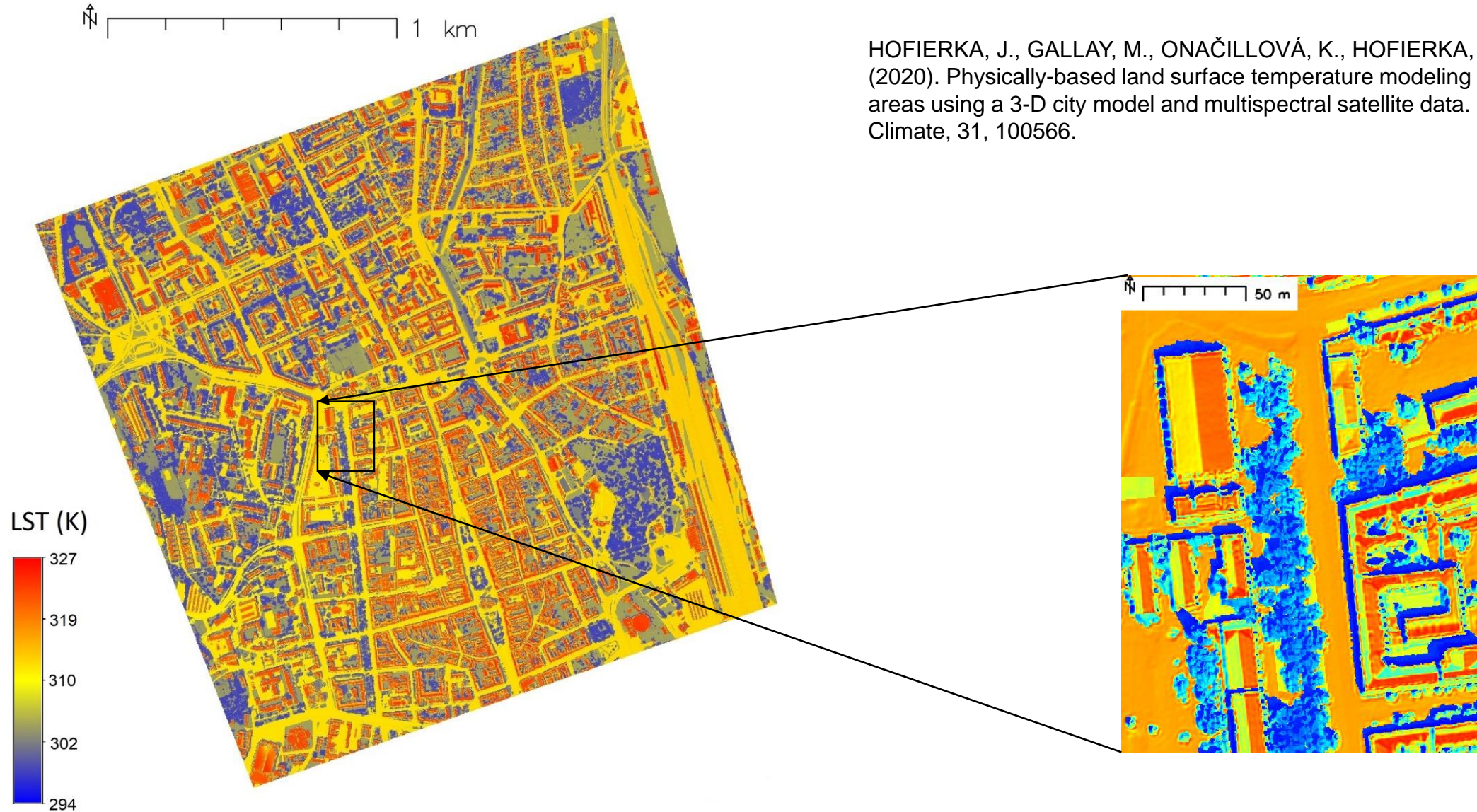
- MYD09Q1 Surface Reflectance 8-Day L3 Glob...
- SRTM Digital Elevation Data 30m
- LandUse TDA Percentile Composite
- MYD02C1 Surface Reflectance 8-Day L...
- Visualization: 1 band (Day/Case) * 3 bands (RGB)
- Range: 100 - 4000
- Opacity: 1.00

Google Earth Engine



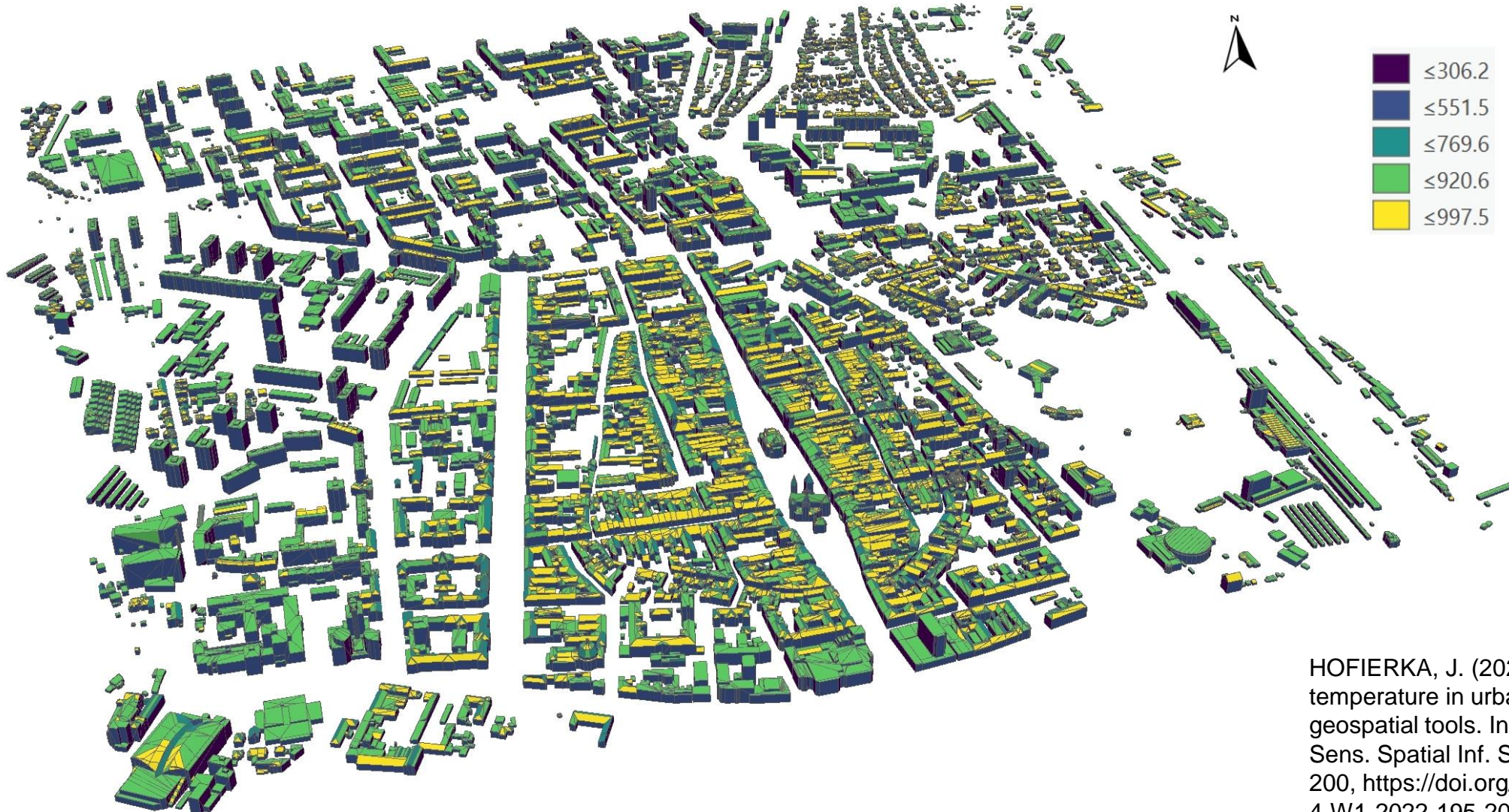
ONAČILLOVÁ, K., GALLAY, M., PALUBA, D., PÉLIOVÁ, A., TOKARČÍK, O., LAUBERTOVÁ, D. (2022). Combining Landsat 8 and Sentinel 2 data in Google Earth Engine to derive higher resolution land surface temperature maps in urban environment. *Remote Sensing* 14(16), 4076.

Modelovanie povrchovej teploty v meste



HOFIERKA, J., GALLAY, M., ONAČILLOVÁ, K., HOFIERKA, J. Jr. (2020). Physically-based land surface temperature modeling in urban areas using a 3-D city model and multispectral satellite data. *Urban Climate*, 31, 100566.

Modelovanie slnečného žiarenia

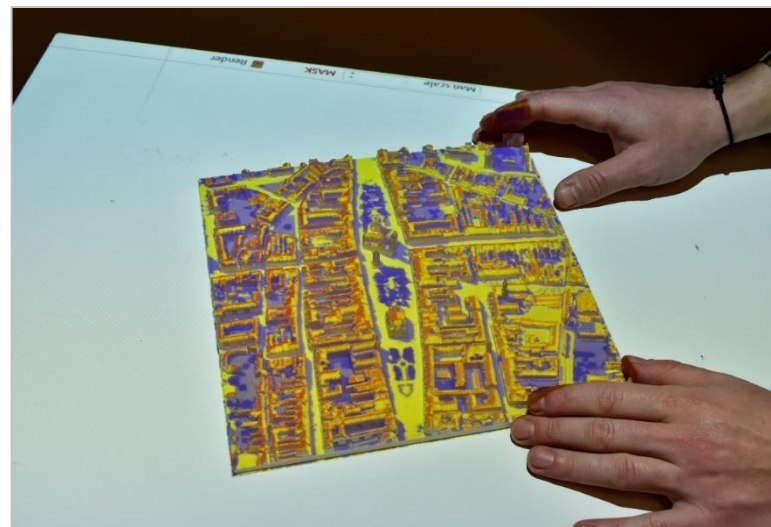
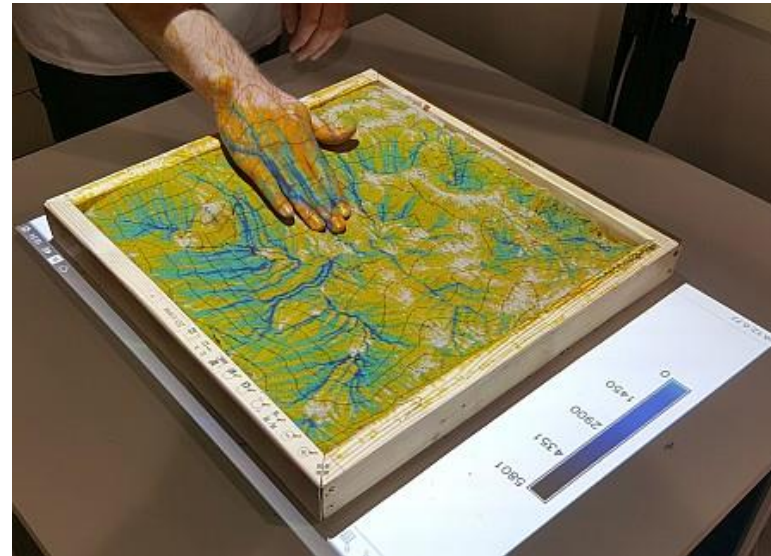
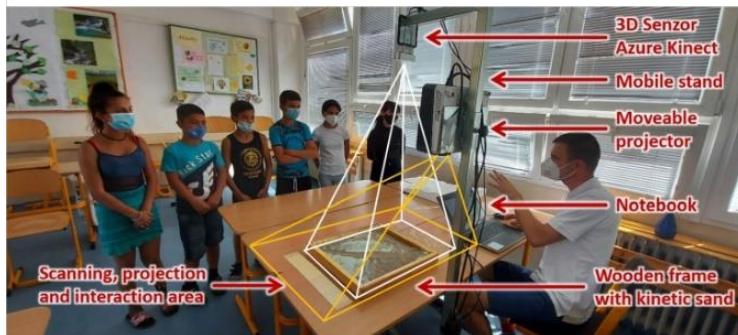
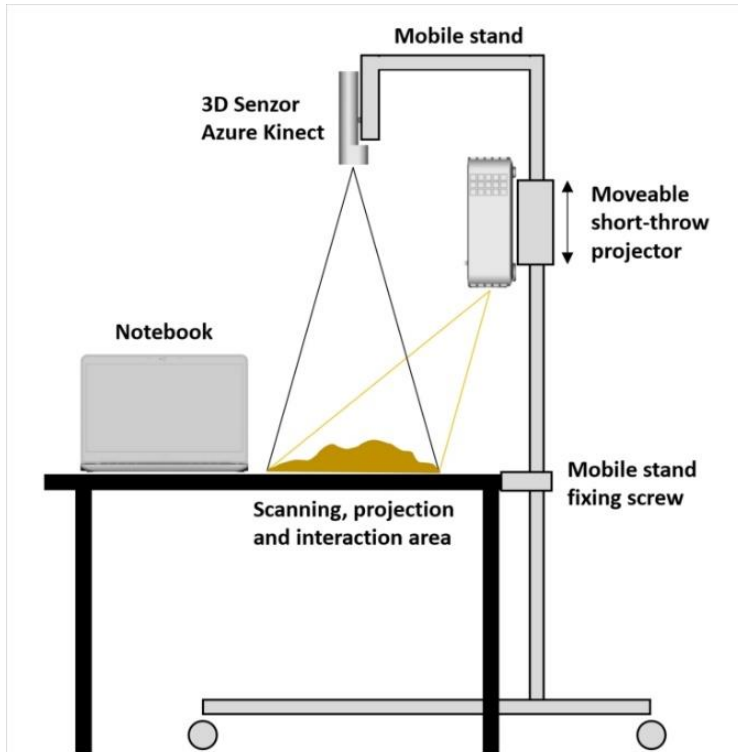


Solar irradiance
(W.m⁻²) calculated
by the v.sun
module in the city
of Košice at B)
12:00 on 1 July.

HOFIERKA, J. (2022). Assessing land surface temperature in urban areas using open-source geospatial tools. *Int. Arch. Photogramm. Remote Sens. Spatial Inf. Sci.*, XLVIII-4/W1-2022, 195–200, <https://doi.org/10.5194/isprs-archives-XLVIII-4-W1-2022-195-2022>.

Krajina na dotyk - Tangible Landscape

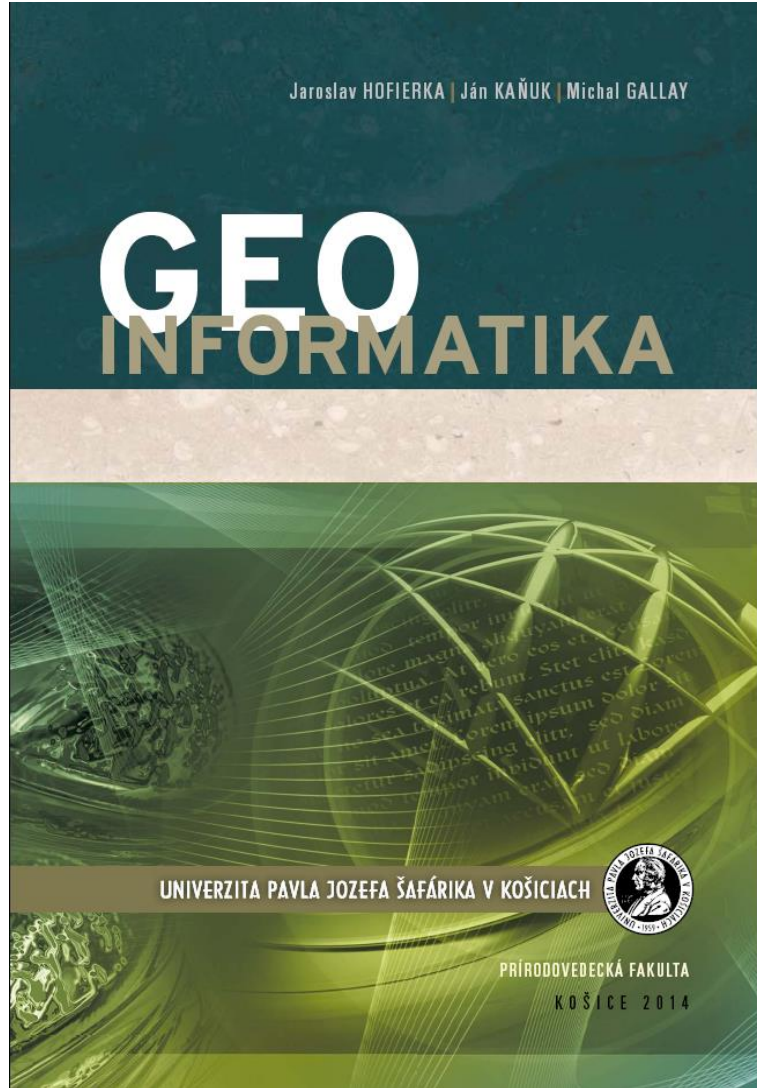
Fyzická interakcia s modelom krajiny – lepšie pochopenie súvislostí a procesov v krajine



HOFIERKA, J., GALLAY, M., ŠUPINSKÝ, J., GALLAYOVÁ, G. (2022). A tangible landscape modeling system for geography education. *Education and Information Technologies*, 27, 4, 5417-5435.

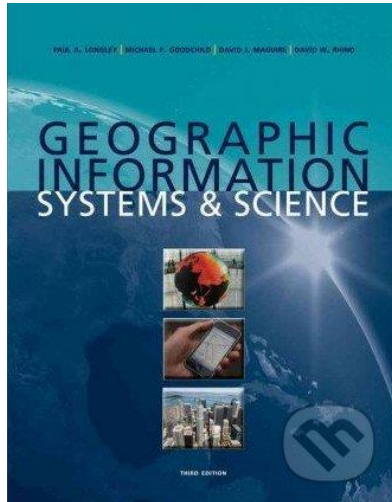
Krajina na dotyk + 3D tlač





Hofierka, J., Kaňuk, J., Gallay, M. (2014):
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ÚSTAV GEOGRAFIE

Prírodovedecká fakulta UPJŠ v Košiciach



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