

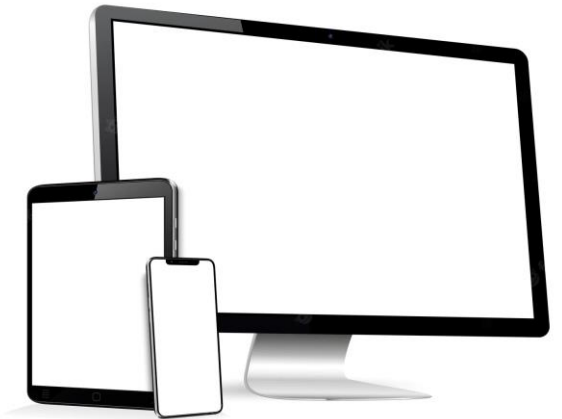


# Online mapy a nástroje, Google Earth Engine

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Mgr. Štefan Gábor

## Výhody

- bez potreby inštalácie
- rýchlosť
- výber a využitie dát (GEE – „cloud“ = dostupné odkiaľkoľvek, z akéhokoľvek zariadenia)
- cenová dostupnosť – mnoho bezplatných nástrojov
- spolupráca
- informácie v reálnom čase



## Nevýhody

- pre pokročilejšie analýzy – potreba znalosti skriptovania
- obmedzené funkcie
- niektoré platformy/funkcie platené
- len online





The hero section features a dark blue background with a network of white lines and dots, resembling a globe or data network. In the center, there is a white ArcGIS Online logo (a cloud with a location pin) above the text "ArcGIS Online". Below the title, there is a paragraph of text in Slovak describing the platform's capabilities. A blue button with the text "Prihlásiť sa" is highlighted with a red border.



## ArcGIS Online

Spojte ľudí, umiestnenia a údaje použitím interaktívnych máp. Pracujte s inteligentnými štýlmi založenými na údajoch a intuitívnymi analytickými nástrojmi. Podelte sa o svoje poznatky so svetom alebo s konkrétnymi skupinami.

[Dozvedieť sa viac o ArcGIS Online](#)

[Prihlásiť sa](#)

# ArcGIS Online

The screenshot displays the ArcGIS Online web interface. At the top left, the text "Untitled map" is visible. On the right side of the top bar, there is a red-bordered button labeled "Open in Map Viewer Classic", a notification bell icon, a grid icon, and a user profile for "Štefan Gábor" with the email "stefan.gabor".

The main map area shows a topographic view of Central Europe, including parts of Poland, Slovakia, and Hungary. Major cities like Ostrava, Bratislava, and Budapest are labeled. The Carpathian Mountains are clearly visible. The map is overlaid with a purple boundary line.

On the left side, there is a "Layers" panel. It contains a stack of layer icons and a text box that says "Add layers to your map and they will appear here." Below this text is a blue button with a plus sign and the text "+ Add layer".

At the bottom of the map, there is a scale bar and the text "Powered by Esri".

# ArcGIS Online

Home ▾ My Map

Open in Map Viewer New Map Štefan ▾

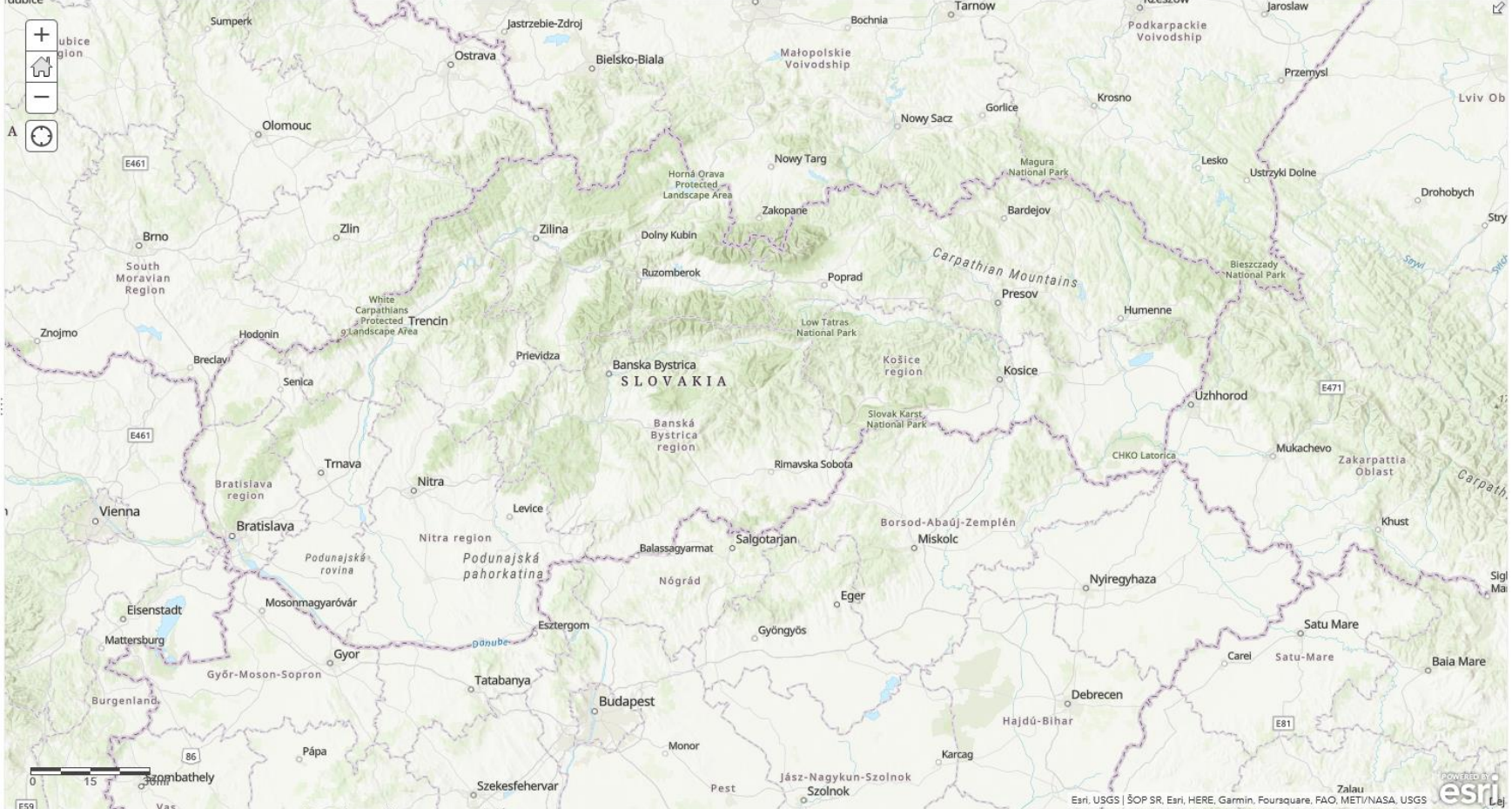
Details Add ▾ Basemap Analysis Save ▾ Share Print ▾ Directions Measure Bookmarks Find address or place

About Content Legend

Make your own map

It's easy to make your own map. Just follow these steps:

- 1. Choose an area.**  
Pan and zoom the map to an area or search by its name or address.
- 2. Decide what to show.**  
Choose a Basemap then Add layers on top of it.
- 3. Add more to your map.**  
Add map notes to draw features on the map.  
Display descriptive text, images, and charts for map features in a pop-up.
- 4. Save and share your map.**  
Give your map a name and description then share it with other people.



Trust Center Contact Esri Report Abuse

Esri, USGS | SOP SR, Esri, HERE, Garmin, Foursquare, FAO, METI/NASA, USGS

# ArcGIS Online

Home ▾ My Map

Open in Map Viewer New Map Štefan ▾

Details Add ▾ Edit Basemap Analysis Save ▾ Share Print ▾ Directions Measure Bookmarks Find address or place

Change Style  
okres - okres - okres 3

1 Choose an attribute to show  
NZ\_10  
Add attribute

2 Select a drawing style

Counts and Amounts (Color)

Counts and Amounts (Size)

Location (Single symbol)

DONE CANCEL

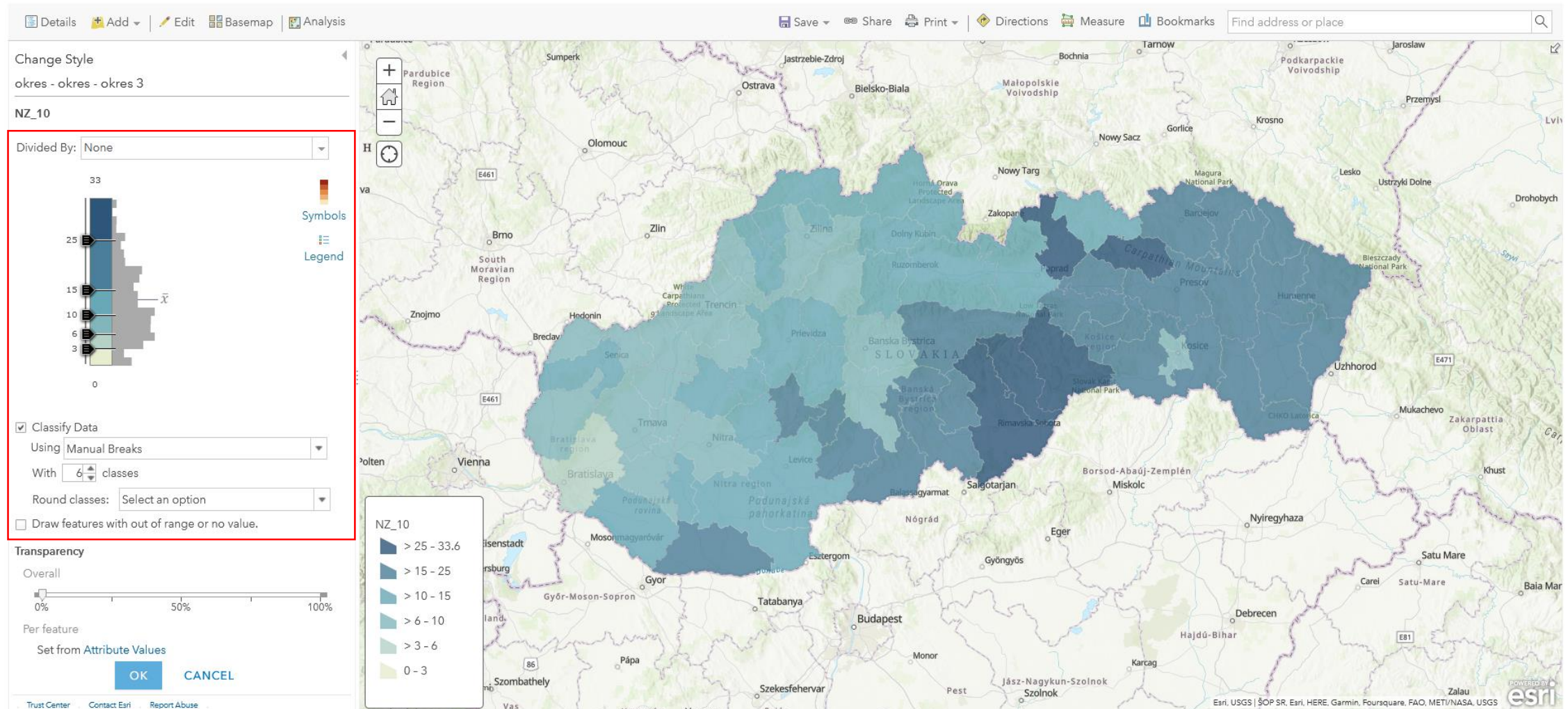
Trust Center Contact Esri Report Abuse

The screenshot displays the ArcGIS Online interface. The main map shows a geographical area of Slovakia, with various regions and cities labeled. A legend on the left side of the map indicates the 'NZ\_10' attribute, with a color scale ranging from light green (< 7) to dark blue (> 20). The style selection panel on the left is highlighted with a red box, showing three options: 'Counts and Amounts (Color)', 'Counts and Amounts (Size)', and 'Location (Single symbol)'. The 'Counts and Amounts (Color)' option is selected, and a 'SELECT' button is visible below it. The map interface includes standard navigation tools like zoom in (+), zoom out (-), home, and refresh, as well as a search bar at the top right.

# ArcGIS Online

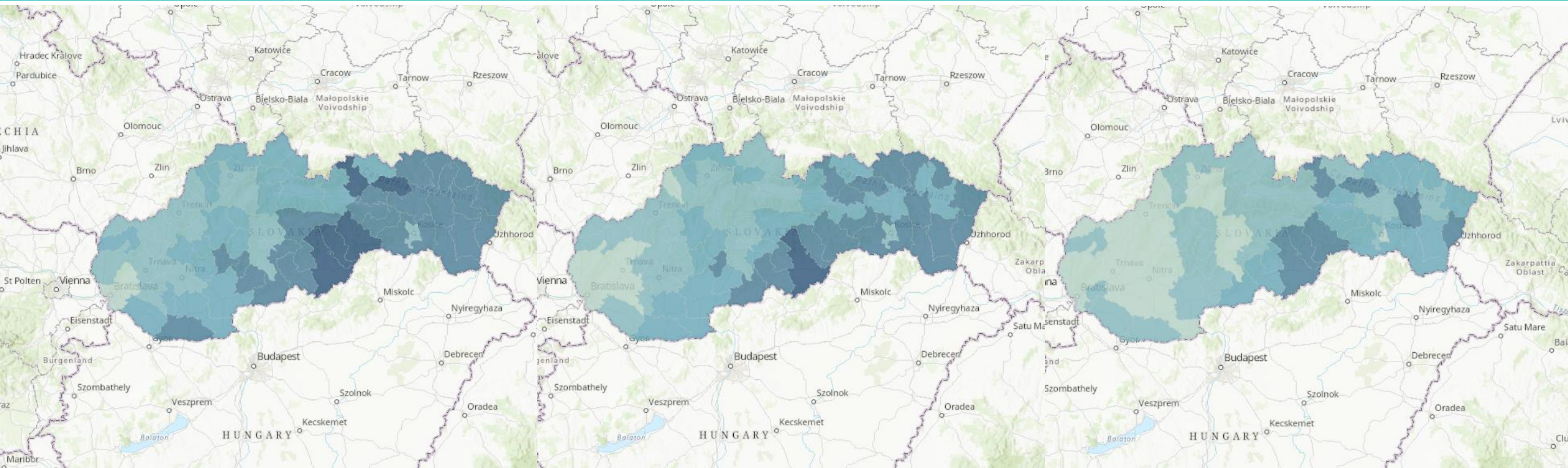
Home ▾ My Map

Open in Map Viewer New Map Štefan ▾





# ArcGIS Online



2010

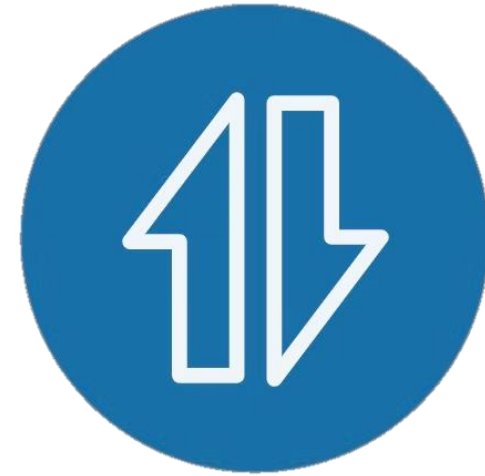
2015

2020



# Flowmap.blue

- interaktívna webová aplikácia
- jazyk JavaScript
- tvorca: Ilya Boyandin
- statická a dynamická simulácia O-D tokov v rôznych časových obdobiach
- zobrazenie aj najmenších tokov, ktoré by mohli ostať v statickej podobe skryté



# Flowmap.blue

Flowmap.blue template spreadsheet ☆ 📄 🔄

Súbor Upraviť Zobrazíť Vložiť Formát Údaje Nástroje Rozšírenia Pomocník

100% 📄 iba zobrazenie

| 1  | A                                   | B  | C   | D   |
|----|-------------------------------------|--|---|---|
| 1  | property                            | value  | comment   | references  |
| 2  | <b>title</b>                        | Template Spreadsheet   | First step: make a copy of this spreadsheet by going to "File" / "Make a copy..."   |   |
| 3  | <b>description</b>                  | This is just a template prepared to help you publish your dataset. Make a copy of this spreadsheet by going to "File" / "Make a copy..." then you can fill your data in. You must be logged in for this to work. |   |   |
| 4  | <b>source.name</b>                  | Not specified  |   |   |
| 5  | <b>source.url</b>                   | <a href="http://some.url.here">http://some.url.here</a>  |   |   |
| 6  | <b>createdBy.name</b>               | Your name  |   |   |
| 7  | <b>createdBy.email</b>              | Your email   | ← We may contact you asking for a permission to add your flow map to the list of examples on the homepage of flowmap.blue.  |   |
| 8  | <b>createdBy.url</b>                | <a href="http://your.website">http://your.website</a>  |   |   |
| 9  | <b>mapbox.accessToken</b>           |  | ← (optional) If you link or embed your map on a web site where you expect high traffic, please, register and use your own Mapbox access token.  | <a href="https://account.mapbox.com/">https://account.mapbox.com/</a>   |
| 10 | <b>mapbox.mapStyle</b>              |  | ← (optional) Custom Mapbox style URL (you can fine tune map rendering or upload your shapes as a tileset or a dataset and add them as a layer). Your style must be public. We recommend to base your style on the "Light" template. | <a href="https://docs.mapbox.com/help/tutorials/create-a-custom-style/">https://docs.mapbox.com/help/tutorials/create-a-custom-style/</a> |
| 11 | <b>colors.scheme</b>                | Default  |   |   |
| 12 | <b>colors.darkMode</b>              | yes  |   |   |
| 13 | <b>animate.flows</b>                | no   |   |   |
| 14 | <b>clustering</b>                   | yes  |   |   |
| 15 | <b>flows.sheets</b>                 | flows  | ← Here you can list multiple comma-separated sheet names if you want to split your flows data into several subsets. There will be a drop-down menu in the UI with the subsets to select from. Here is an example: →                 | <a href="https://flowmap.blue/1mK1ZMxNmGtSSxMhtoK05h7nxyDMXFC_">https://flowmap.blue/1mK1ZMxNmGtSSxMhtoK05h7nxyDMXFC_</a>                 |
| 16 | <b>msg.locationTooltip.incoming</b> | Incoming trips   | ← Here you can customize some of the messages.  |   |
| 17 | <b>msg.locationTooltip.outgoing</b> | Outgoing trips   |   |   |
| 18 | <b>msg.locationTooltip.internal</b> | Internal & round trips   |   |   |
| 19 | <b>msg.flowTooltip.numOfTrips</b>   | Number of trips  |   |   |
| 20 | <b>msg.totalCount.allTrips</b>      | {0} trips  |   |   |
| 21 | <b>msg.totalCount.countOfTrips</b>  | {0} of {1} trips   |   |   |

properties locations flows

a) šablóna tabuľky Google

| A1 | fx | id | A         | B              | C          | D          | E   |
|----|----|----|-----------|----------------|------------|------------|---|
| 1  |    |    | <b>id</b> | <b>name</b>    | <b>lat</b> | <b>lon</b> |   |
| 2  |    |    | 1         | New York       | 40.713543  | -74.011219 | If you only have the location names in your dataset and no geographic coordinates, our Geocoding utility can be of help → <a href="https://flowmap.blue/geocoding">https://flowmap.blue/geocoding</a> |
| 3  |    |    | 2         | London         | 51.507425  | -0.127738  |   |
| 4  |    |    | 3         | Rio de Janeiro | -22.906241 | -43.180244 |   |
| 5  |    |    |           |                |            |            |   |
| 6  |    |    |           |                |            |            |   |

b) hárok *locations*

| A1 | fx | origin | A             | B           | C            | D           | E  |
|----|----|--------|---------------|-------------|--------------|-------------|--|
| 1  |    |        | <b>origin</b> | <b>dest</b> | <b>count</b> | <b>time</b> |  |
| 2  |    |        | 1             | 2           | 42           |             | ↑ It's better to delete the unused columns if you have many rows in your dataset ↑                                   |
| 3  |    |        | 2             | 1           | 51           |             |  |
| 4  |    |        | 3             | 1           | 50           |             | ← The "time" column is optional. Supported formats: YYYY-MM-DD HH:MM:SS, YYYY-MM-DD HH:MM, YYYY-MM-DD, YYYY-MM, YYYY |
| 5  |    |        | 2             | 3           | 40           |             |  |
| 6  |    |        | 1             | 3           | 22           |             |  |
| 7  |    |        | 3             | 2           | 42           |             | Use the OD-matrix data conversion tool if your movement counts are stored as an OD-matrix. →                         |
| 8  |    |        |               |             |              |             | <a href="https://flowmap.blue/od-matrix-converter">https://flowmap.blue/od-matrix-converter</a>                      |

c) hárok *flows*

# Flowmap.blue



mapa je dostupná na [tomto linku](#)

# Flowmapper

**Flow Mapper** File View Tools Help Contact About Geo-Social

Base Map **Regions** Nodes **Flows**

Base Map: ?  
Esri Light Gray Canvas

Display base map references

Base map opacity(%): ? 100

Projection: ?  
Albers Equal Area Europe

Add title ?

Add description ?

Add north arrow

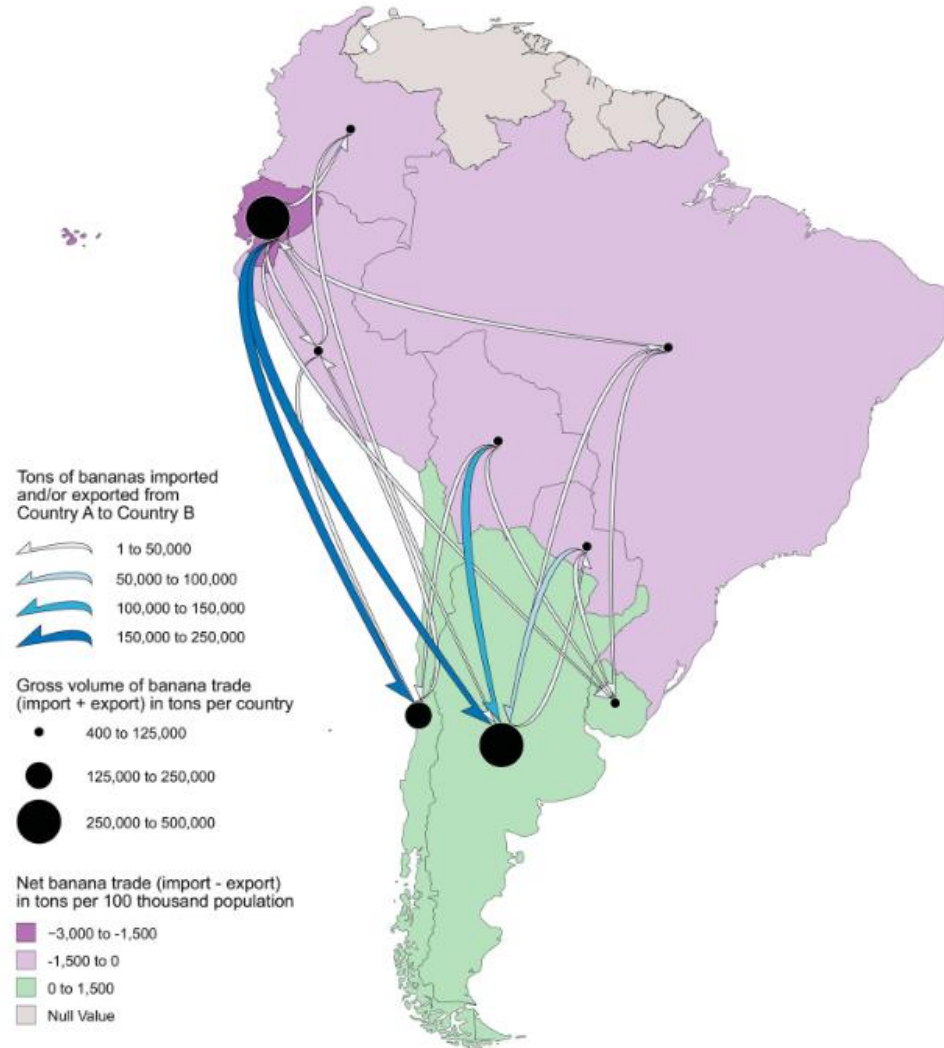
Add projection label

Upload custom references ?

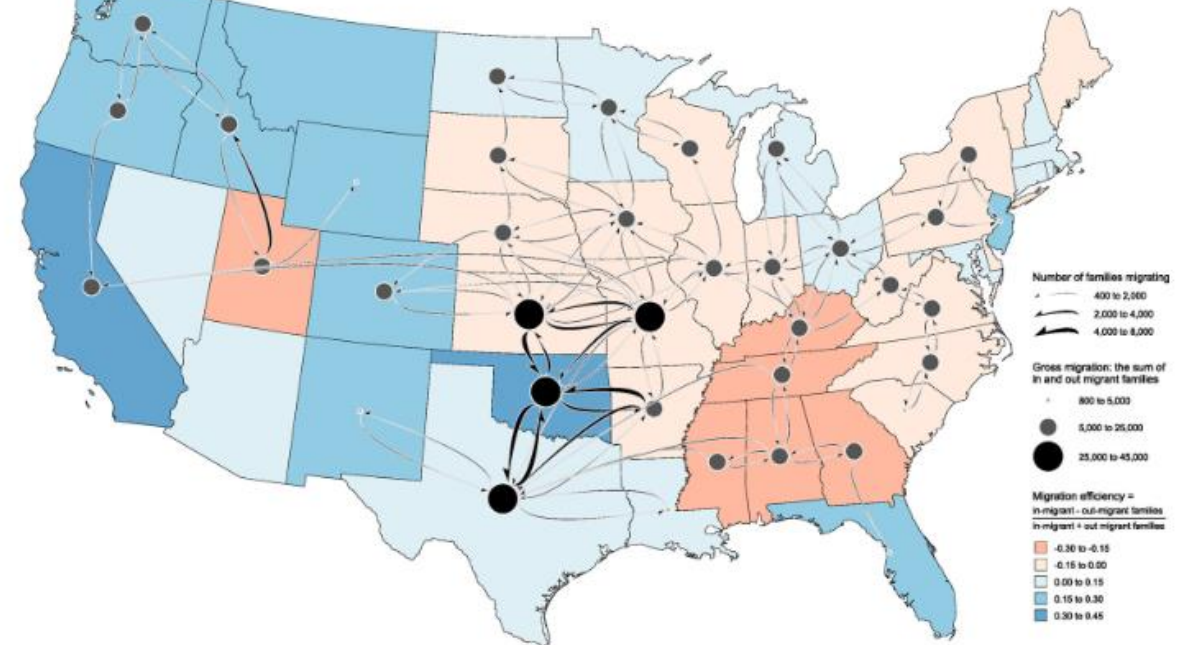
500 km

# Flowmapper

### Banana trade between countries in South America



### Family migration between 1887 and 1924



Koylu, Tian, Windsor, 2022



# Google Earth Engine

~ využitie sily cloudu

- Cloudová platforma pre geopriestorové analýzy
- Voľne prístupný katalóg dát > 200 datasetov, >5 PB dát
- Import vlastných dát a ich integrácia s datasetmi GEE
- Aplikácia rôznych algoritmov
- Export mapových výstupov, tabuliek, grafov...

## The Earth Engine Public Data Catalog



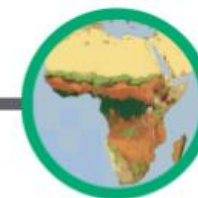
**Landsat and Sentinel**  
Raw, TOA, SR, ...



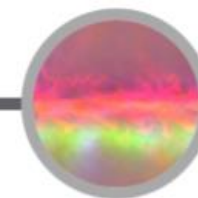
**MODIS**  
Daily, NBAR, LST, ...



**Terrain**  
SRTM, GTOPO, NED, ...



**Land Cover**  
GlobCover, NLCD, ...



**Atmospheric**  
NOAA NCEP, OMI, ...

... and many more, updating daily!

> 200 public datasets

> 5 million images

> 4000 new images every day

> 5 petabytes of data



# Google Earth Engine

~ využitie sily cloudu

- Prevažné využitie JavaScript
- Nie je potrebné byť expertom v kódovaní, mnoho tutoriálov je dostupných aj online:
- <https://developers.google.com/earth-engine/getstarted>
- <https://developers.google.com/earth-engine/tutorials>

The screenshot shows a web browser displaying a tutorial page on the Google Earth Engine community site. The URL in the address bar is `developers.google.com/earth-engine/tutorials/community/modis-ndvi-time-series-animation`. The page title is "MODIS NDVI Times Series Animation". The author is listed as "jdbcode". There are links for "EDIT ON GITHUB", "REPORT ISSUE", and "PAGE HISTORY". A blue banner states: "★ Tutorials contributed by the Earth Engine developer community are not part of the official Earth Engine product documentation." Below this, there is a link "Open In Code Editor". The main text describes the tutorial: "Time series animations of Earth observation imagery are captivating and engaging. In this tutorial, you'll learn how to generate an animated GIF representing 20-year median NDVI for serial 16-day MODIS composites spanning January 1st through December 31st. The following image is an example of the resulting animation." Below the text is a satellite image of Africa showing a color gradient from brown (arid) to green (vegetated). The left sidebar contains a navigation menu with categories like "Community Overview", "Tutorials", "JavaScript Tutorials", and "Monitoring Forest Vegetation Condition".





# Google Earth Engine

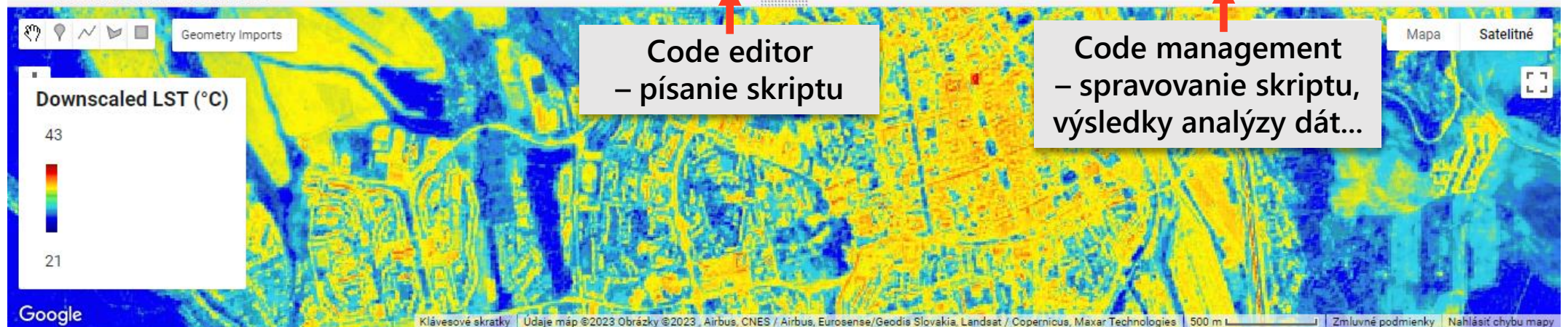
~ využitie sily cloudu

Príklady kódov,  
uložené skripty

The screenshot shows the Google Earth Engine web interface. On the left, the 'Scripts' panel lists various scripts, including 'downscaling\_27\_9', 'emissivity', 'karst\_sinkholes', 'maya', 'no2\_concentrations\_london', and 'veronika\_DP'. Below this is a 'Writer' section with a message 'No accessible repositories. Click Refresh to check again.' and a 'Reader (4)' section listing user folders like 'users/aakashchhabra7489/GEE' and 'users/MohsenSaber/SP5\_NO2\_Monitori...'. The central 'Code editor' displays a JavaScript script for LST calculation, including imports for 'study\_area' and 'geometry\_random\_points', and code for selecting and filtering Landsat 8 data. The right 'Inspector' panel shows the execution results, including an 'ImageCollection COPENICUS/S2\_SR' and a scatter plot titled 'Correlation LST - NDVI based on Landsat 8 image'. The plot shows a positive correlation between LST (°C) on the y-axis (ranging from 20 to 50) and NDVI on the x-axis (ranging from -0.5 to 1.0).

Code editor  
– písanie skriptu

Code management  
– spravovanie skriptu,  
výsledky analýzy dát...





# Google Earth Engine

~ porovnanie tradičnej metódy analýzy s analýzou v GEE

## ANALÝZA ZMIEN LESA V OBDOBÍ MEDZI ROKMI 2000 – 2010

### TRADIČNÝ POSTUP

- Výber záujmového územia
- Príprava dát:
  - stiahnutie a uloženie satelitnej scény (snímky) počas vegetačného obdobia (1 scéna ~ 1 GB/zip)
  - orezanie scény a zmozaikovanie (výsledná scéna ~ 1.75 GB)

= ~48 scén za rok \* 11 rokov = ~528 scén = ~ 924 GB

+ aplikácia korekcií, odstránenie oblačnosti, vytvorenie výslednej kompozície za 1 rok, výpočet vegetačného indexu NDVI (+ďalšie stovky GB)

- Analýza dát

➔ *Niekoľko mesiacov práce pre dosiahnutie výsledku*

### GOOGLE EARTH ENGINE

V GEE získa skúsenejší programátor ten istý výsledok za ~1 hodinu a pomocou 100 riadkov kódu

The screenshot displays the Google Earth Engine web interface. At the top, there's a search bar and navigation tabs for Scripts, Docs, and Assets. The main area is divided into a script editor on the left, a console on the right, and a map visualization at the bottom. The script editor shows a JavaScript function named 'bustClouds' that uses the 'ee.Algorithms.Landsat.simpleCloudScore' function to mask clouds from a Landsat image. The console shows the output of the script, including a list of band names and a list of 7 elements. The map visualization shows a satellite image of a region with a color scale overlay representing the NDVI index, ranging from 2000 to 2010. A 'Change Year visualization parameters' dialog box is open, showing options for 1 band (Grayscale) or 3 bands (RGB), a range of 2000 to 2010, and an opacity of 1.00.

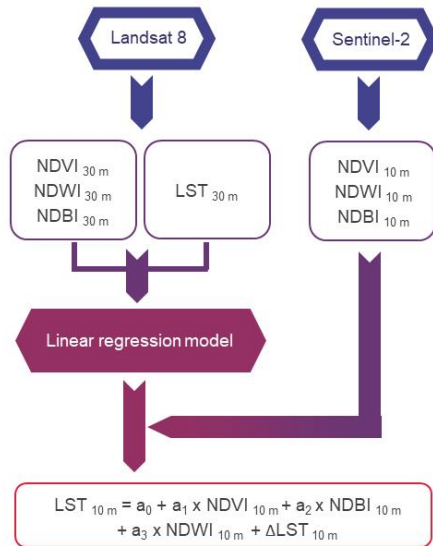


# Google Earth Engine

~ príklad využitia

## Combining Landsat 8 and Sentinel-2 Data in Google Earth Engine to Derive Higher Resolution Land Surface Temperature Maps

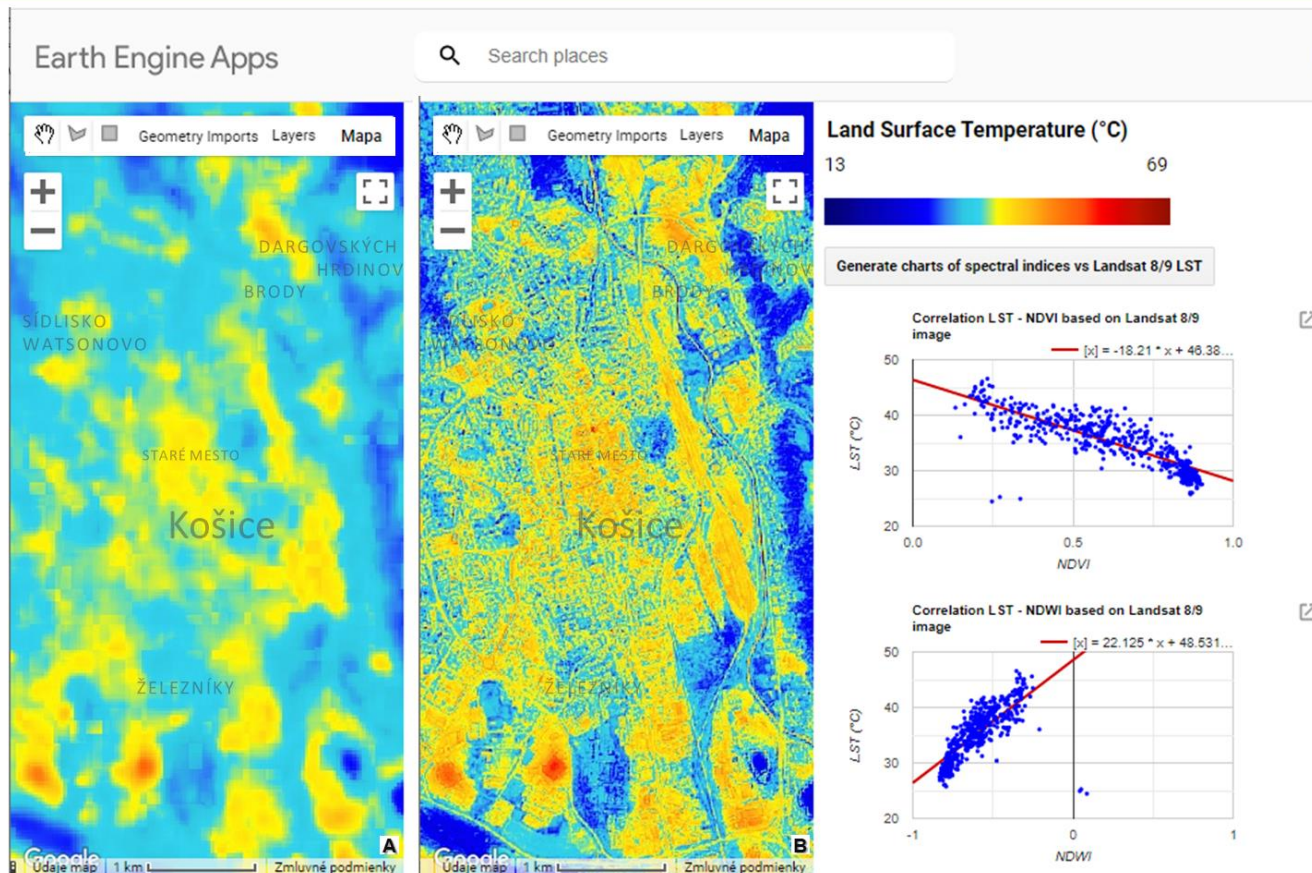
### THE FLOWCHART OF PROCEDURAL STEPS



### SUPPLEMENTARY MATERIAL

The GEE application for downscaling Landsat LST imagery to 10 m spatial resolution:  
<https://danielp.users.earthengine.app/view/lst-downscaling>

The source code of the application and a short manual on how to use it:  
<https://github.com/palubad/LST-downscaling-to-10m-GEE>



Example of the custom output of the implementation of the L8 LST downscaling at 10 m resolution, over the city of Košice, Slovakia, in Google Earth Engine. LST derived: A) from Landsat 8 TIRS data at 30 m resolution, B) as downscaled LST at 10 m resolution with residuals

*Kombinácia dát z družíc Landsat 8 a Sentinel-2 v Google Earth Engine pre odvodenie máp teploty povrchu krajinej pokrývky (LST) vo vyššom priestorovom rozlíšení*

<https://danielp.users.earthengine.app/view/lst-downscaling>

ONAČILLOVÁ, K., GALLAY, M., PÉLIOVÁ, A., PALUBA, D., 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.



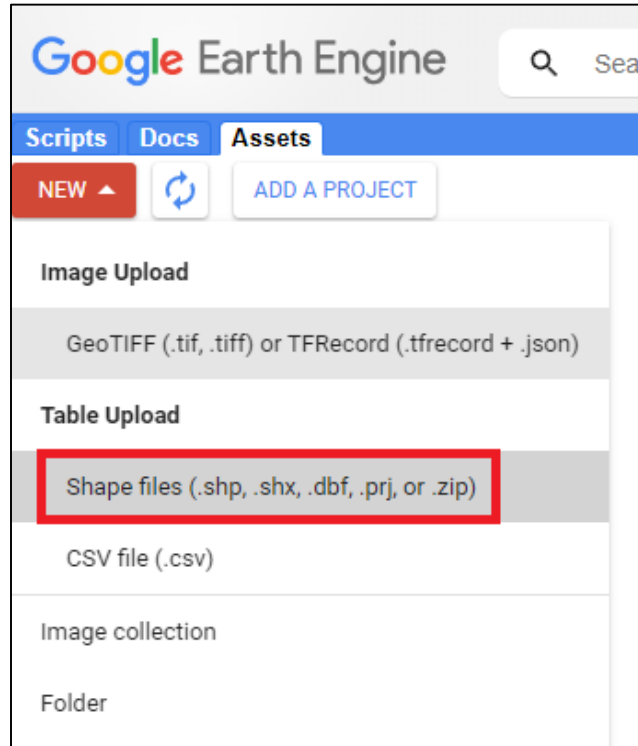
**Google Earth Engine**

**PRAKTICKÁ UKÁŽKA**

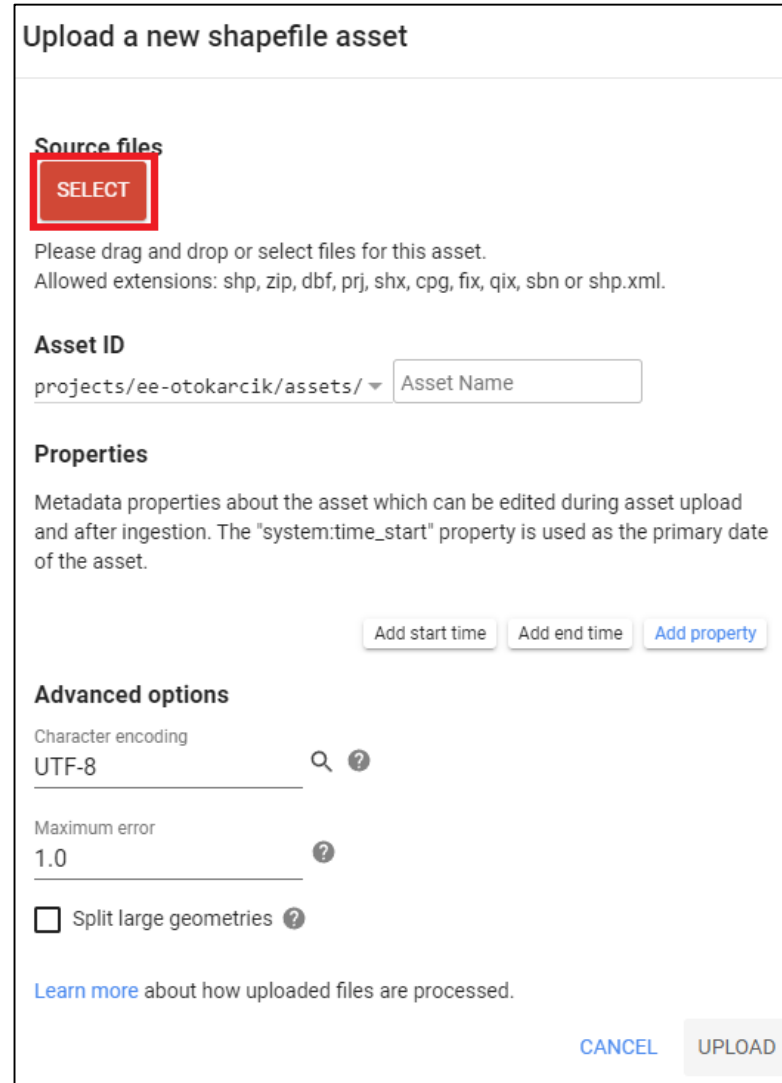
# 1. Nahratie vlastných vektorových dát do GEE

(administratívnych hraníc SR)

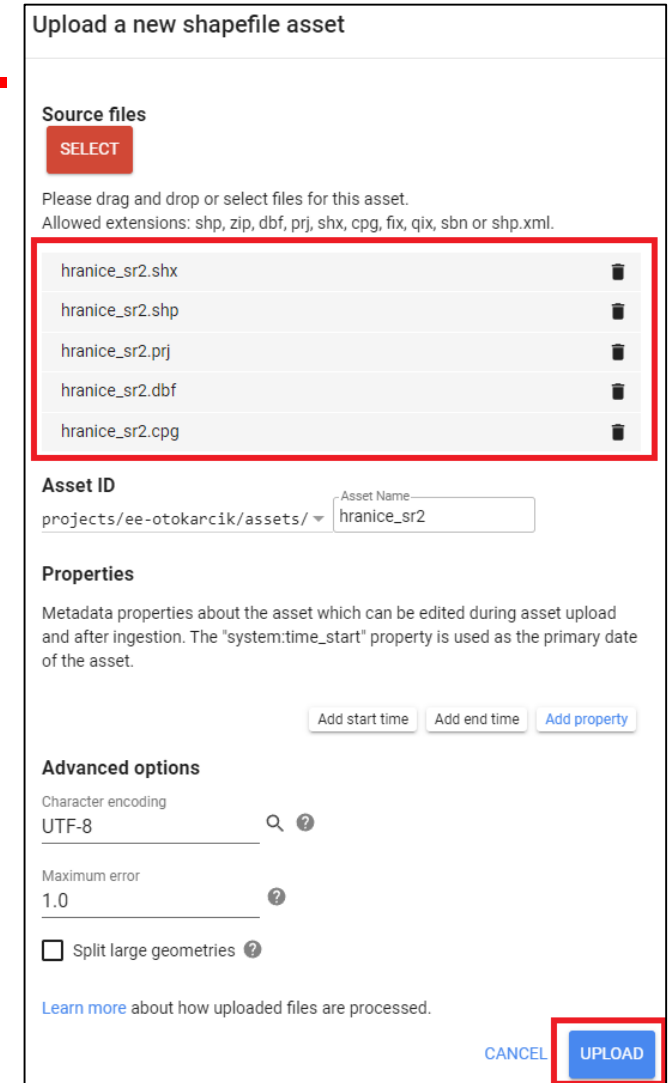
1.



2.

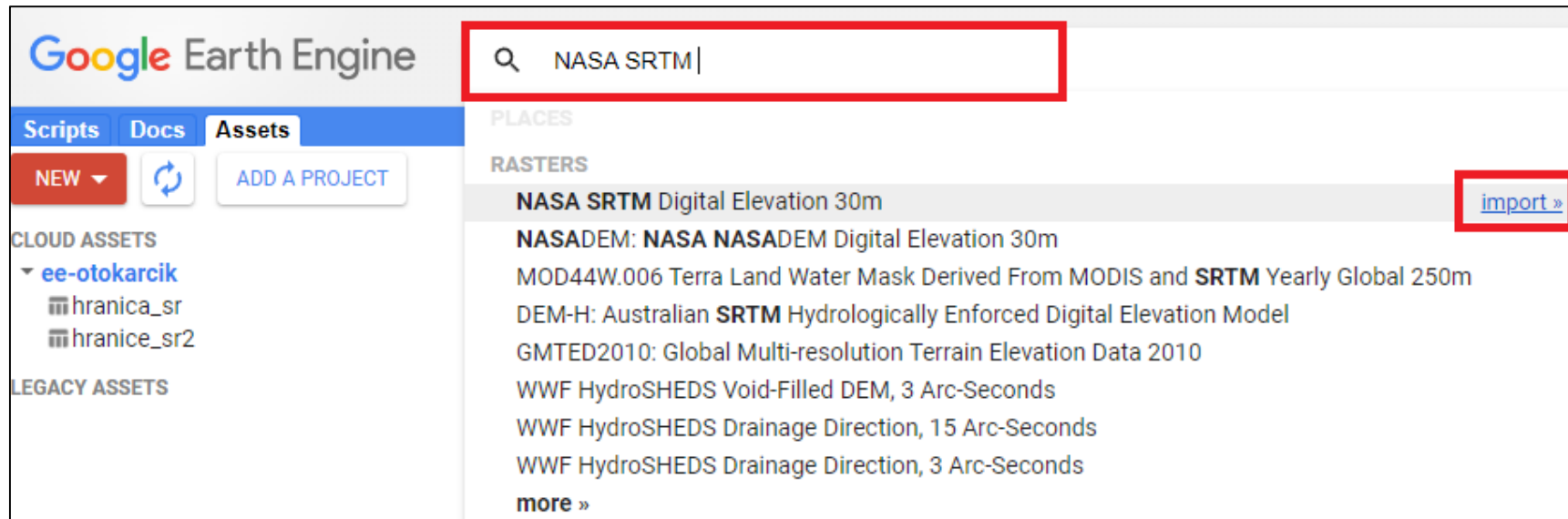


3.



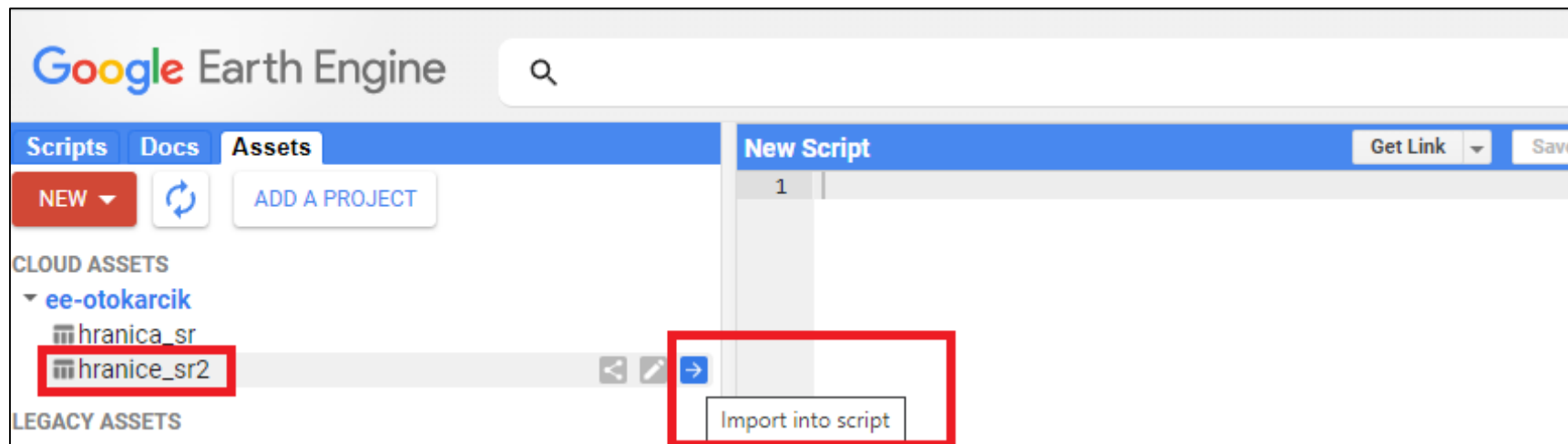
## 2. Import potřebných dát do skriptu (NASA SRTM Digital elevation, hranice SR)

1.



The screenshot shows the Google Earth Engine interface. The search bar at the top contains the text "NASA SRTM". Below the search bar, the "Assets" tab is selected. The search results are categorized into "PLACES" and "RASTERS". Under "RASTERS", the first result is "NASA SRTM Digital Elevation 30m", which is highlighted. To the right of this result, there is a blue "import »" button. The left sidebar shows the "Assets" tab with a "NEW" button and an "ADD A PROJECT" button. Below these, there are sections for "CLOUD ASSETS" and "LEGACY ASSETS". Under "CLOUD ASSETS", there is a folder named "ee-otokarcik" containing two assets: "hranica\_sr" and "hranice\_sr2".

2.

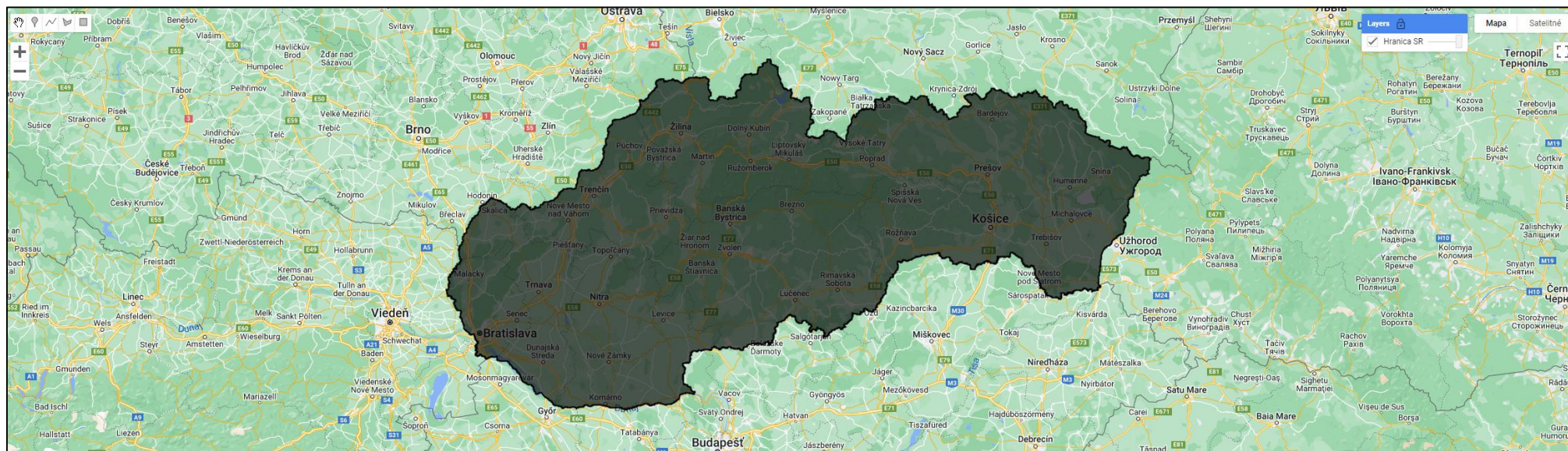


The screenshot shows the Google Earth Engine interface with a "New Script" window open. The "Assets" tab is selected. The search bar is empty. The left sidebar shows the "Assets" tab with a "NEW" button and an "ADD A PROJECT" button. Below these, there are sections for "CLOUD ASSETS" and "LEGACY ASSETS". Under "CLOUD ASSETS", there is a folder named "ee-otokarcik" containing two assets: "hranica\_sr" and "hranice\_sr2". The "hranice\_sr2" asset is highlighted. To the right of this asset, there is a blue "Import into script" button. The "New Script" window is open, showing a single line of code with the number "1".

### 3. Nastavenie geometrie pre tabuľku a pridanie administratívnych hraníc do mapového okna

```
var sr=table.geometry();  
Map.addLayer(sr, {color:"black"}, "Hranica SR");
```

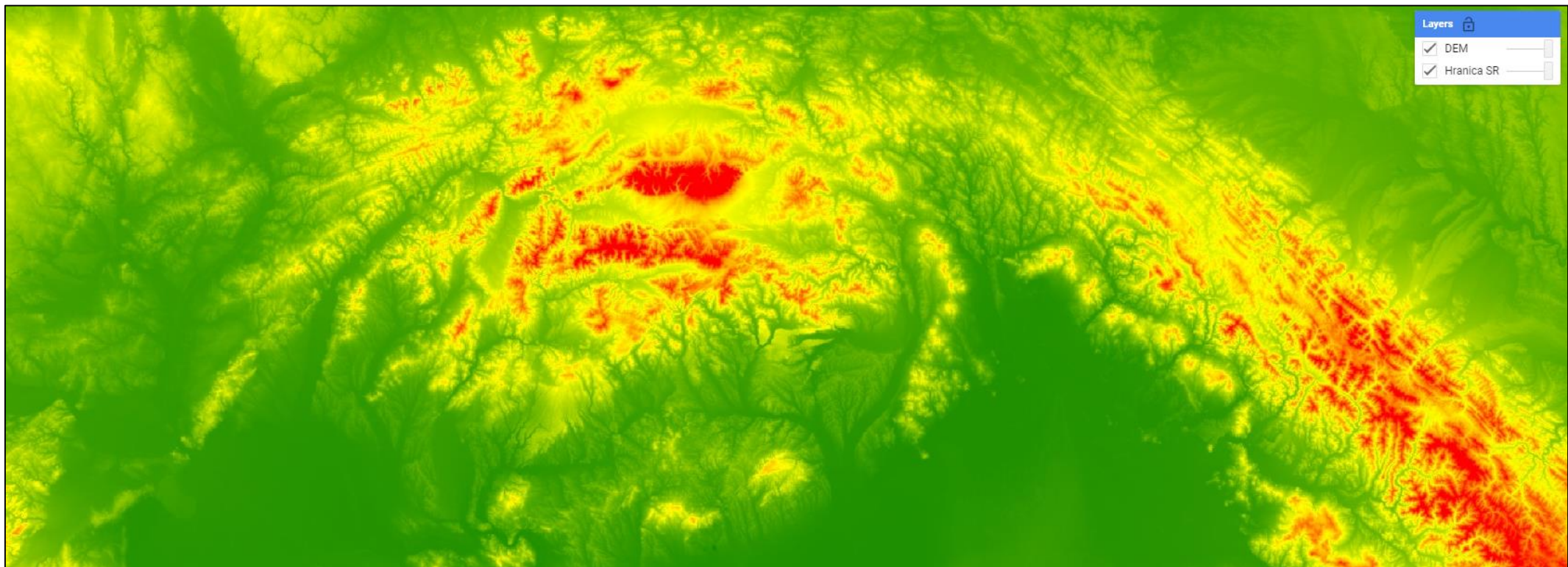
```
New Script *  
Imports (2 entries)   
  var raster: Image "NASA SRTM Digital Elevation 30m" (1 band)   
  var table: Table projects/ee-otokarcik/assets/hranice_sr2  
1 //importované hranice SR majú formát tabuľky preto jej potrebujeme pridať geomtriu//  
2  
3 var sr=table.geometry();  
4  
5 //pomocou funkcie "Map.addLayer" pridáme hranice SR do mapového okna, nastavíme farbu a vrstvu pomenujeme//  
6  
7 Map.addLayer(sr, {color:"black"}, "Hranica SR");  
8
```



## 4. Pridanie DEM do mapového okna

```
Map.addLayer(raster, {min:0, max:1500, palette:"green, yellow, red"}, "DEM");
```

```
//do mapového okna pridáme digitálny výškový model, nastavíme farebnú škálu a intervaly//  
Map.addLayer(raster, {min:0, max:1500, palette:"green, yellow, red"}, "DEM");
```



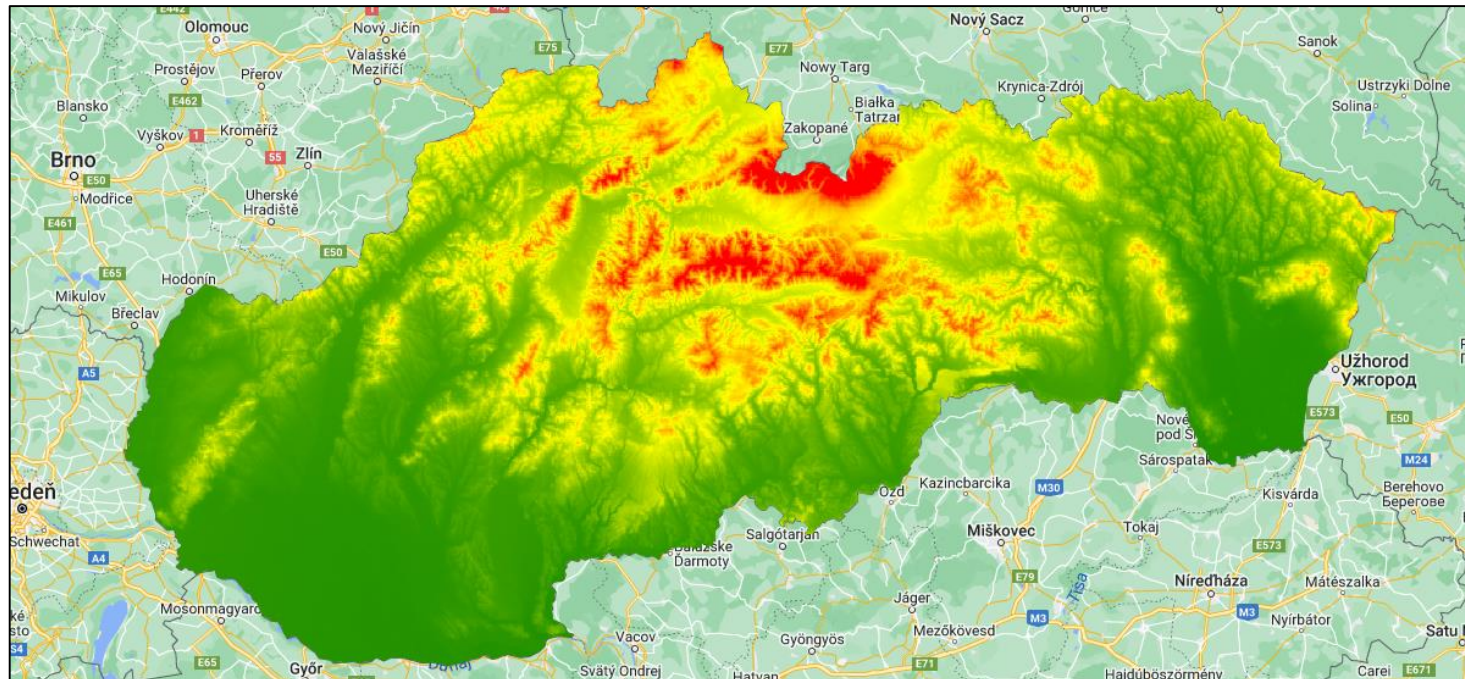


## 5. Orezanie DEM podľa hraníc SR

```
var clip_sr=raster.clip(sr);
```

```
Map.addLayer(clip_sr, {min:0, max:1500, palette:"green, yellow, red"}, "DEM_sr");
```

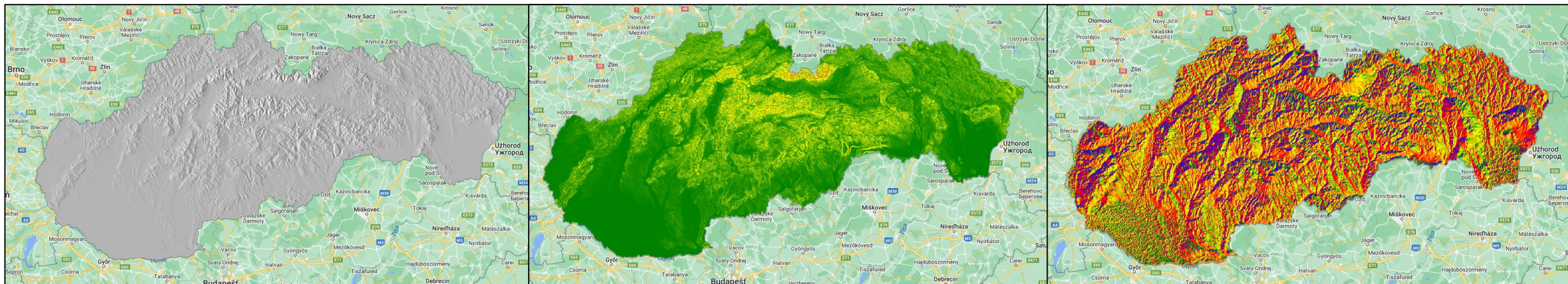
```
//pomocou nástroja clip orežeme DEM podľa hraníc SR//  
var clip_sr=raster.clip(sr);  
  
//orezané DEM pridáme do mapového okna opäť pomocou nástroja Map.addLayer//  
Map.addLayer(clip_sr, {min:0, max:1500, palette:"green, yellow, red"}, "DEM_sr");
```



# 6. Analýzy terénu pomocou príkazu „ee.Terrain“ a pridanie výsledkov do mapového okna

```
var hillshade= ee.Terrain.hillshade(clip_sr);  
var slope=ee.Terrain.slope(clip_sr);  
var aspect=ee.Terrain.aspect(clip_sr);  
Map.addLayer(hillshade, {min:0, max:255}, "Hillshade");  
Map.addLayer(slope, {min:0, max:40, palette:"green, yellow, red"}, "Slope");  
Map.addLayer(aspect, {min:0, max:360, palette:"green, yellow, red, blue"}, "Aspect");
```

```
//s orezaným DEM urobíme ešte ďalšie analýzy: tieňovaný reliéf (hillshade), mapu sklonov(slope) a orientáciu voči svetovým stranám, použijeme nástroj "ee.Terrain"/>  
var hillshade= ee.Terrain.hillshade(clip_sr);  
var slope=ee.Terrain.slope(clip_sr);  
var aspect=ee.Terrain.aspect(clip_sr);  
  
//výsledky analýz pridáme do mapového okna//  
Map.addLayer(hillshade, {min:0, max:255}, "Hillshade");  
Map.addLayer(slope, {min:0, max:40, palette:"green, yellow, red"}, "Slope");  
Map.addLayer(aspect, {min:0, max:360, palette:"green, yellow, red, blue"}, "Aspect");
```



## 7. Export mapy na disk

```
Export.image.toDrive({image: clip_sr, description: 'Digitální výškový model SR', scale: 20,  
                    region: sr, maxPixels: 1e13,});
```

```
//export mapy na disk//  
Export.image.toDrive({image: clip_sr, description: 'Digitální výškový model SR', scale: 20, region: sr, maxPixels: 1e13,});
```

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# Ďakujeme za pozornosť!

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