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Estimation and mapping of drought vulnerability on the basis of climate, land use and soil parameters using GIS technique

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Final conference of DMCSEE project
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- Drought vulnerability – scientific background
- The output standard
- Vulnerability maps of participants

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Drought vulnerability

- **Natural vulnerability:** *the rate of the reply*, if a natural anomaly occurs. This rate is defined by the natural and social environment. E.g. the loss on vulnerable fields will be larger, than on less vulnerable lands.
- This is fully **valid for drought** as a phenomenon.

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Drought vulnerability estimations

- **Importance:**
  - optimalisation of protection against drought: action plan can be developed to mitigate the damages (even to prevent the damages in an ideal case).
  - cost reductions in the agriculture, in the land management and many other sectors in connection with sustainable development.

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Output standard

- **Output:** 8 maps of drought vulnerability based on GIS functionality
- **Purpose:** According to the maps evaluation the vulnerability of the region to drought.
- **Method:** The drought vulnerability maps should be calculated from category maps which are made of the selected parameters.

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Output standard

- **Scientific background:**
  - Wilhelmi, O. V. – Wilhite, D. A., 2002: Assessing Vulnerability to Agricultural Drought: A Nebraska Case Study, 2000 — Natural Hazards vol. 25, pp. 37 – 58.
  - Bella Sz., 2003: Magyarország egyes tájainak aszályérzékenysége – szakdolgozat, ELTE, Budapest, 63 p. (Drought vulnerability of Hungary's each regions – MSc thesis, Eötvös Univerity, Budapest - Hungary)
- **Simplyfication:**
  - *Parameters*: widely measured / easily generatable / accessible for free

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Output standard

- **Category maps**
  - Creating the category maps from the selected parameters:
    - *necessary parameters*
    - *optional parameters*
  - Participants were allowed to use data sources differed from the suggested sources if they were equivalent with these.

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Output standard

- **Category maps**
  - Creating the category maps from the selected parameters:
    - ***necessary parameters***
    - *optional parameters*
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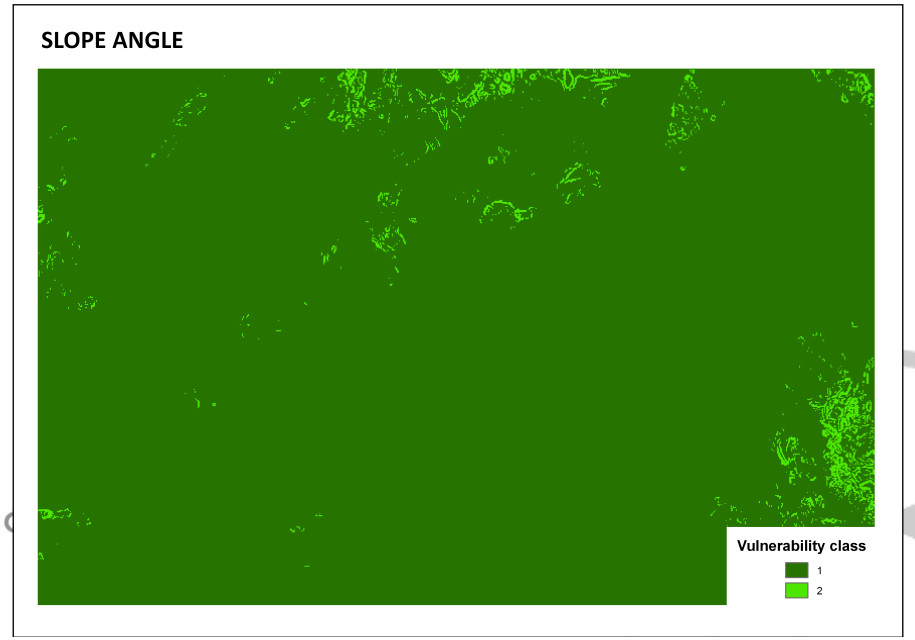
Necessary parameters

- **Slope angle**
  - larger is slope angle, the greater amount of precipitation runs off.
  - by increasing of the slope angle the specific surface decreases consequently it can receive less precipitation
  - *In case of Hungary: The values were derived from SRTM digital elevation model.*

	Angle [°]	Vulnerability class
Slope	(0-5)	0,2
	(5-12)	0,4
	(12-20)	0,6
	(20-35)	0,8
	(35-90)	1



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Necessary parameters

- **Sunshine duration OR global radiation**
  - in the vegetation period (daily mean temperature > 5°C).
  - the sunshine absorbed by surface and plants has an effect on evaporation.
  - five classes with equidistant division between the minimum and the maximum value
  - *Hungary: The sunshine duration values, which were measured in the observing network during the vegetation period (April-September), were interpolated by MISH taking into account among others the influence of elevation.*

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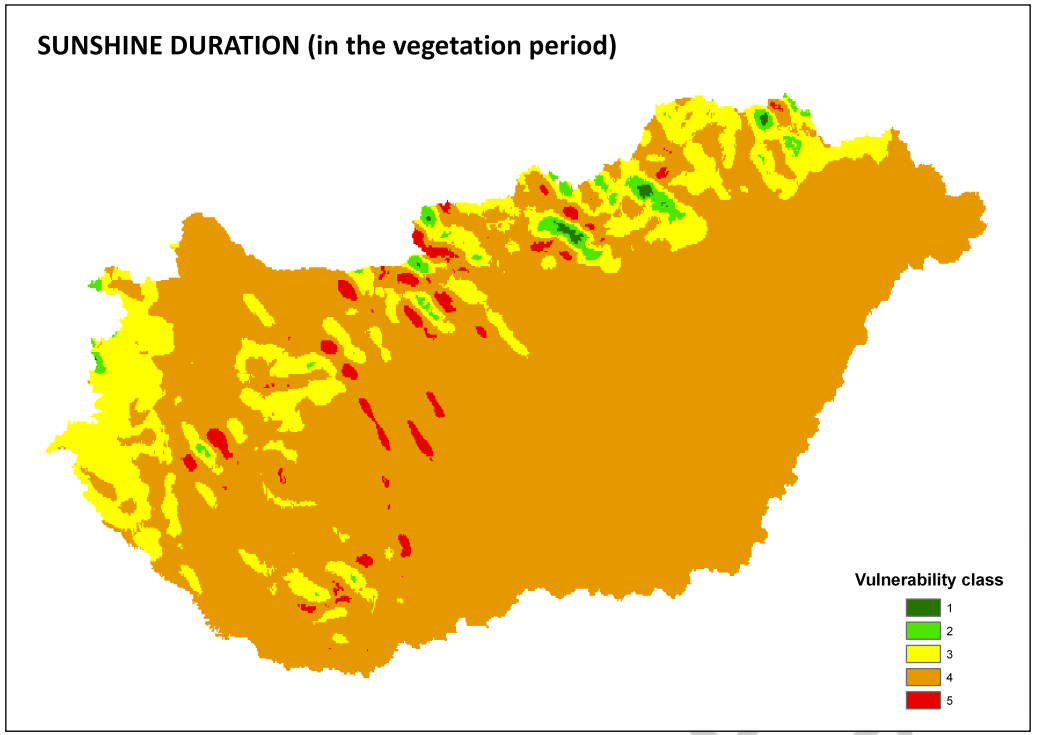
Necessary parameters

- **Sunshine duration -** *Hungary*

	Radiation [h]	Vulnerability class
Sunshine duration	991,8-1109,9	0,2
	1109,9-1228,1	0,4
	1228,1-1346,2	0,6
	1346,2-1464,4	0,8
	1464,4-1582,5	1



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Necessary parameters

- **Precipitation**
  - Pupose: quantifying the extremity of the precipitation.
  - As the precipitation follows Gamma-distribution:

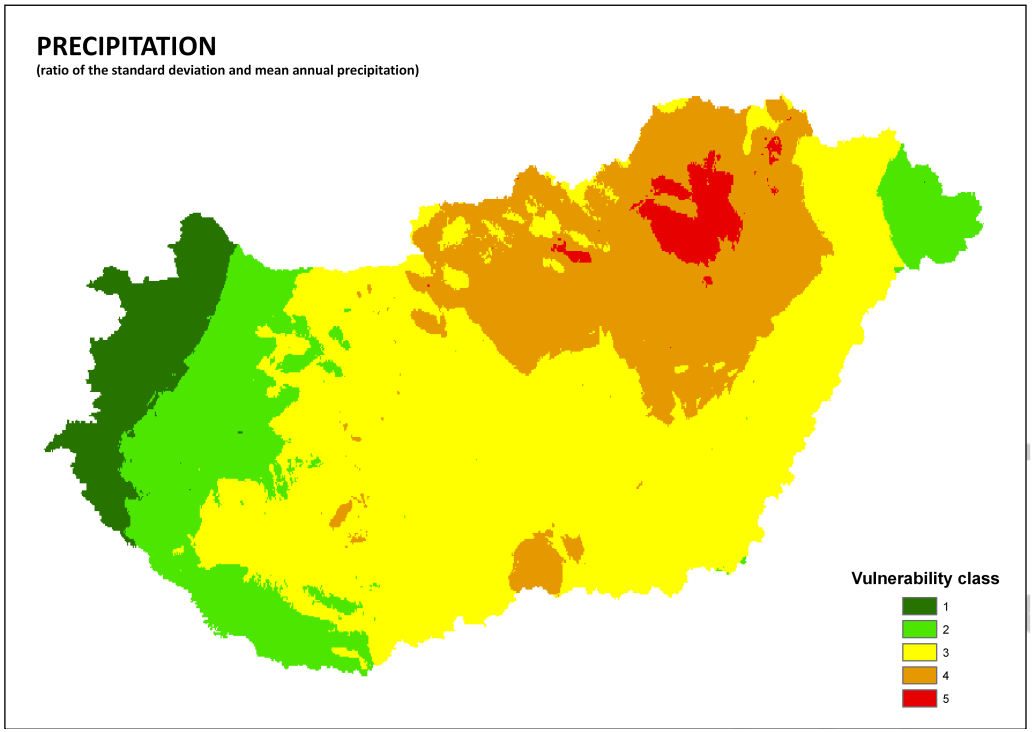
$$E = \frac{p}{\lambda} \qquad D = \frac{\sqrt{p}}{\lambda} \quad \Rightarrow \quad \boxed{\frac{D}{E} = \frac{1}{\sqrt{p}}}$$

  - This ratio can characterize the extremity. If D is great, it means that extreme sum can occur, while E is small, it means that low precipitation sum is expected in the given point. In this case the risk of drought is great and consequently the vulnerability is high.
  - Five classes with equidistant division between the minimum and the maximum value.

Necessary parameters

- **Precipitation**
  - *Hungary: Both the mean and the standard deviation were interpolated by MISH using homogenized data of 177 stations from period 1951-2010.*

	$\frac{D}{E}$	Vulnerability class
Precipitation	0,148-0,172	0,2
	0,172-0,195	0,4
	0,195-0,219	0,6
	0,219-0,242	0,8
	0,242-0,266	1



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Output standard

- **Category maps**
  - Creating the category maps from the selected parameters:
    - *necessary parameters*
    - ***optional parameters***
  - Participants were allowed to use data sources differed from the suggested sources if they were equivalent with these.

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Optional parameters

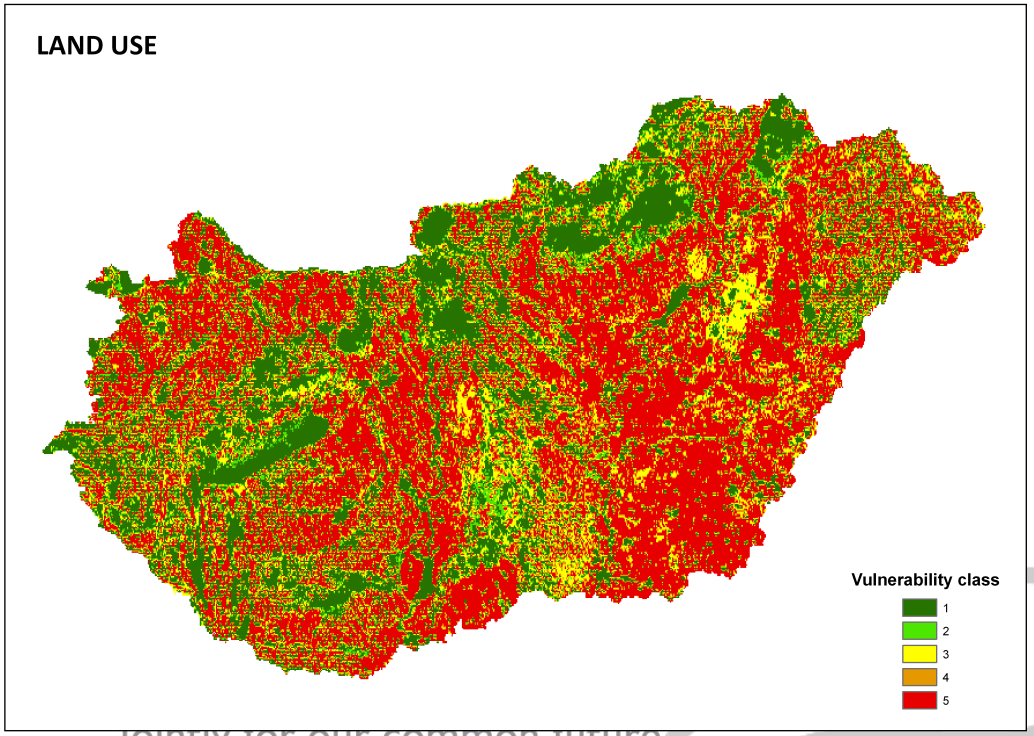
- **Landuse:**
  - Only the agricultural land was taken into account.
  - Participants could derive the map from the Corine100 or Corine50 LandCover database.
  - The characteristic types of landuse were classified into five vulnerability classes.

	Type of landuse (CLC50)	Vulnerability class
Landuse	2113, 223, 2431, 2432, 2433, 2434, 2435, 244, 3111, 3112, 3113, 3114, 3121, 3131, 3135, 3241, 3243, 3244, 3245, 3341	0,2
	2211	0,4
	2312, 241, 2421, 2422, 3115, 3125, 3139, 3211, 3212, 322, 323, 3331, 3332, 3333	0,6
	2221, 2222, 2223, 2226	0,8
	2111, 2112, 2121, 2311	1
	Type of landuse (CLC100)	Vulnerability class
	223, 243, 244, 311, 312, 313,324	0,2
	221	0,4
	241, 242, 321, 322, 323, 333	0,6
	222	0,8
	211, 212, 213	1

Optional parameters

- **Landuse –** *Hungary*

	Type of land use (CLC100)	Vulnerability class
Land use	223, 243, 244, 311, 312, 313,324	0,2
	221	0,4
	241, 242, 321, 322, 323, 333	0,6
	222	0,8
	211, 212, 213	1



Optional parameters

- **Soil type:**
  - water capacity of soil
  - After examination of the soil types of WRB, they were ranged into five vulnerability classes.
  - Partners had to classify soil types of their countries into the WRB (FAO) categories.

	Soil type	Vulnerability
Soil type	Histosols (HS)	0,2
	Gleysols (GL), Luvisols (LV)	0,4
	Cambisols (CM), Chernozems (CH), Fluvisols (FL)	0,6
	Phaeozems (PH), Solonetz (SN)	0,8
	Arenosols (AR), Leptosols (LP), Solonchaks (SC), Vertisols (VR)	1

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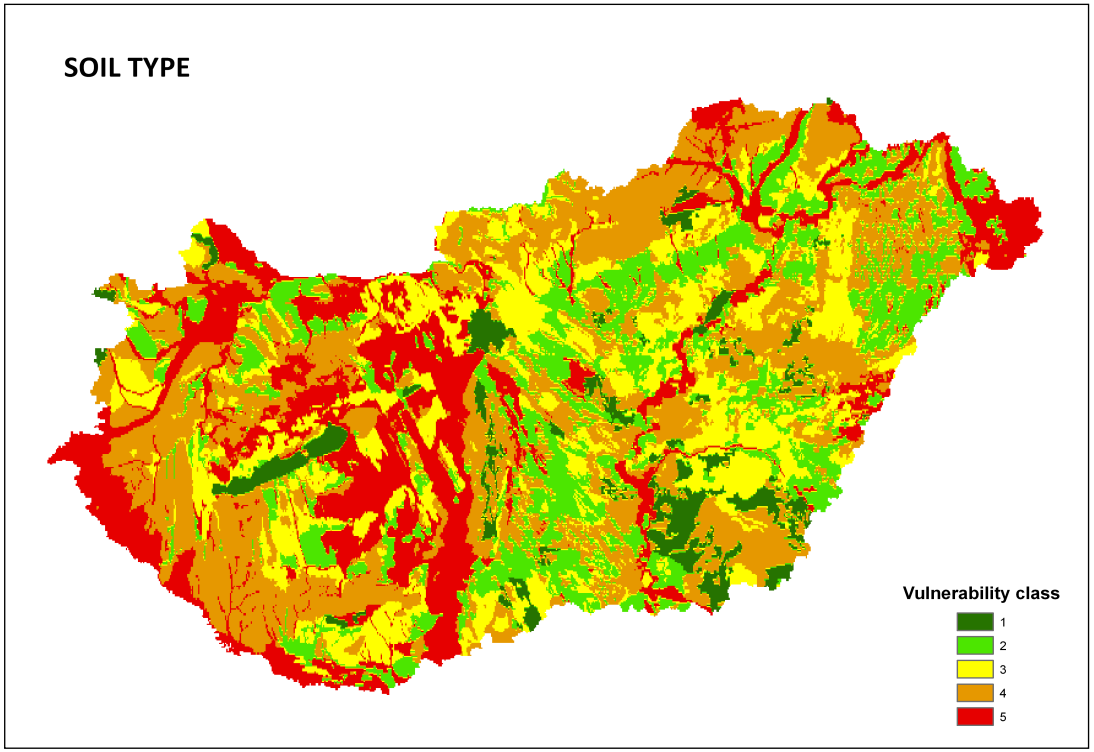
Optional parameters

- **Soil type -** *Hungary*



	Soil type	Vulnerability
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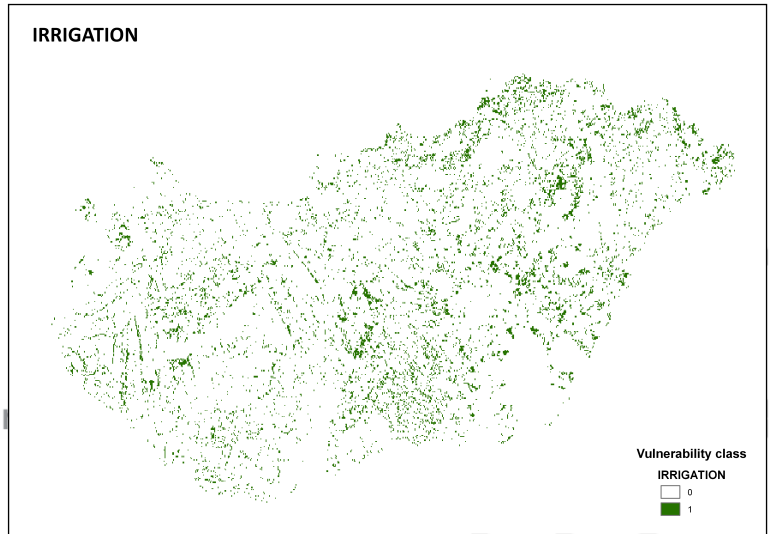
Optional parameters

- **Irrigation:**
  - based on Corine LandCover database.
  - **human factor**: if drought strikes an irrigated area, people can handle it by enhancing the irrigation, while in a non-irrigated area there is no chance for the human intervention. Consequently the irrigated areas are less vulnerable to drought than the non-irrigated ones.

Irrigation	Irrigation	Vulnerability class
	YES	0
	NO	1



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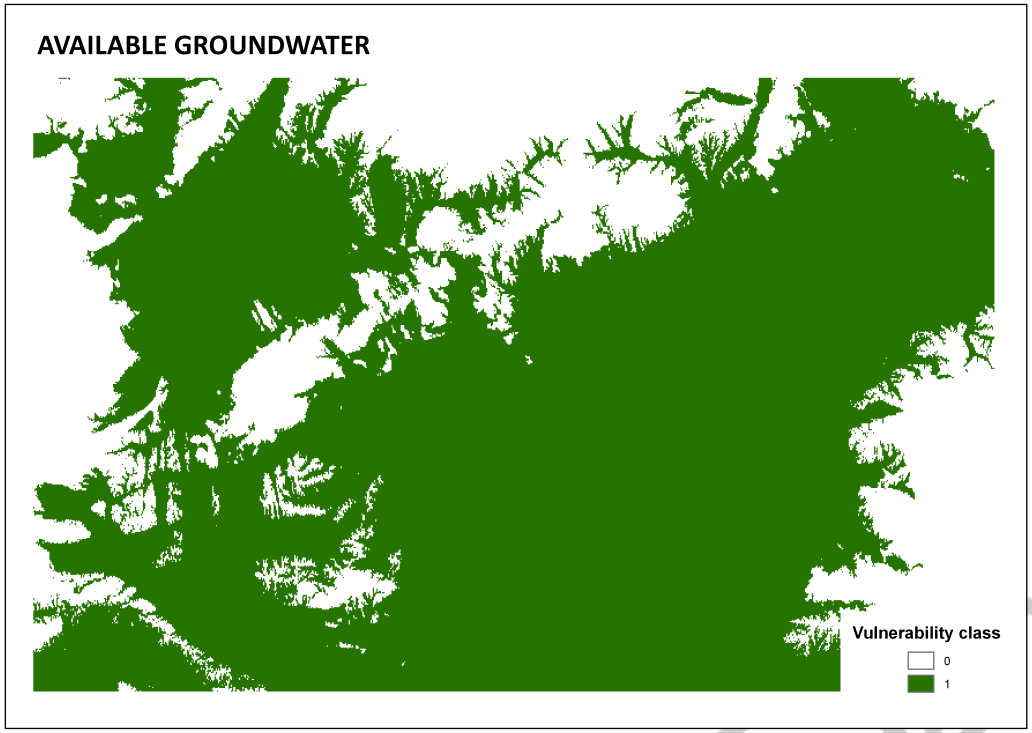
Optional parameters

- **Relative groundwater level :**
  - based on groundwater level measurements. (The relative depth measured from the surface.)
  - Five classes with equidistant division between the minimum and the maximum value.
  - *Hungary: As there is no available groundwater measurements in Hungary, we proceeded on the base of geographical practice. According to that groundwater is ignorable higher than 200 m above sea level, because at this height groundwater is located so deep, that it is cannot be available for plants.*

Optional parameters

- **Relative groundwater level -** *Hungary*

Available groundwater	Height above Sea level [m]	Vulnerability class
	(0-200)	0
	(200-)	1



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Creating the drought vulnerability map

- **Reclassifying:** summing up the values of the category maps, and then the values between the maximum and the minimum dividing equidistantly into five classes.

- **Using weighted mean**: Before the reclassifying producing the weighted mean of the category maps by using the software IDRISI (by Clark Labs). The software calculates easily the weighted factors.

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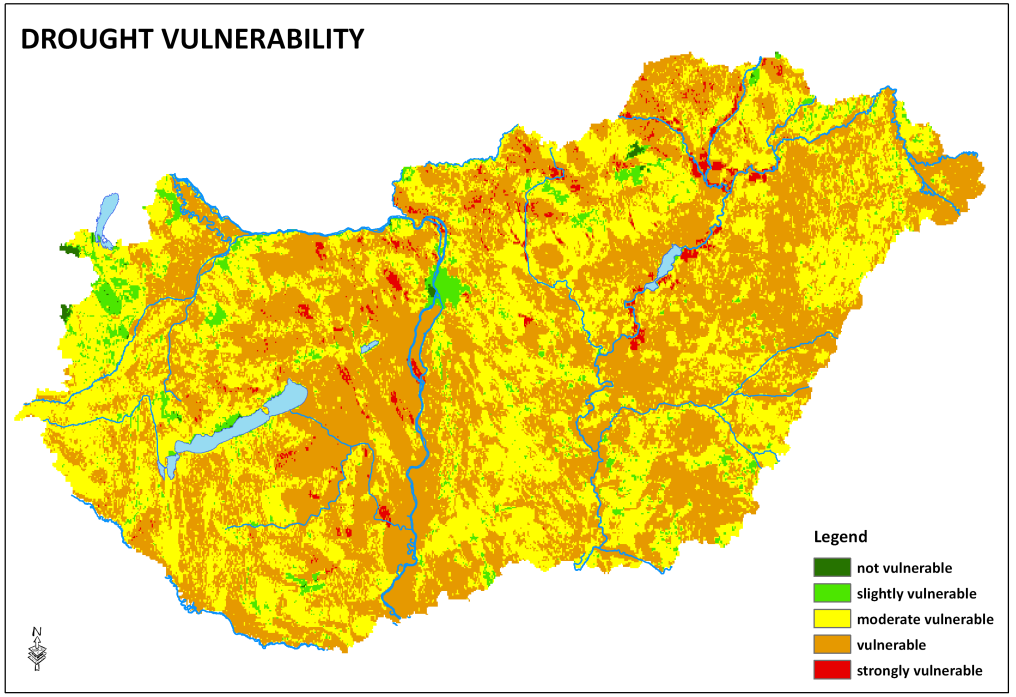
Creating the drought vulnerability map

- ***Hungary:*** *calculating with weighted mean*

Parameter	Weight
Slope	0.1623
Available Groundwater	0.0518
Sunshine duration	0.3071
Precipitation	0.1180
Land use	0.0858
Soil type	0.2232
Irrigation	0.0518



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Vulnerability maps of participants

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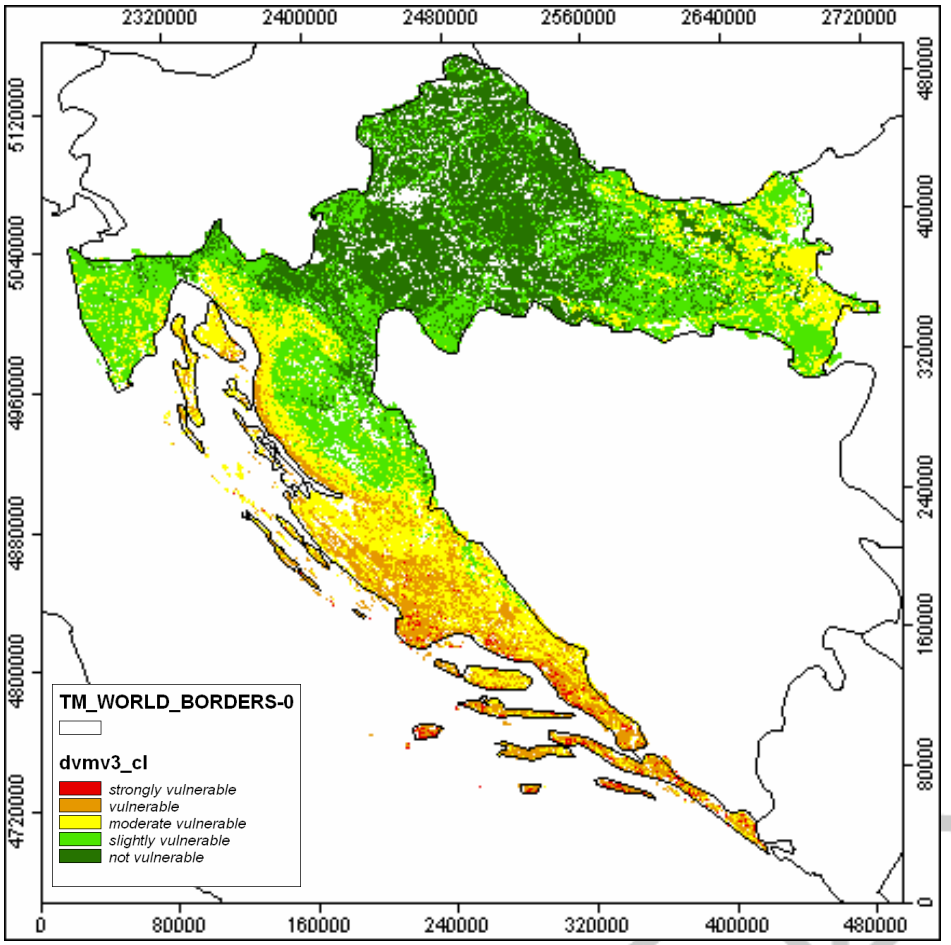
Croatia

Drought vulnerability map for the areas covered with vegetation.



Paramaters:

- Slope,
- irradiation,
- precipitation,
- soil type,
- land cover type.

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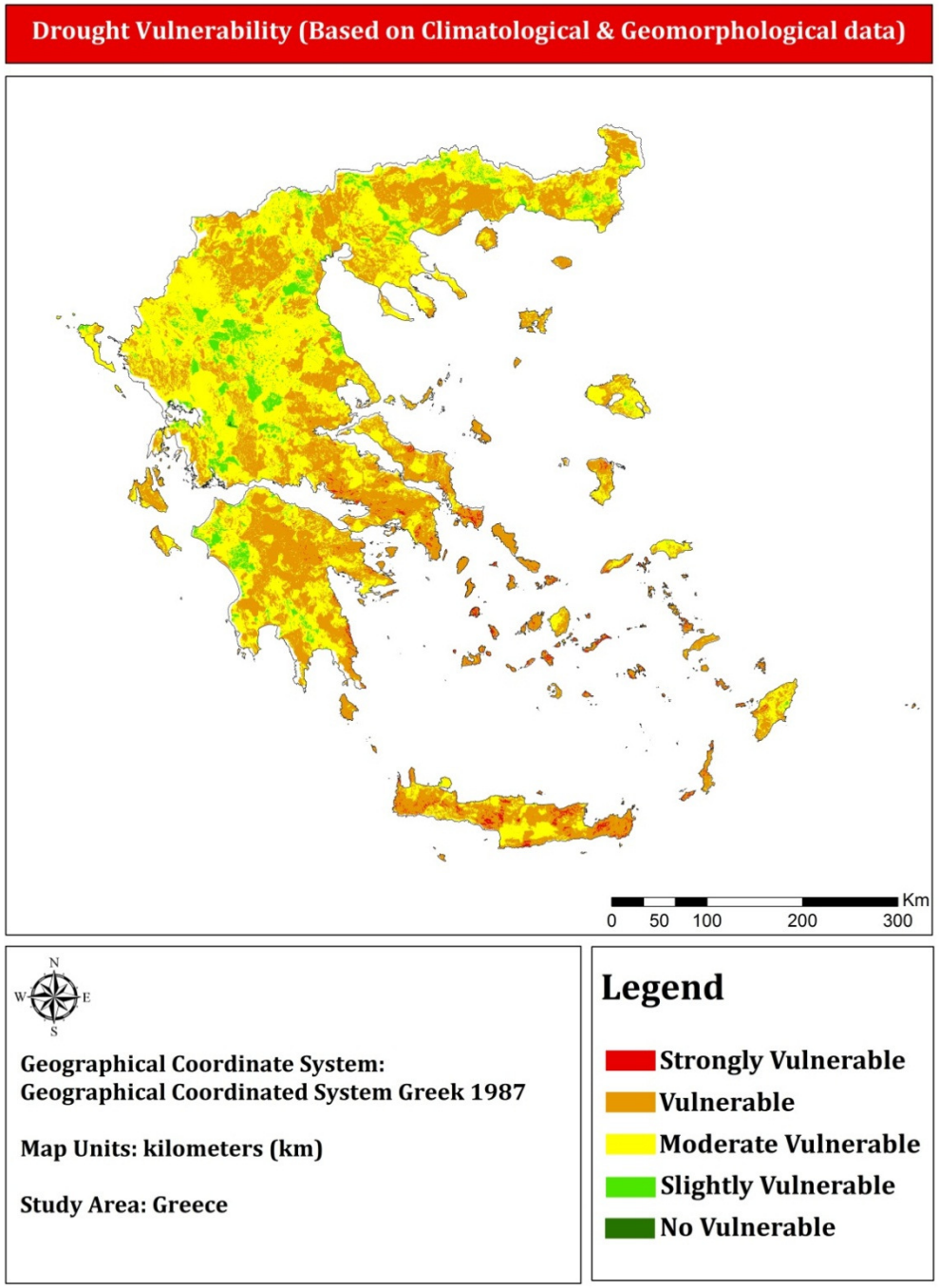
Greece

Paramaters:

- Slope
- Irrigation
- Solar Radiation
- Land Use
- Precipitation
- Soil Type



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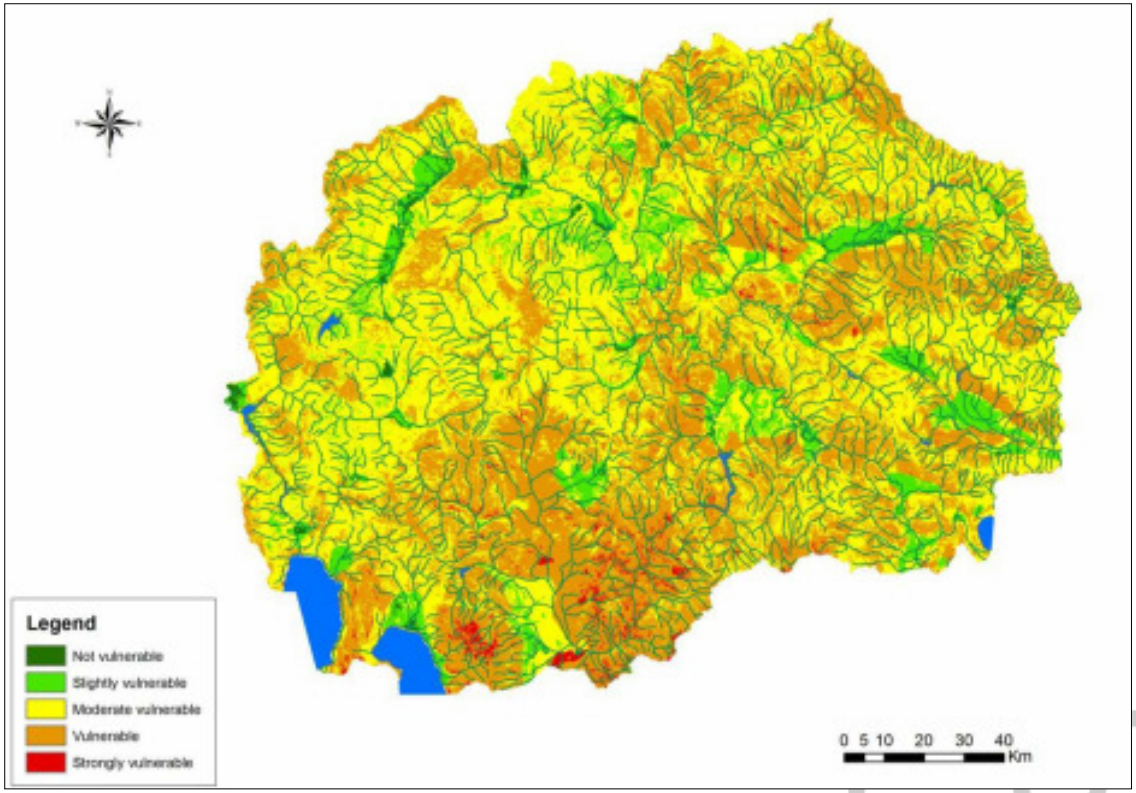
Republic of Macedonia

Paramaters:

- Slope
- Irrigation
- Solar Radiation
- Land Use
- Precipitation
- Soil Type



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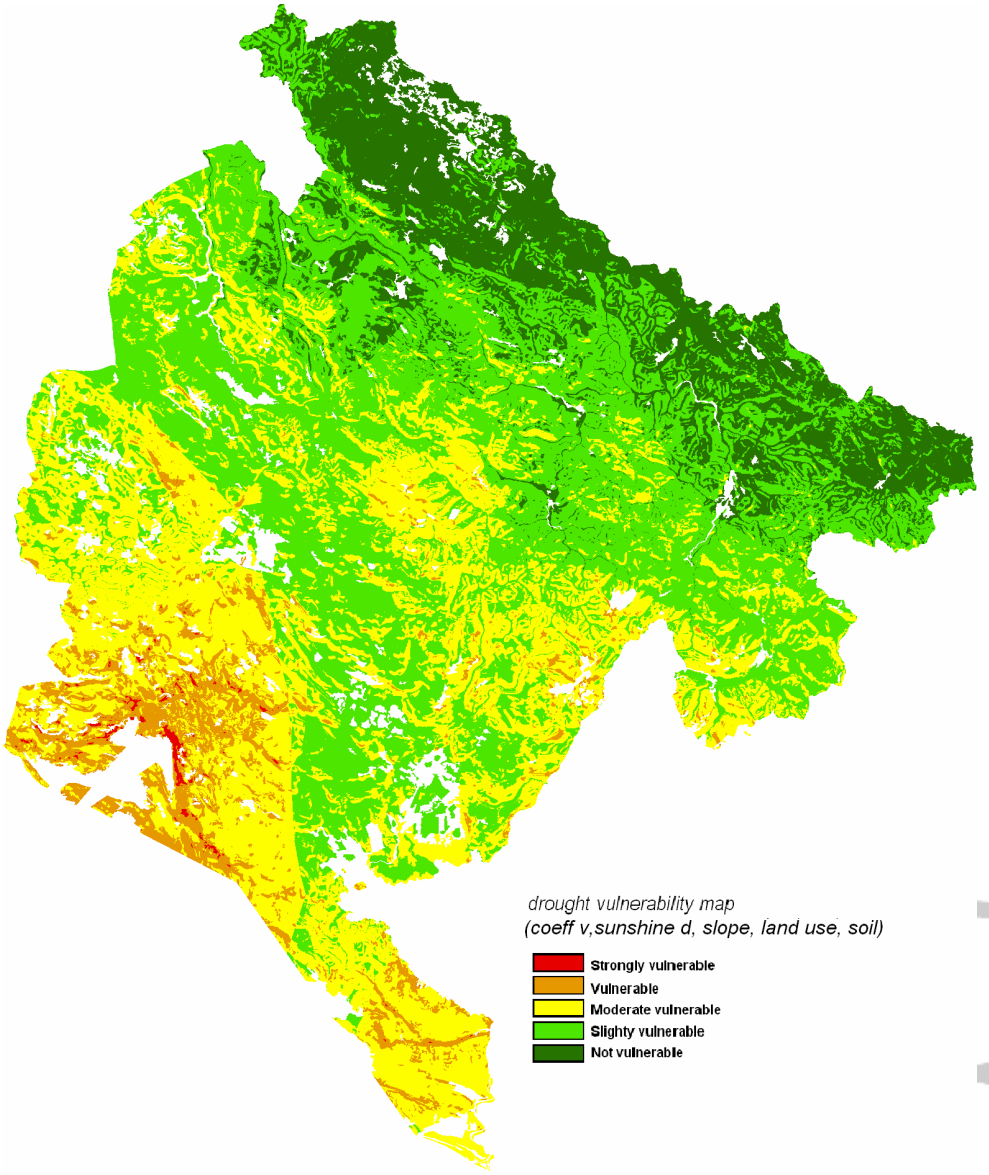
Montenegro

Paramaters:

- Slope,
- sunshine duration,
- precipitation,
- land use
- soil type.



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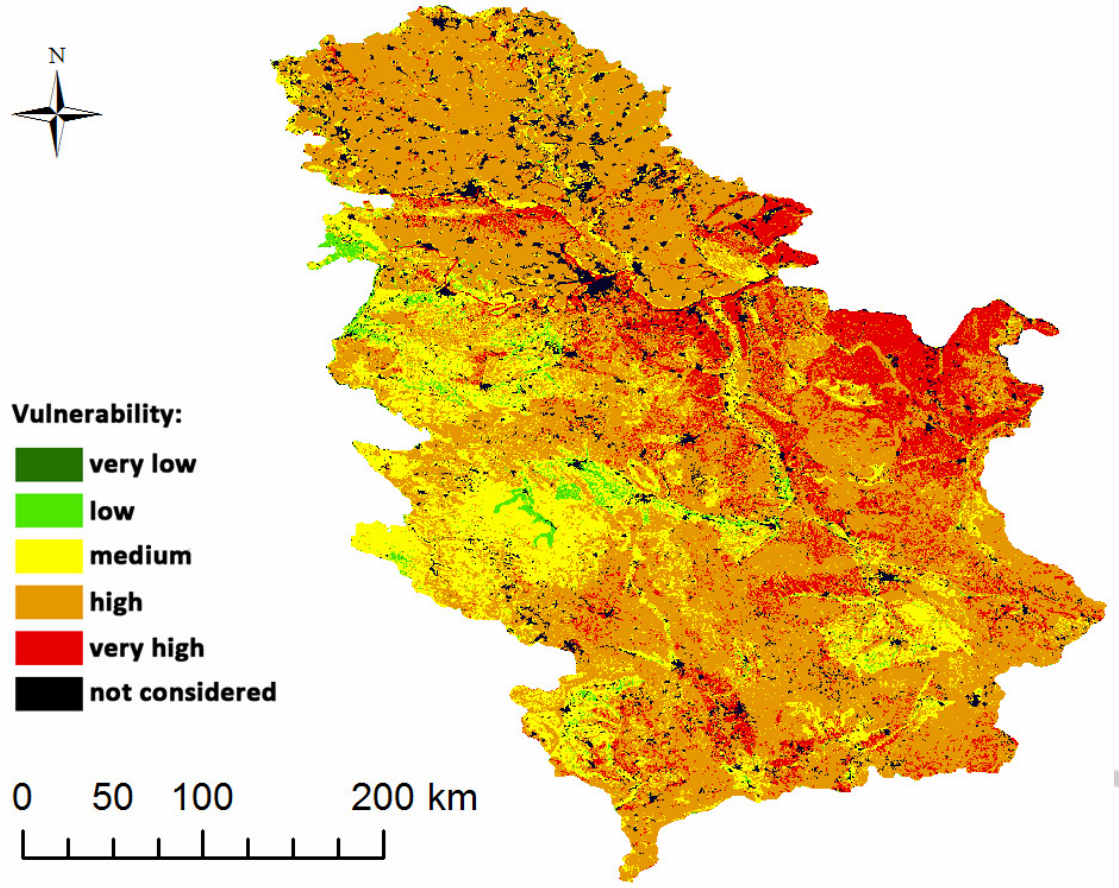
Serbia

Paramaters:

- Slope angle,
- sunshine duration,
- precipitation,
- land cover,
- soil type.



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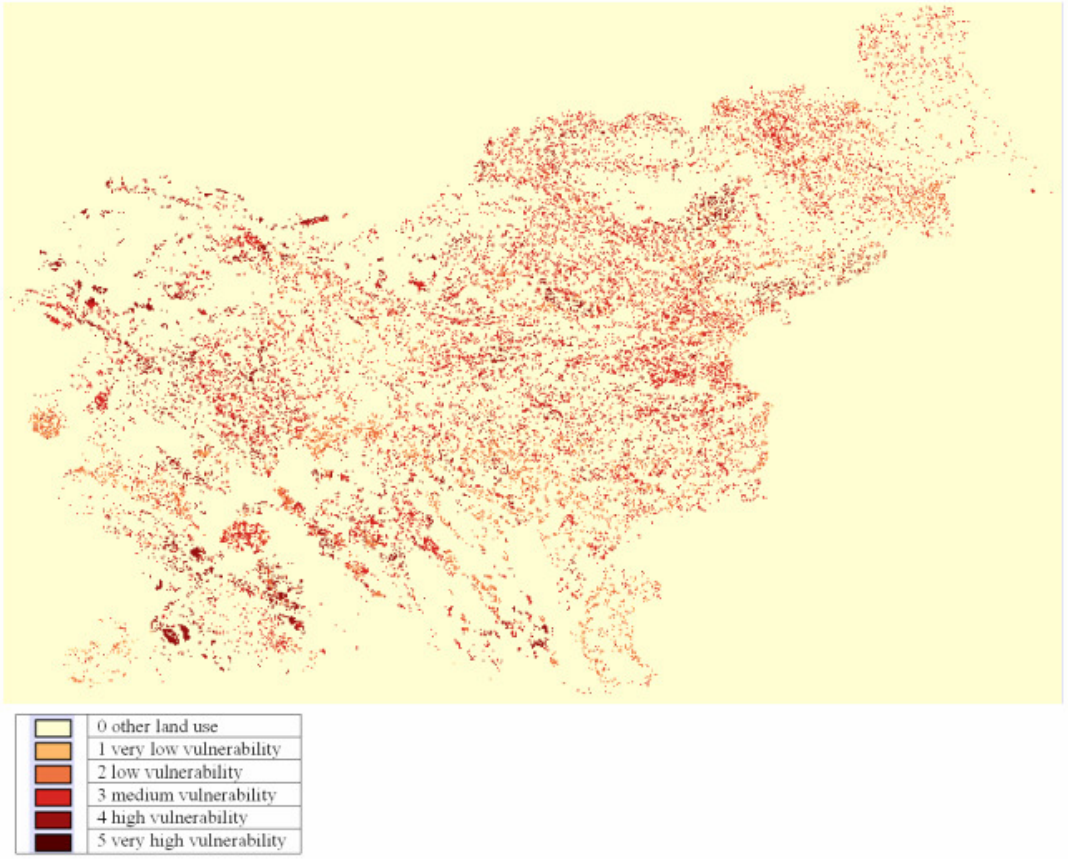
Slovenia

Paramaters:

- Amounts of plant available water in the soil,
- slope,
- solar radiation,
- irrigation,
- land use.



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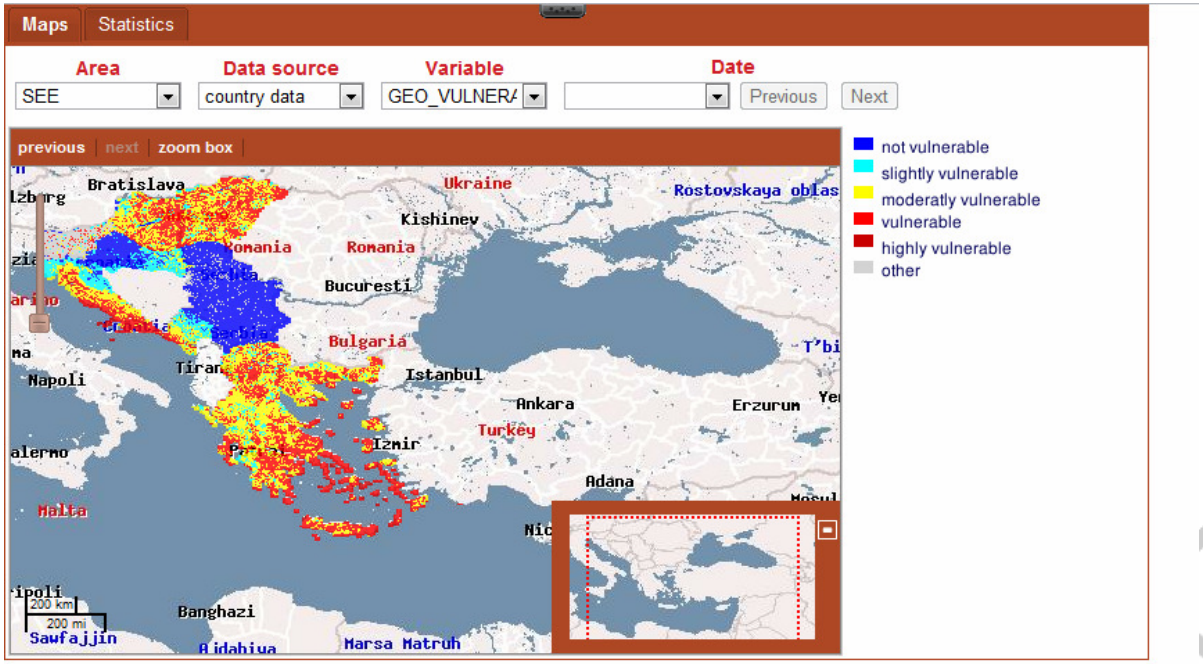
Homepage:

http://www.dmcsee.org/GISapp/

The vulnerability maps of the project partners were uploaded onto the homepage of the DMCSEE.



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