

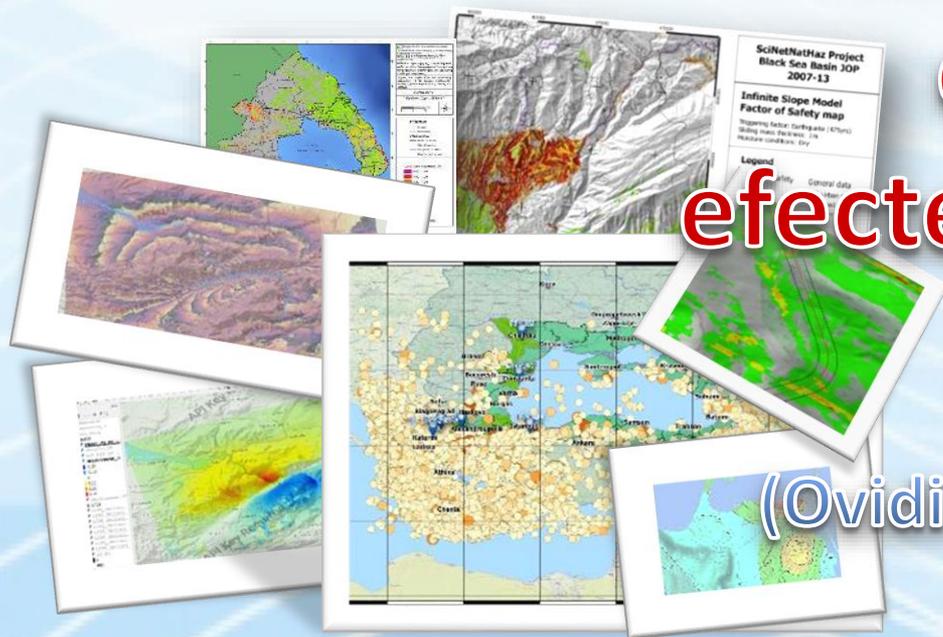


Project funded by
EUROPEAN UNION

REDACT
Rapid Earthquake Damage Assessment Consortium



REDAS - Sistemul de estimare rapidă a efectelor cutremurelor



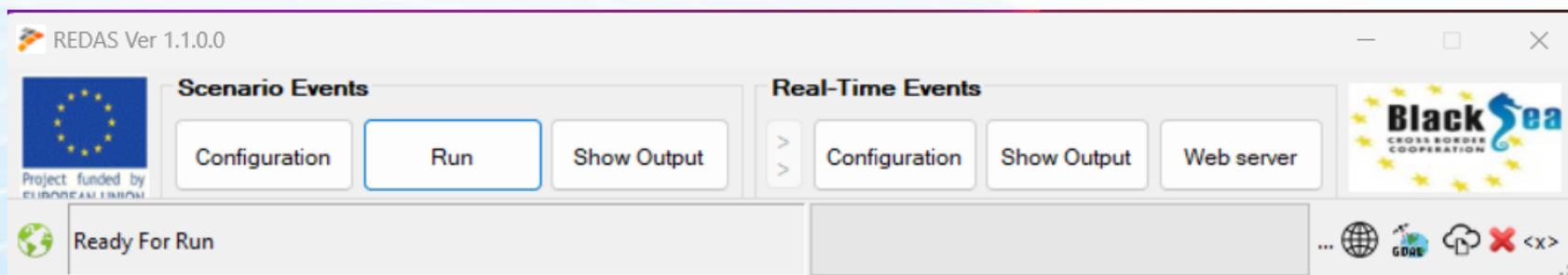
Dragoș Toma-Dănilă
(Ovidius University of Constanța)
& REDACT team

Seminar – Rezultatele Proiectului REDACT, 23 iunie 2023

Common borders. Common solutions.

Caracteristici:

- REDAS = Rapid Earthquake Damage Assessment System
- Coordonator: Gebze University (în special Yasin Fahjan și Can Zulfikar)
- Scris în C#, cu resurse adiționale: GDAL și EGIS
- Ultima versiune: 1.1



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Caracteristici:

- **Conține 5 module distincte:**
 - Estimare hazard prin intermediul ecuațiilor de predicție a mișcării solului (GMPE)
 - Shakemap
 - Estimare pagube clădiri
 - Estimare probleme geotehnice (alunecări de teren, susceptibilitate lichiefiere)
 - Conducte
- **Funcționează atât în timp real cât și pentru scenarii**
- **Poate utiliza date de la stații seismice: PGA, SA, PGV precum și detalii despre cutremure în format .xml (ShakeMap)**

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Date partajate pe Cloud

Timp (aproape) real



Server local

- 📁 **Cutremure**
 - Event ID1
 - Event Trigger xml Files
 - Station Data xml Files

- 📁 **Date operationale**
 - Hărți cu falii
 - Hărți Vs30
 - Funcții de fragilitate și vulnerabilitate
 - Zone de activare REDAS
 - Coeficienți și ponderi pentru GMPE

📄 Event ID> Grid Based Damage Data

REDAS pe server partener

- 📁 **Bază de date**
 - Clădiri
 - Populație
 - Conduce

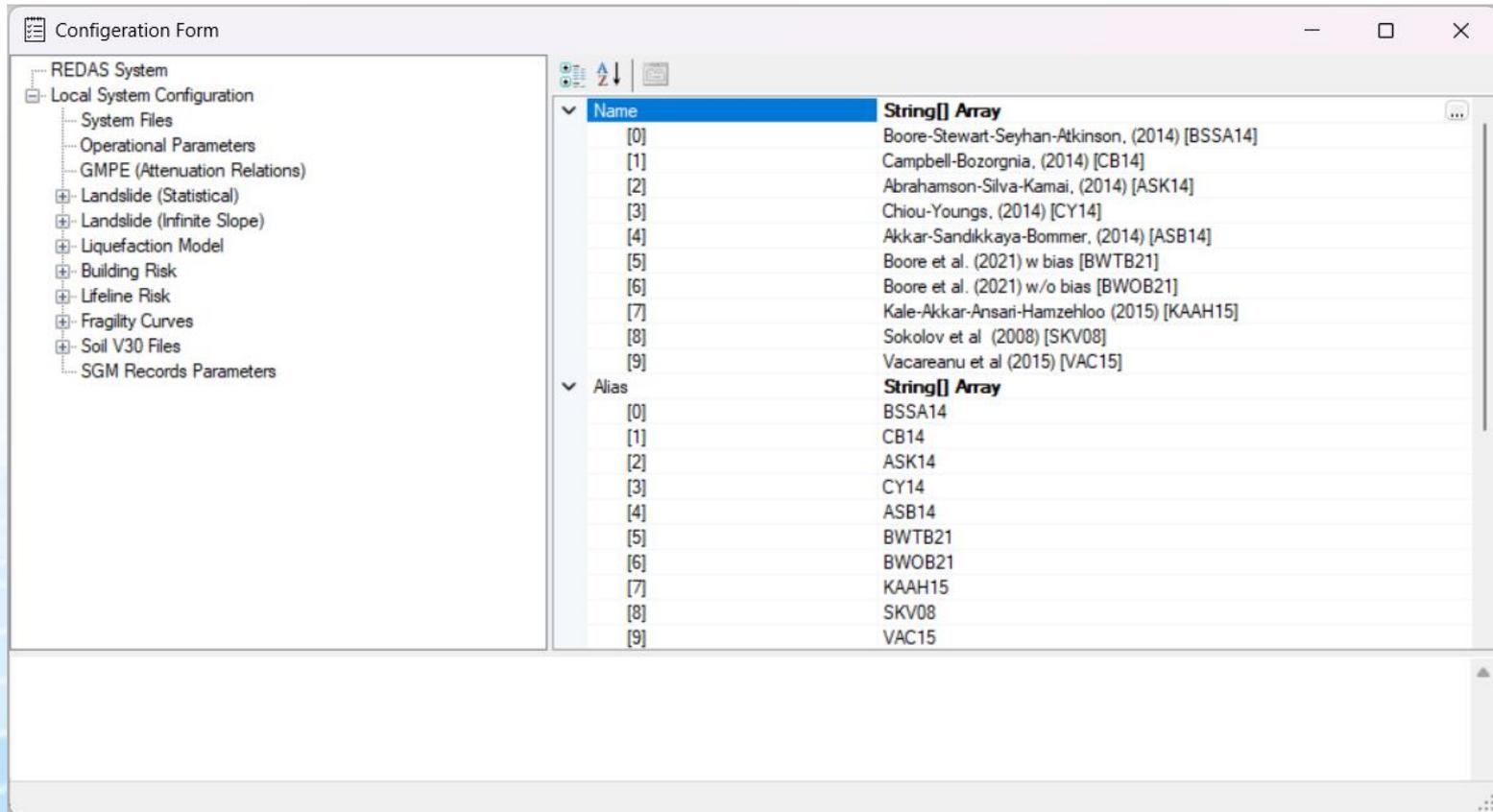
Rezultate: pe server local

- 📄 Hărți de intensitate
- 📄 Hărți PGA, PGV, PSA
- 📄 Clădiri afectate
- 📄 Rată de reparații pentru conduce
- 📄

Processing

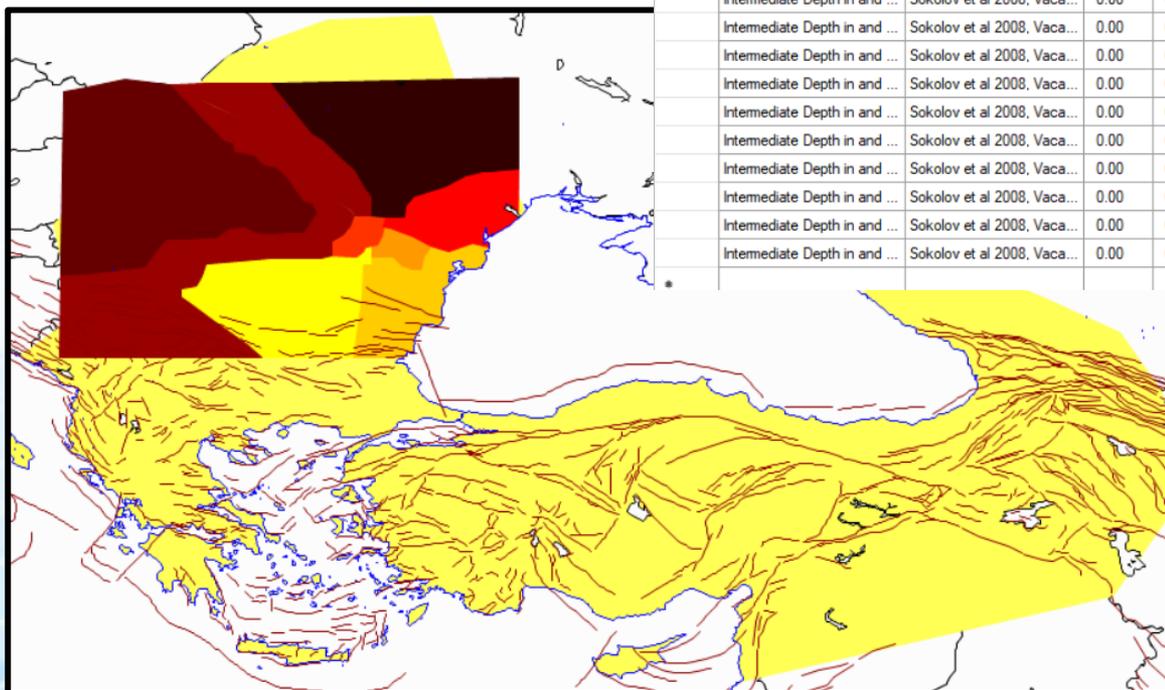
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Ground Motion Prediction Equations



Common borders. Common solutions.

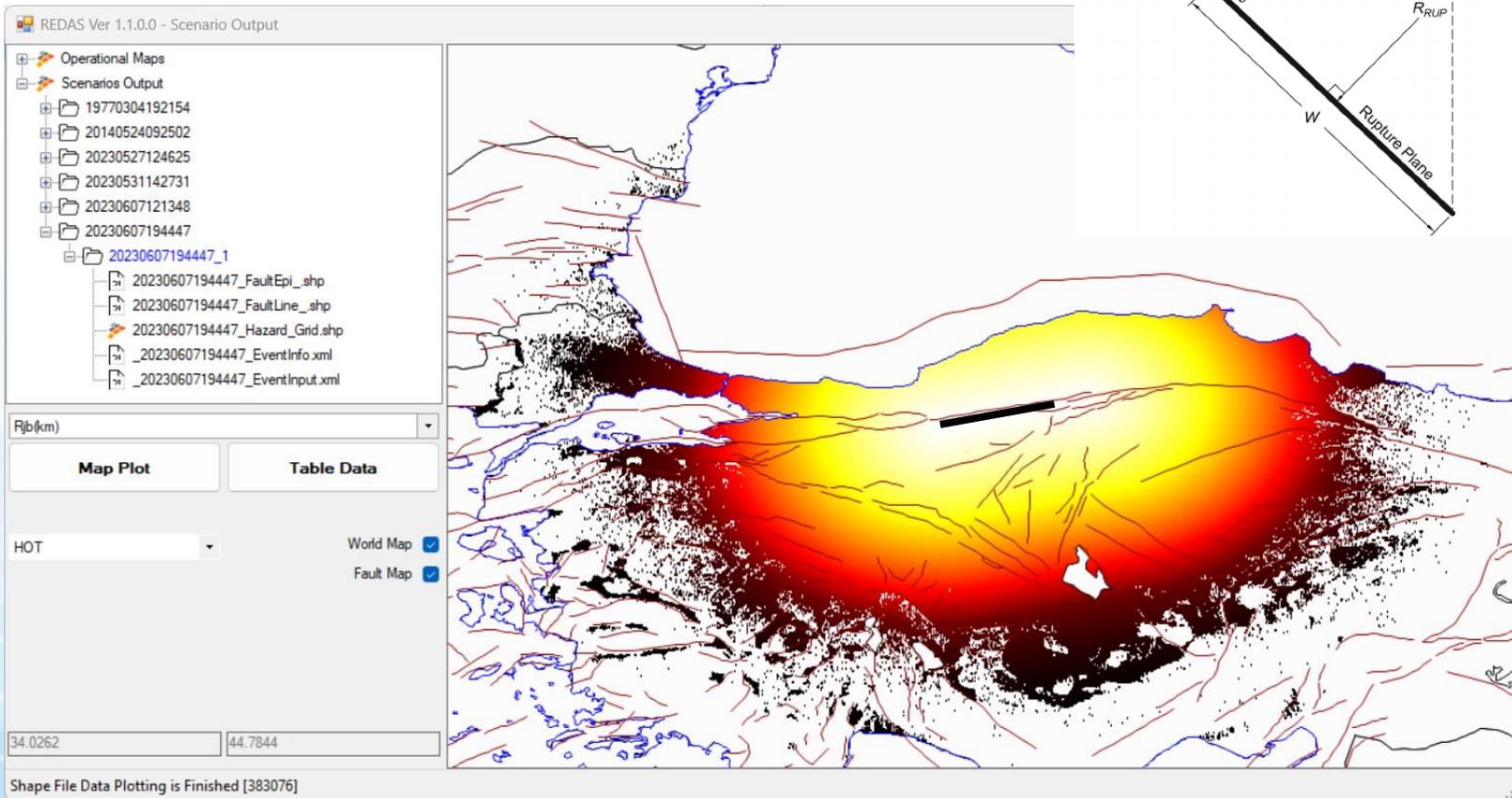
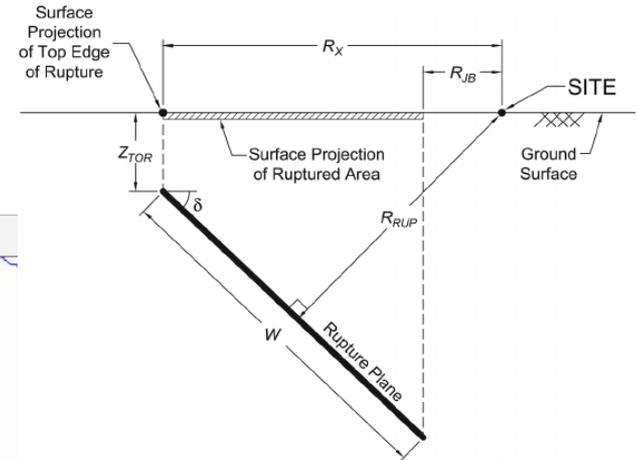
Ground Motion Prediction Equations



	ZONE	GMPE	BSSA14	CB14	ASK14	CY14	KAH15	BWTB21	BWOB21	SKV08	VAC15	ZMIN
▶	Crustal earthquakes in and...	Boore et al (2014), Cauzz...	0.50	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.000
	Crustal earthquakes in Vra...	Boore et al (2014), Cauzz...	0.50	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.000
	Crustal earthquakes in and...	Boore et al (2021) with a...	0.00	0.00	0.00	0.00	0.34	0.33	0.33	0.00	0.00	0.000
	Intermediate Depth in and ...	Sokolov et al 2008, Vaca...	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.50	60.000
	Intermediate Depth in and ...	Sokolov et al 2008, Vaca...	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.50	60.000
	Intermediate Depth in and ...	Sokolov et al 2008, Vaca...	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.50	60.000
	Intermediate Depth in and ...	Sokolov et al 2008, Vaca...	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.50	60.000
	Intermediate Depth in and ...	Sokolov et al 2008, Vaca...	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.50	60.000
	Intermediate Depth in and ...	Sokolov et al 2008, Vaca...	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.50	60.000
	Intermediate Depth in and ...	Sokolov et al 2008, Vaca...	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.50	60.000
	Intermediate Depth in and ...	Sokolov et al 2008, Vaca...	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.50	60.000
	Intermediate Depth in and ...	Sokolov et al 2008, Vaca...	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.50	60.000
	Intermediate Depth in and ...	Sokolov et al 2008, Vaca...	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.50	60.000

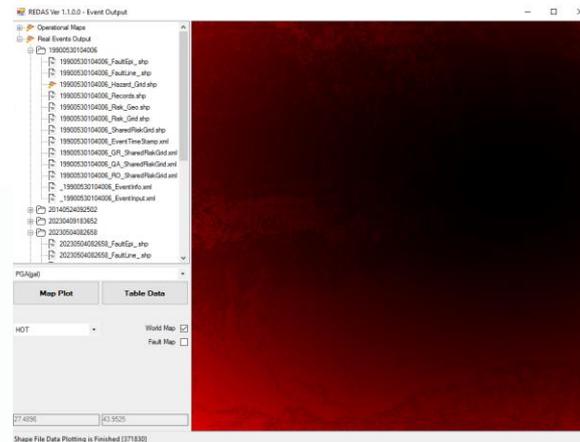
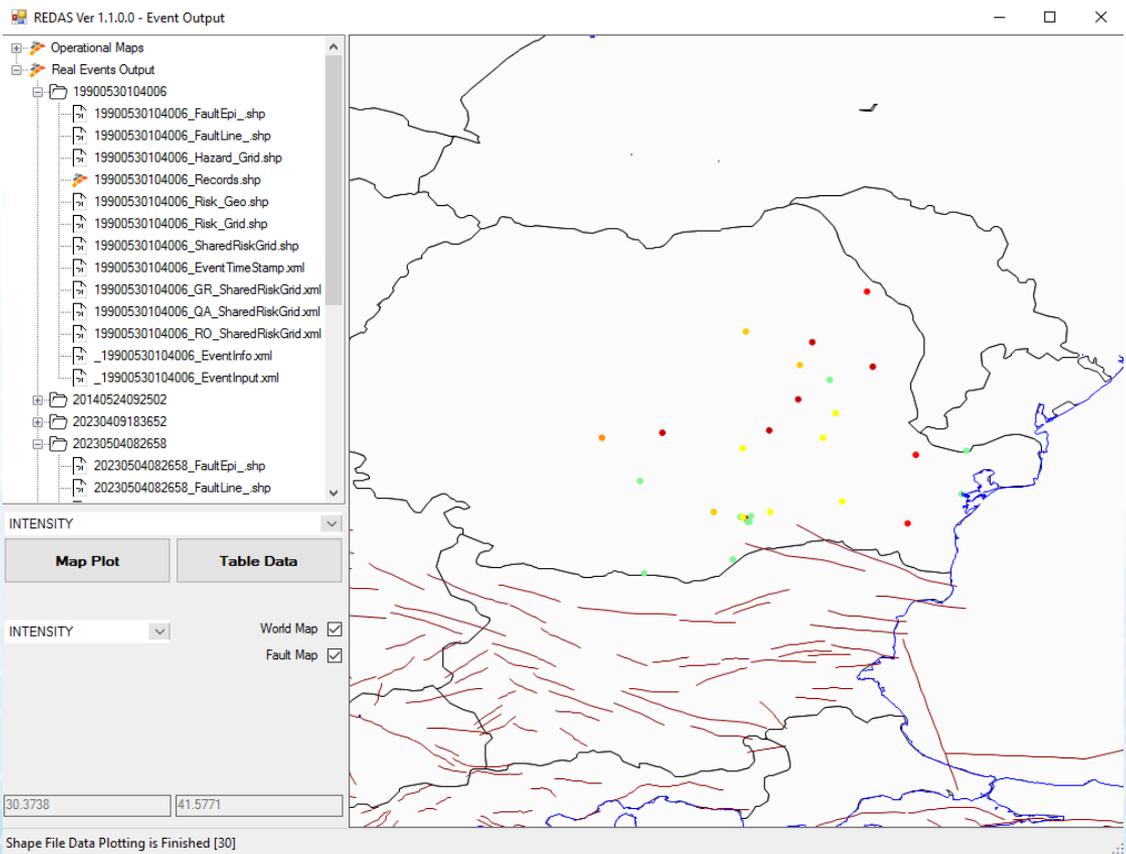
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Rupture distance Calculation



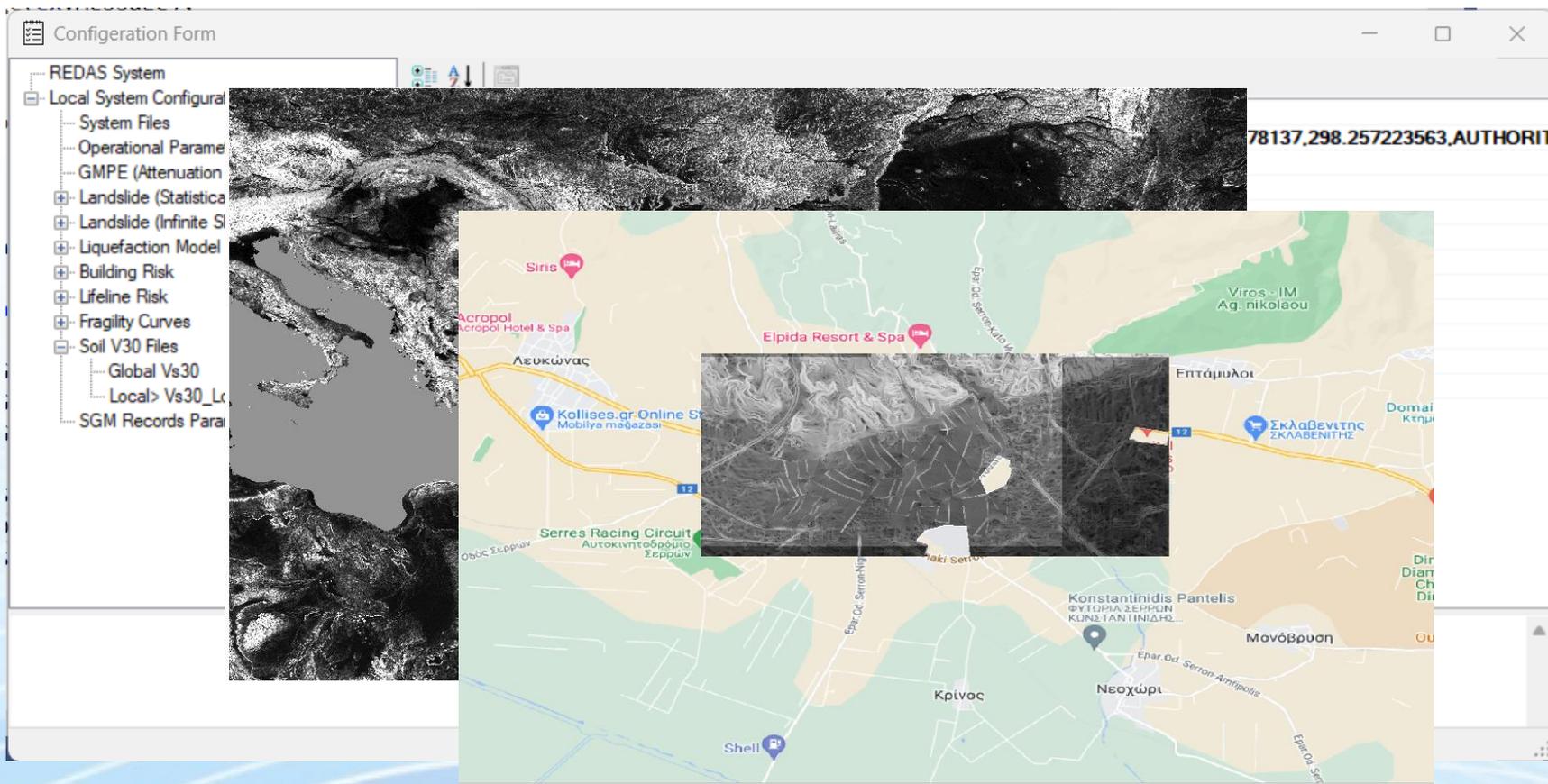
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Date de la stații seismice



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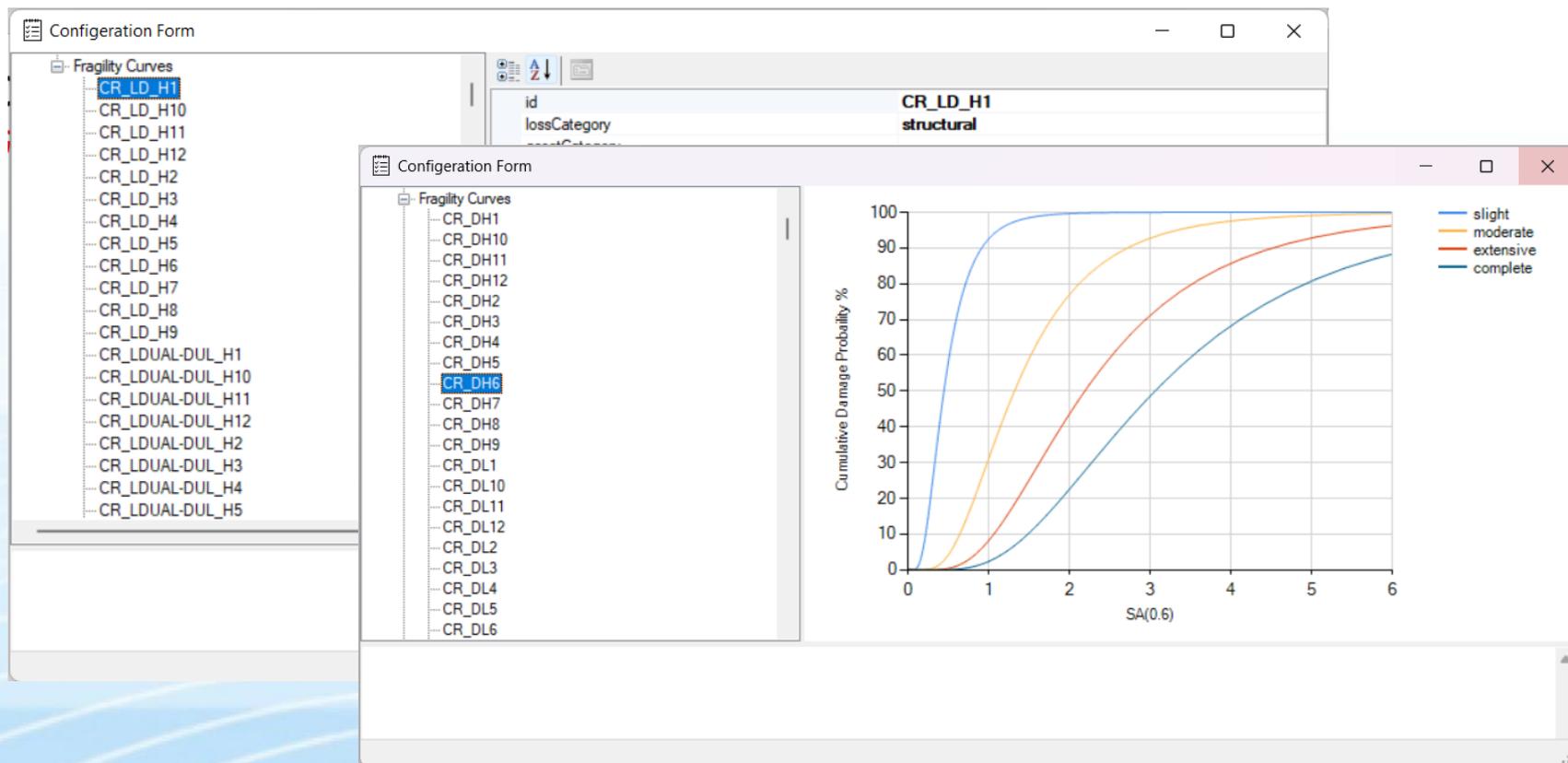
Soil Shear Wave Velocity Distribution, Vs30



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Funcții de fragilitate

Martins L, Silva V (2020) Development of a fragility and vulnerability model for global seismic risk analyses. *Bulletin of Earthquake Engineering* 19: 6719–6745.



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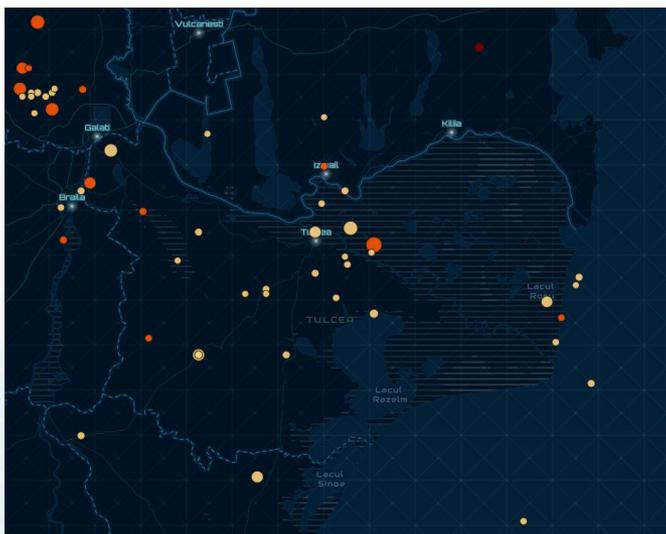
Date de expunere

- De la Recensământul din 2011, cu privire la clădiri rezidențiale, la nivel de UAT (județele Constanța și Tulcea):
 - Procesate adițional pentru încadrarea pe tipologii adecvate
 - Problema datelor colectate greșit – evidentă
 - Nu sunt considerate deocamdată clădirile cu risc seismic din zona analizată, dar pot fi adăugate separat

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Rezultate preliminariei pentru România

Cutremurul crustal din 1981 (Tulcea)
Mw 5.1, 15 km adâncime



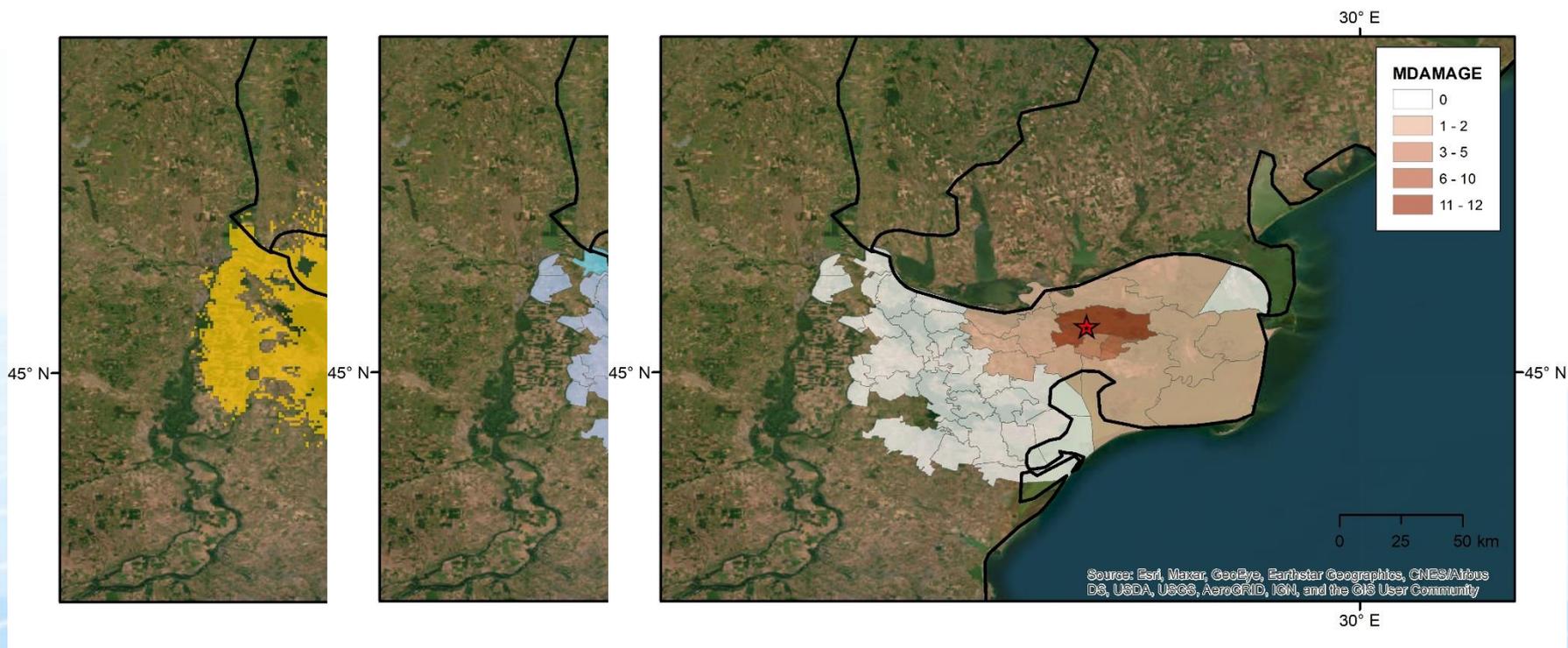
Avarii din orașul Tulcea (la Liceul Pedagogic, Consiliul Județean sau Magazinul Diana)

Sursa foto: prezentare Emil Sever Georgescu (URBAN-INCERC)

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Rezultate preliminarii pentru România

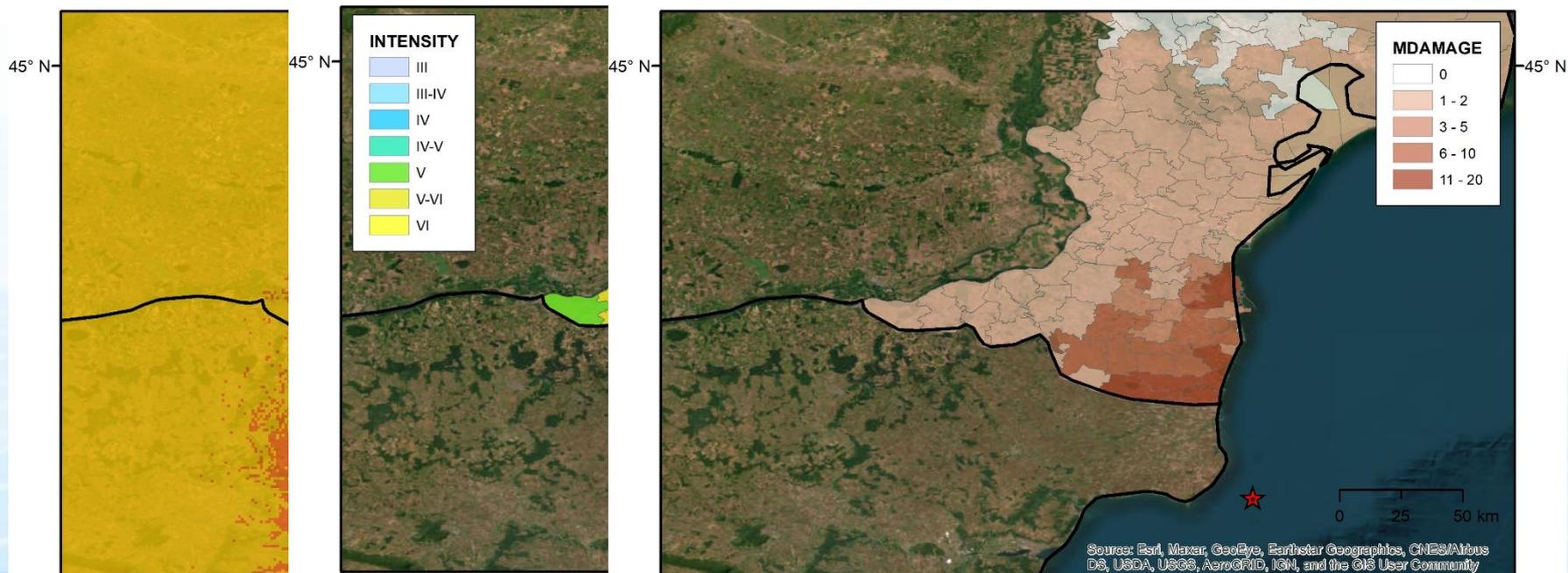
Cutremurul crustal din 1981 (Tulcea)
Mw 5.1, 15 km adâncime



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Rezultate preliminarii pentru România

Cutremurul crustal din 1901 (Shabla)
Mw 7.2, 14 km adâncime



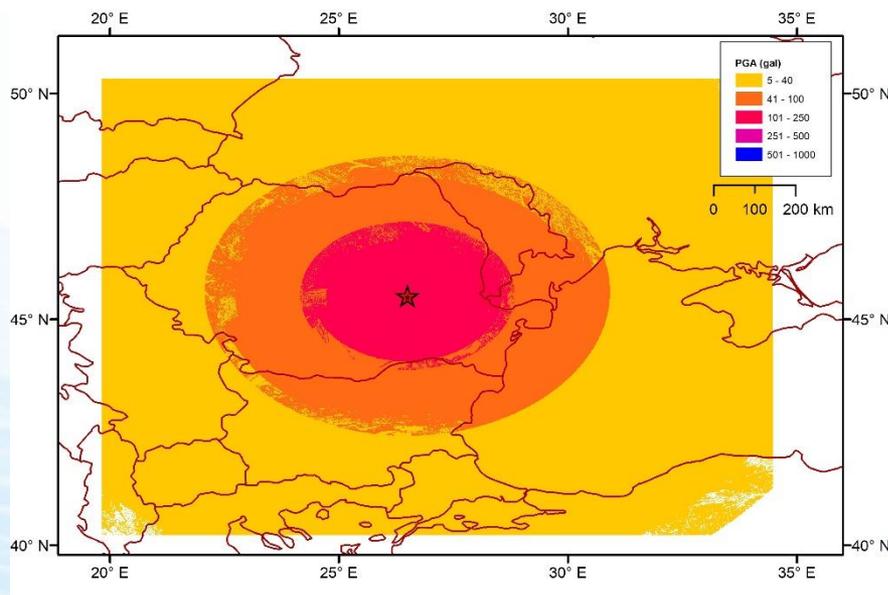
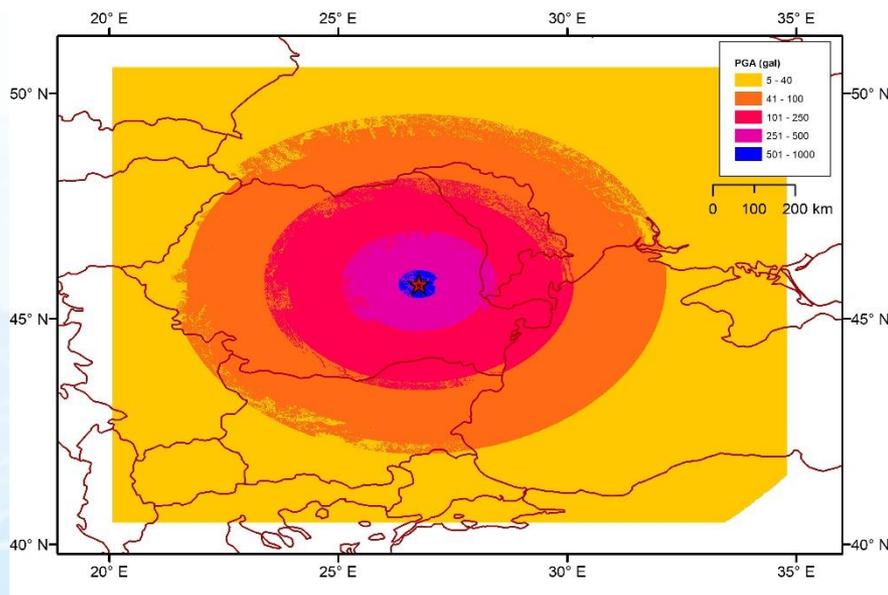
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Rezultate preliminare pentru România

Cutremurele de adâncime intermediară din zona Vrancea

1977 – 4 martie, Mw 7.4, 94 km adâncime

1986 – 31 august, Mw 7.1, 131 km adâncime



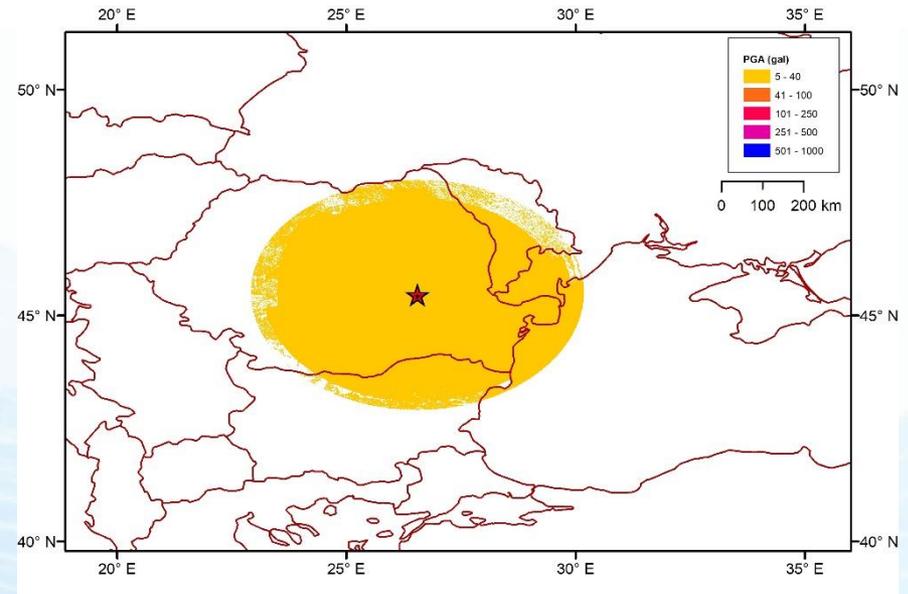
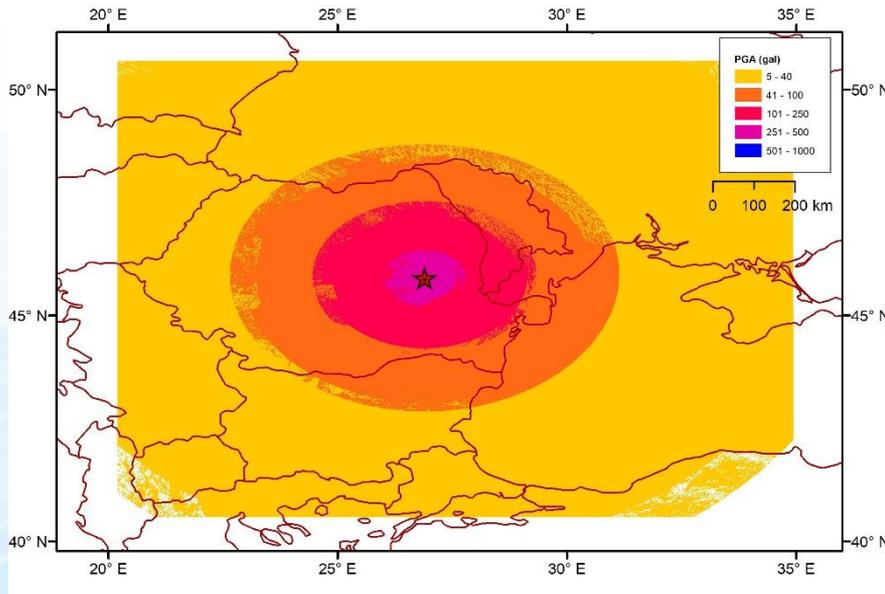
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Rezultate preliminarii pentru România

Cutremurele de adâncime intermediară din zona Vrancea

1990 – 30 mai, Mw 6.9, 91 km adâncime

2022 – 3 noiembrie, Mw 4.9, 149 km adâncime

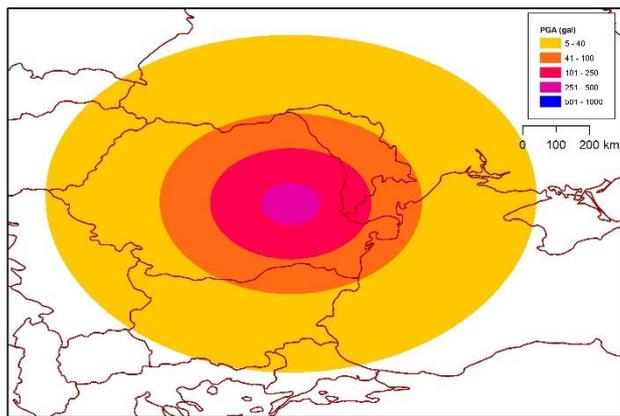


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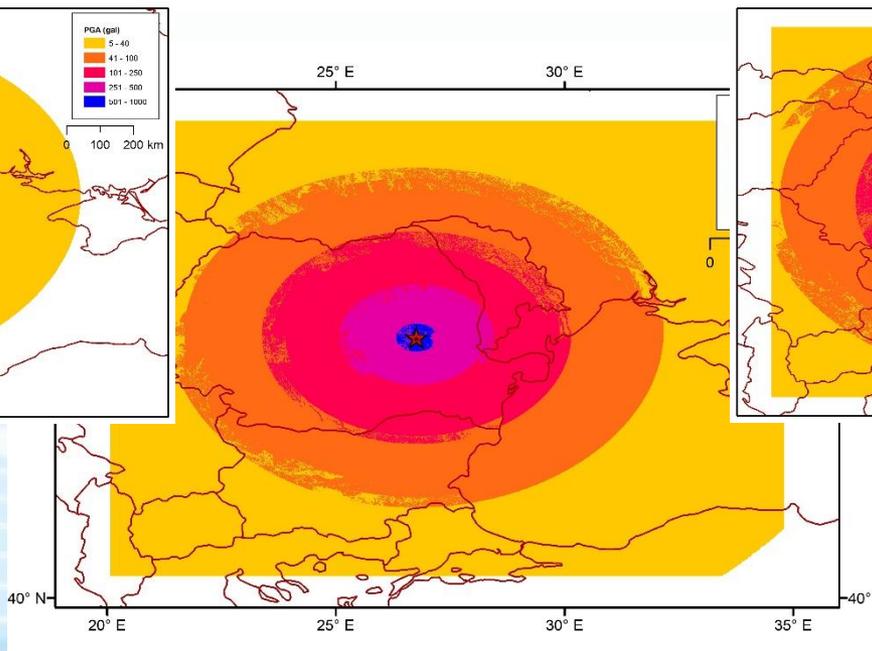
Rezultate preliminare pentru România

Cutremurele de adâncime intermediară din zona Vrancea

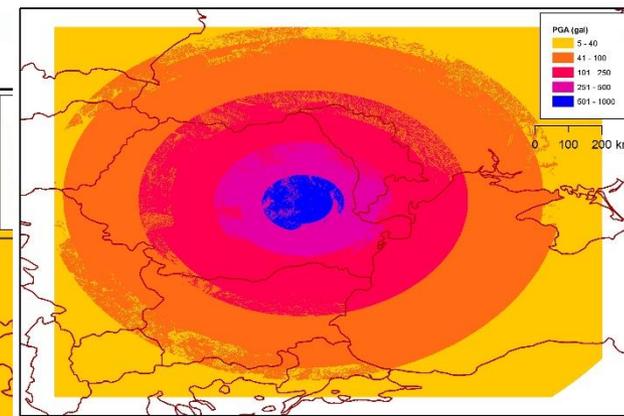
1977 - 4 martie, Mw 7.4, 94 km adâncime



Sokolov GMPE



combinat



Vacareanu GMPE

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Estimarea susceptibilității alunecărilor de teren

Metoda statistică: Jesse et al. (2018)

SlopeRasterFile	C:\REDAS\Scenarios\GeotechnicalHazardData\InfiniteSlopeModel\Lefkas\SlopeAngle_DEG.tif
SoilFrictionRasterFile	C:\REDAS\Scenarios\GeotechnicalHazardData\InfiniteSlopeModel\Lefkas\FrictionAngle_DEG.tif
SoilCohesionRasterFile	C:\REDAS\Scenarios\GeotechnicalHazardData\InfiniteSlopeModel\Lefkas\Cohesion_kPa.tif
SoilUnitWeightRasterFile	C:\REDAS\Scenarios\GeotechnicalHazardData\InfiniteSlopeModel\Lefkas\UnitWeight_kN_m3.tif
SoilDepthRasterFile	C:\REDAS\Scenarios\GeotechnicalHazardData\InfiniteSlopeModel\Lefkas\Z_Vert_Thick_Sliding_slab.tif
SaturationRasterFile	C:\REDAS\Scenarios\GeotechnicalHazardData\InfiniteSlopeModel\Lefkas\Saturation_Percent_%.tif
Vs30RasterFile	C:\REDAS\Scenarios\Operational\Vs30_Global.tif

GridSize	0.00025
IMinHazard	5
AnalysisMethod	Infinite Slope

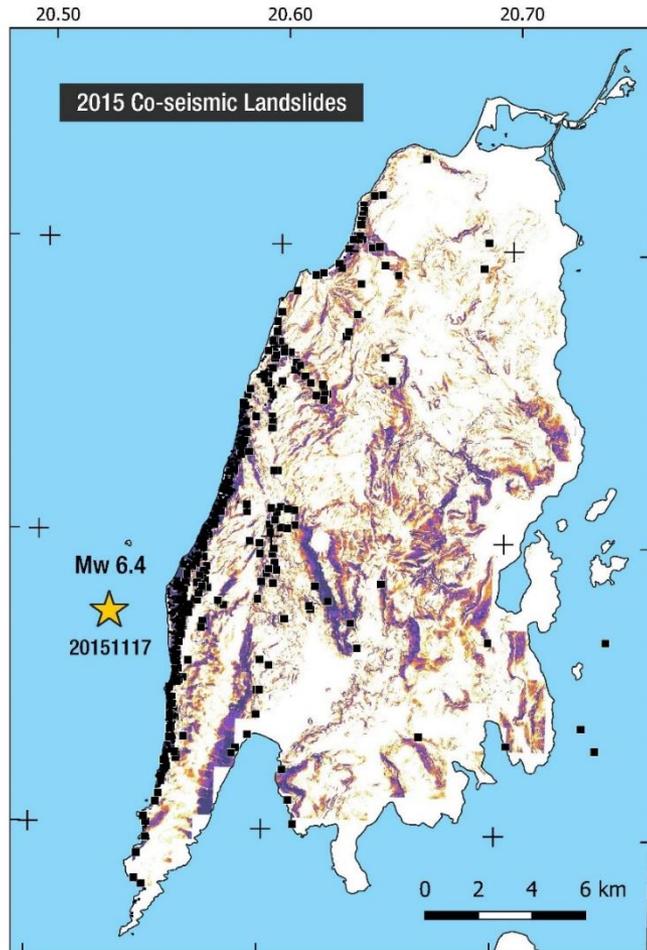
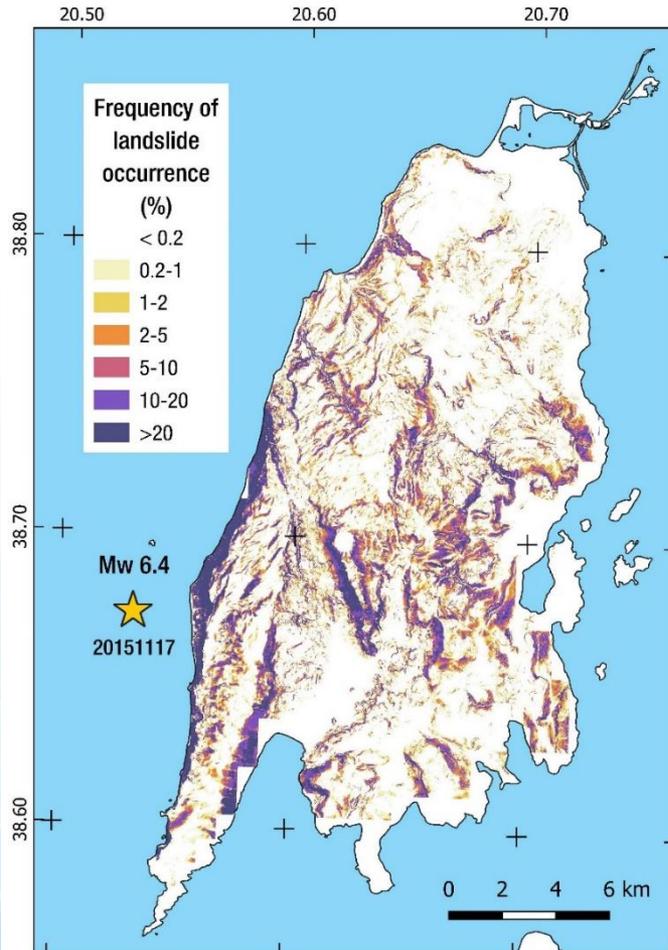
- ϕ' : effective angle of friction of geomaterial (0)
- c' : effective cohesion of geomaterial (kPa),
- β : slope angle (Deg),
- ρ : bulk density (Kg/m³)
- γ : specific weight (kN/m³),
- γ_w : specific weight of the water (kN/m³),
- a : earthquake acceleration (m/s²)
- z : normal thickness of the failure slab (m)
- $m = z_w/z$ % of the water saturated failure slab

Metoda Infinite Slope

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$$P(t) = 1 / (1 + \exp(-t))$$

$$L_p(P) = e^{(a + b \times P + c \times P^2 + d \times P^3)}$$



$$a = -7.592$$

$$b = 5.237$$

$$c = -3.042$$

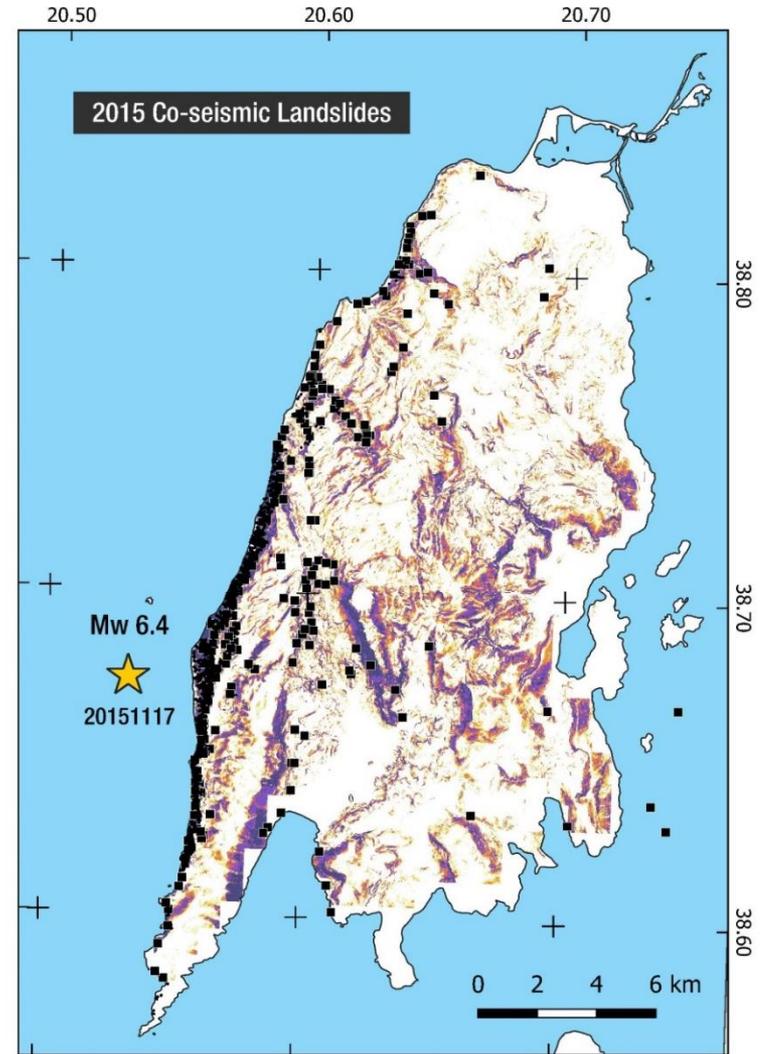
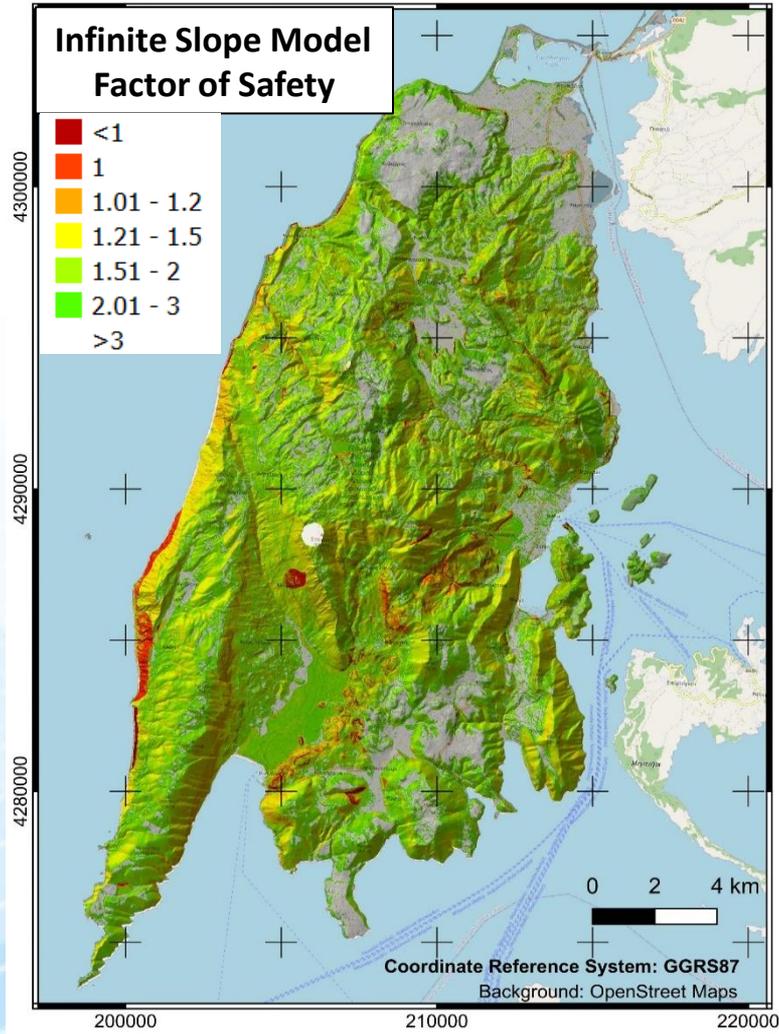
$$d = 4.035$$

This equation corrects the predicted probability. Represents the **frequency of landslide occurrence** i.e. the portion of each cell expected to have landslide occurrence (areal coverage)

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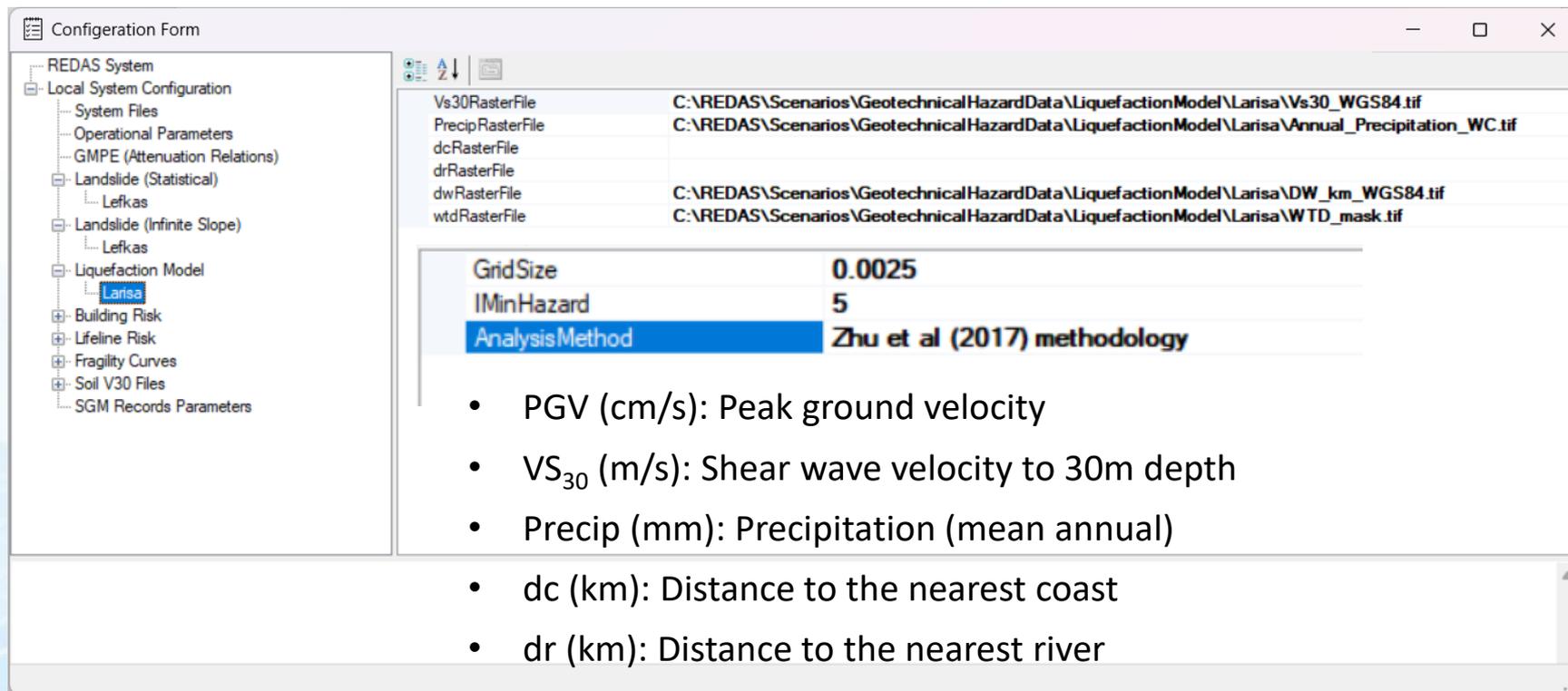
Wet conditions Sliding mass thickness: 1m

Statistical model and observed landslides



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Estimarea susceptibilității de lichefiere



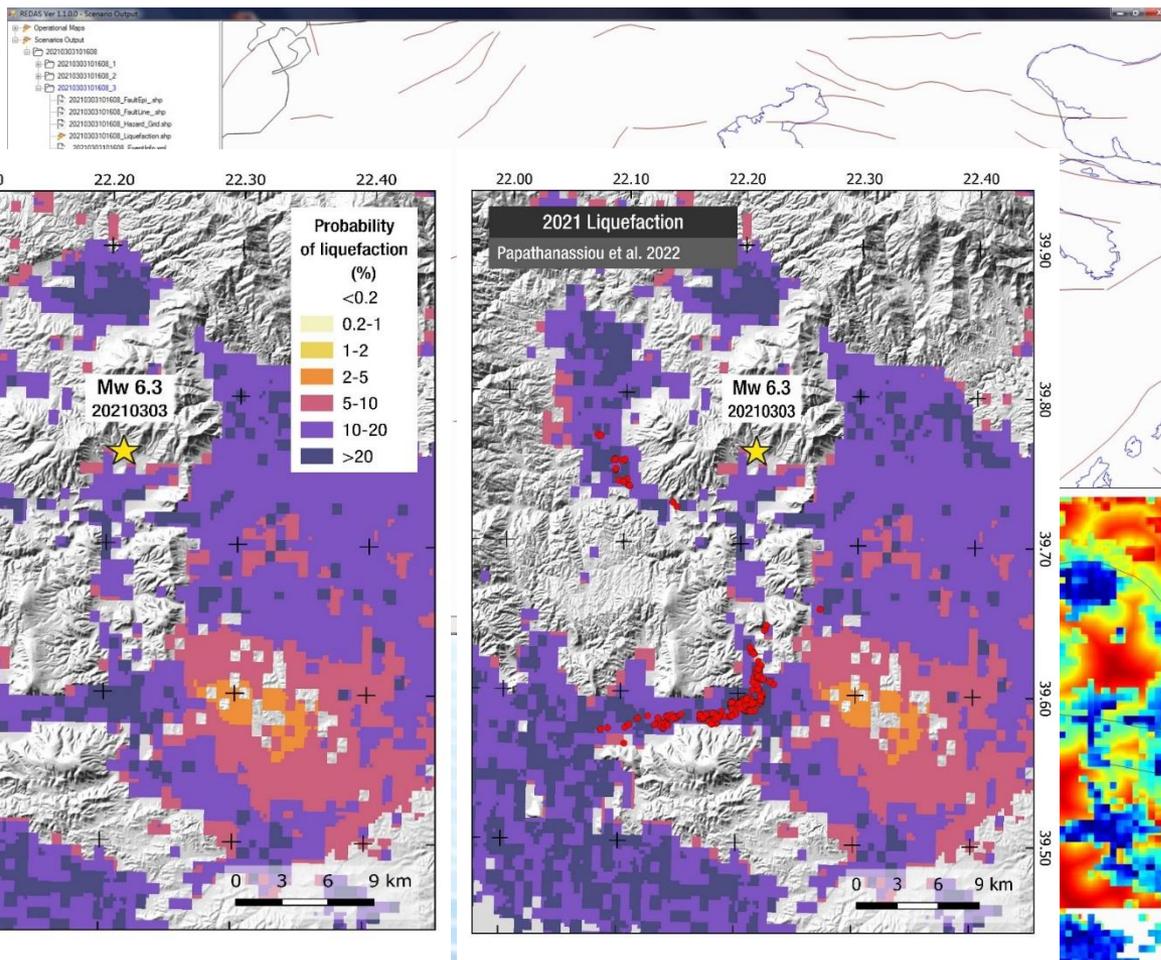
Vs30RasterFile	C:\REDAS\Scenarios\Geotechnical HazardData\LiquefactionModel\Larisa\Vs30_WGS84.tif
PrecipRasterFile	C:\REDAS\Scenarios\Geotechnical HazardData\LiquefactionModel\Larisa\Annual_Precipitation_WC.tif
dcRasterFile	
drRasterFile	
dwRasterFile	C:\REDAS\Scenarios\Geotechnical HazardData\LiquefactionModel\Larisa\DW_km_WGS84.tif
wtdRasterFile	C:\REDAS\Scenarios\Geotechnical HazardData\LiquefactionModel\Larisa\WTD_mask.tif

GridSize	0.0025
IMinHazard	5
AnalysisMethod	Zhu et al (2017) methodology

- PGV (cm/s): Peak ground velocity
- VS₃₀ (m/s): Shear wave velocity to 30m depth
- Precip (mm): Precipitation (mean annual)
- dc (km): Distance to the nearest coast
- dr (km): Distance to the nearest river
- dw (km): Distance to the nearest water body
- wtd (m): Water table depth

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Estimarea susceptibilității de lichiefiere



**REDAS – M6.3
Larisa, Greece
(03/03/2021)**

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Estimarea ratei de reparații necesare pentru conducte

The screenshot displays the REDAS software interface with three main windows:

- Configuration Form:** Shows a tree view of system settings. The 'Local System Configuration' folder is expanded, showing sub-folders like 'System Files', 'Operational Parameters', 'GMPE (Attenuation Relations)', 'Landslide (Statistical)', 'Landslide (Infinite Slope)', 'Liquefaction Model', 'Building Risk', 'Lifeline Risk', 'Fragility Curves', and 'Soil V30 Files'. The 'Lifeline Risk' folder is expanded to show 'botas_dogalgaz_boru_hatti' and 'TestLifeLineData'.
- DataBaseFolder:** A table showing analysis methods and factors.

AnalysisMethod	Value
[0]	JWA (1998)
[1]	ALA (2001)
[2]	Chen et al.(2002)

Factor	Value
[0]	0.5
[1]	0.5
[2]	0.5
- REDAS Ver 1.1.0.0 - Scenario Output:** Shows a file tree of output files and a map plot. The file tree includes folders for various scenarios and files for fault lines, hazard grids, life lines, risk grids, and event info. The map plot shows a geographical area with colored lines representing different data series. Below the map, there are checkboxes for 'World Map' and 'Fault Map', both of which are checked.

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Sistemul este/va fi:

- Instalat pe serverele INCDFP (în baza unui parteneriat între INCDFP și OUC) și operat în timp real, cu date din Shakemap-ul INCDFP
- Adaptat în continuare la specificul cutremurelor vrâncene
- Configurat pentru estimarea susceptibilității la alunecări de teren și lichefiere
- Testat cu noi funcții de fragilitate și date despre clădiri
- O nouă platformă de vizualizare avansată (webGIS) a rezultatelor este în lucru (coordonată de IHU)

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Rapid Earthquake Damage Assessment Consortium



Mulțumesc pentru atenție!

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