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5TH REGIONAL SYMPOSIUM ON LANDSLIDES IN ADRIATIC-BALKAN REGION

ICL ADRIATIC-BALKAN NETWORK

5th Regional Symposium on Landslides in Adriatic-Balkan Region
Rijeka, Croatia, 23-26 March 2022

Rock Frost Weathering and Rockfall Activity Assessment in Slovenia

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About the presentation.

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5TH REGIONAL SYMPOSIUM ON LANDSLIDES IN ADRIATIC-BALKAN REGION

- Introduction - History.
- Research Question.
- Materials & Methods.
- Reanalysis of Era5-Land data 2016-2020.
- Freeze-Thaw map of Slovenia.
- Rockfall Susceptibility Models.
- Conclusions.

Introduction - History.

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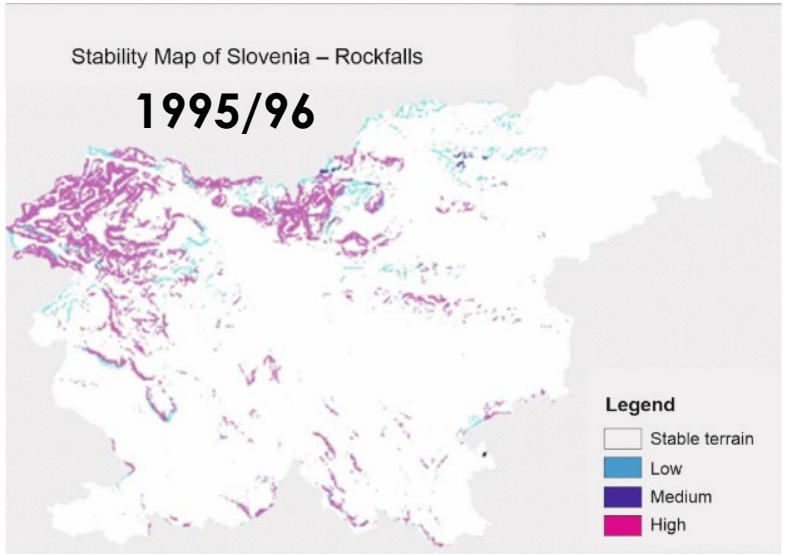
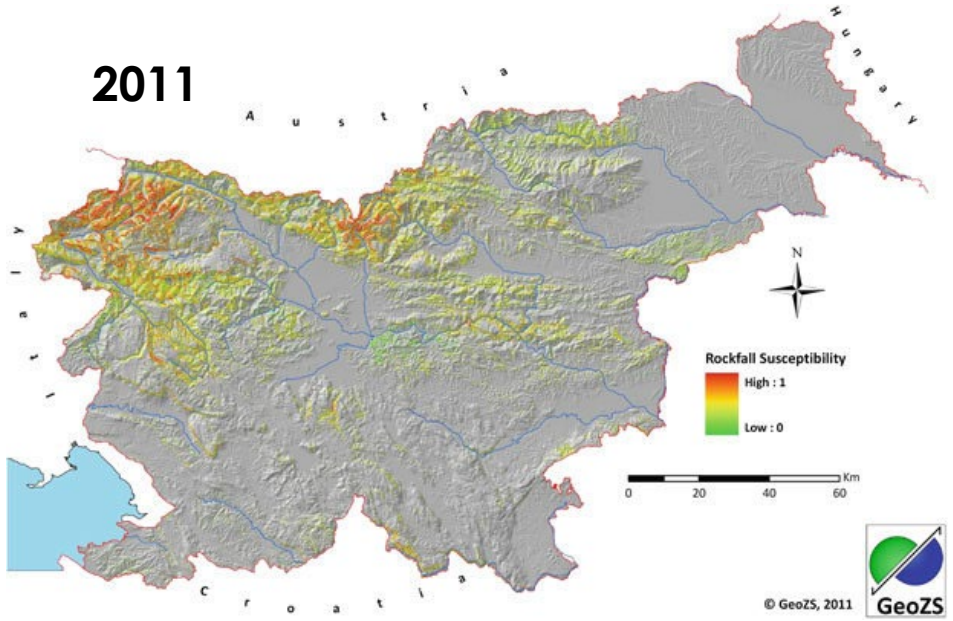
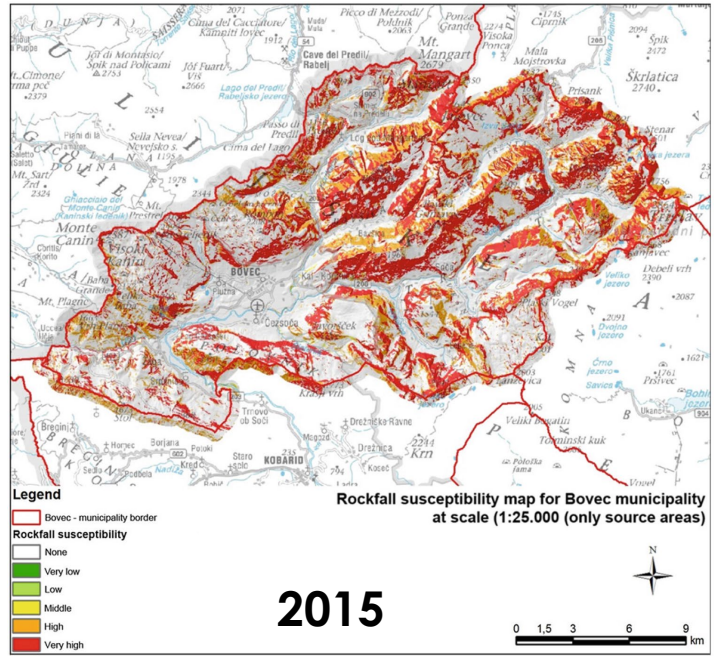
- Rockfalls/Rockslides are common natural hazard in Slovenia.
- Many times they are studied at local scale using different tools/methods.



Susceptibility map @ scale1:400,000 – engineering-geological map



Susceptibility map @ scale 1:250,000 – lithology, slope angle, tectonic structures



Validated map @ scale 1:25,000

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Research Question.

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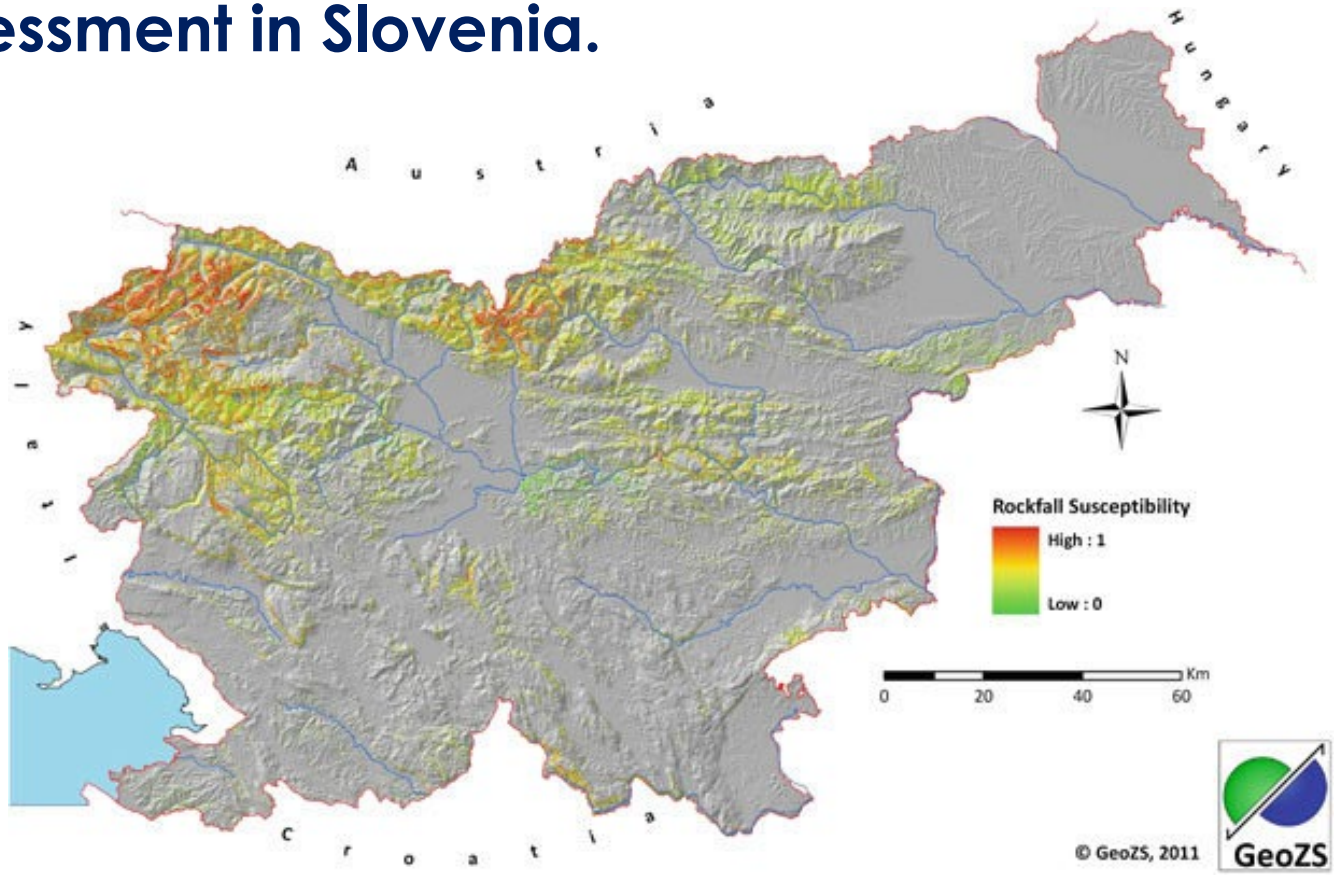
- Can the analysis of rock frost weathering improve/change the rockfall susceptibility assessment in Slovenia.



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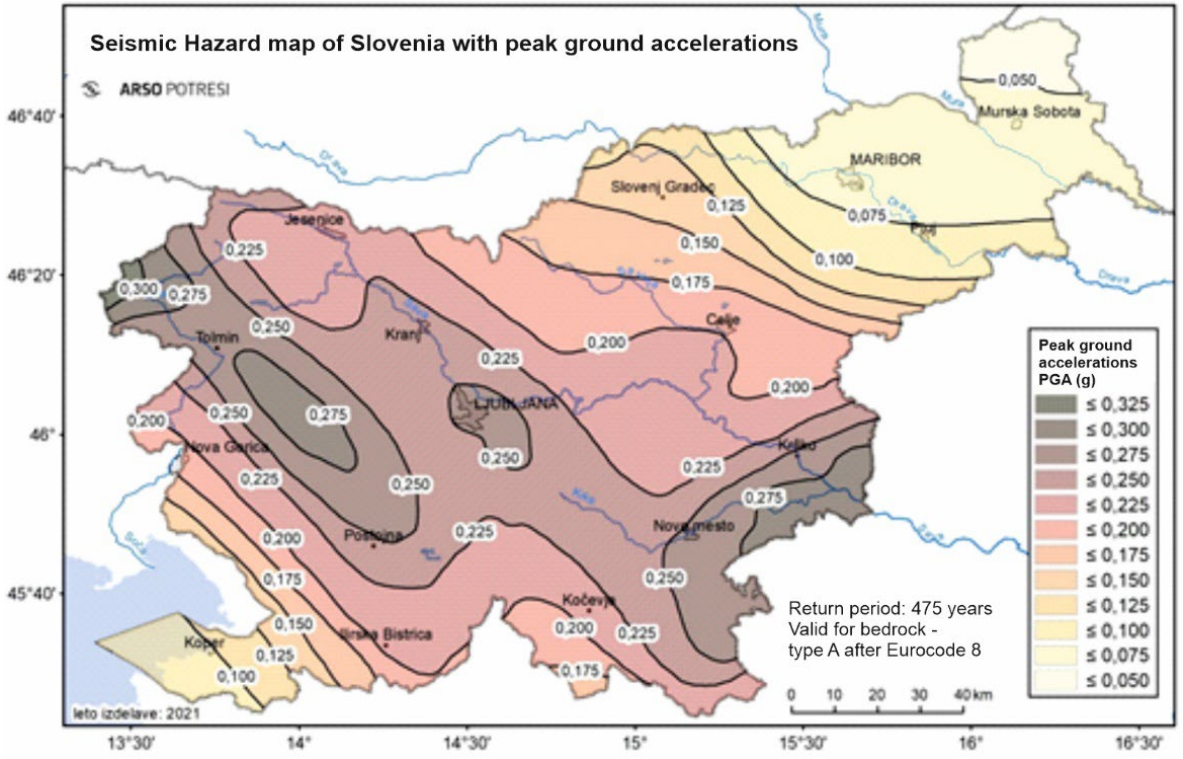
Materials & Methods.

- Lithology - the Lithological map of Slovenia.
- Earthquakes - New Seismic Hazard map.
- Slope gradient as energy indicator.
- Slope aspect as thermal stress indicator.
- Mean annual precipitation & 5-min. rates as climate indicators.
- Freeze-thaw cycles as indicators for cracks initiation.



Reanalysis of Era5-Land data 2016-2020.

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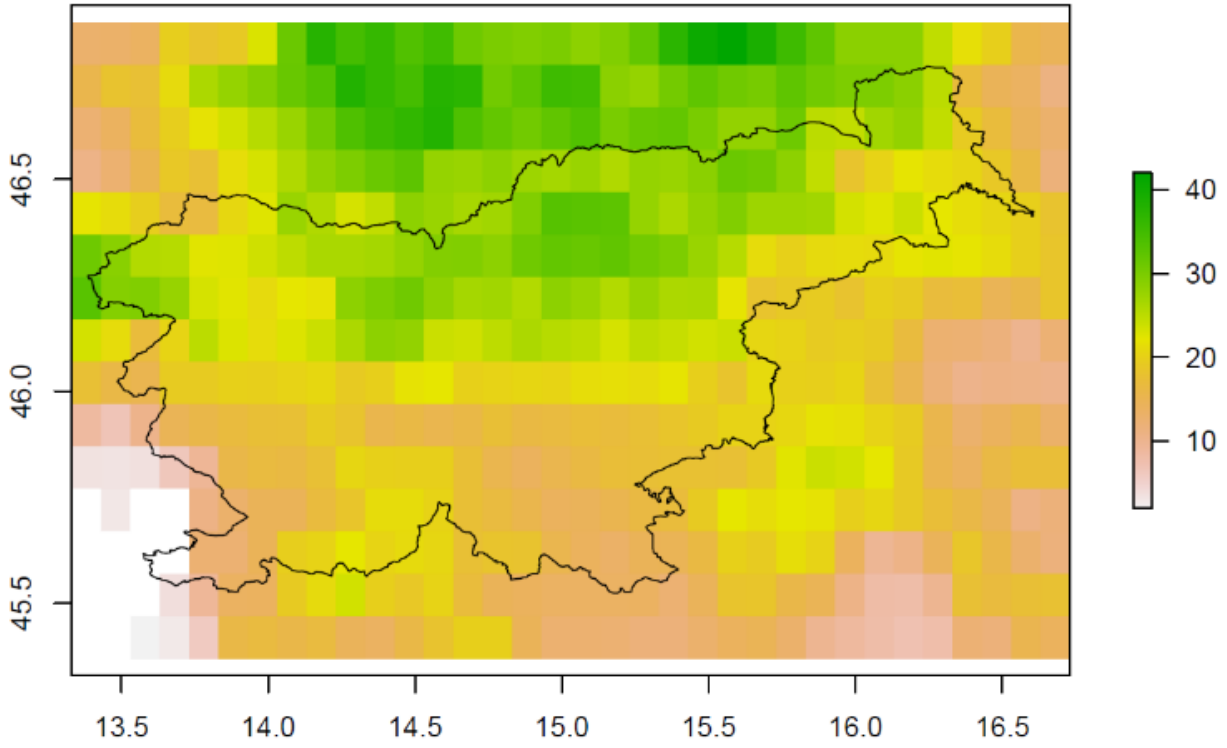
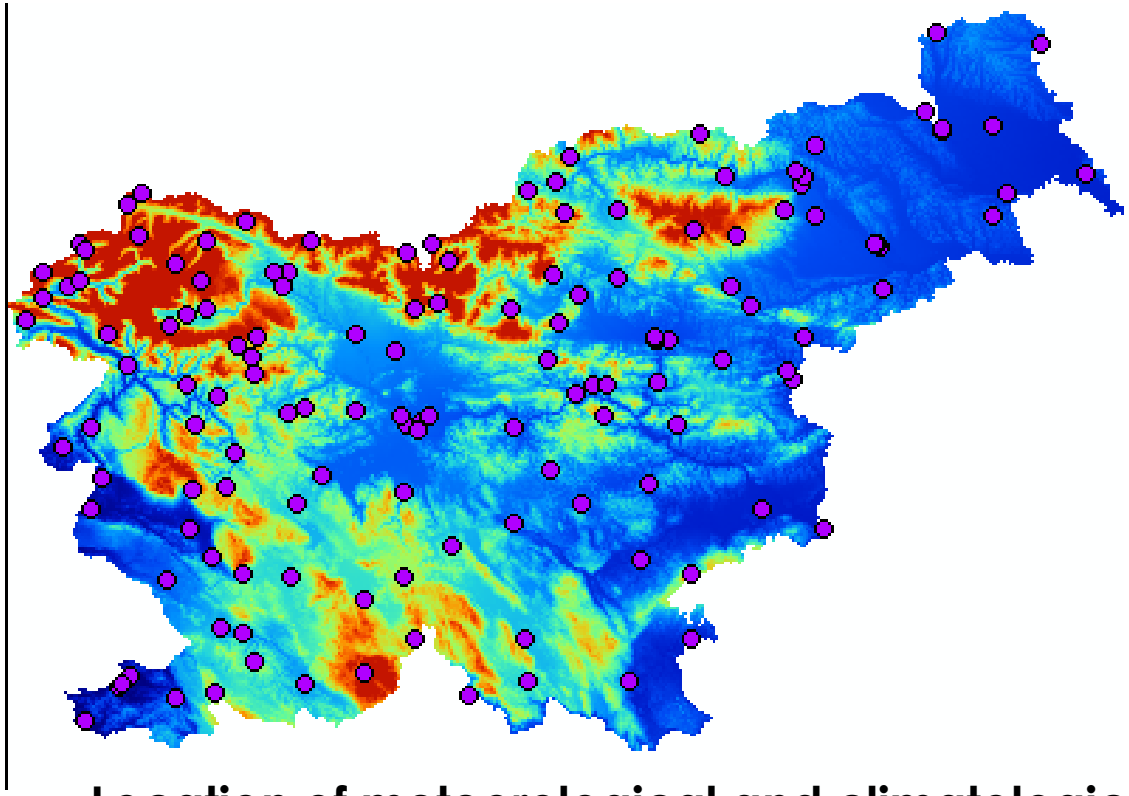
Average number of days when „Soil temperature at level 1“ is below and above Zero degree Celsius).





Location of meteorological and climatological stations with the hourly „2m air temperature“ data. Digital elevation model is shown as background.

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Reanalysis of Era5-Land data 2016-2020.

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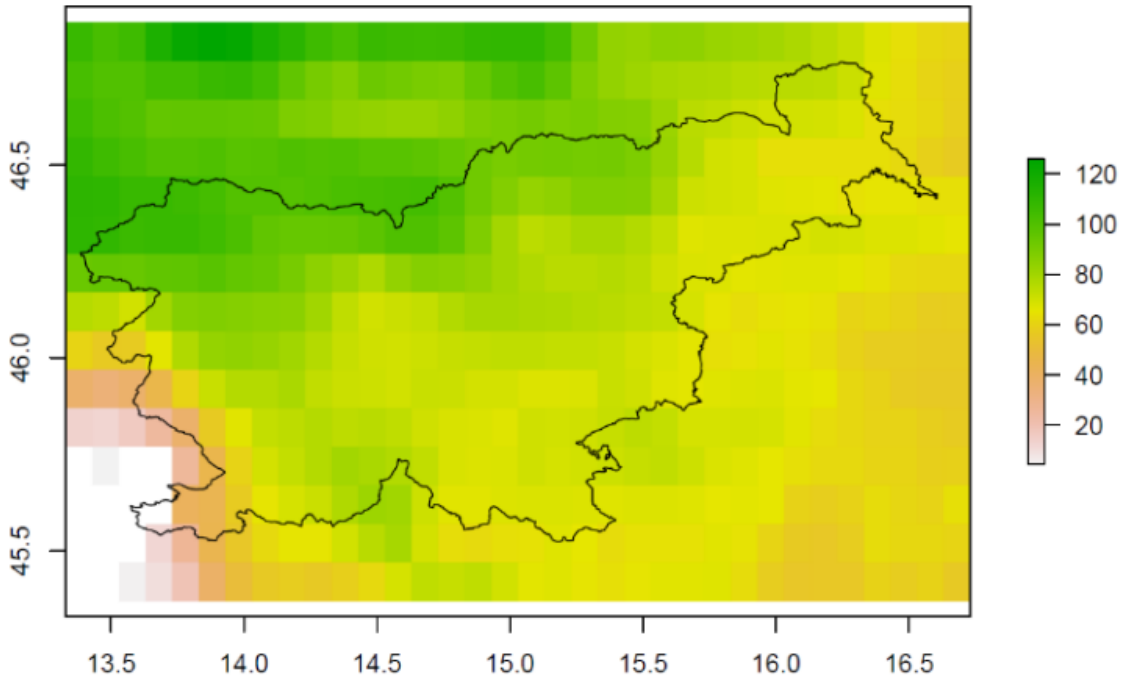
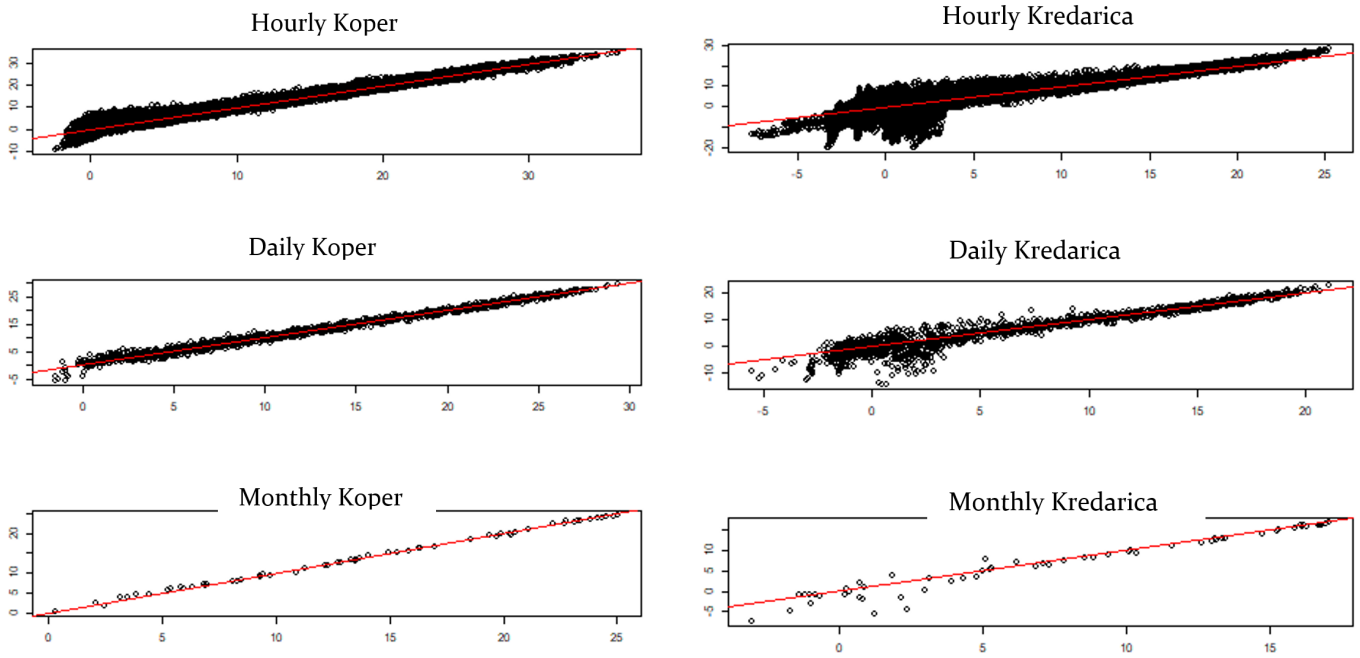
Average number of days when air temperature data is below and above Zero degrees Celsius.





„2 m air temperature“ (y-axis) vs. „Soil temperature level 1“ (x-axis) at hourly, daily and monthly time step for Kredarica (high-altitude Alpine station) and Koper (low-altitude Mediterranean station) stations.

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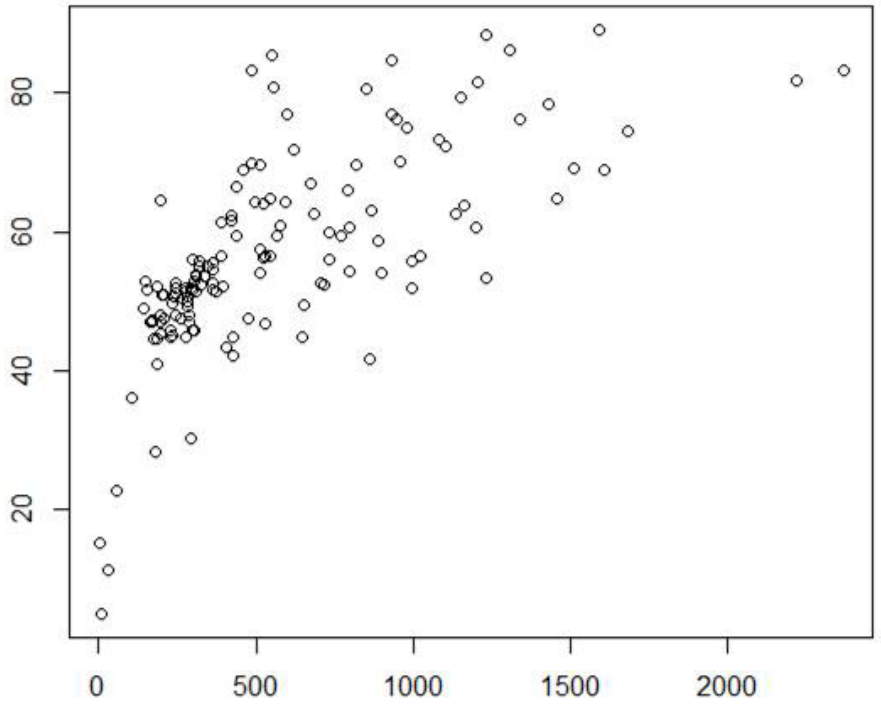
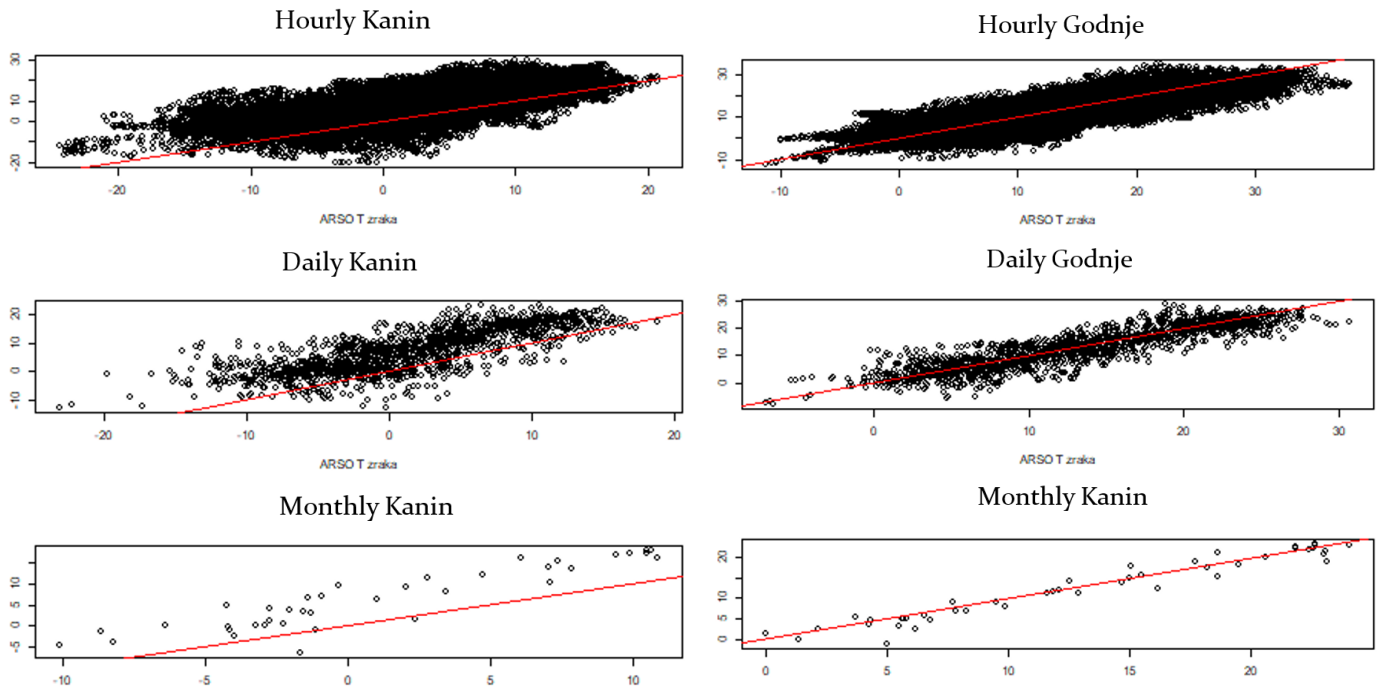
Station altitude (x-axis) vs. number of FT-cycle calculated using air temperature and soil temperature data (y-axis).





„2 m air temperature“ (y-axis) vs. station-based air temperature (x-axis) for Kanin (high-altitude Alpine station) and Godnje (low-altitude Mediterranean station) stations.

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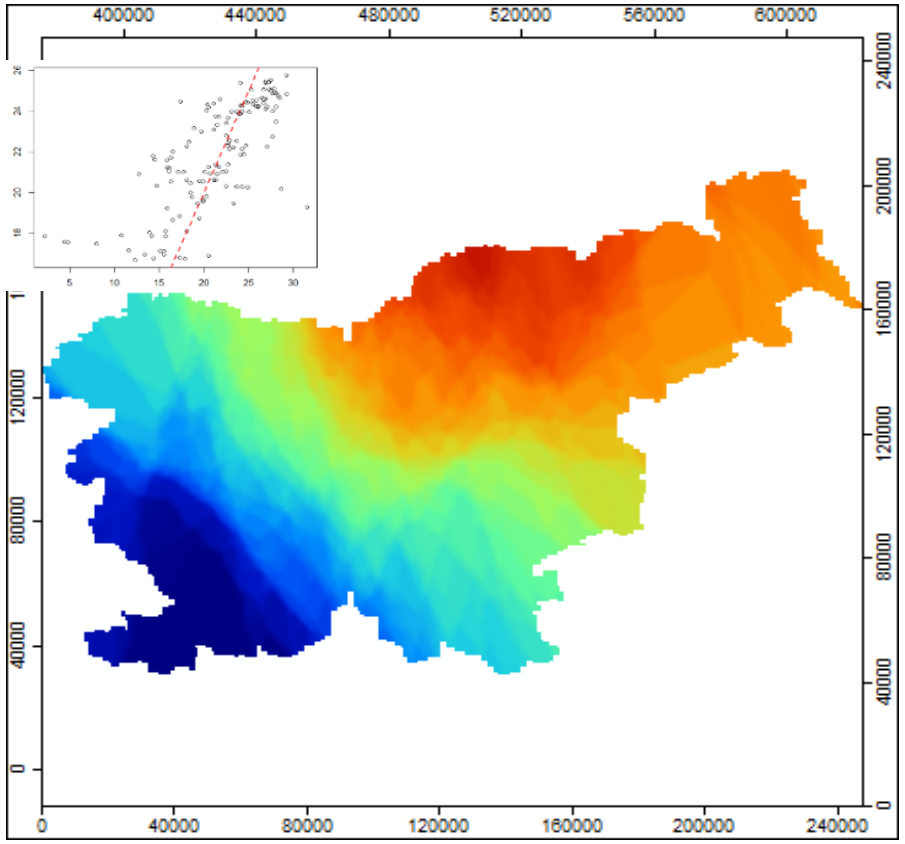
FT map of Slovenia.



FT map of Slovenia (average annual daily FT cycles) using ERA5-Land soil temperature data. Ordinary kriging (elevation) & cross validation.

S-Slope; LI-Lithology; FT-Freeze-Thaw, A-Aspect, P-Total annual precipitation; P100-5-minute rainfall with 100-year return period; SH-Seismic-Hazard). MVS - mean values Slovenia, MVR – mean values for rockfall cells.

ID	Rockfall Susceptibility Model	MVS	MVR (Min-Max values)
1	$0.2*S+0.2*LI+0.2*P+0.2*FT+0.2*A$	0.46	0.55 (0.15-0.87)
2	$0.3*S+0.3*LI+0.1*P+0.2*FT+0.1*A$	0.47	0.59 (0.12-0.90)
3	$0.3*S^{1/2}+0.3*LI+0.1*P+0.2*FT+0.1*A$	0.51	0.63 (0.19-0-89)
4	$0.3*S^{1/2}+0.3*LI^{1/2}+0.1*P+0.2*FT+0.1*A$	0.55	0.67 (0.19-0-91)
5	$0.5*S^{1/2}+0.5*LI^{1/2}$	0.51	0.68 (0.18-0.94)
6	$0.7*S^{1/2}+0.3*LI^{1/2}$	0.45	0.63 (0.24-0-93)
7	$0.7*S^{1/2}+0.3*LI$	0.42	0.60 (0.24-0.92)
8	$0.3*S^{1/2}+0.3*LI^{1/2}+0.1*P_{100}+0.2*FT+0.1*A$	0.56	0.68 (0.22-0-88)
9	$0.3*S^{1/2}+0.3*LI^{1/2}+0.1*P_{100}+0.1*FT+0.1*A+0.1*SH$	0.50	0.64 (0.22-0.91)

Rockfall Susceptibility Models – 164 locations.

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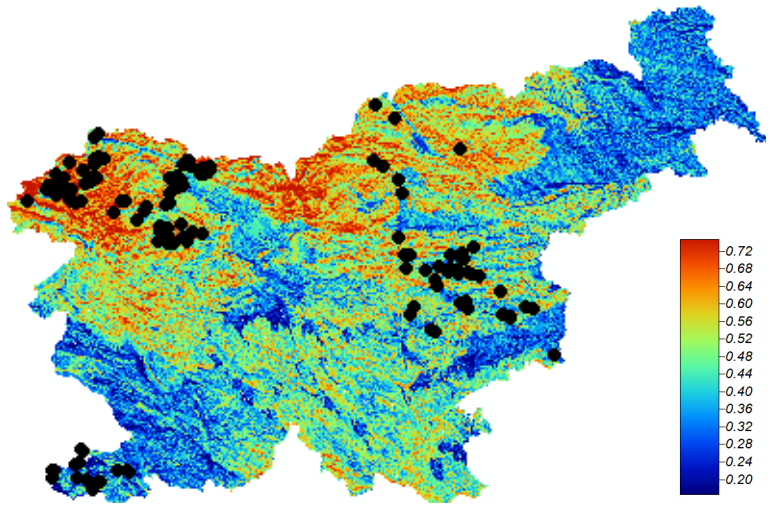
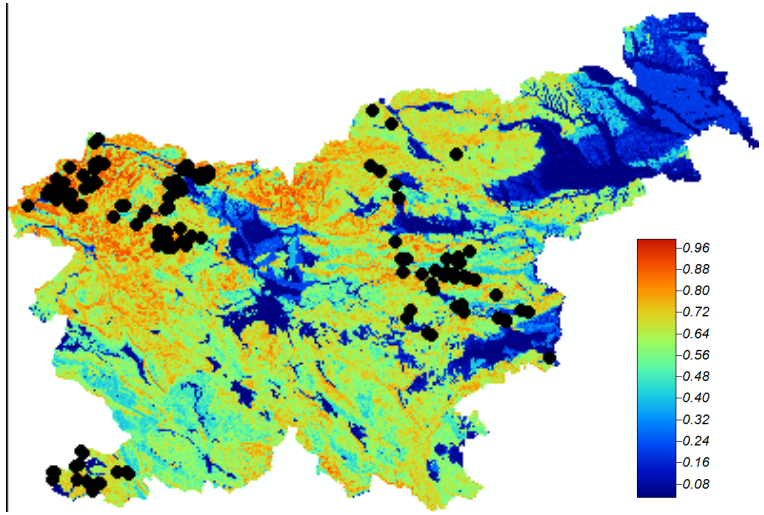
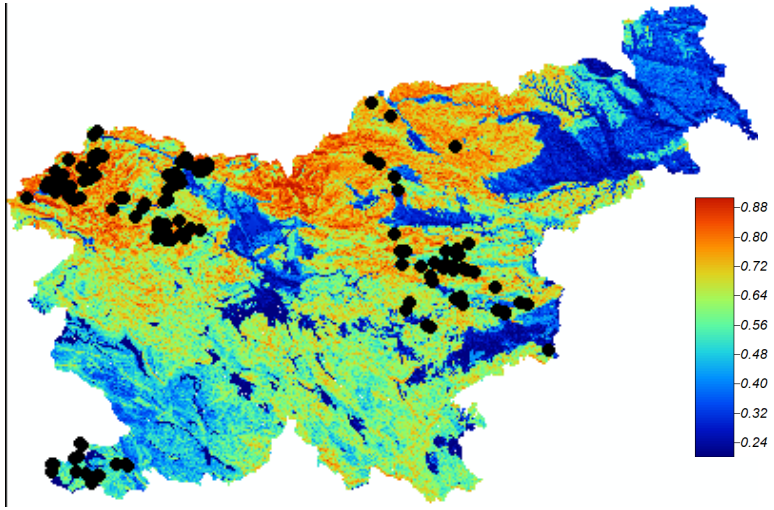
Model #1

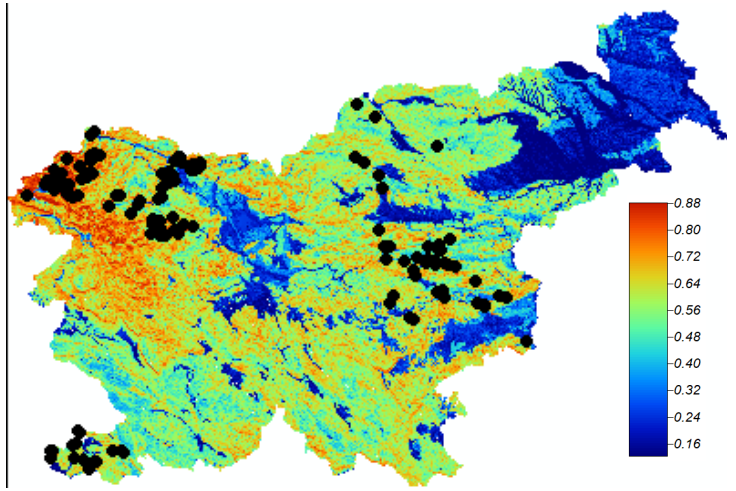




Model #5

Model #4





Model #9

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Conclusions.

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- Consideration of the newly developed Freeze-thaw map does not significantly improve simple rockfall susceptibility maps of Slovenia.
- Slope and lithology are predominant preconditioning factors (especially for flysch like rocks in cliffs).
- In the Mediterranean area freeze-thaw cycles are the lowest, peak ground acceleratrions are low and annual precipitation is not high.
- For this part of Slovenia 5-minute precipitation rates with the 100-year return period can be needed (model #9).
- More validation for large-scale rockfall susceptibility map development is needed – not enough georeferenced data are available in inventory maps/database.

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Thank you for your attention

Hvala za pozornost

Hvala na pažnji

Grazie per la vostra attenzione

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