



INTERPRAEVENT

2024 - Vienna, Austria

Urša Vilhar, Erika Kozamernik, Jaša Saražin,
Matjaž Dovečar, Aleksander Marinšek, Primož
Simončič, Peter Smolnikar, David Štefanič, Jože
Papež

Slovenian Forestry Institute & Hidrotehnik d.o.o.

**The identification of forested areas
prone to erosion in the torrent
catchments in Slovenia**



Forestry in Slovenia is challenged by large-scale forest disturbances

- Floods,
- Windthrow,
- Pest and disease outbreaks,
- Forest fires,
- Ice storms,
- ...



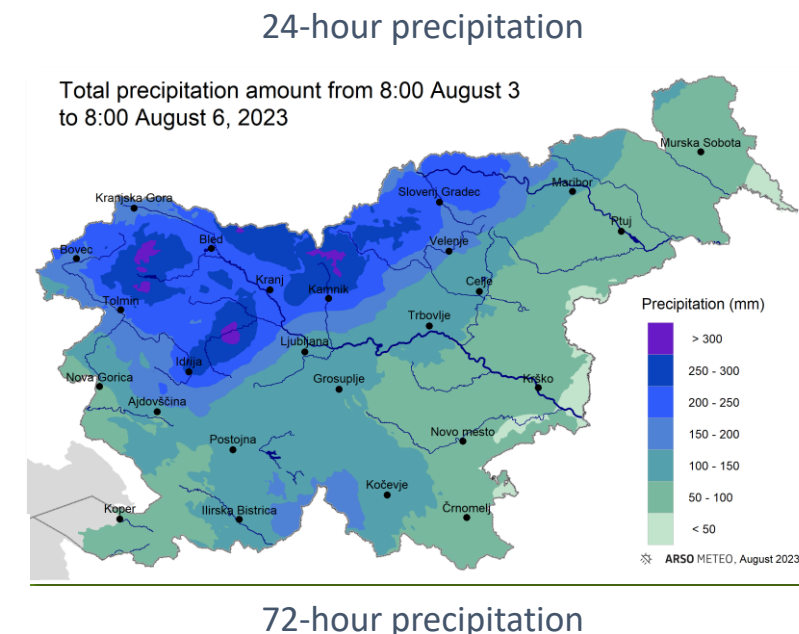
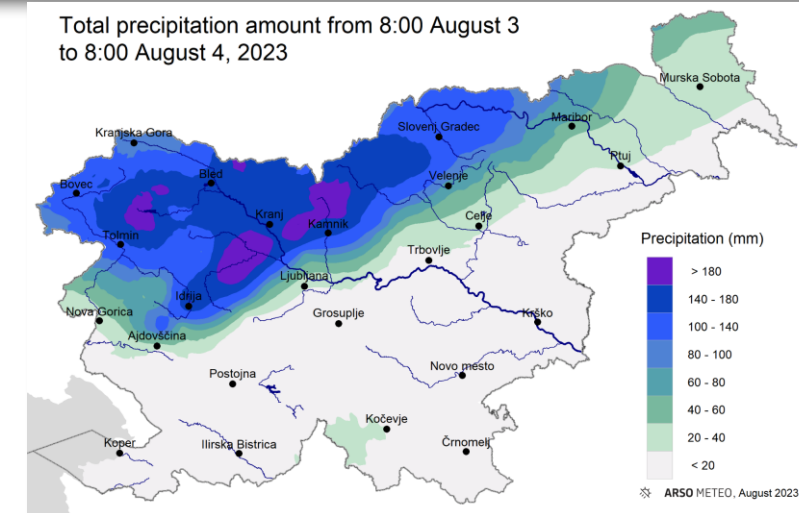
Vilhar et al. 2022. The effects of large-scale forest disturbances on hydrology – An overview with special emphasis on karst aquifer systems. *Earth-Science Reviews*, 104243.

The identification of forested areas prone to erosion in the torrent catchments in Slovenia

Extreme flash-floods and floods

3. to 6. August 2023

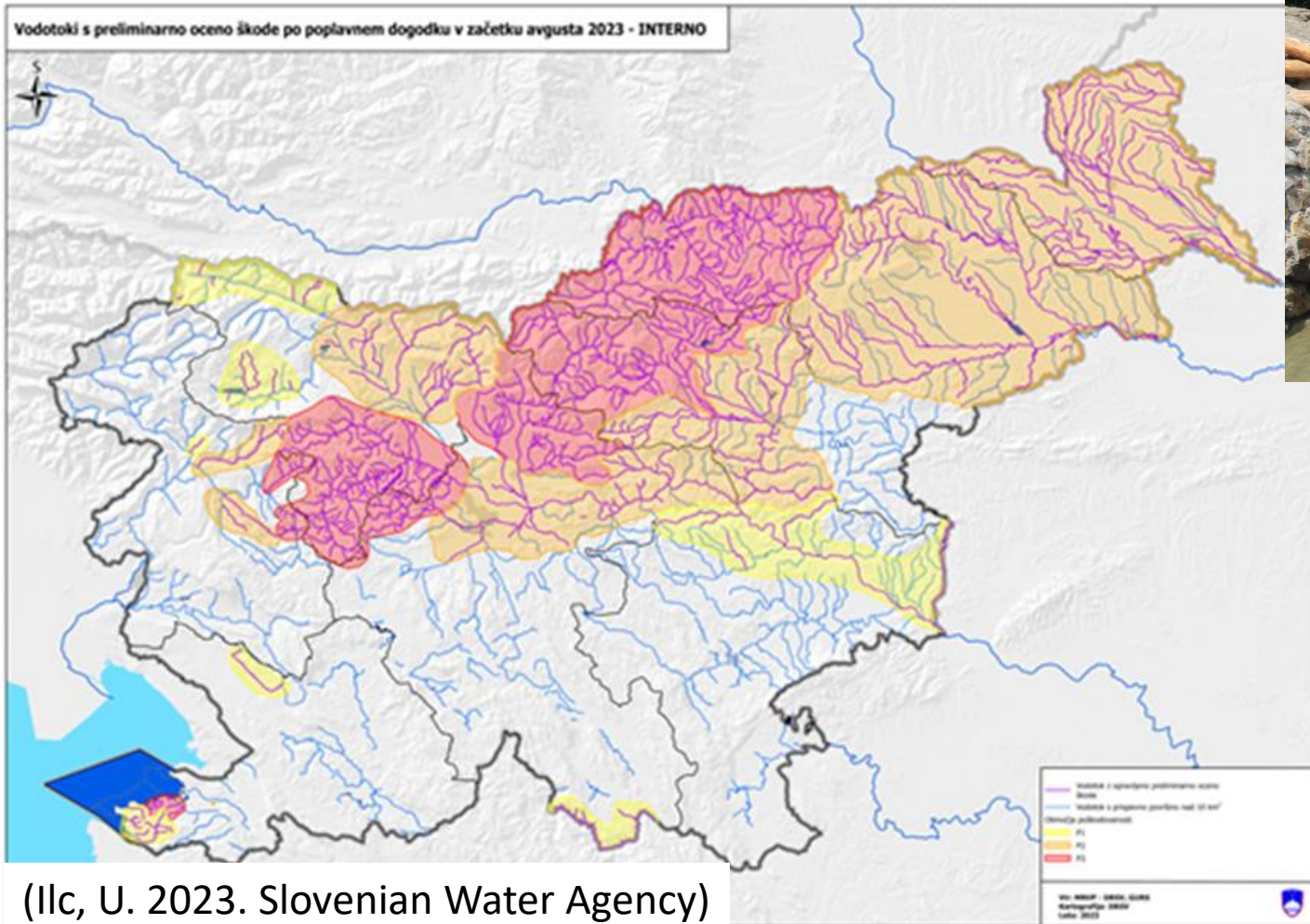
- Unfavorable initial conditions
 - ➔ July rainfall totals 3-times larger than average
 - ➔ higher soil moisture and river discharges
- Night 3.-4. Aug. -> 150 to 200 mm in less than 12 h, mostly in only 4 h!
- Additional 100 mm until 6. August



Extreme flash-floods and floods

3. to 6. August 2023

Affected watersheds



(Ilc, U. 2023. Slovenian Water Agency)



(Papež, J. 2024. EUSALP AG8)

Medvode – Sora-Sava rivers confluence



Savinjska Valley (Luče-Ljubno)



Koroška Region (Prevalje)



Pomurska Region (Mura River)

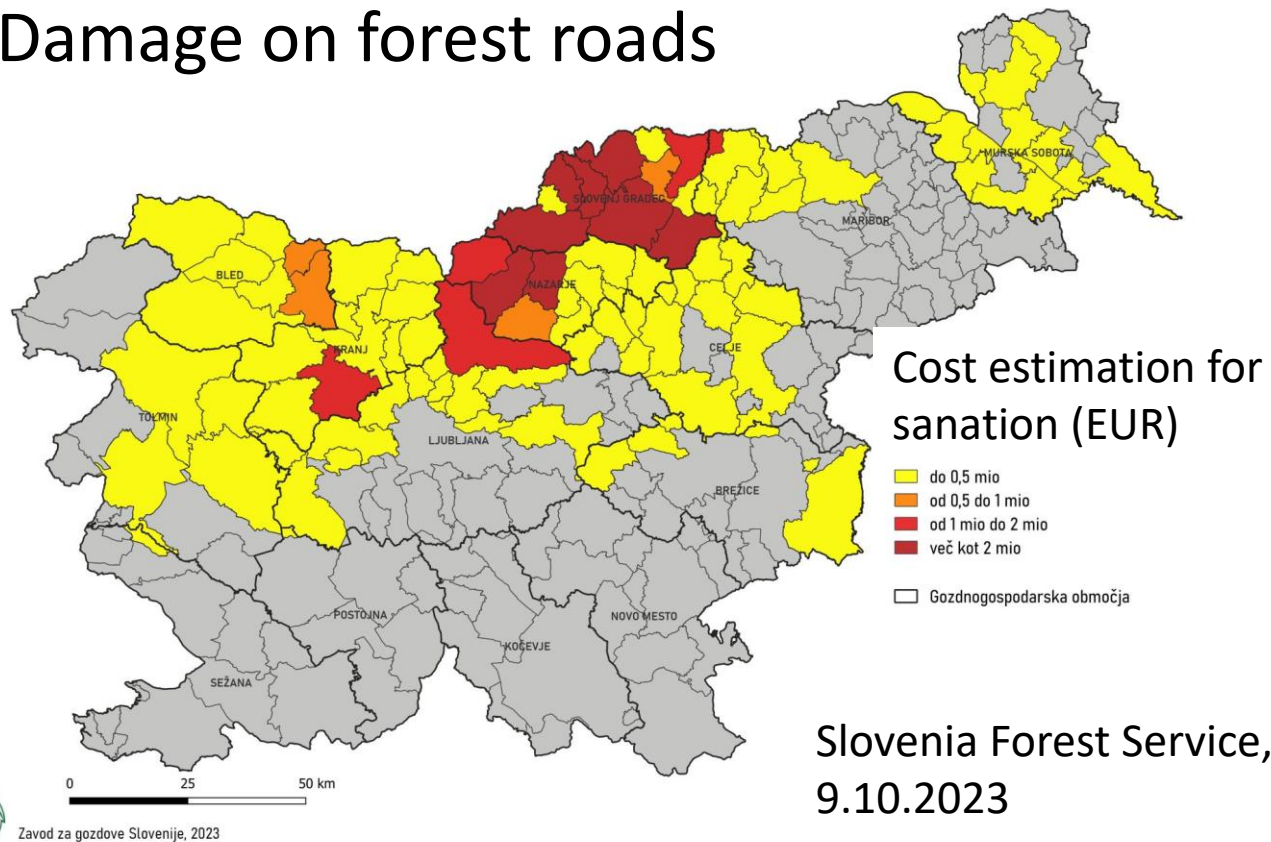


Extreme flash-floods and floods

3. to 6. August 2023

Impact on forests

Damage on forest roads

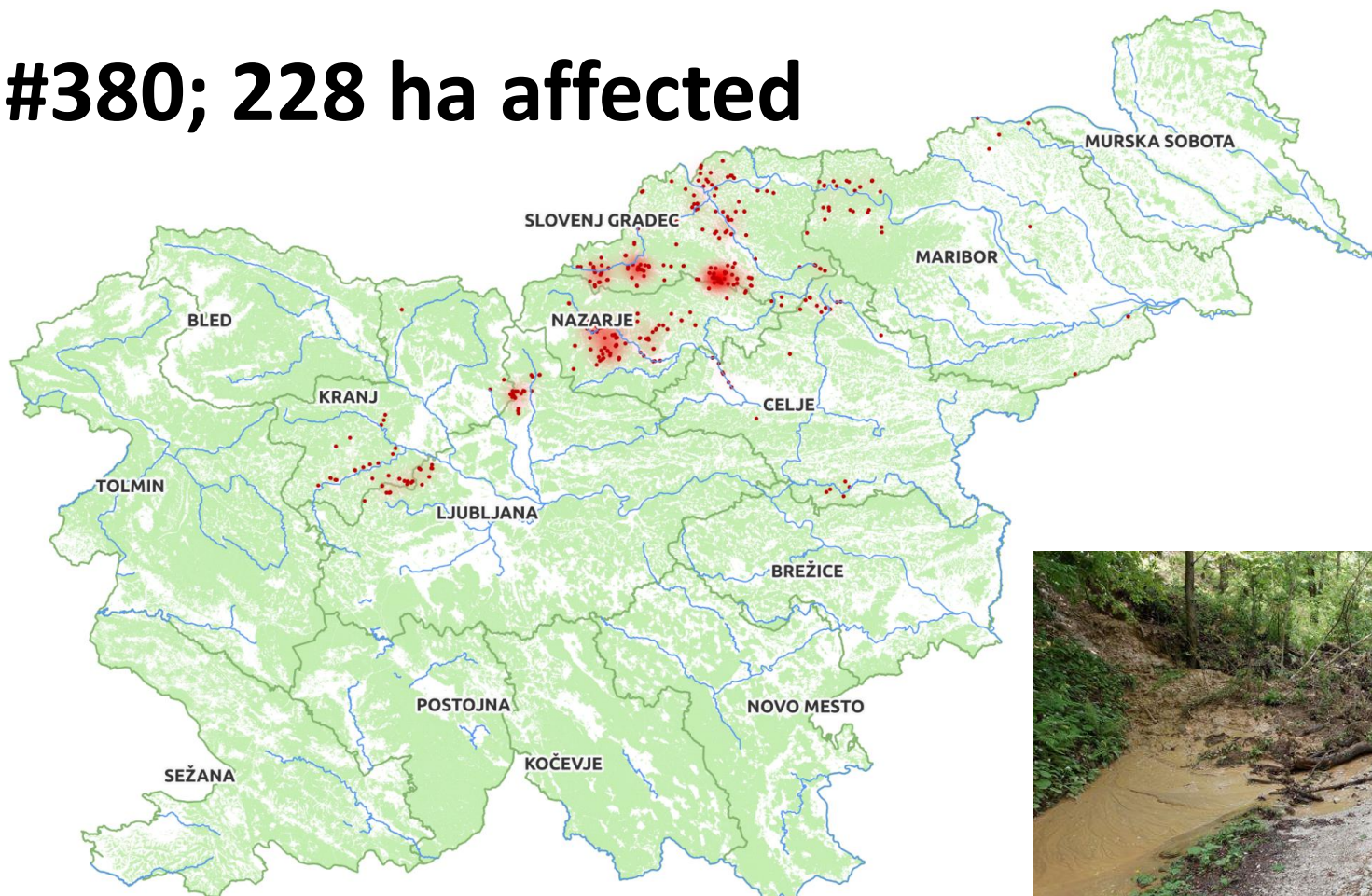


Forest management unit	Land slides in forested areas (ha)	Damage on forest roads (km)
Tolmin		147
Bled		328
Kranj	25	288
Ljubljana	22	166
Postojna		
Kočevje		
Novo mesto		
Brežice		33
Celje	4	172
Nazarje	46	365
Slovenj Gradec	118	823
Maribor	13	155
Murska Sobota		149
Sežana		
Total	228	2626

Extreme flash-floods and floods 3. to 6. August 2023

Ljubno ob Savinji, Slovenia

Landslides in forested areas #380; 228 ha affected



Close – to – natural, sustainable, multifunctional forest management (Mlinšek et al. 1981, Kraigher et al 2018):

- Adapting forest management to the characteristics of the sites and the natural evolution of the forests;
- forest management is carried out in all stages and forms of forest development to support vigorous and high-quality trees that can optimally provide all forest functions;
- natural regeneration is supported in all forests;
- These principles are also laid down in the Forest Act (1993,... 2023) and in the Resolution on the National Forest Programme (2007).



(Foto: Kutnar L.)

Does the existing forest legislation in Slovenia need to be adapted?

To increase vitality and resilience of forests (climate-fit forests)?

- The current expert knowledge of the Forest Service is of a high standard.
- A lack of a map of erosion-prone forest areas in the catchment areas of torrents.
- Such a map would inform forest managers and owners about the need for adapted forest management in such areas and alert them for detailed guidelines and recommendations.

Methodology for identifying forested areas prone to erosion in the catchments of torrents

Based on the map of small water catchments, the risk map for the occurrence of mass movement processes and the forest land use map.

- The methodology was tested in 4 pilot areas (municipalities) and will be further developed at the national level.
- The “silent witnesses” of torrential processes were assessed in a small catchment of the Zala torrent.

Methodology for identifying forested areas prone to erosion in the catchments of torrents

Pilot areas

4 municipalities: Železniki, Žalec, Koper, Kranjska Gora

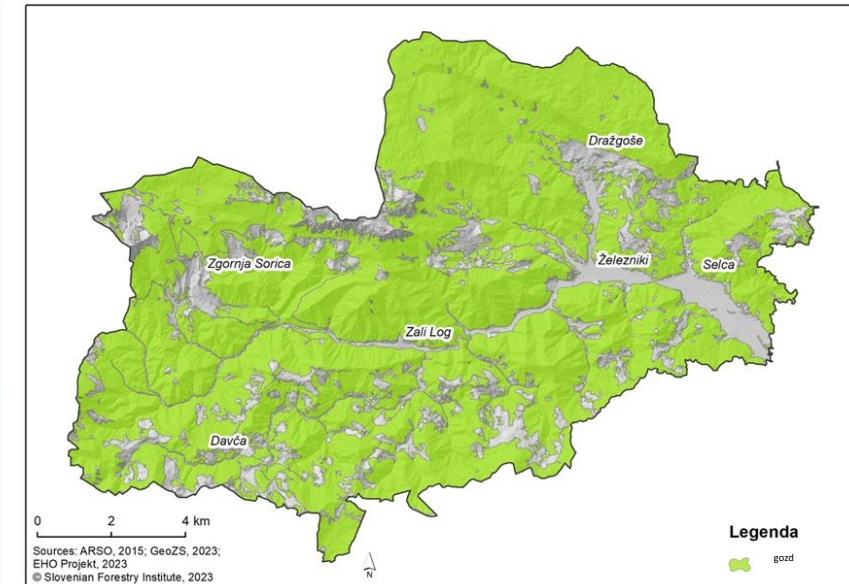
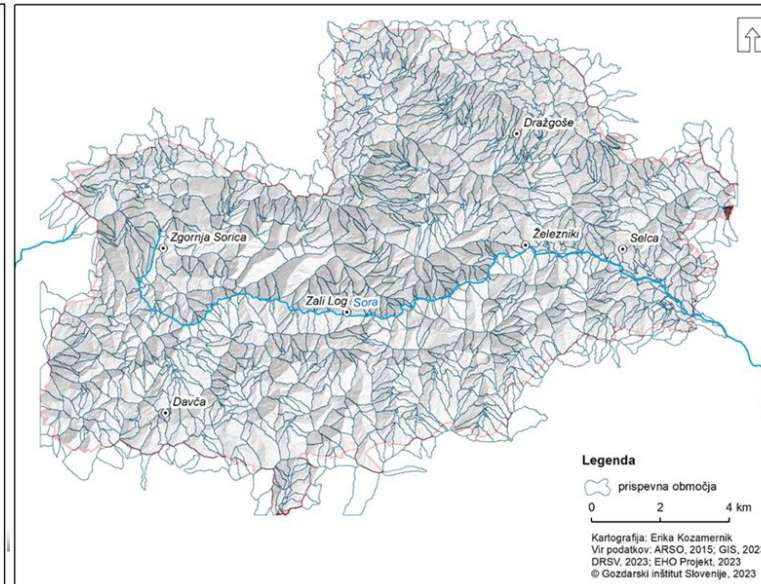
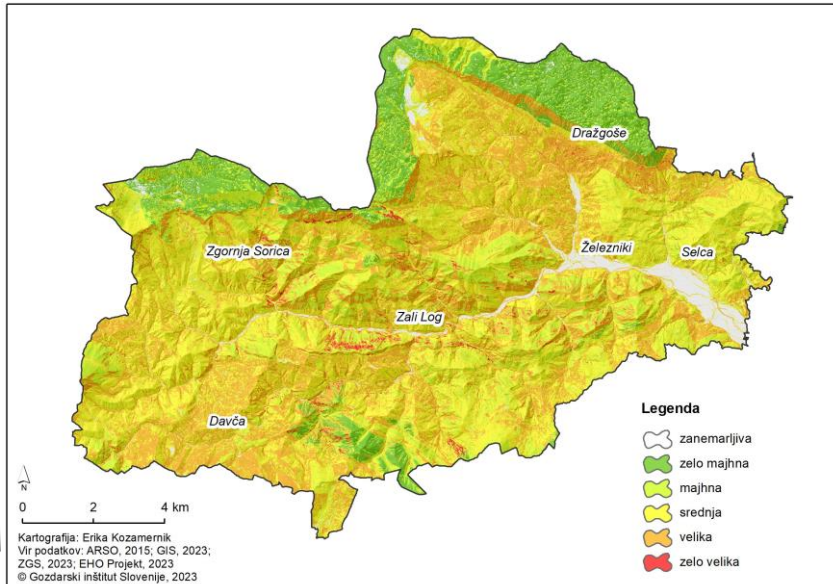
Differentiation according to:

- geological and geomorphological features,
- intensity of mass movement processes (landslides, rockfalls,...),
- vegetation, hydrographic and climatological characteristics (absence/presence of surface river network, water balance, annual rainfall, etc.) and
- the availability of the input data.

Methodology for identifying forested areas prone to erosion in the catchments of torrents

Input data

- I. Mass Movement Processes Hazard Map (GeoHazard viewer <https://geohazard.geo-zs.si/>)
- II. River catchments (automatically generated by Arc Hydro tool in ArcMap)
- III. Forest cover map (Slovenia Forest Service)



The identification of forested areas prone to erosion in the torrent catchments in Slovenia

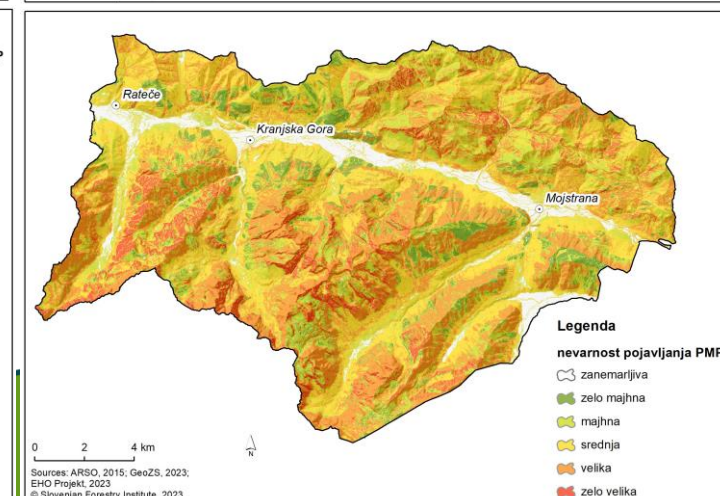
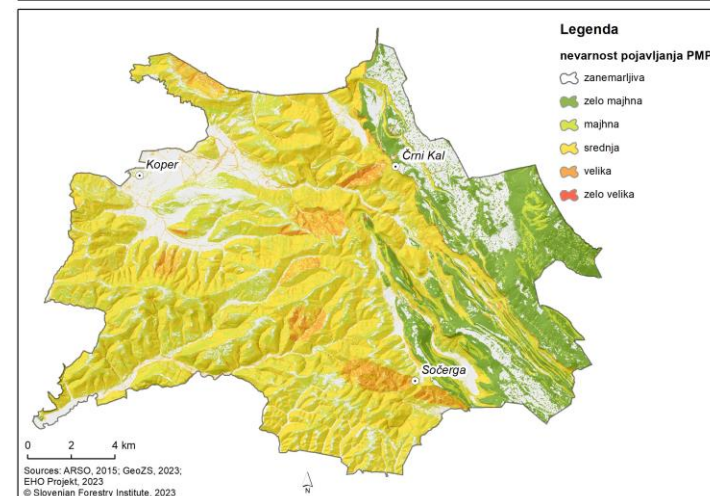
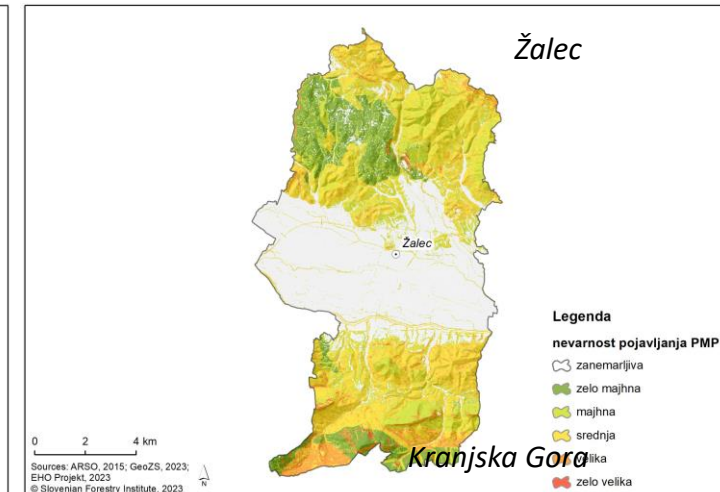
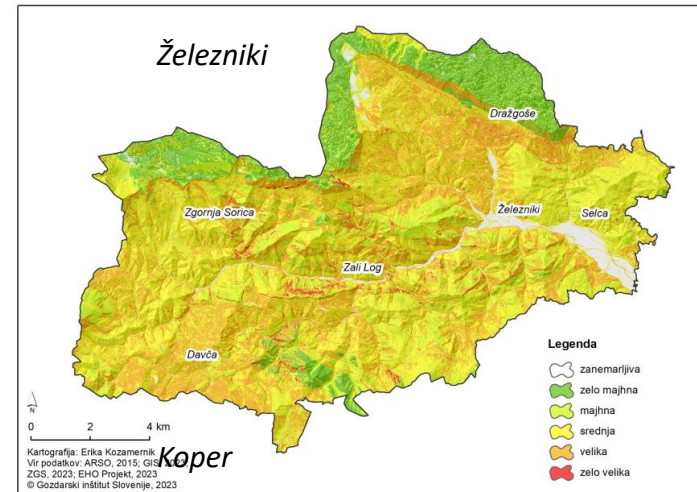
Methodology for identifying forested areas prone to erosion in the catchments of torrents

Mass Movement Processes (MMP) Hazard Map

— existing (in the past) and projected mass movement events (landslides, rockfalls, debris flows) - only source areas (not accumulation areas)

—GeoHazard Viewer:

<https://geohazard.geo-zs.si/>

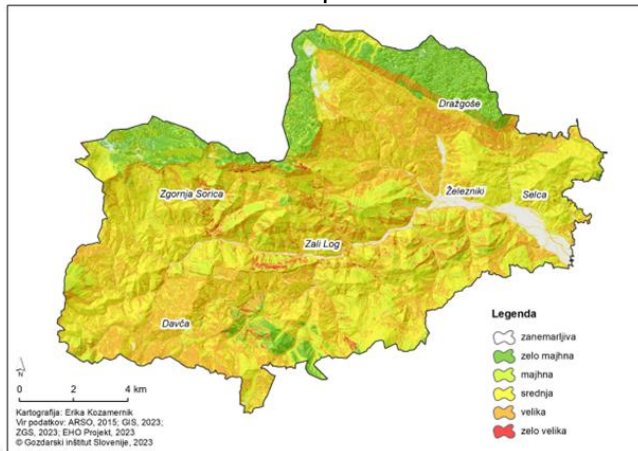


Methodology for identifying forested areas prone to erosion in the catchments of torrents

Extraction of MMP problem areas

risk of MMP

- negligible
- very low
- low
- medium
- high
- very high



Weighting of each category

new (weighted) categories risk of MMP

- 0 = negligible
- 1-10 = very low
- 11-30 = low
- 31-55 = medium
- 56-85 = high
- 86-125 = very high

Old values	New values
0	0
1	10
2	30
3	55
4	85
5	125
NoData	NoData

The weights were based on the study by Gavrilović et al., 2008.

Torrent Classification – Base of Rational Management of Erosive Regions

Zoran Gavrilovic, Milutin Stefanovic, Irina Milovanovic, Jelena Cotric and Mileta Milojevic

Institute for the Development of Water Resources "Jaroslav Cerni", 11226 Beograd (Pinosava), Jaroslava Cernog 80, Serbia tel./fax (+381) 11-3906-461

The identification of forested areas prone to erosion in the torrent catchments in Slovenia

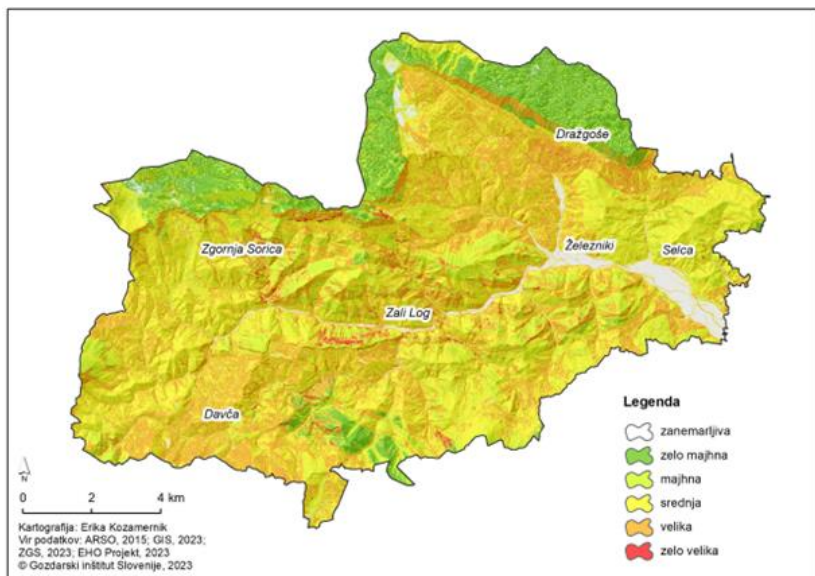
The categories of highest risk of MMP were given the highest weights.



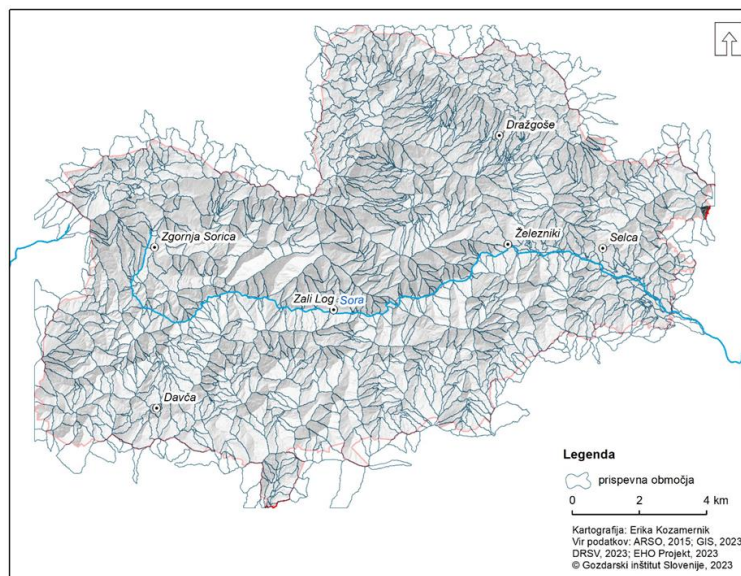
INTERPRAEVENT
2024 - Vienna, Austria

Methodology for identifying forested areas prone to erosion in the catchments of torrents

Calculation of mean MMP categories by river catchment



+



ArcMap:
“Zonal Statistics”:
MEAN

...

A weighted raster layer of MMP risk

River catchments

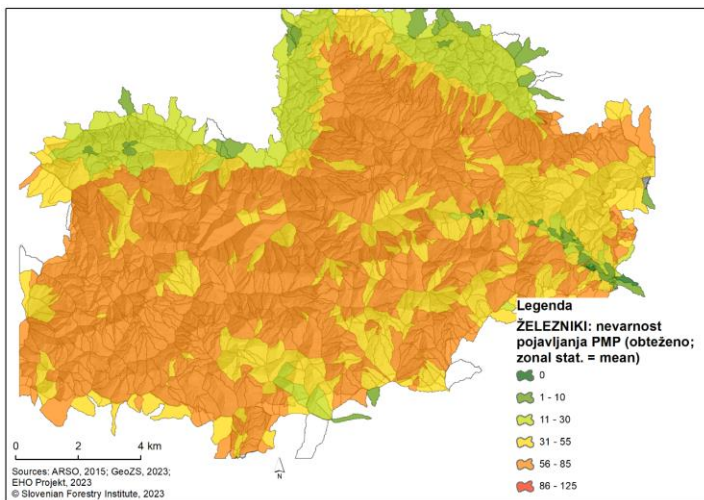
The identification of forested areas prone to erosion in the torrent catchments in Slovenia



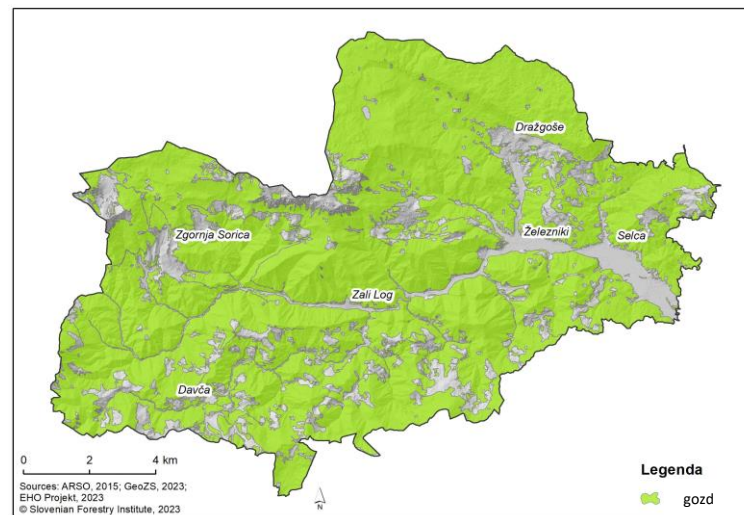
INTERPRAEVENT
2024 - Vienna, Austria

Methodology for identifying forested areas prone to erosion in the catchments of torrents

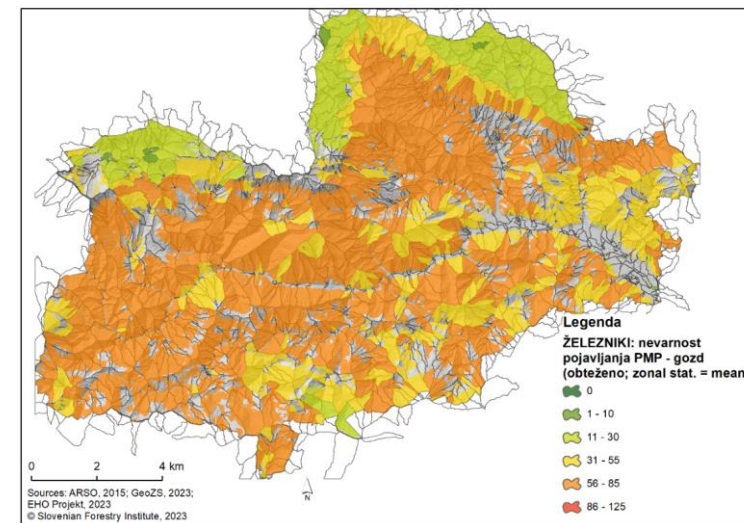
Calculation of mean MMP categories by river catchment



MEAN values (weighted raster layer) of **MMP risk** by river catchment



Forest cover map
(Slovenia Forest Service)







MEAN values (weighted raster layer) of **MMP risk** by river catchment – **FORESTED AREAS**

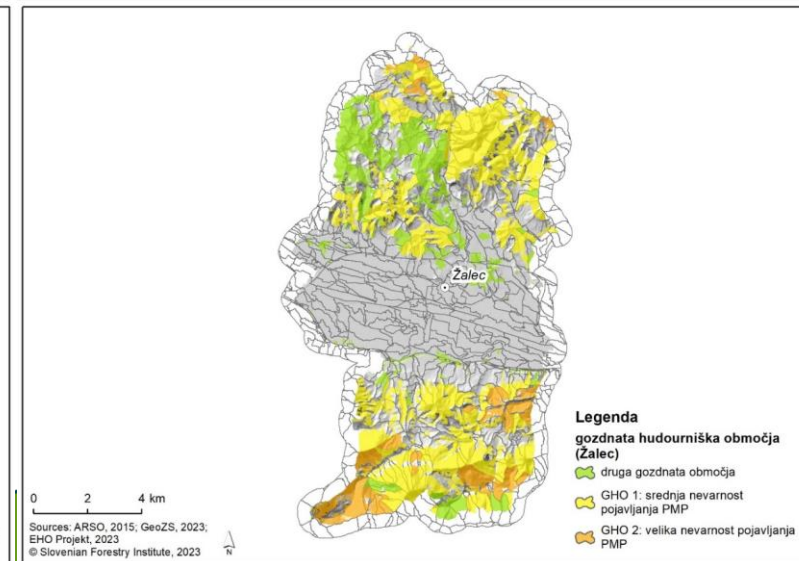
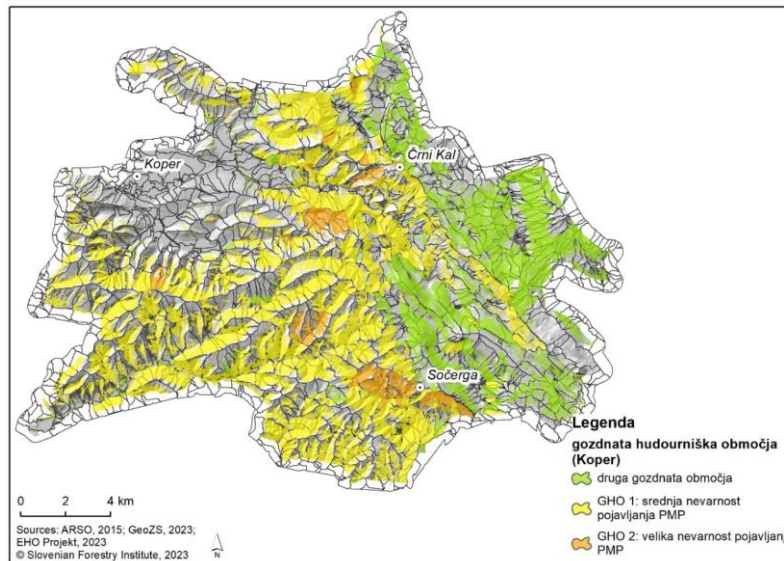
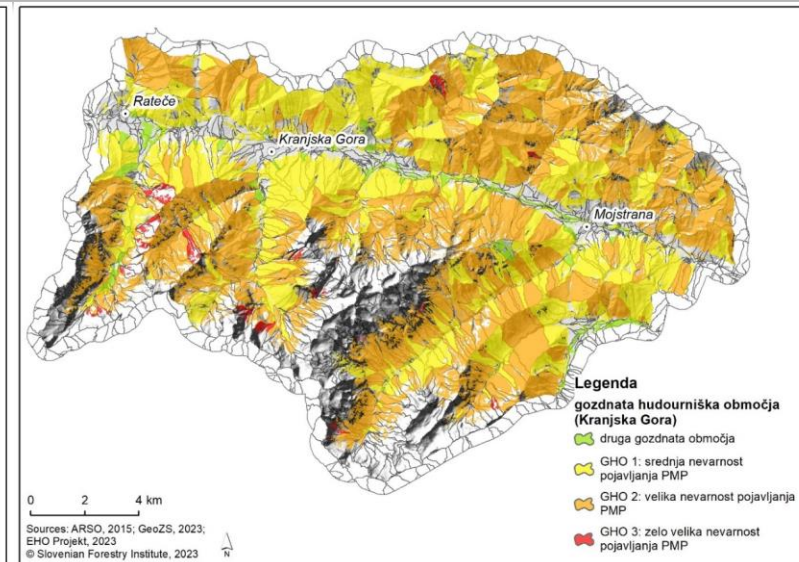
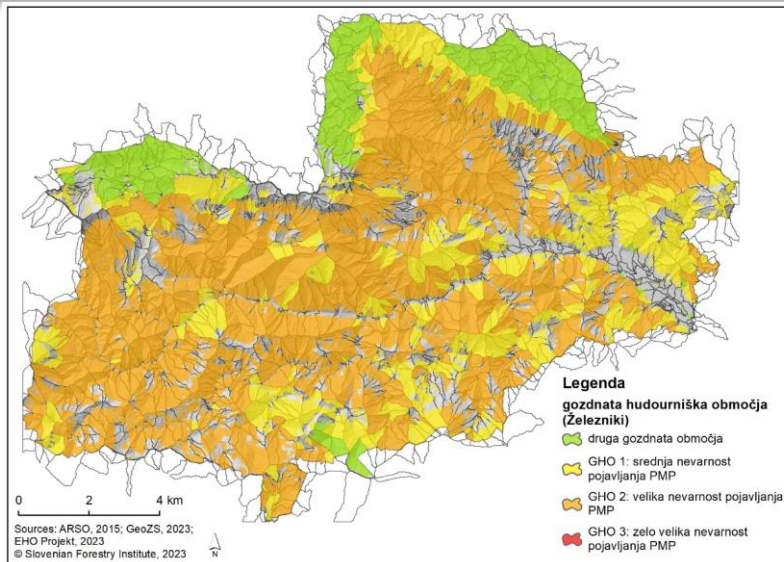
The identification of forested areas prone to erosion in the torrent catchments in Slovenia

Methodology for identifying forested areas prone to erosion in the catchments of torrents

Forested areas, prone to erosion in the catchments of torrents— *preliminary results for pilot municipalities*

Legend

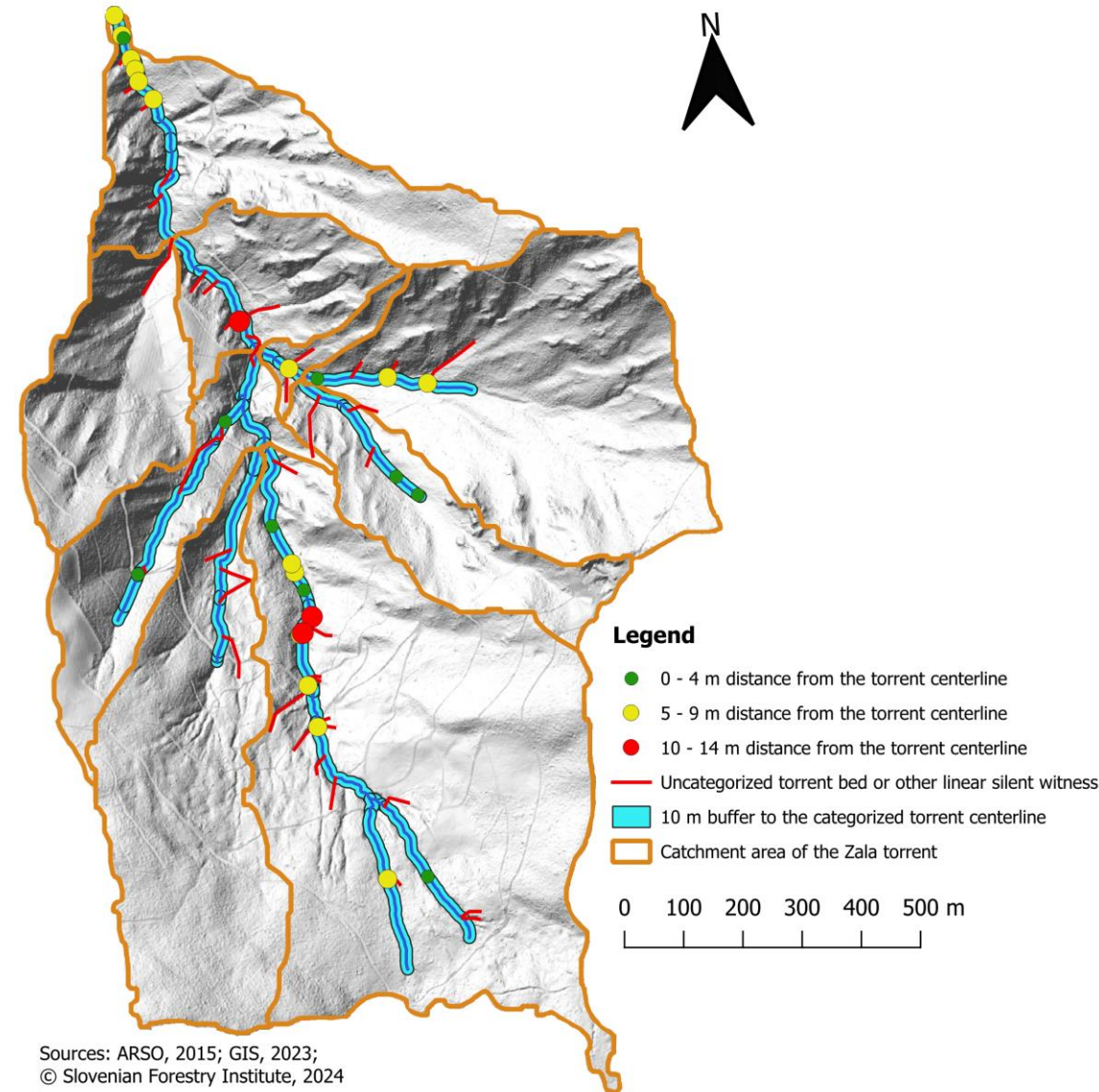
-  other forested areas
-  GHO 1: medium risk of MMP
-  GHO 2: high risk of MMP
-  GHO 3: very high risk of MMP



Silent witnesses – field mapping

A small catchment of the Zala torrent

river bed widening, hawkish tree growth, floatation, debris deposits, erosion gullies etc.



The identification of forested areas prone to erosion in the torrent catchments in Slovenia

Plans for the future...

- Testing of proposed methodology in a forest management unit of the Slovenia forest Service – practical application in forest management process.
- Development of detailed guidelines and recommendations for management of forested areas, prone to erosion.
- Coordination with the Slovenian Water Agency (DRSV).

The identification of forested areas prone to erosion in the torrent catchments in Slovenia



Thank you for your attention!

Acknowledgements:

Drafting of the platform and guidelines for forest management in torrential forest areas (ARIS and CRP project V4-2212)

<https://www.gozdis.si/projekti/strokovna-izhodisca-ter-smernice-za-gospodarjenje-z-gozdovi-na-hudourniskih-obmocjih-crp-v4-2212/>

