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Managing fire-induced risks of water quality contamination

Assessing the impact of wildfires on long-term erosion, using two different approaches: LAPSUS and IC

European Soil Observatory Stakeholder Forum: Young Soil Researchers Forum
19th to 21st October

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INTRODUCTION

Mediterranean countries, such as Portugal, have their ecosystem services on pressure after wildfires due to the association of land degradation risks with water erosion.

In fact, burnt areas tend to increase sediment connectivity by changing vegetation cover and physic-chemical soil properties.

OUR GOAL will be to assess sediment connectivity by studying the links between wildfire, topography, and the mobilization and transport of sediments in burnt areas using new developments in connectivity theory and modelling.

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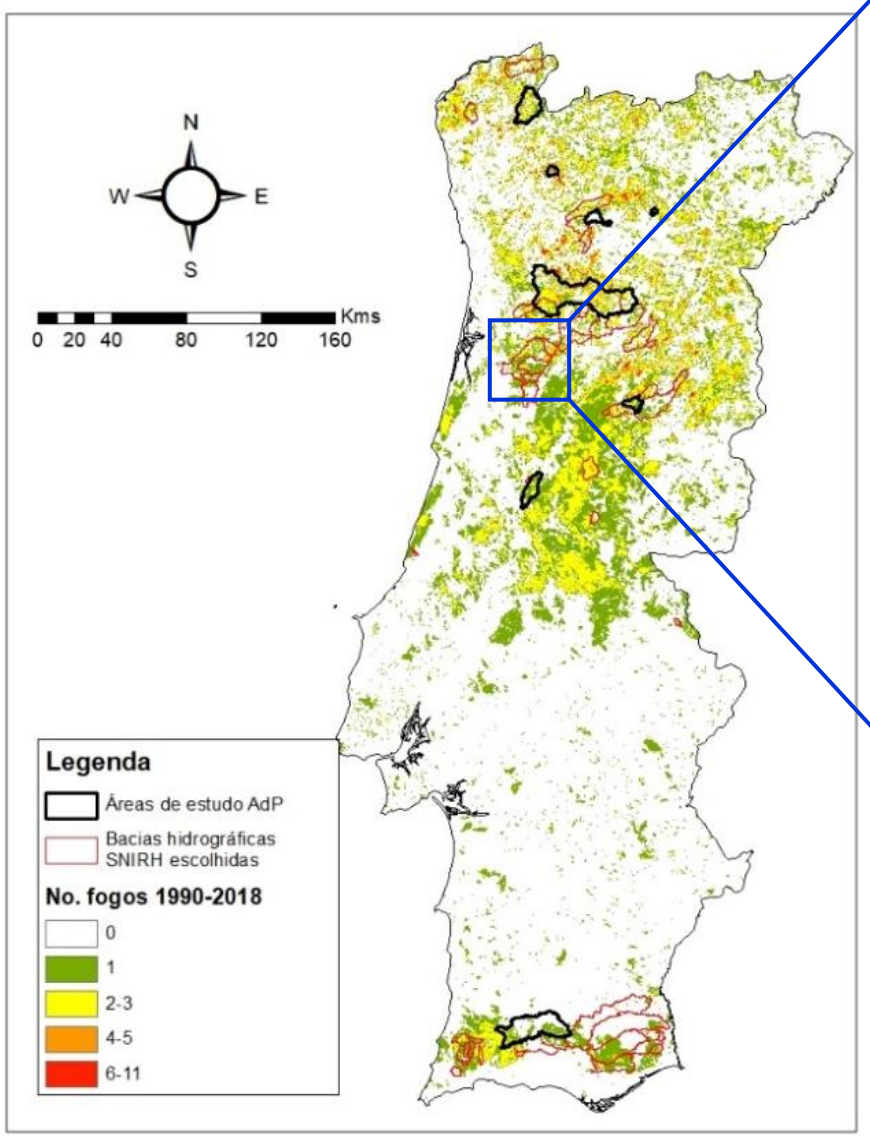
MATERIALS: STUDY AREA



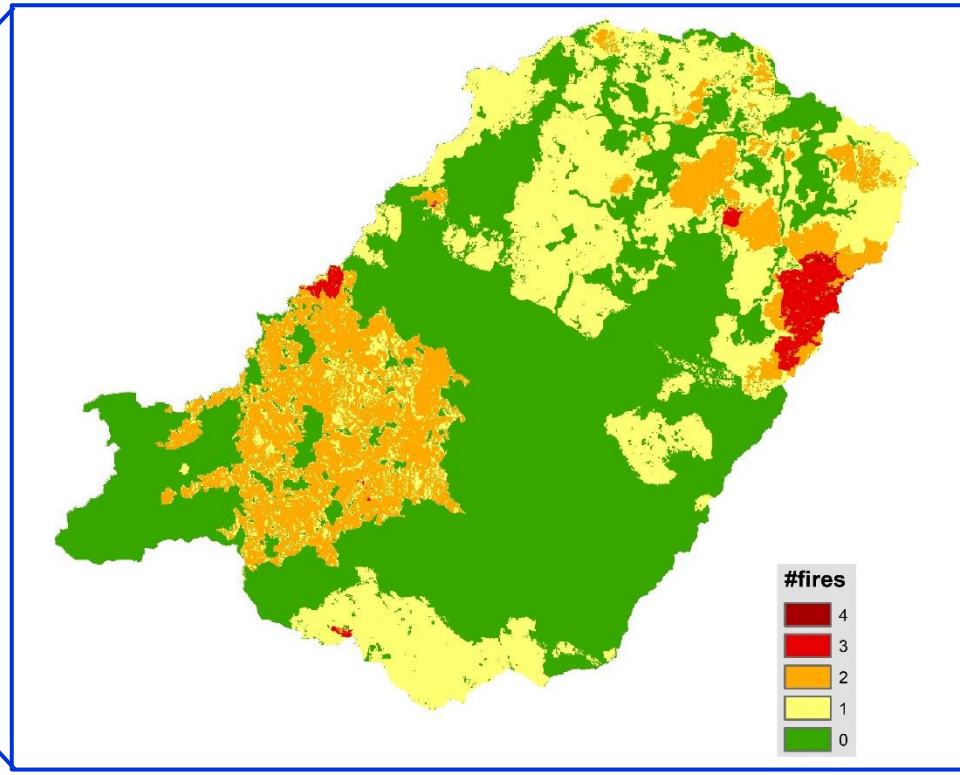


Figure 1 - Burnt area in 1985, 2005, 2016 and 2017

Black: FRISCO study areas
Brown: burnt watersheds with pre- and post-fire water quality data

MATERIALS: STUDY AREA

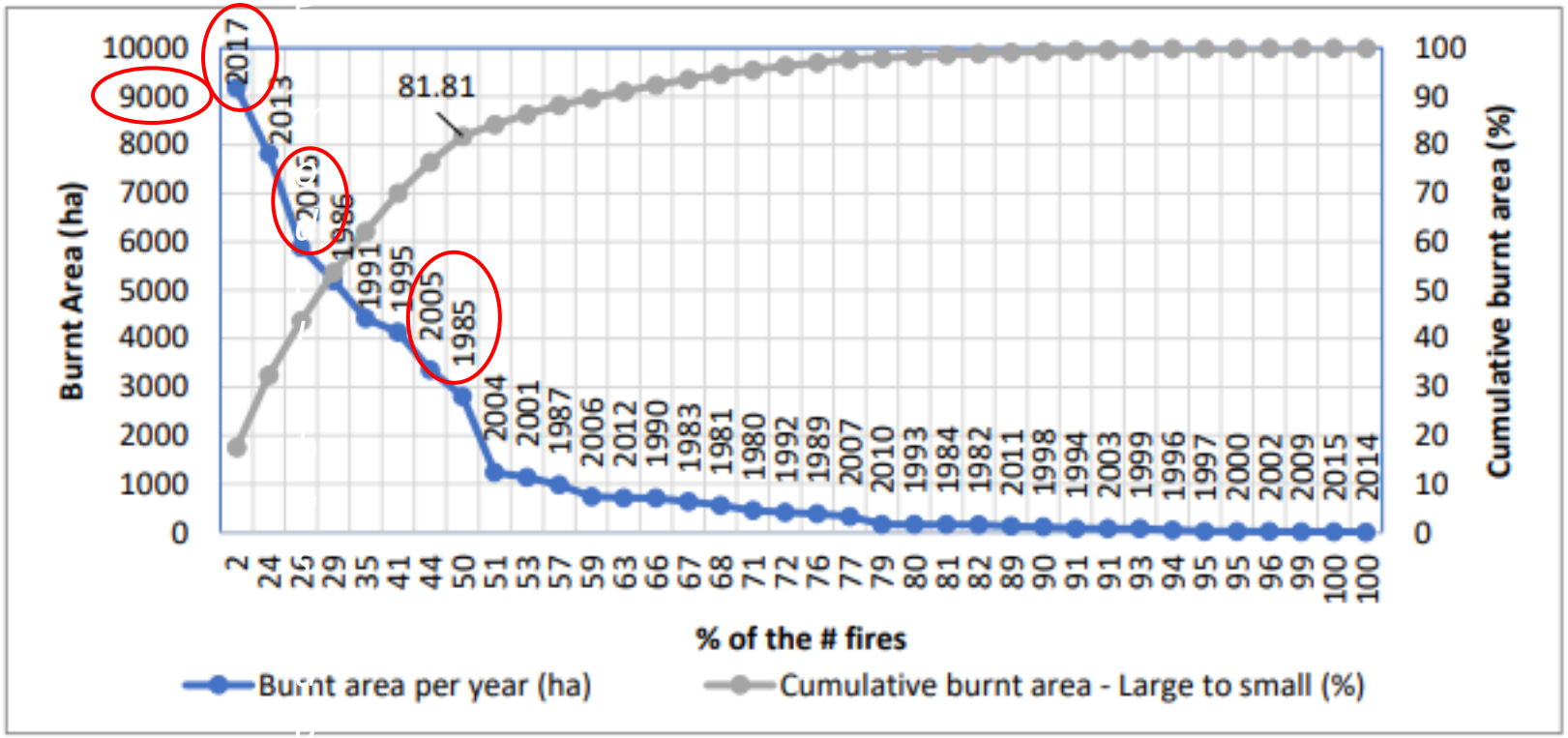


Figure 2 - Burnt area in hectares for each year in the Águeda catchment shown by the left y-axis. On the x-axis the percentage of the number of fires that happened over the period 1979/80 until 2019/20. The right y-axis shows the cumulative percentage of burnt area. Source: Föllmi, D. (2021)[1].

[1]Föllmi, D. (2021). *Assessing the impact of large fire events on long-term erosion, using LAPSUS: A multi-decade, model-based assessment for the Águeda catchment, north-central Portugal*. Wageningen University & Research.

MATERIALS: INPUT DATA

Table 1 - Main input data for LAPSUS model and IC.

NAME	DESCRIPTION
DEM (elevation model)	Map of elevation of the Águeda catchment (25 x 25 m)
Land-use	Land-use maps for the study period
Soil depth	Spatial raster map of soil depths within the catchment
Precipitation	Annual time series of precipitation
Evapotranspiration	Annual time series and spatial distribution of evapotranspiration
Infiltration	Annual time series and spatial distribution of infiltration

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METHODS: FRAMEWORK

LAPSUS by Dante
- Computation
- Calibration

Index of connectivity (IC)
- Based on IC of Borcelli et al. (2008)[1] and modified by Cavalli et al. (2013)[2].
- Computed with Dante's input maps.

Remove valleys and water flows
- Flow direction with the spatial analyst tool from ArcGIS.
- Topographic position index using Focal statistics from ArcGIS.

Contingency tables
- Using the table function in R environment.

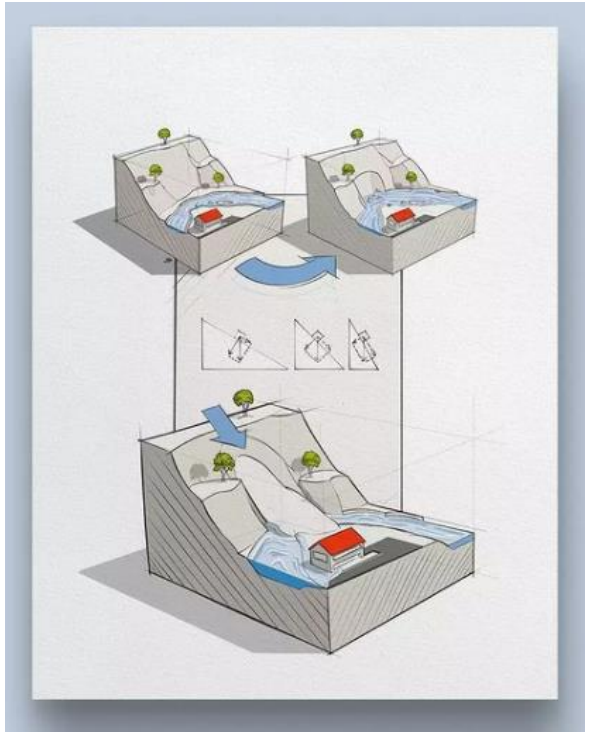

Figure 3 – Mass movement sliding downhill and accumulation in a riverbed. Source: @dorothee.post - Instagram

[1]Borselli, L., Cassi, P., & Torri, D. (2008). Prolegomena to sediment and flow connectivity in the landscape: A GIS and field numerical assessment. *Catena*, *75*(3), 268–277. https://doi.org/10.1016/j.catena.2008.07.006.

[2]Cavalli, M., Trevisani, S., Comiti, F., & Marchi, L. (2013). Geomorphometric assessment of spatial sediment connectivity in small Alpine catchments. *Geomorphology*, *188*, 31–41. https://doi.org/10.1016/j.geomorph.2012.05.007.

METHODS: LAPSUS

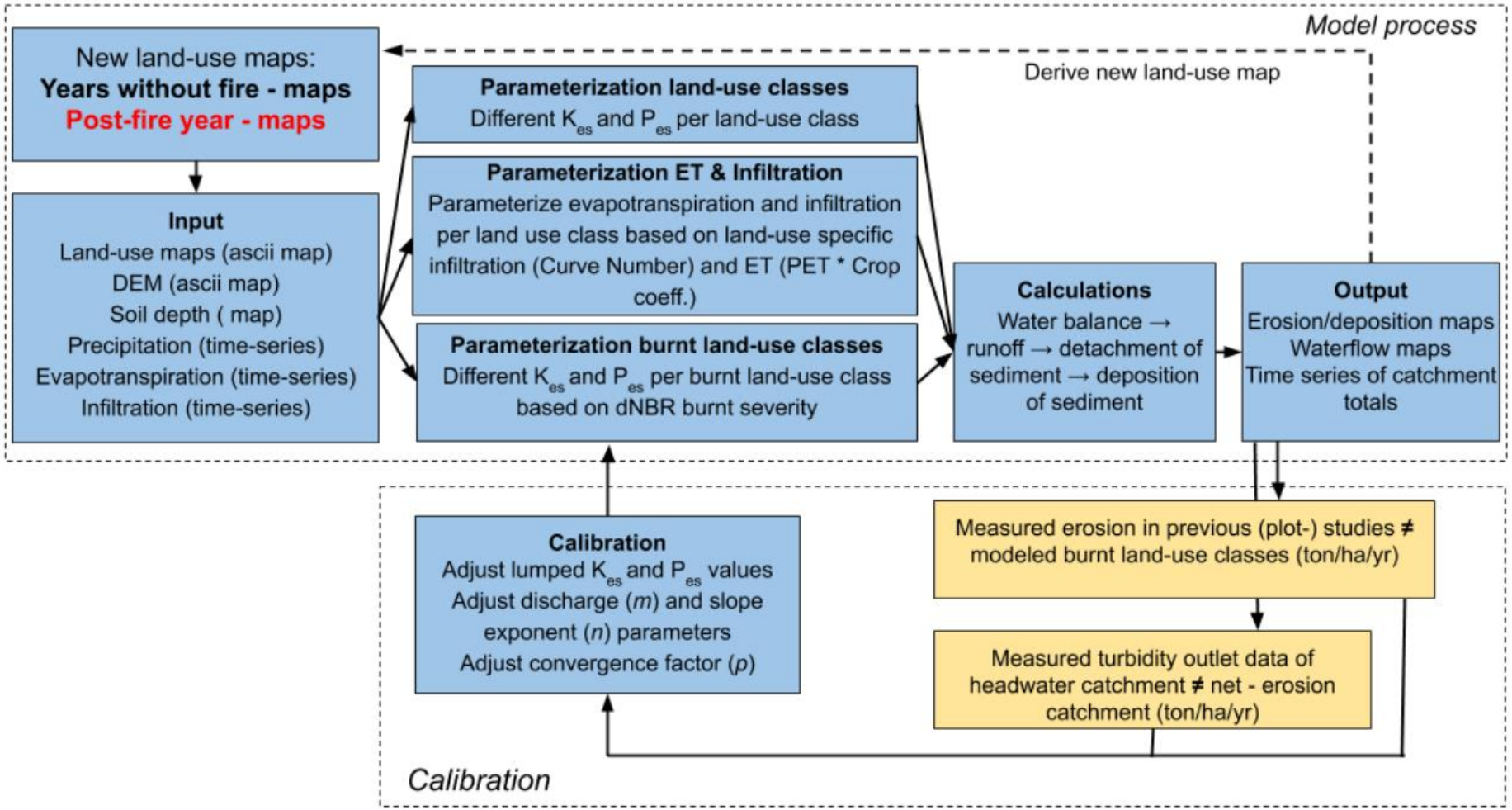

Figure 4 - Model procedure for LAPSUS showing data input, parameterization, output and calibration. Source: Föllmi, D. (2021)[1].

[1]Föllmi, D. (2021). *Assessing the impact of large fire events on long-term erosion, using LAPSUS: A multi-decade, model-based assessment for the Águeda catchment, north-central Portugal*. Wageningen University & Research.

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METHODS: IC

DTM was hydrologically correct with TauDEM tool from ArcGIS. It will give a catchment-scale connectivity

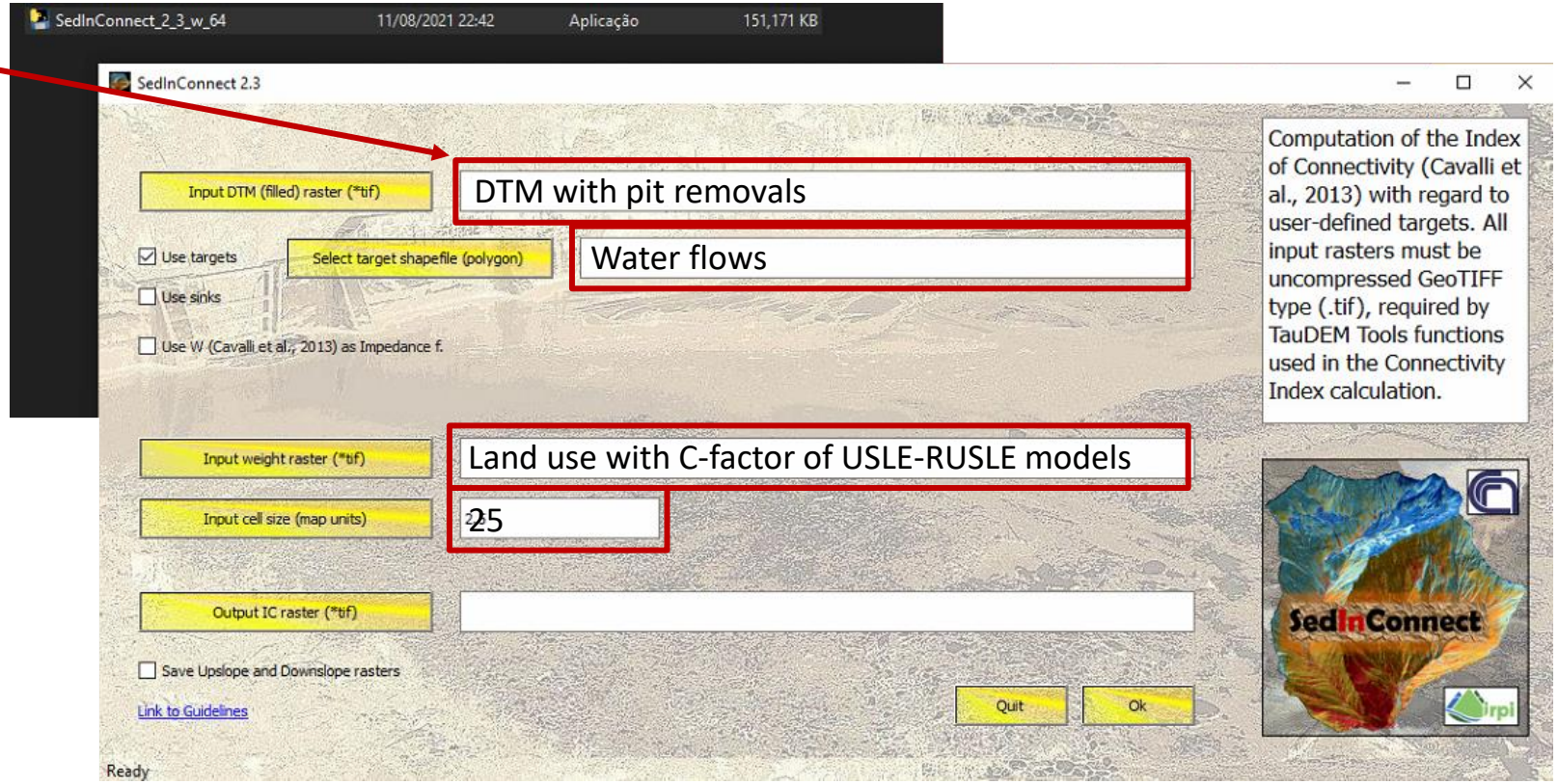

Figure 5 - SedInConnect: a free, open source and stand-alone application for the computation of the Index of Connectivity (IC), as expressed in Cavalli et al. (2013)[1] with the addition of specific innovative features[2].

[1]Cavalli, M., Trevisani, S., Comiti, F., & Marchi, L. (2013). Geomorphometric assessment of spatial sediment connectivity in small Alpine catchments. *Geomorphology*, *188*, 31–41. https://doi.org/10.1016/j.geomorph.2012.05.007.
[2]Crema, S., & Cavalli, M. (2018). SedInConnect: a stand-alone, free and open source tool for the assessment of sediment connectivity. Computers and Geosciences, 111, 39–45. https://doi.org/10.1016/j.cageo.2017.10.009.

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WEISS, A. (2001)[1] CLASSIFICATION

Table 2 – Weiss, A. (2001)[1] classification.

CLASS	DESCRIPTION
1- Ridge	TPI > +1 STDV
2- Upper slope	TPI> 0.5 STDV, TPI=< 1 STDV
3- Middle slope	TPI> -0.5 STDV, TPI < 0.5 STDV, slope > 5 deg
4- Flat slope	TPI>= -0.5 STDV, TPI=< 0.5 STDV , slope <= 5 deg
5-Lower slopes	TPI>= -1.0 STDV, TPI< 0.5 STDV
6- Valleys	TPI< -1.0 STDV

[1]Weiss, A. (2001). Topographic position and landforms analysis. *Poster Presentation, ESRI User Conference, San Diego, CA*. http://www.jennessent.com/downloads/TPI-poster-TNC_18x22.pdf.

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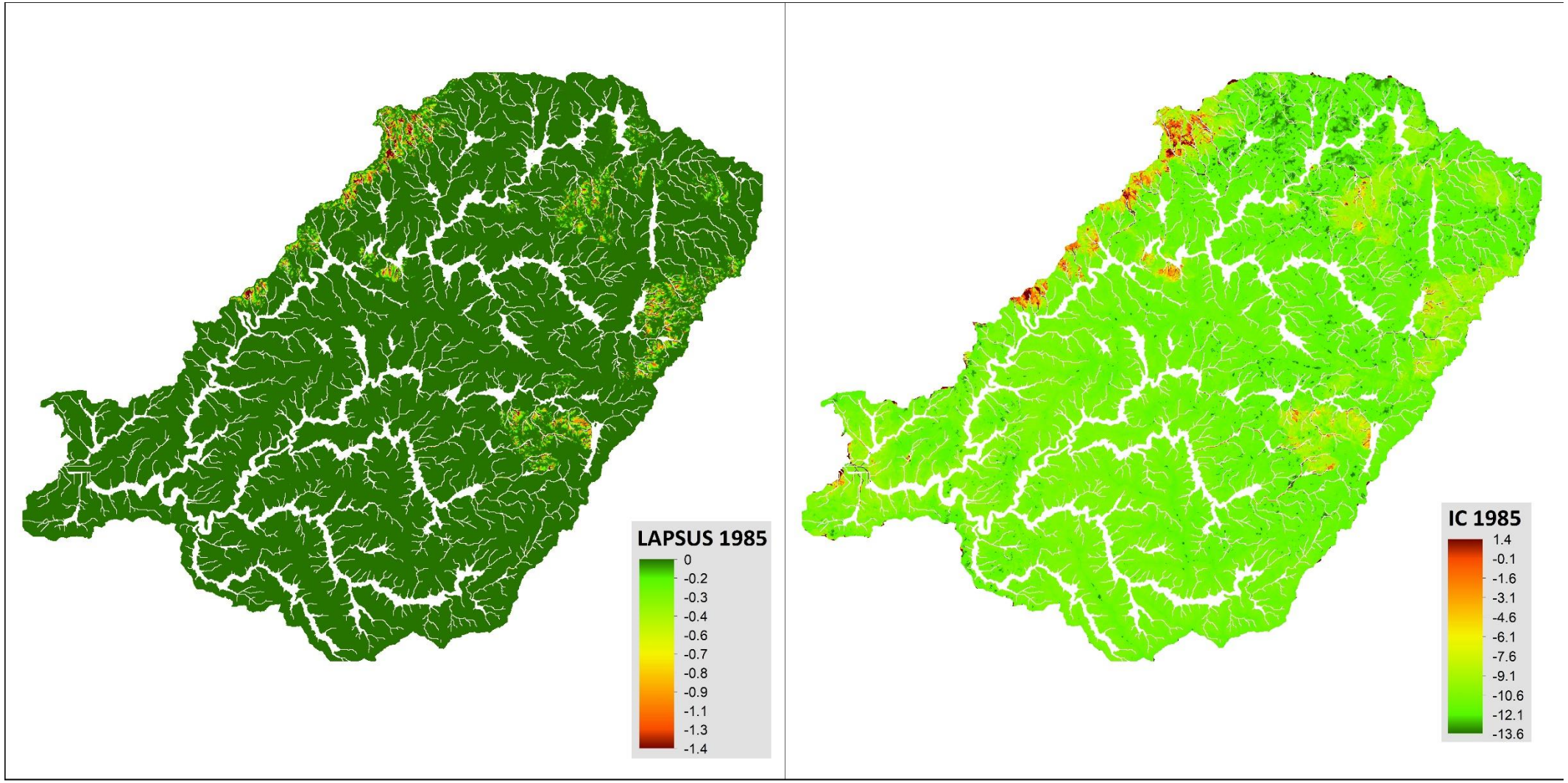
LAPSUS vs IC: 1985



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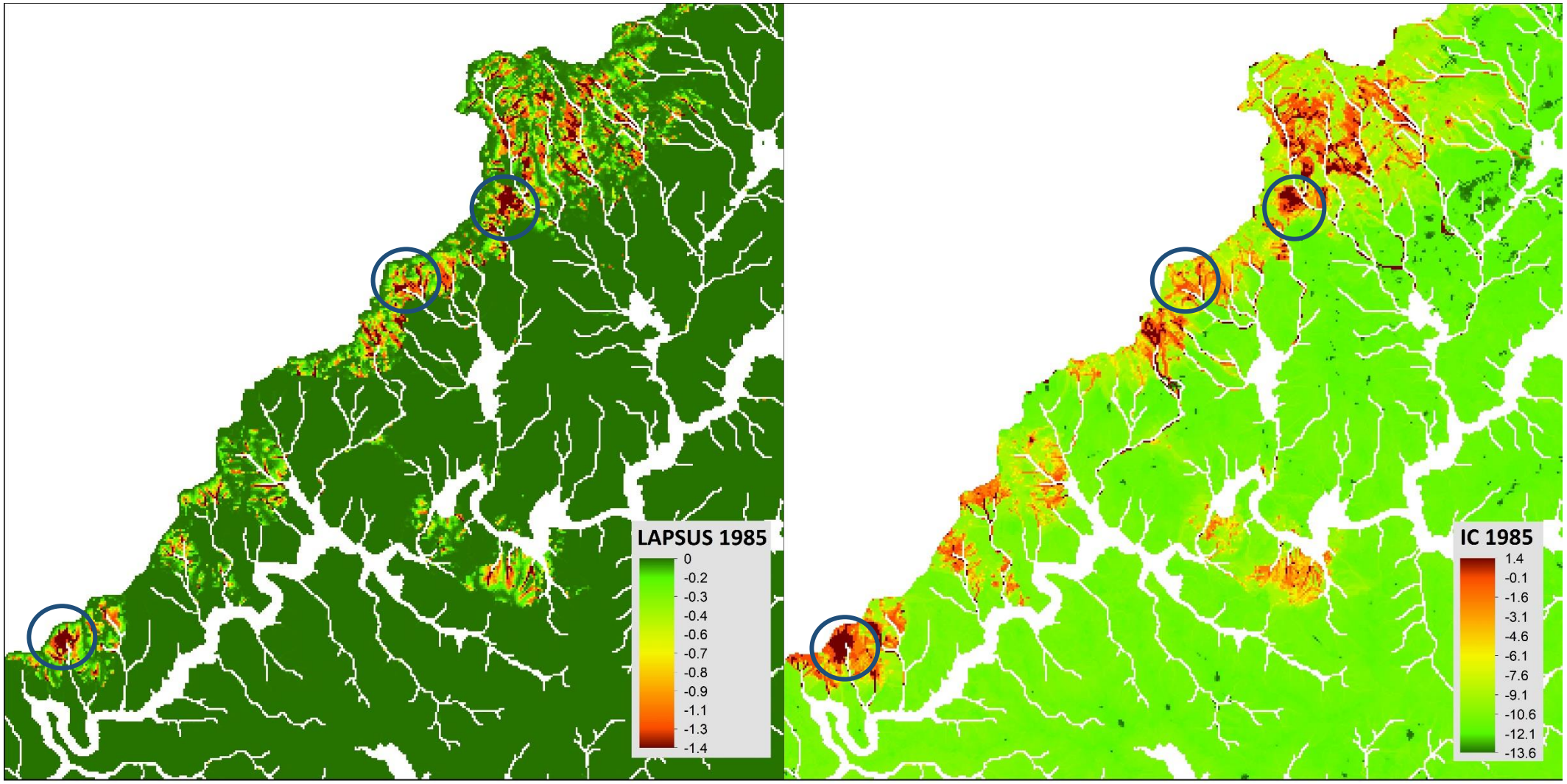
LAPSUS vs IC: 1985



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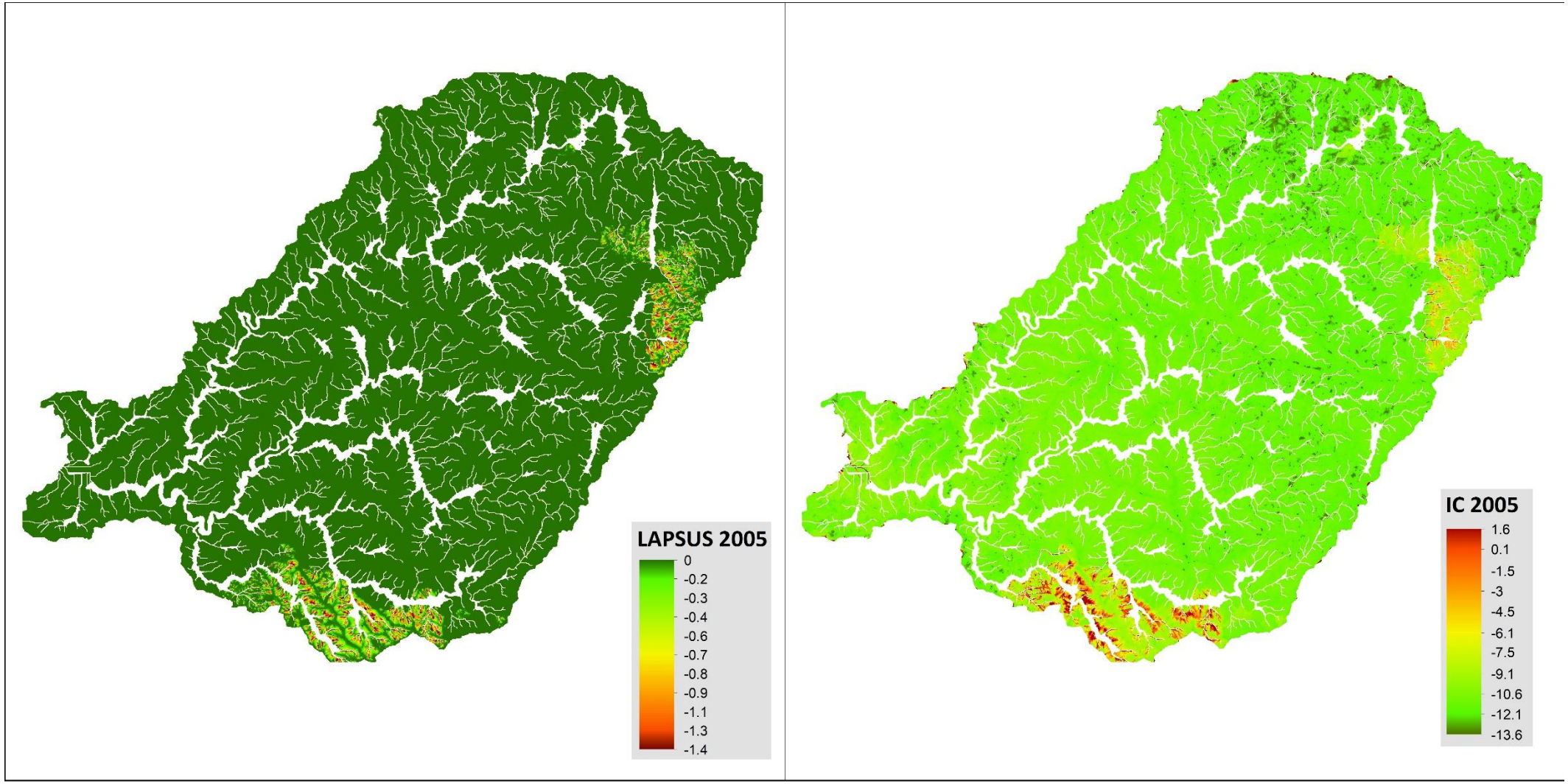
LAPSUS vs IC: 2005



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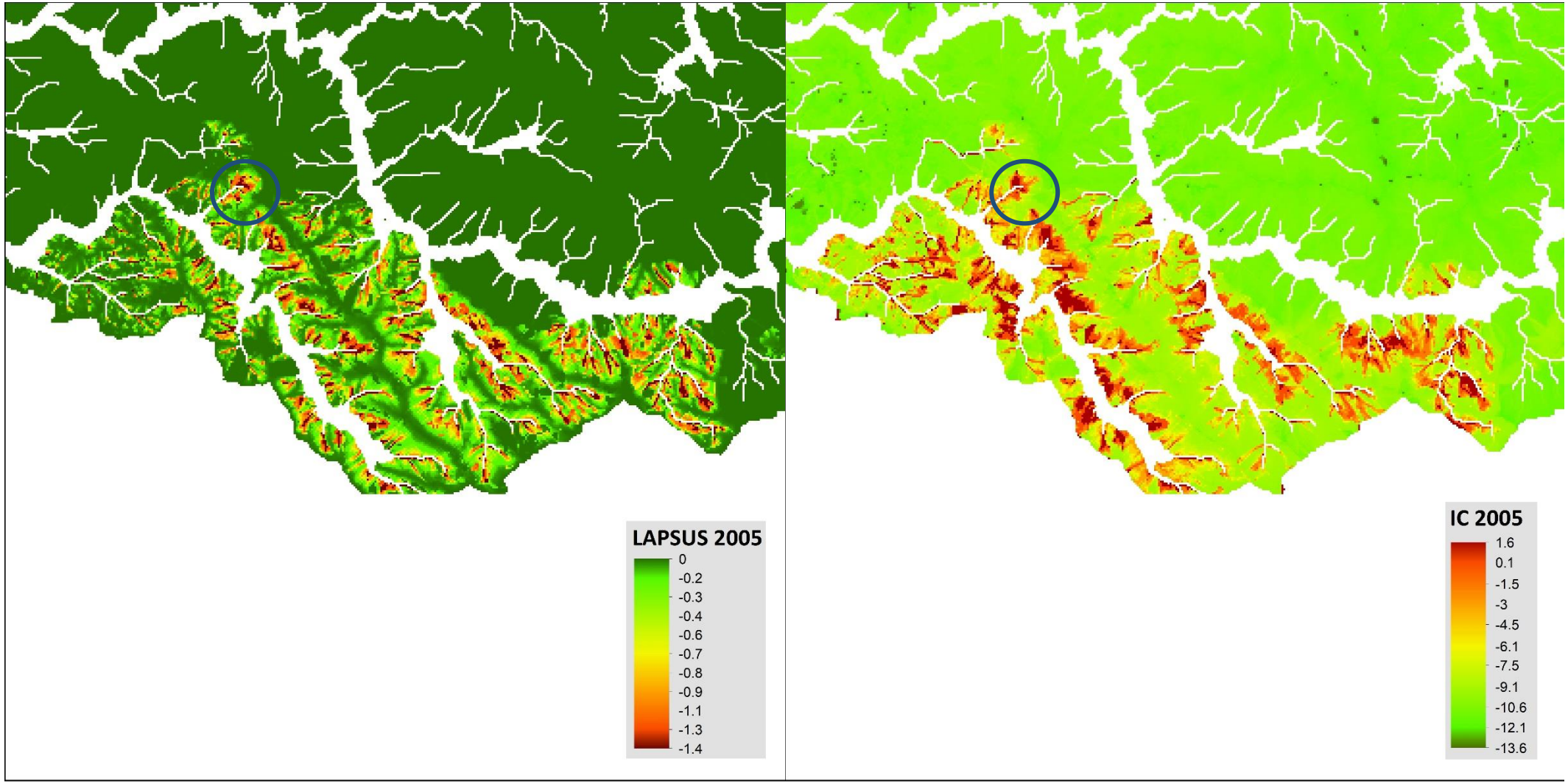
LAPSUS vs IC: 2005



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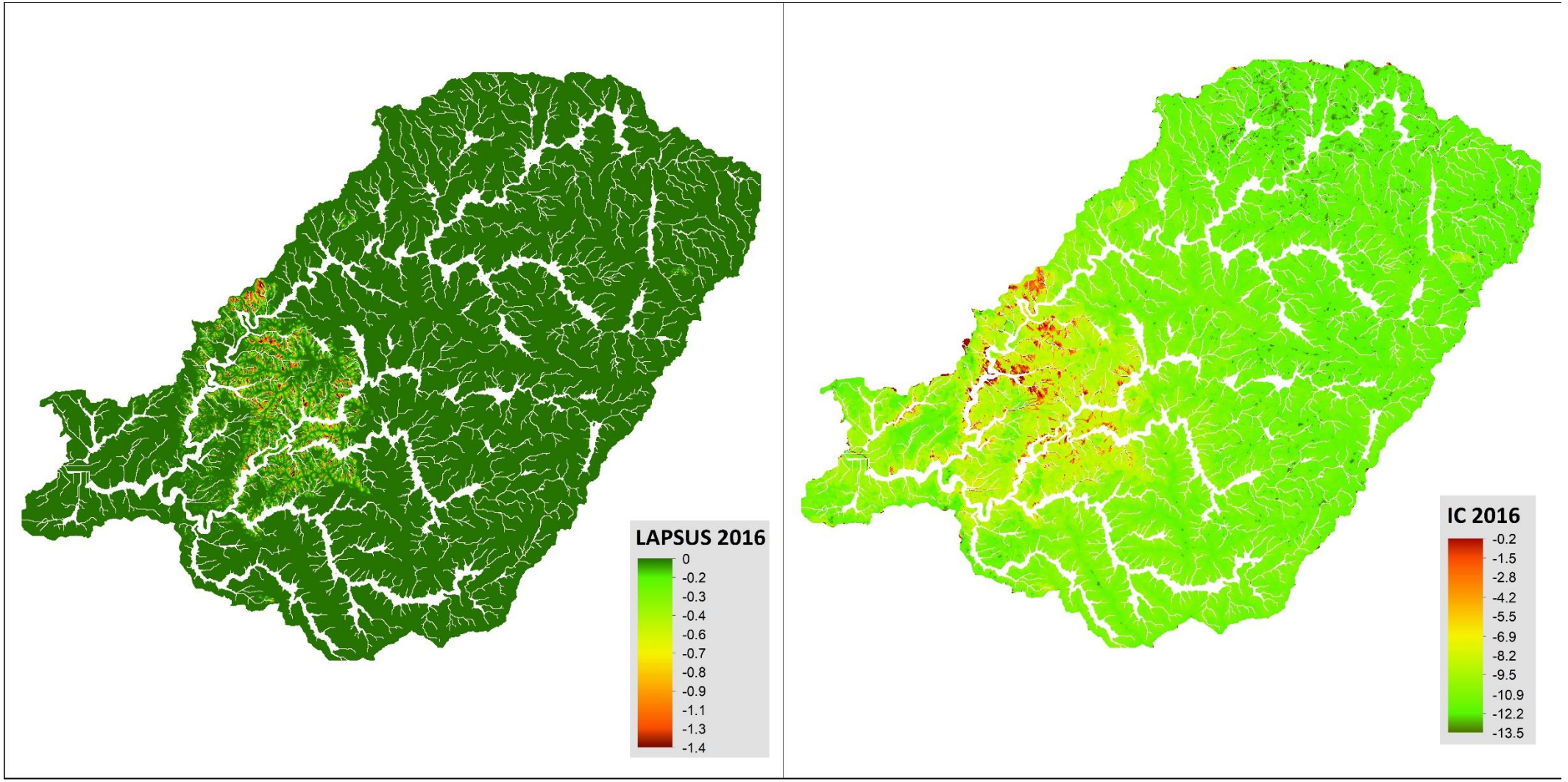
LAPSUS vs IC: 2016



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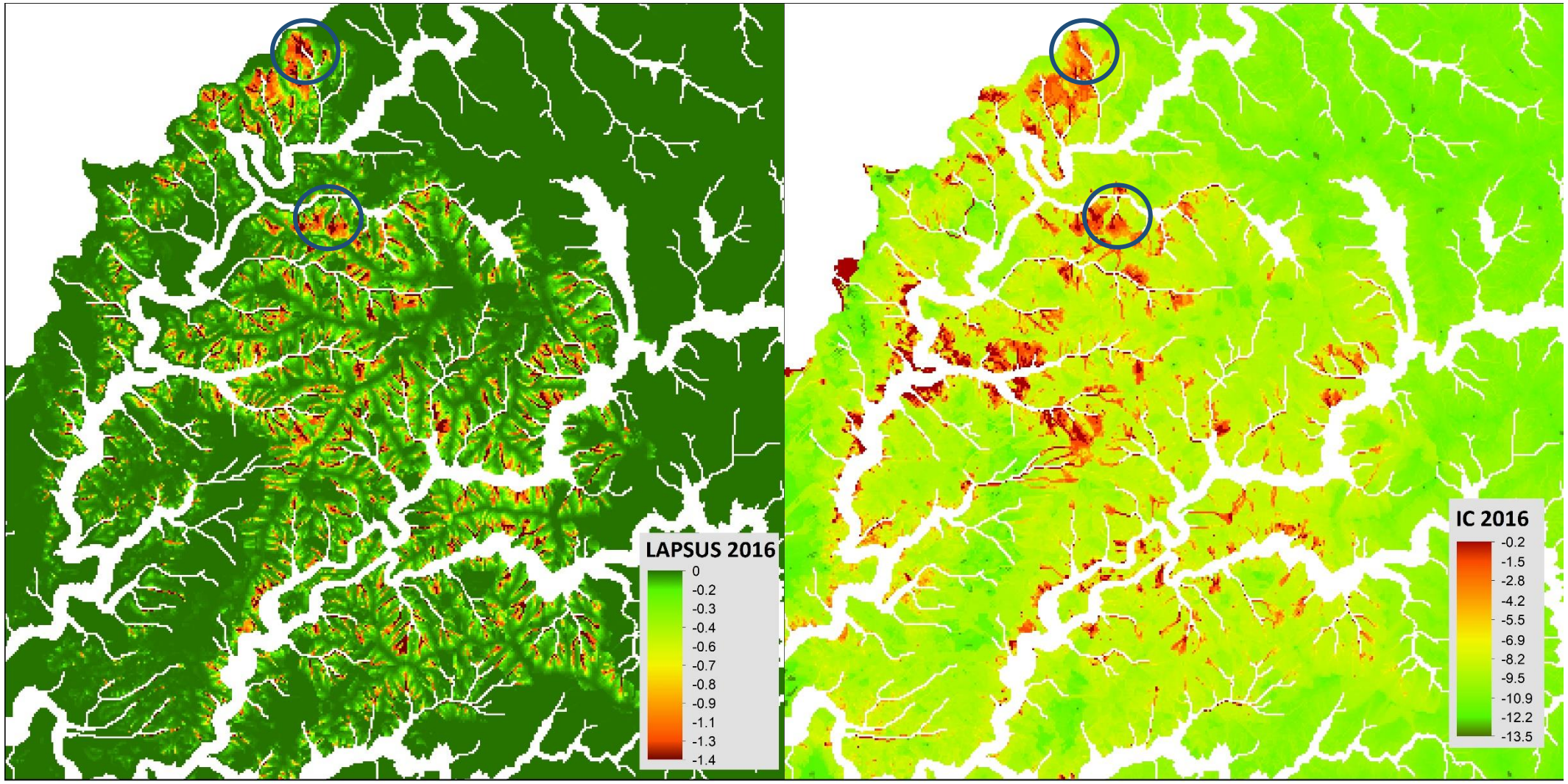
LAPSUS vs IC: 2016



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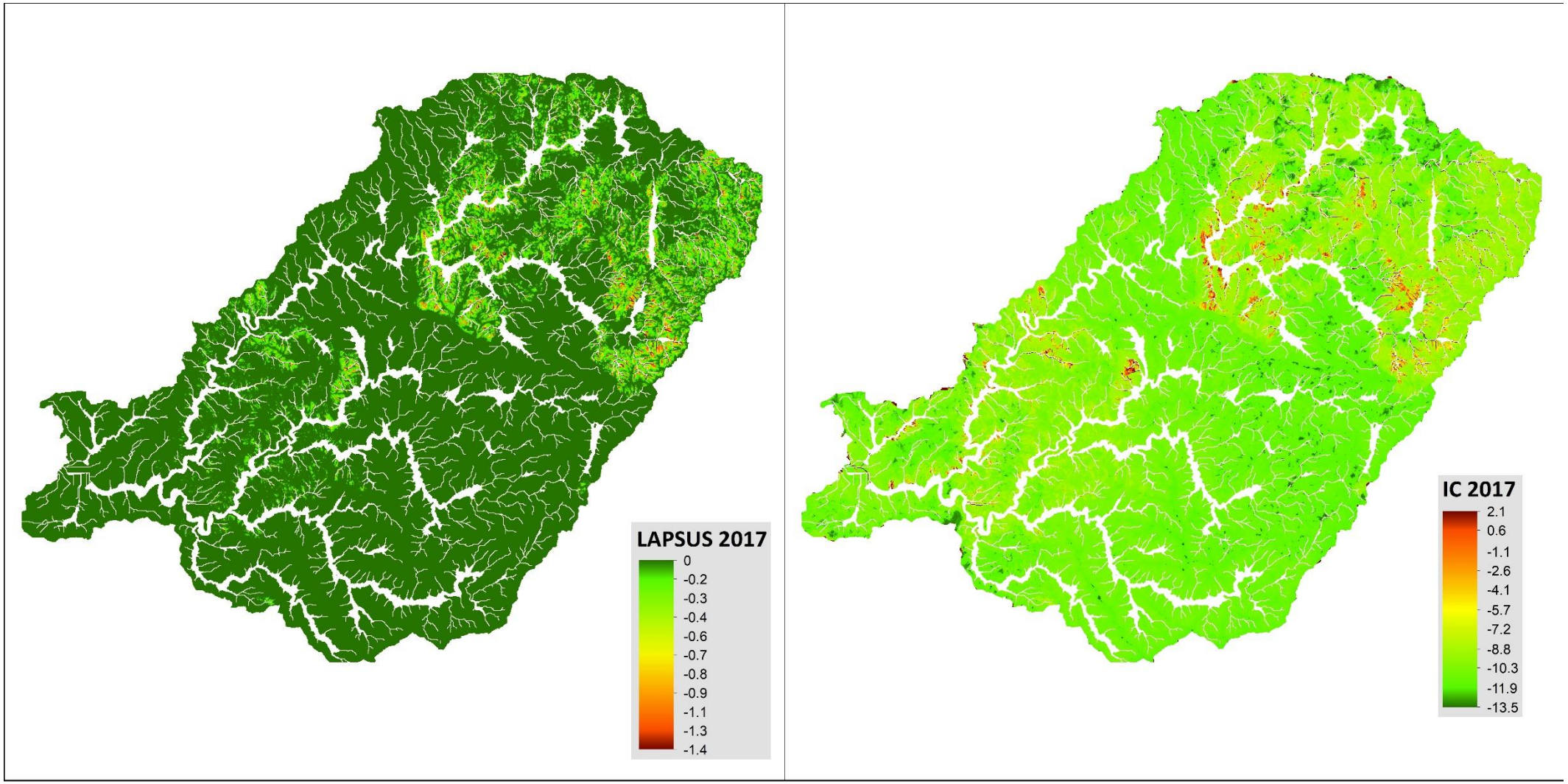
LAPSUS vs IC: 2017



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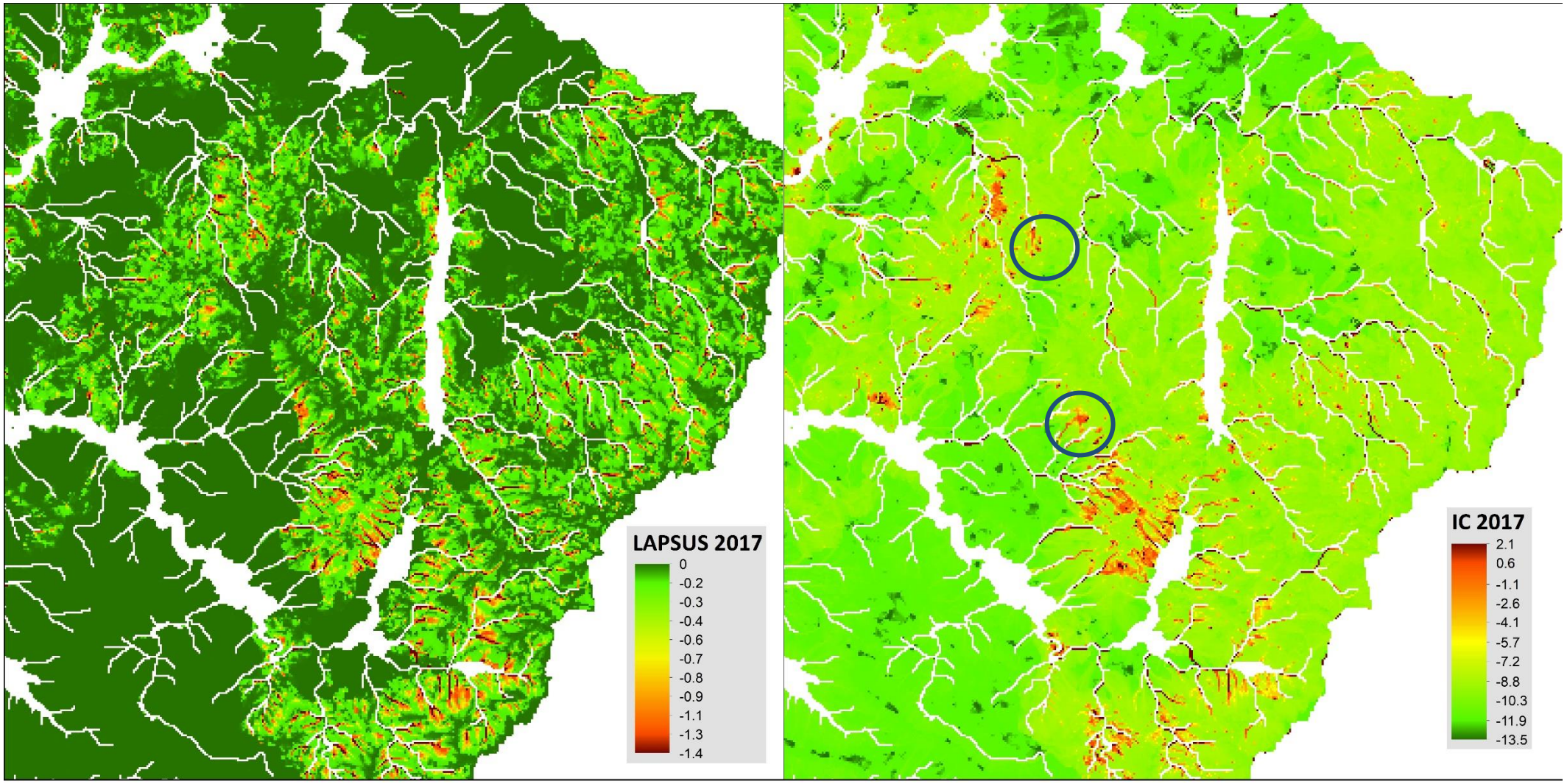
LAPSUS vs IC: 2017



LAPSUS vs IC

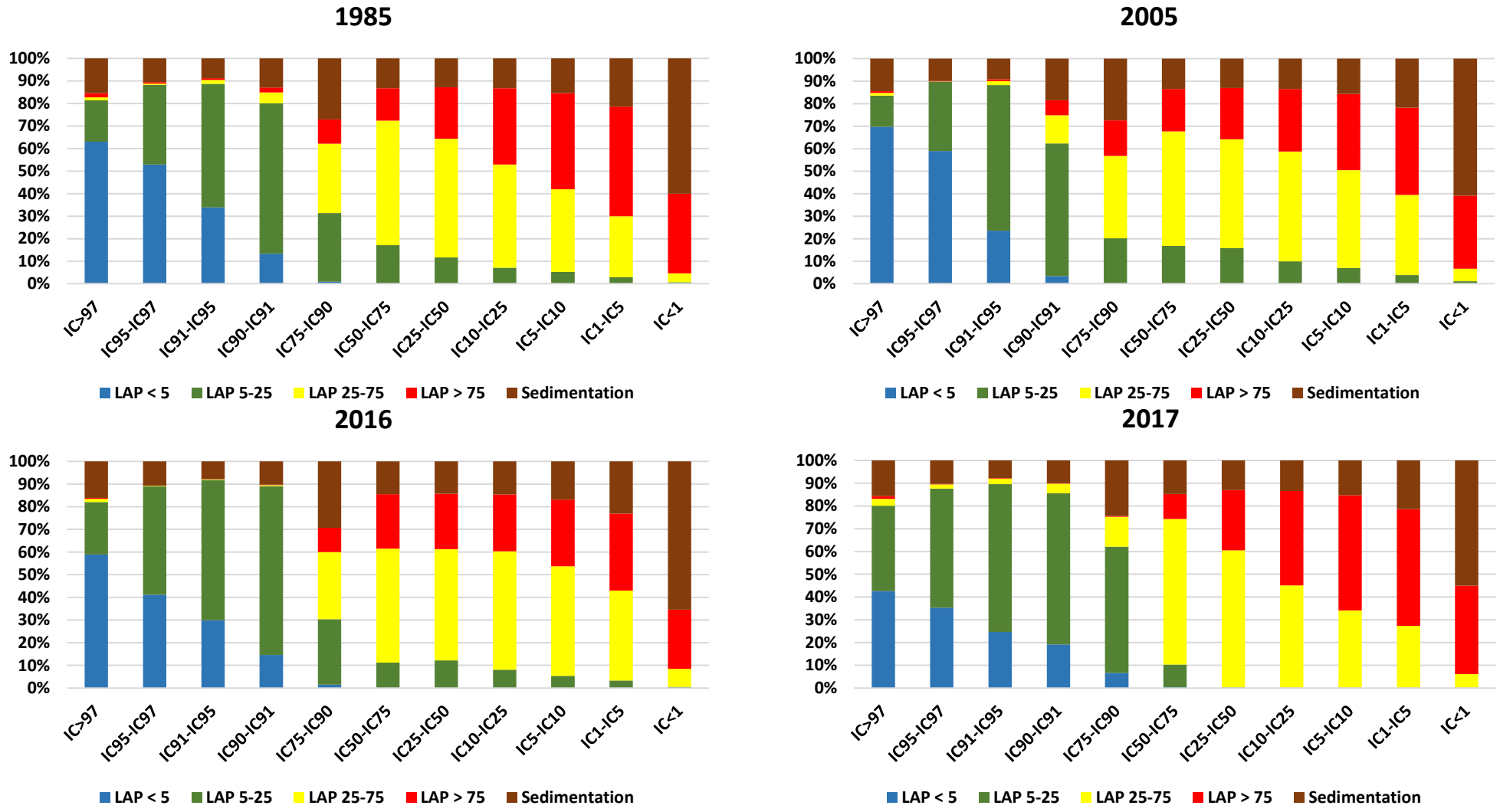


Figure 6 – Contingency tables.

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CONCLUSIONS

- ✓ LAPSUS takes about 3 months to concluded, IC takes less than 12 hours.
- ✓ LAPSUS and IC relation depends on the target year and/or position of the fire and/or even of the fire itself.
- ✓ LAPSUS and IC leads to the identification of potential sources of ash and post-fire contaminants.

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Thanks for listening

I'm available for questions and discussion of our work.

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