TEMPORAL CLUSTERING OF PRECIPITATION FOR DETECTION OF POTENTIAL LANDSLIDES

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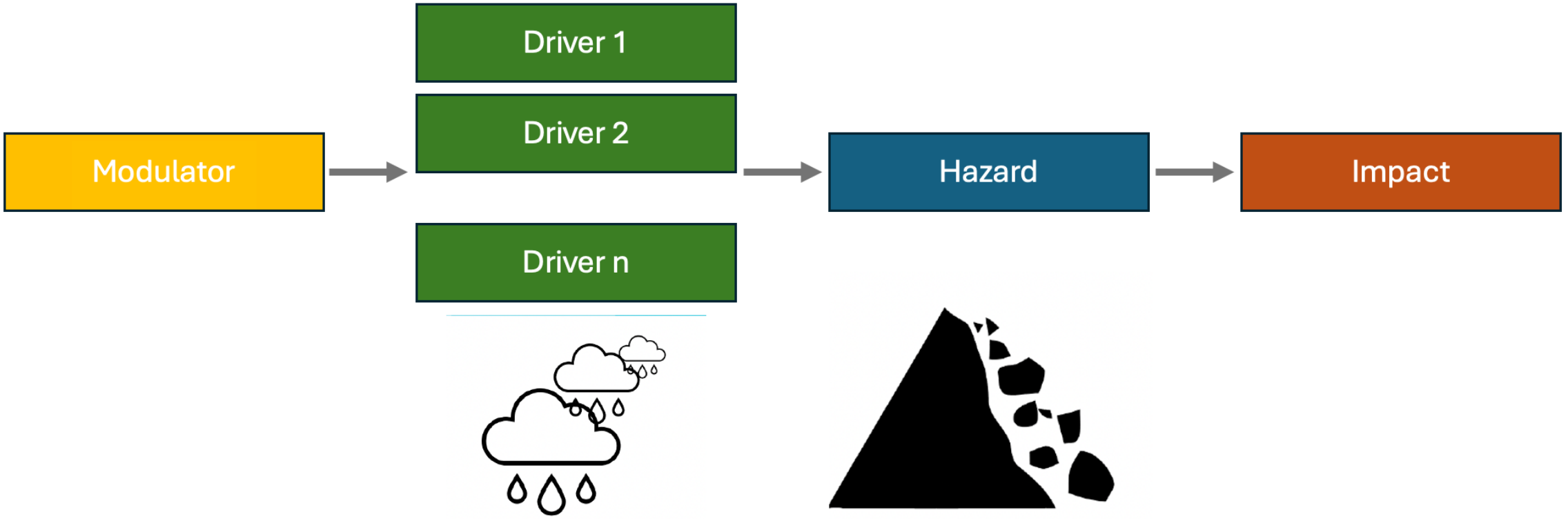
Temporal clustering



Zscheischler et al. 2020

Aim of the work

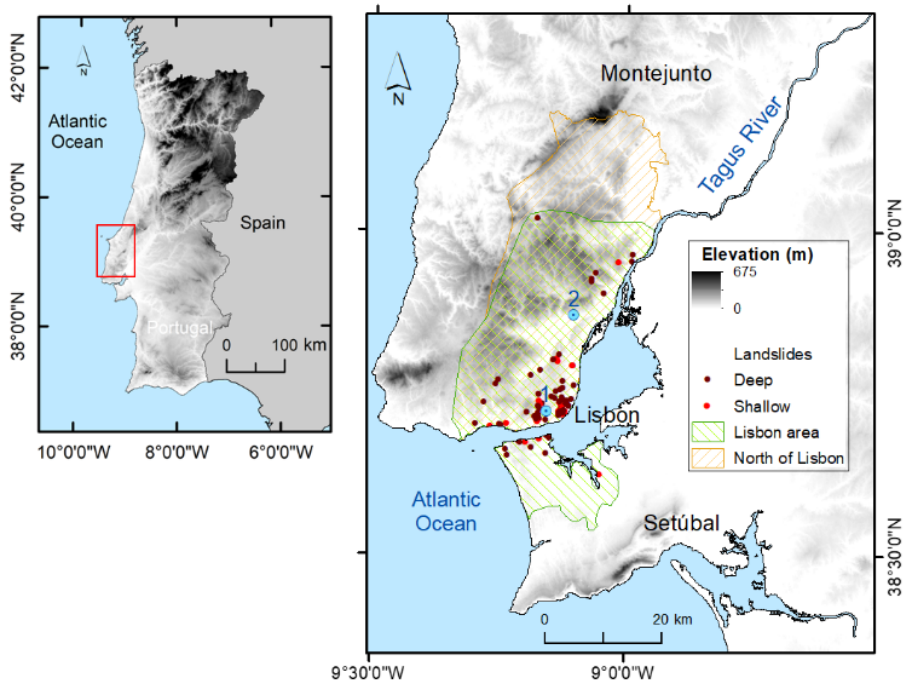
Improving landslides detection using information on temporal clustering of precipitation with respect to classical empirical rainfall thresholds

Dataset

Two data sets of **landslide events** in the Lisbon region by **Zezere et al. (2015)**:

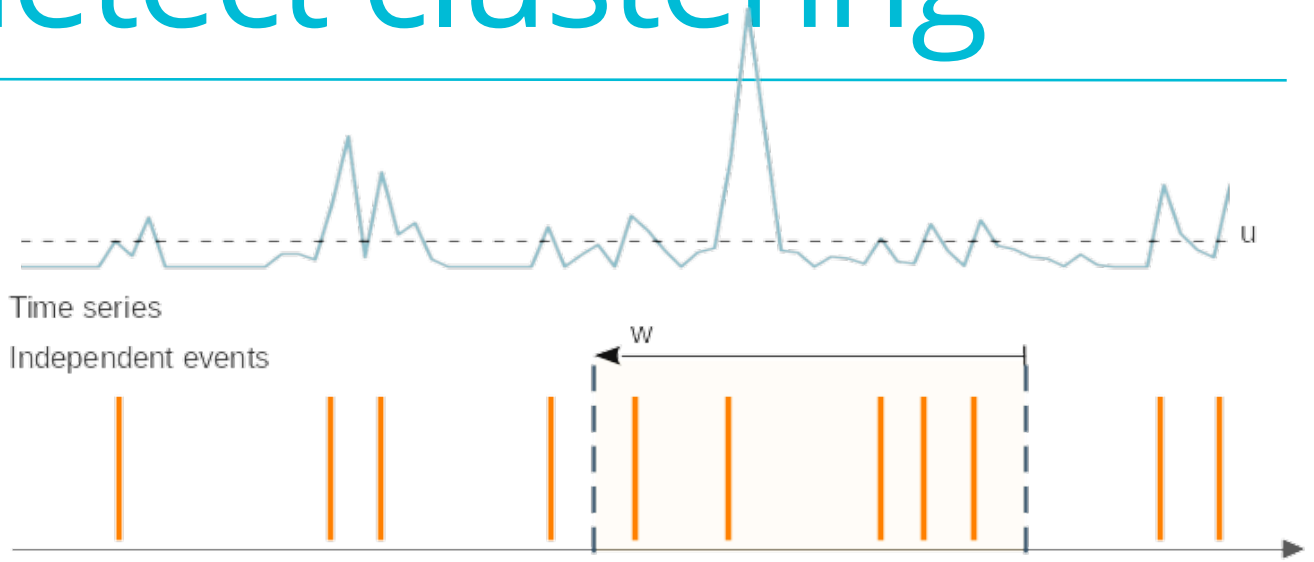
The first covers the area of Lisbon, from 1865 until 2010, and it includes 39 events, which were collected from newspapers

The second covers the North of Lisbon region, from 1956 until 2010, and it includes 25 events. Data were obtained from technical and scientific documents, fieldwork, and interviews with the local population



Novel method to detect clustering

Temporal clustering investigated with a statistical test (Banfi et al. 2022, modified from Bevacqua et al. 2021)



1 • Time series

2 • Exceedances

4 • Is the number of exceedances inside w ~ Bin(w_{eff}, p)

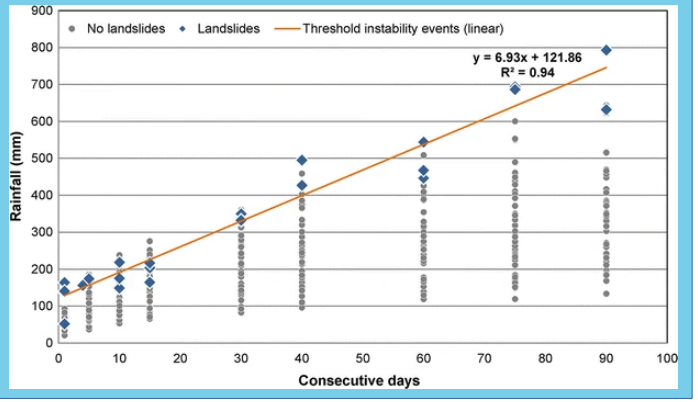
5 • If not → temporal clustering

W_{eff} → window size reduced due to high-frequency declustering
P → probability of having an event

Landslides detection

Empirical rainfall thresholds

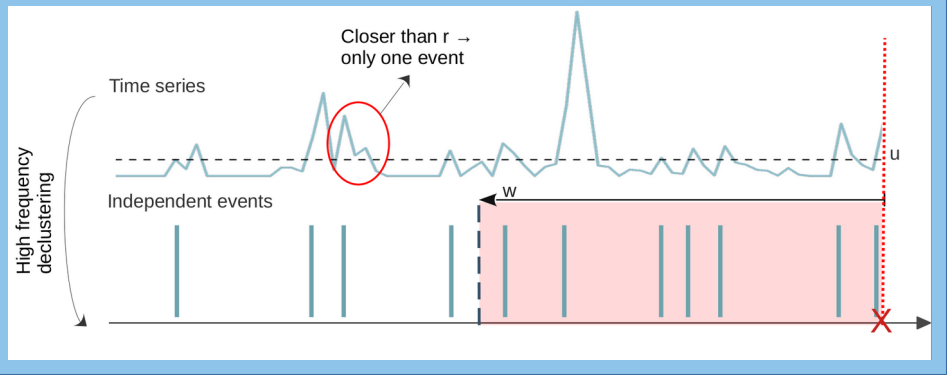
Regression curves that provide for each duration a critical **rainfall total** above which a landslide is detected



Zezere et al 2015

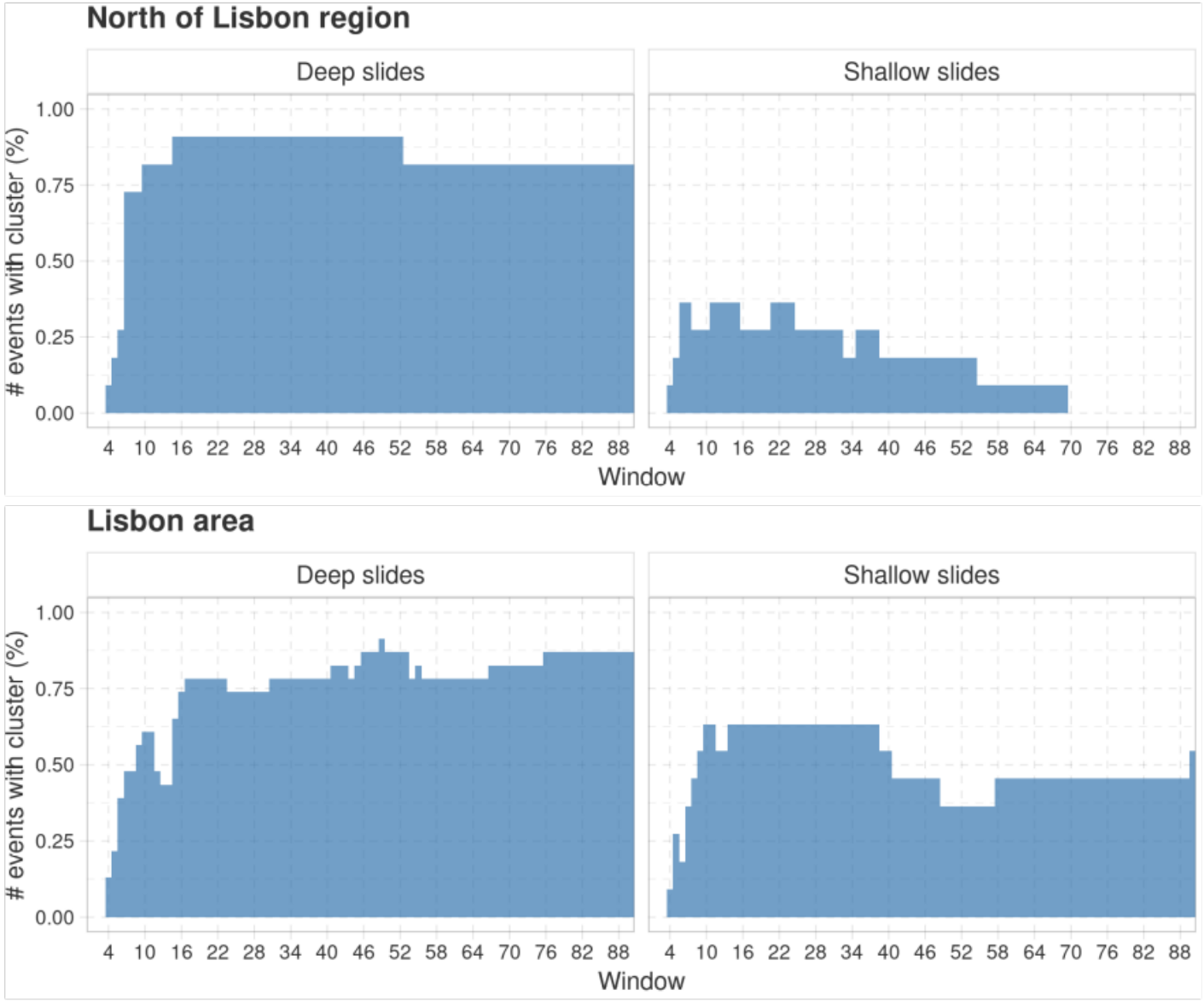
Our novel approach

A landslide is detect if temporal clustering is present in at least one of the windows from **4 to 90 days.** Different **threshold levels** are tested



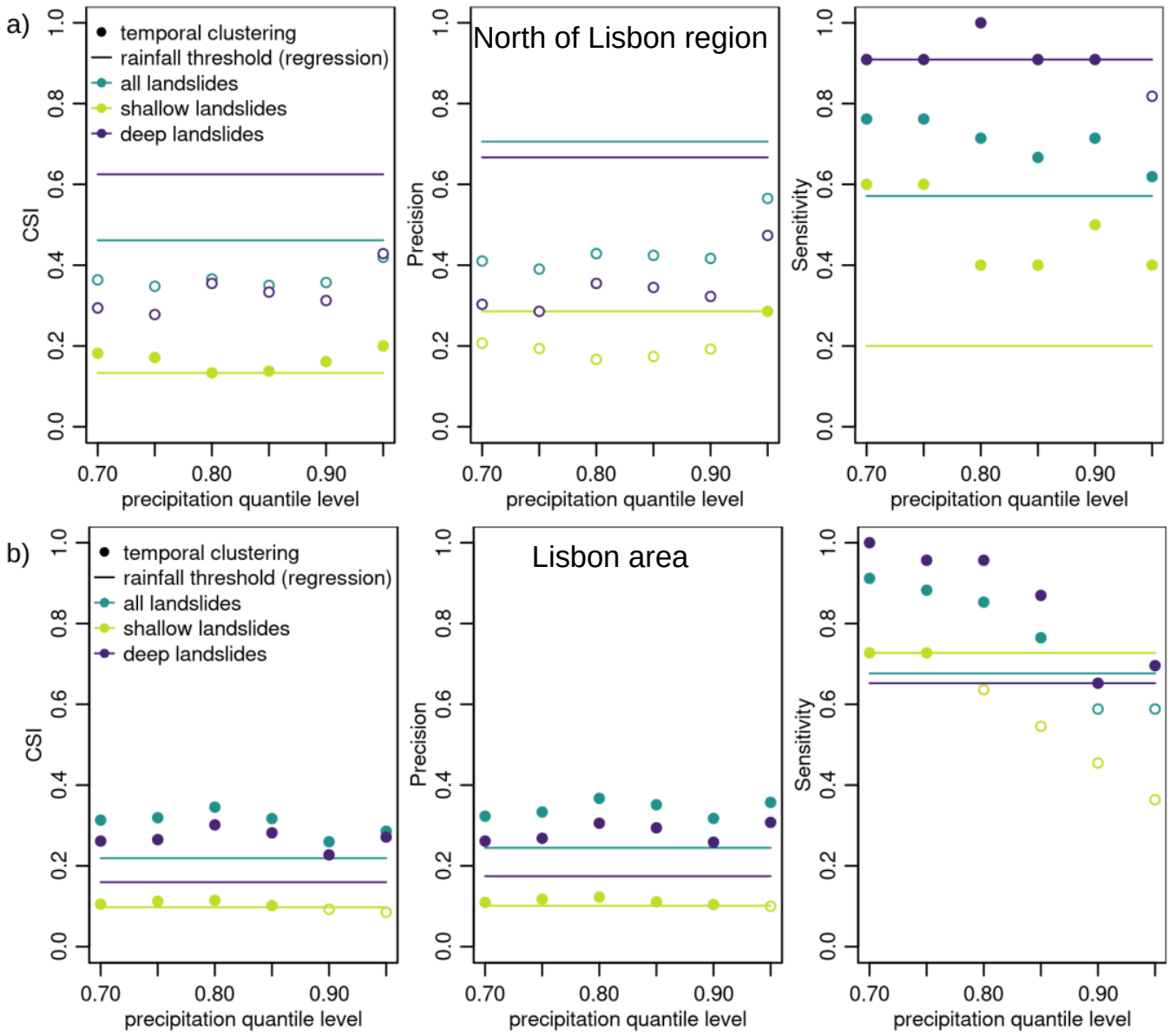
Sensitivity (POD)	Precision (SR)	Critical success index (CSI)
$\frac{TP}{TP+FN}$	$\frac{TP}{TP+FP}$	$\frac{1}{\mathrm{POD}^{-1}+\mathrm{SR}^{-1}-1}$

Temporal clustering before landslides



Results

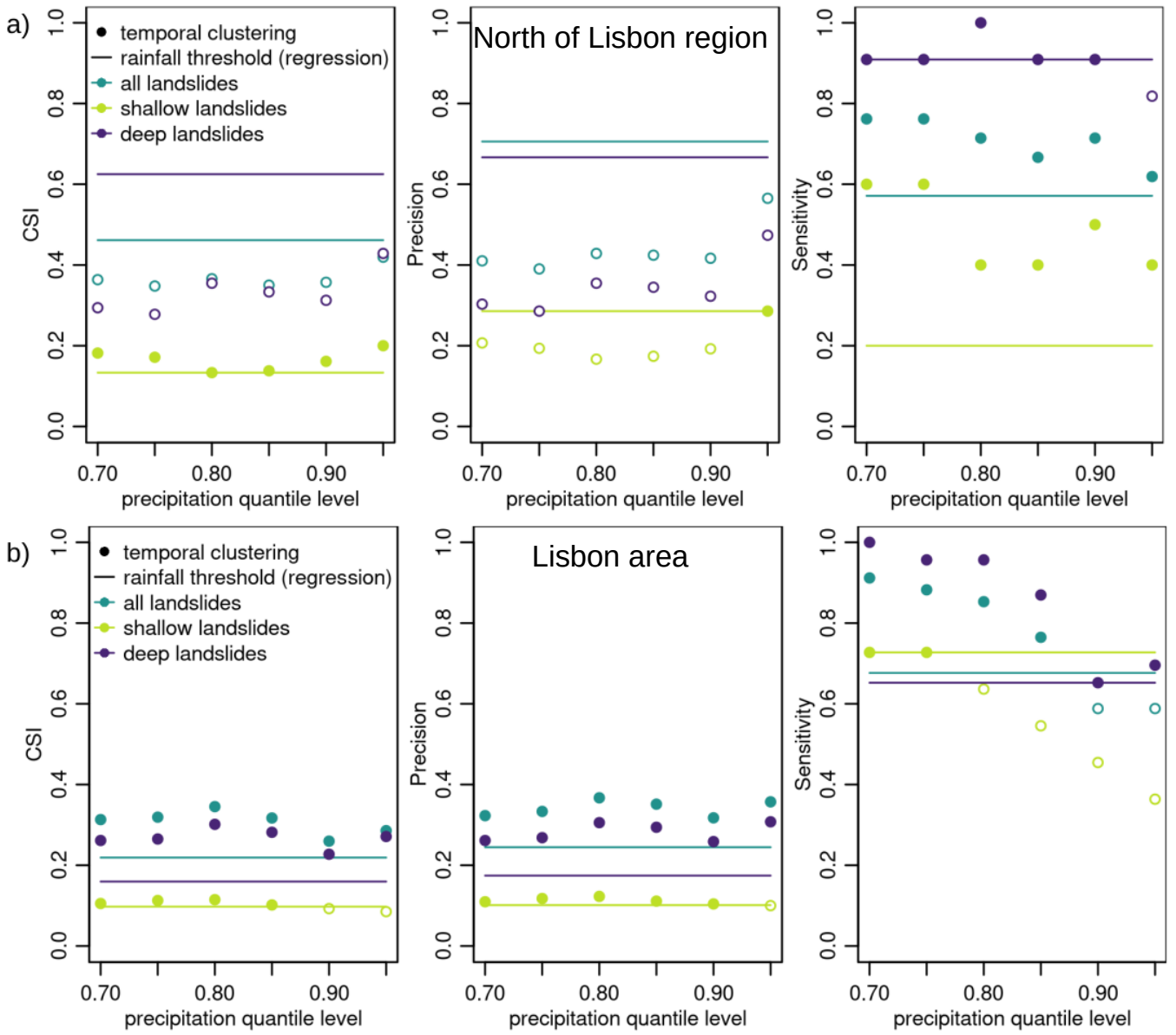
Better sensitivity of the new method, for both sites and type of landslides



Results

Better sensitivity of the new method, for both sites and type of landslides

Performances in terms of **precision** are fairly different **depending on the site**

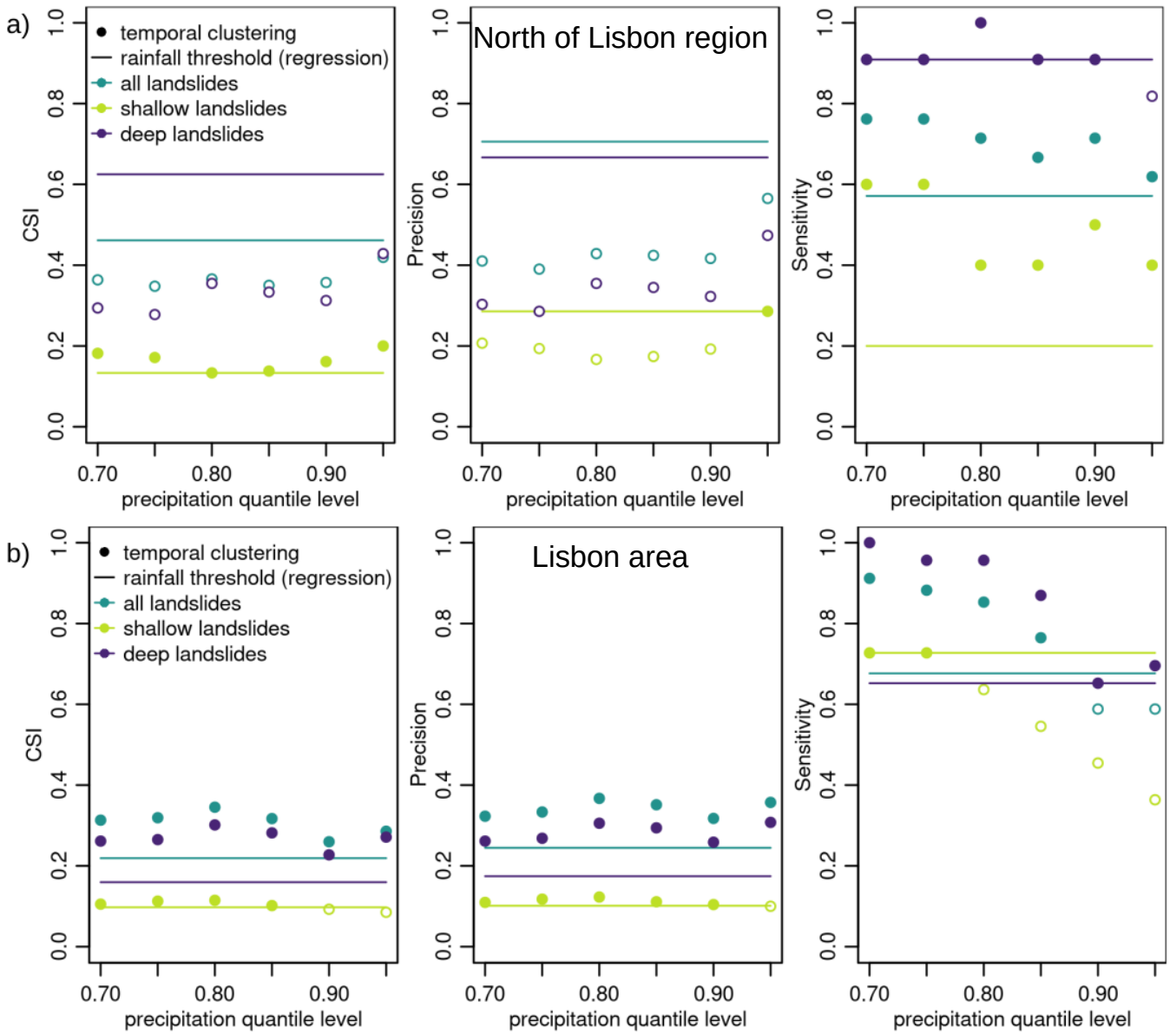


Results

Better sensitivity of the new method, for both sites and type of landslides

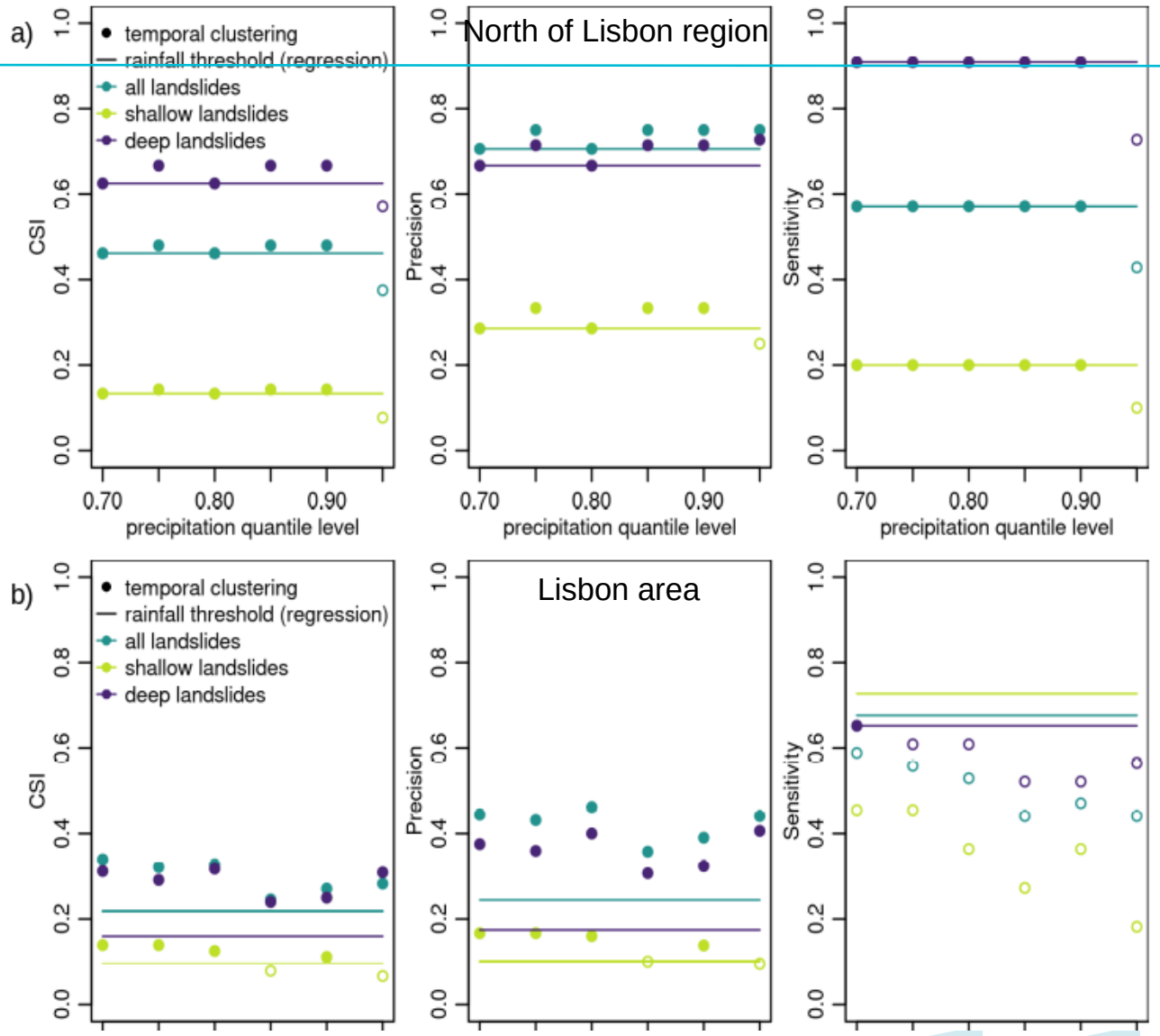
Performances in terms of **precision** are fairly different **depending on the site**

Combining the two indexes (CSI), we observe **higher performances** for Lisbon area and **variables performances** for North of Lisbon region depending on landslide event types



Results

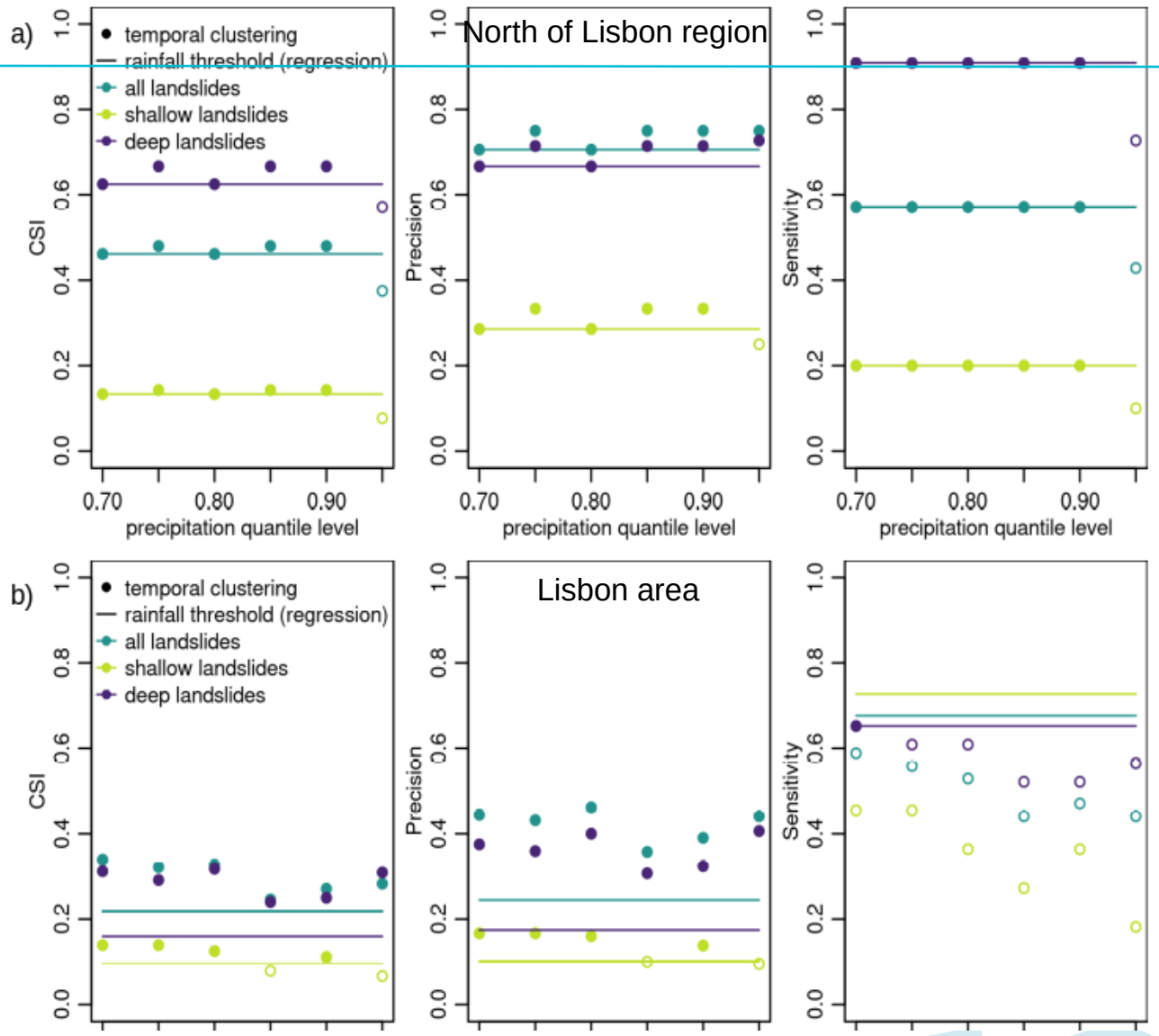
We have worse or equal performances in term of **sensitivity**



Results

We have worse or equal performances in term of **sensitivity**

Performances in terms of **precision** are better in both sites

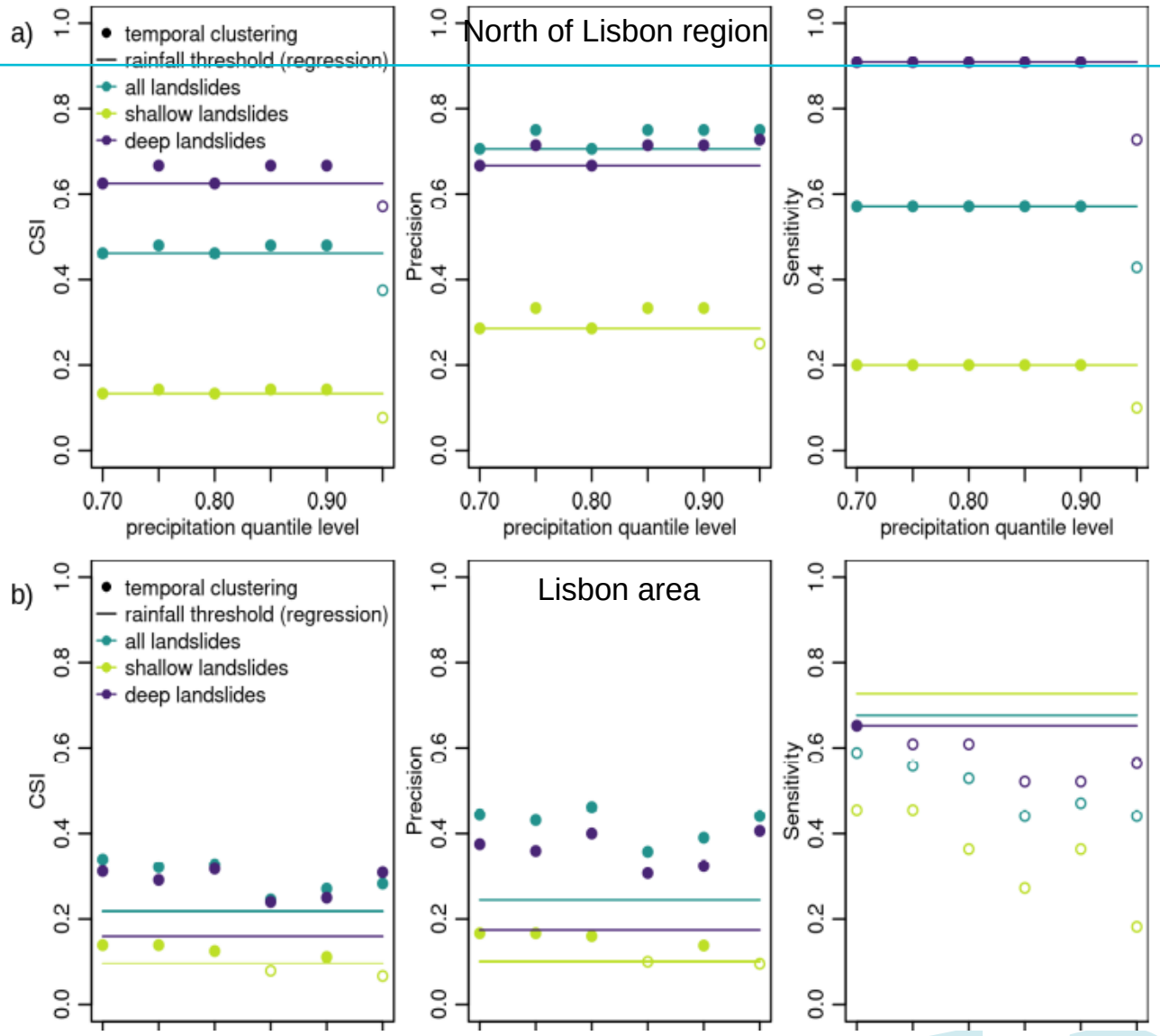


Results

We have worse or equal performances in term of **sensitivity**

Performances in terms of **precision** are better in both sites

Combining the two indexes (CSI), we observe **higher performances** for both sites



Conclusions

Temporal clustering of precipitation has an important role in the occurrence of landslides and it has promising performances as detection tool for landsides, mainly in terms of sensitivity. Combined with empirical rainfall thresholds it instead increases precision.
Given the observed differences in the performances depending on the dataset, the application to other inventories could confirm these results.

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Banfi, F., Bevacqua, E., Rivoire, P., Oliveira, S. C., Pinto, J. G., Ramos, A. M., and De Michele, C.: Temporal clustering of precipitation for detection of potential landslides, Nat. Hazards Earth Syst. Sci. Discuss. [preprint], https://doi.org/10.5194/nhess-2023-212, in review, 2023.

References

J. L. Zêzere et al. «Rainfall thresholds for landslide activity in Portugal: a state of the art». In: Environmental Earth Sciences 73.6 (2015), pp. 2917–2936. DOI: 10.1007/s12665- 014-3672-0.

J. Zscheischler et al. «A typology of compound weather and climate events». In: Nature reviews earth & environment 1.7 (2020), pp. 333–347. DOI: 10.1038/s43017-020-0060-z

E. Bevacqua et al. «Guidelines for studying diverse types of compound weather and climate events». In: Earth's Future 9.11 (2021), e2021EF002340. DOI: 10.1029/2021EF002340.

F. Banfi and C. De Michele. «Compound flood hazard at Lake Como, Italy, is driven by temporal clustering of rainfall events». In: Communications Earth & Environment 3.1 (2022), p. 234. DOI: 10.1038/s43247-022-00557-9