TEMPORAL CLUSTERING OF PRECIPITATION FOR DETECTION OF POTENTIAL LANDSLIDES

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Temporal clustering

Modulator → Driver 1 → Driver 2 → Driver n → Hazard → Impact

Zheischler et al. 2020
Aim of the work

Improving landslides detection using information on temporal clustering of precipitation with respect to classical empirical rainfall thresholds
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 $w \sim \text{Bin}(w_{\text{eff}}, p)$
5. If not $\rightarrow$ temporal clustering

$w_{\text{eff}} \rightarrow$ window size reduced due to high-frequency declustering

$P \rightarrow$ 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

<table>
<thead>
<tr>
<th>Sensitivity (POD)</th>
<th>Precision (SR)</th>
<th>Critical success index (CSI)</th>
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</thead>
<tbody>
<tr>
<td>$\frac{TP}{TP + FN}$</td>
<td>$\frac{TP}{TP + FP}$</td>
<td>$\frac{1}{POD^{-1} + SR^{-1} - 1}$</td>
</tr>
</tbody>
</table>
Temporal clustering before landslides

North of Lisbon region

Lisbon area
Results

Better sensitivity of the new method, for both sites and type of landslides
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Performances in terms of precision are fairly different depending on the site
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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
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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 landslides, 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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References


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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