Flood synchronicity at confluences in the Danube river basin

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1. Introduction and research questions

Flood events have a **spatio-temporal connotation**: they are more than the simple overflow of water, submerging for a certain time normally dry lands. A flood is a complex process which includes implicitly the places where the water comes from and where it goes to, the duration of when the water started to rise to when it causes no more harm, and all the concomitant mechanisms in between.

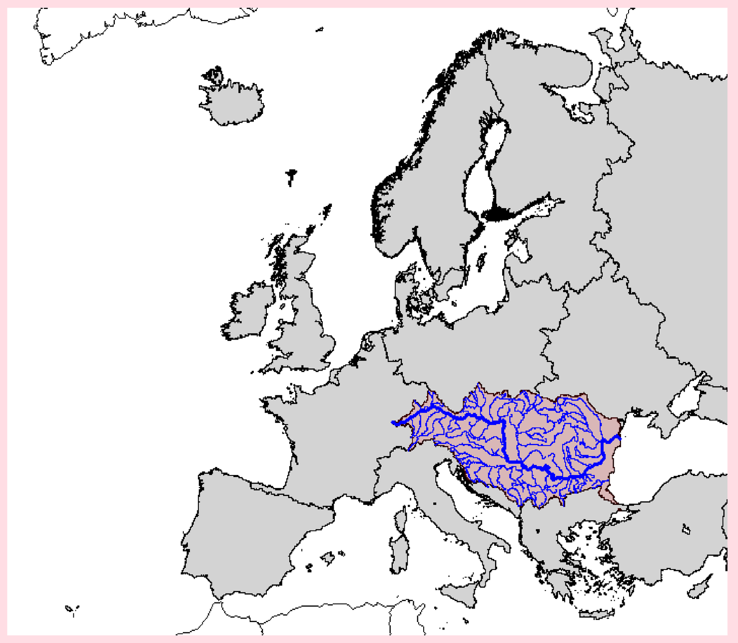
The present work is a preliminary attempt toward performing a regional characterisation of floods, through the quantification of the spatio-temporal **synchronicity in the Danube basin**.

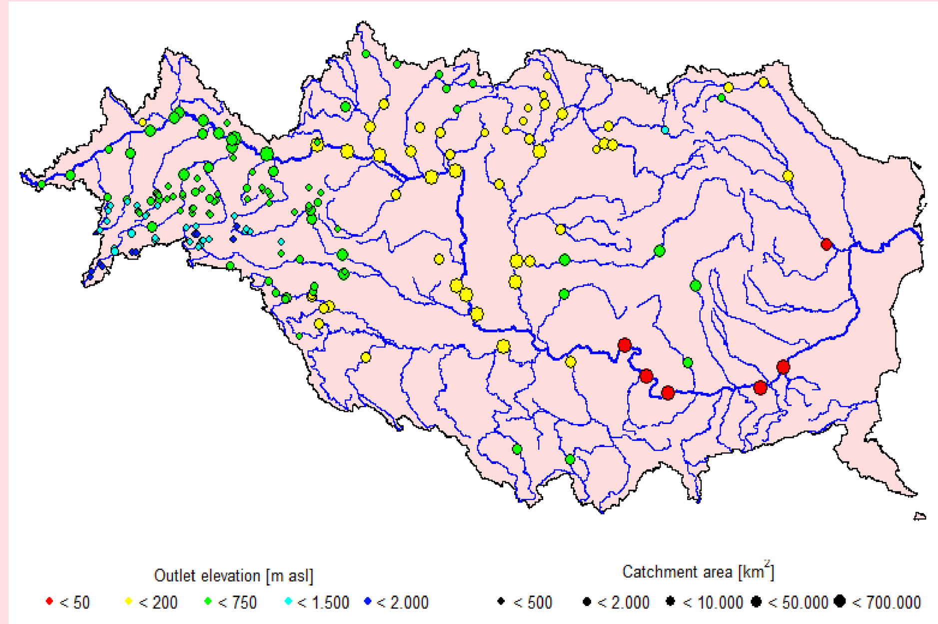
Three main research questions are the background of the analysis:
1) How **can we measure the flood synchronicity**, in a river basin, between nested catchments?
2) What are, if existing, the **spatial patterns of synchronicity**?
3) **How does synchronicity scale** with the ratio of nested catchment areas and their relative spatial distance?

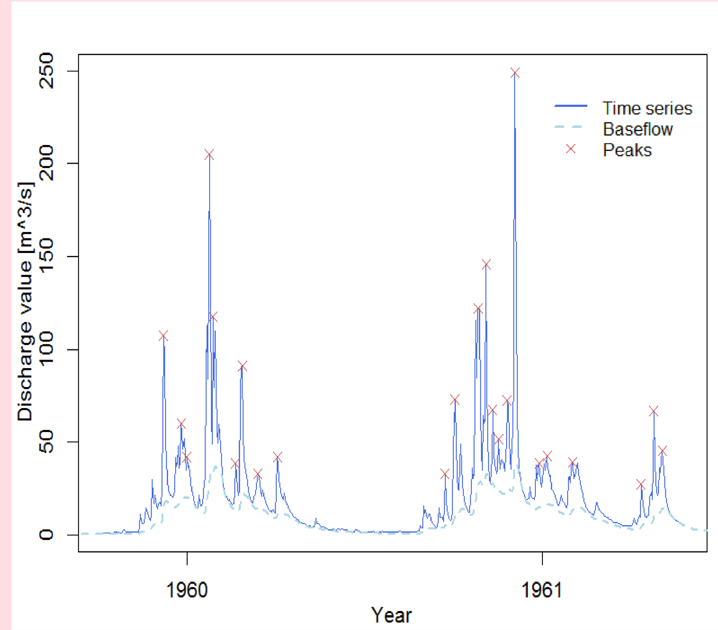
A **downward approach** is used here: flow data are collected from up and downstream gauging stations and **coincident floods are identified and compared in pairs**.

2. Case study and peak separation

Streamflow records of 196 Global Runoff Data Center stations are used here and a baseflow based algorithm is implemented as a filter of time series for peak flow separation. A digital catalogue of basin boundaries is thus developed based on the CCM database, to couple gauging stations and for visualization purposes.







3. Synchronicity in time and space

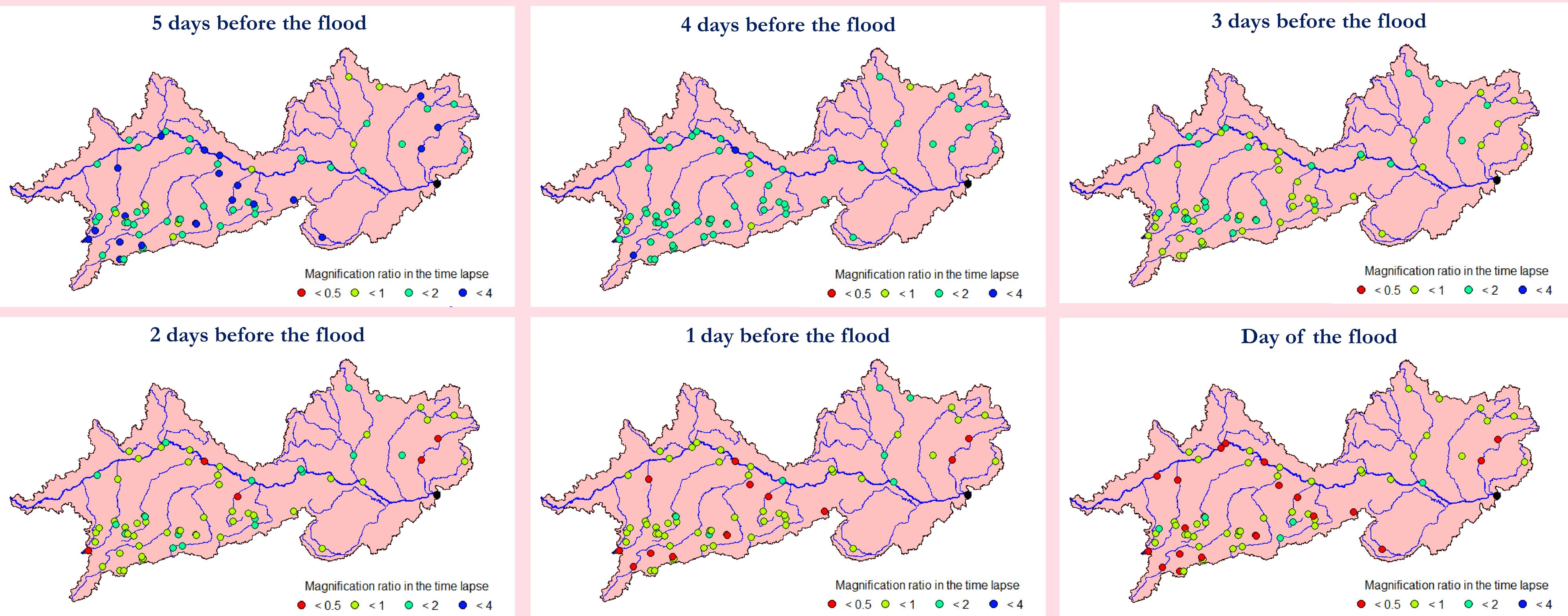
Spatio-temporal analysis of synchronicity: **time-lapse representation.**

How did the basin contribute to the flood in the antecedent days?

Magnification ratio:

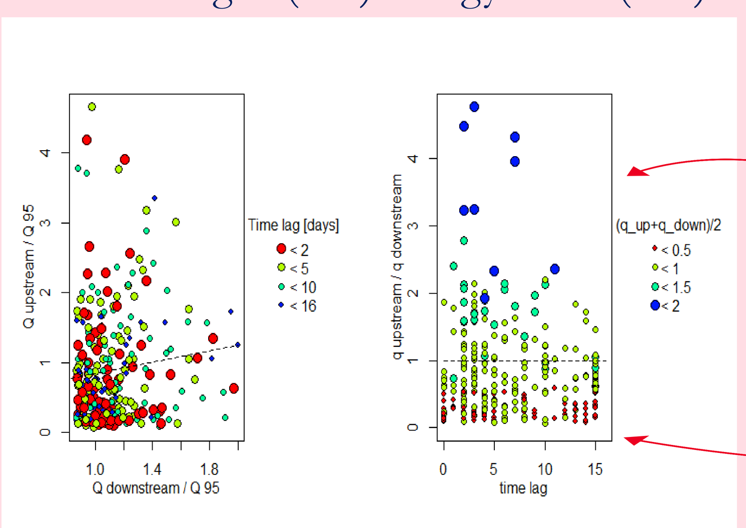
$$\frac{Q_{day\ i}}{mean(Q_{antecedent\ 5\ days})}$$

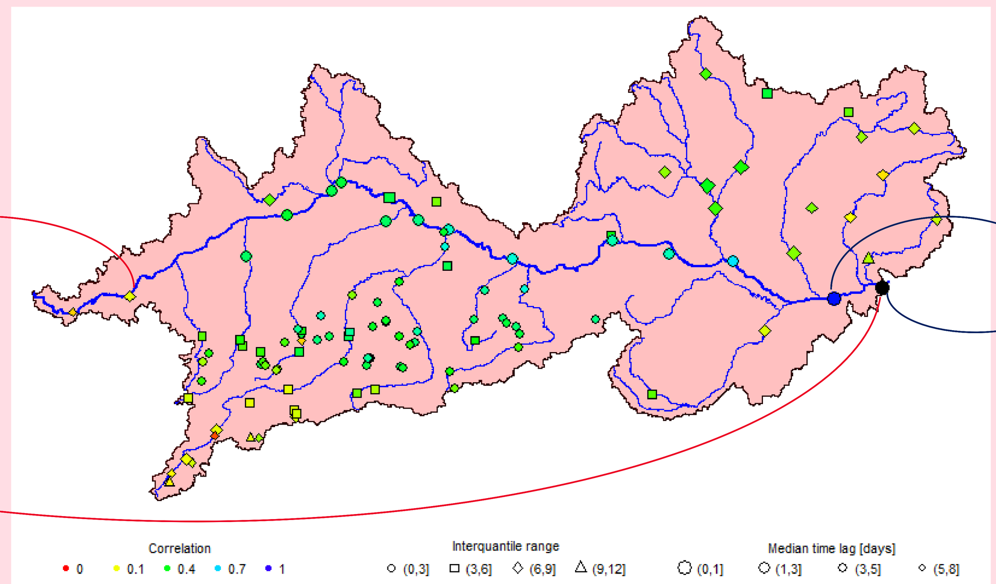
Station: Nagymaros-HU
Magnitude: Quantile 0.9
Date event: 24.07.1997



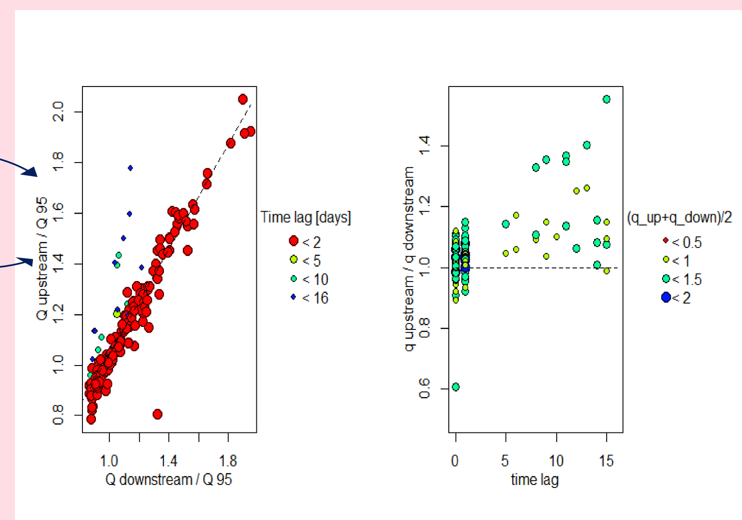
Synchronicity in the upper Danube

Hundersingen (DE) - Nagymaros (HU)





Dunaalmás (HU) - Nagymaros (HU)

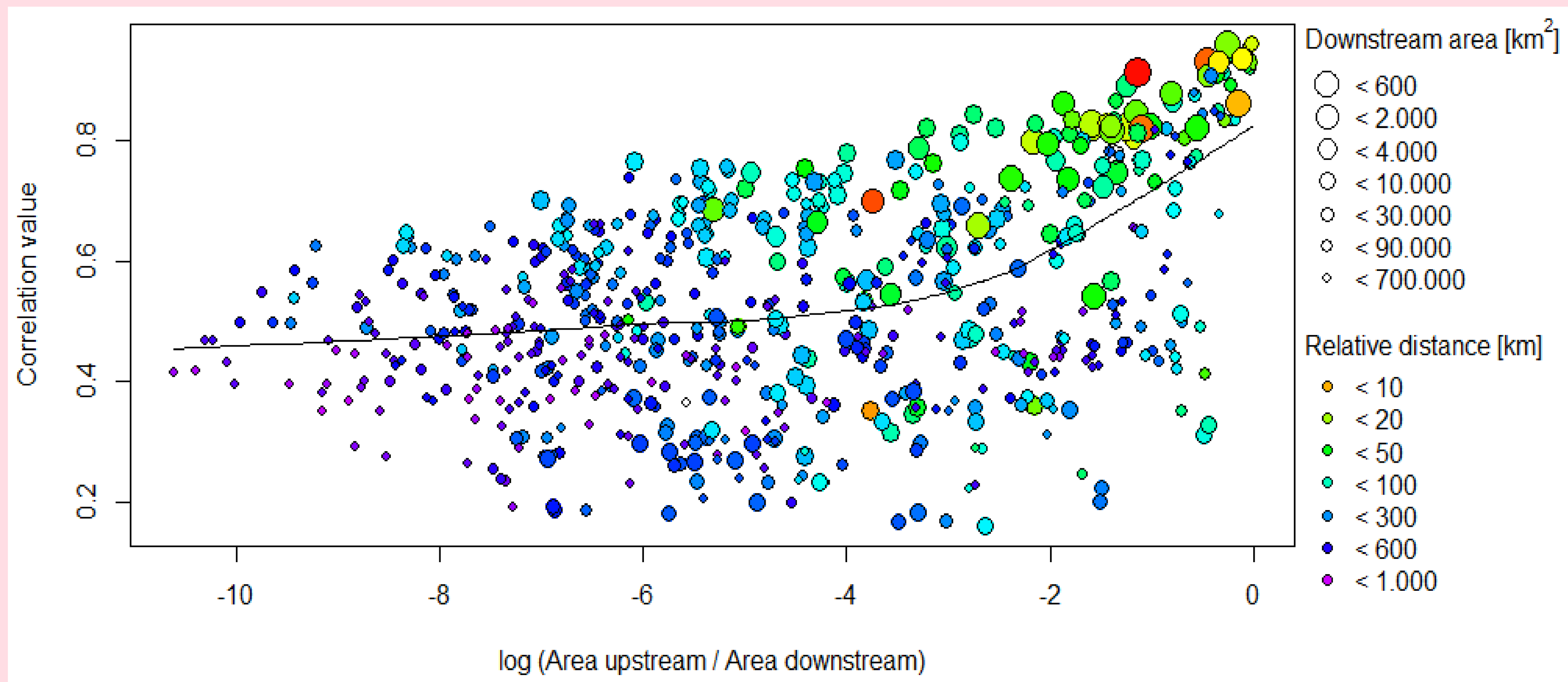


4. The scale of synchronicity in the Danube catchment

By coupling flood events downstream and coincident increase in discharge upstream, it is thus possible to evaluate synchronous responses across the whole Danube catchment, as observed correlation between discharge values.

Correlation values are shown as function of area ratio, downstream area and relative distance. Only significant values are presented here.

The line in black shows the LOWESS line (smooth coefficient 0.5).



5. Conclusions

Flood synchronicity is here defined as contribution of two factors: 1) **Correlation of coincident flood** peak **magnitudes** at upstream/downstream sites; 2) **Inverse of the time lag variability** of flood waves recorded.

Results show **spatial patterns of the synchronicity** between one downstream gauge and all the upstream ones. The **synchronicity** is **maximum for neighboring gauges** on the same river reach and greater **for small neighboring catchments**.

The practical value of this study is **to provide means to assist/enhance regional flood frequency analyses**, i.e. to use the information on data dependency to improve flood peak estimation in ungauged catchments.

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