Can tree-ring isotopes be used for improving the flood frequency analysis?

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For over forty years, tree-ring studies have been used to analyze flood frequency and magnitude. This is the so-called dendrogeomorphology or dendrohydrology, which are two subdisciplines of dendrochronology. On the other hand, for several years, stable and radiogenic isotopes in tree-rings have been also used for reconstructing past environmental conditions (i.e. temperature, precipitation and water availibility) and their pattern changes.

However, so far both techniques and approaches have not been combined and integrated. One possible application of this integration could be improving the flood frequency analysis for hazard and risk assessment. As is well known, the floods may have different origins and causes, such as heavy convective rainstorms, persistent frontal precipitations, snow melting, etc. Each those floodwater sources have their particular isotopic fingerprints, which can be used for identifying the meteorologic origin of the flood. This classification allows us to sepparate different populations of flood events and then apply individual frequency analysis to each data sample, improving the return period estimation compared to conventional analysis of the entire mixed dataset.

In fact, during a particular tree growing season, the floodwaters may have one of those predominant sources (i.e. convective, frontal, snow melting...); so, trees close to the watercourse would only use a specific floodwater isotopic fingertprint in their physiological activities. Therefore, if we date the flood event using dendrogeomorphic techniques based on anatomic evidence, it could be possible to relate this flood event to its meterological origin by mean tree-ring isotopes. Our hypothesis is that if we apply these procedures to several past floods, we could distinguish different populations of flood events based on their floodwater sources. It could help us to improve the return period estimation compared to conventional analysis of the entire mixed dataset, which could be consequence in the hazard flood asessment and we could apply separate frequency analysis.

The research projects MAS Dendro-Avenidas (www.dendro-avenidas.es, funded by the Spanish Ministry of Science and Innovation), and IDEA-GesPPNN (funded by the Spanish Environmental Ministry) are exploring this reseach line. This communication presents an overview of this innovate methodological proposal, focused on their possibilities and limitations for improving flood frequency analysis in Spain using tree-ring isotopes. We are beginning to study the 16O/18O ratio patterns of different types of precipitation in Central Spain corresponding to recent wellknown flood events. These singular events will be choosen looking for vegetative periods in which only one type of precipitation has been described in the meteorological reports. Later, it will be analyzed the alpha-cellulose 16O/18O ratio form the wood sequence used for dating flood event by dendrochronological techniques.

Both isotopic ratios will be compared in order to find statistical relations. These results will be used to extrapolate this relation to the entire tree-ring sequence completing the past flood record and their classification in two or three event populations. The last step will be the frequency analysis of each single population, and the comparison with the traditional frequency analysis of the entire flood dataset.

This year by year or even intra seasonal decoding of isotopic information may represent a powerful tool for the reconstruction of environmental changes (extreme flood events) and its application to the natural risk assesment and prevention.