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Past Holocene detritism quantification and modeling from lacustrine archives in order to deconvolute human-climate interactions on natural ecosystem over long time-scale

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Study site

This method is applied to close but contrasted mountainous lacustrine environments from the western French Alps: Lakes Blanc Huez (g) and Paladru (q), sensitive to same climatic influences but where past human activities were different (mining versus agriculture, respectively). Lakes Blanc Huez and Paladru are defined by period Holocene chronologies and well detailed lithofacies (Simonneau et al., 2013 - JAS) and in press - QSR. Soils, rocks (g) and lacustrine sediment (q) were sampled and analysed for each site in order to calibrate climatic and organic signals.

Climate- versus human-driven soil erosion over the Holocene in French Alps

Based on AMS 14C, 137Cs, 210Pb and historical events, Holocene alpine environmental changes in the vicinity of lakes Blanc Huez and Paladru were reflected by clastic and organic signals (magnetic susceptibility, spectrocolorimetry, XRF core scanner, laser ICP-MS versus Rock Eval pyrolysis, quantitative organic petrography, molecular compounds) see Simonneau et al. (2013, JAS) and Simonneau et al. (in press, QSR) for more details.

Results

Both archaeological evidences and interdisciplinary characterizations of Lake Blanc Huez sedimentary infill demonstrated that, over the Holocene period, the system is only sensitive to climatic forcing and that soil fluxes are therefore only related to run off processes and not in relation to mining activities close to the lake [Simonneau et al., in press - QSR].

Holecos soil fluxes (a) were therefore considered as being proportional to snow and/or water rainfalls and the volume of soil accumulated into the lake (b) was used to estimate annual precipitation in the vicinity of Lake Blanc Huez for the last 10000 years (s).

Results show that rainfall has been threefold between the Holocene Climatic Optimum and the Late Holocene. Modern estimation is in agreement with meteorological data (see Study site). However, our model need to be improved notably during the Little Ice Age or the Dark Age during which snow accumulation could exaggerate soil fluxes, and the Roman period and the Iron Age when Lake Blanc Huez infill was disturbed by mass wasting deposits.

Conclusions

Humans are considered as geomorphologic agents since few thousand years and it is now recognized that such an impact on natural ecosystem profoundly modified soils properties as well as aquatic ecosystems dynamics over long-term periods. For the first time, we develop an integrative approach combining the multiparameter characterization of natural lacustrine archives with soil erosion modelling over long time-scale. Such approach is not only relevant to reconstitute past hydrological changes but also promising since it allows to objectify quantify and rate which and when past human activities have had an impact on soil fluxes over the last 10000 years. The quantification of such inference over long time-scale is essential to establish new policies to reduce mechanic soil erosion, which is one of the dominant processes in Europe, and anticipate the potential consequences of future climate change on hydric erosion.

References & Acknowledgements

Simonneau et al., in press – Quaternary Science Reviews.

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