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Quantifying geomorphological response to climate change by "unmixing" of lake sediments from Lake Donggi Cona, north-eastern Tibetan Plateau, China

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The catchment of Lake Donggi Cona, situated at north-eastern Tibetan Plateau, is a region influenced by monsoonal air masses of different origin and character, highly variable in space and time. Reconstruction of Quaternary monsoon dynamics focuses mainly on high-resolution archives (e.g. glacier ice and speleothem records) with detailed proxy information on temperature and precipitation regimes in the past. However, also sedimentological and geomorphological processes respond to and register monsoon dynamics, mainly amount and spatio-temporal variation of precipitation. In lake catchments, climatic signals affect the whole process system within the geomorphological inventory on different scales. Sediment traps store these signals and the landscape's response to them, though buffering and topological dependencies of archives have to be considered. Within temporal or final sediment storage basins, sediment properties represent a mixture of terrestrial and lacustrine processes during and after deposition (e.g. aeolian, fluvial transport, and water current directions). Each process as well as different sediment sources (e.g. sub-catchments with a certain geochemical and mineralogical fingerprint) can be regarded as an end-member.

We present an approach of “unmixing” lake sediment properties, i.e. grain size distributions, geochemical and mineralogical compositions, to reveal end-members of geomorphological processes and sediment source. In a first step, modern surface samples from the bottom of Lake Donggi Cona are used to test a flexible iterative end-member modelling algorithm (EMMA) with different types of data transformation, eigenspace analysis and goodness-of-fit tests. Empirical end-members are derived and compared to natural end-members, i.e. terrestrial surface samples from locations dominated by a single geomorphological process regime or sediment source. Using Bayesian approaches, conditional probabilities can be given for the variation within and between sediment properties. This determines the significance of a single value against randomness and accounts for interferences and/or buffering of external signals in the sediments. As a second step, end-members derived from modern analogues as probability density functions can be applied to fossil lake sediments of high resolution reaching back to the Last Glacial Maximum. Thus, a spatio-temporal quantification of geomorphic processes and regions is facilitated probabilistically and allows a coupling with climate records.