# HUMAN-ASSOCIATED ECOLOGICAL EVOLUTION HISTORY OF LAKE ERHAI IN YUNNAN, SOUTHWESTERN CHINA OVER THE PAST ~150 YEARS

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Lacustrine ecosystem history since the industrial revolution provides important evidence of natural vs. anthropogenic effects on the environment. With high-resolution sedimentary core samples and organic geochemical methods, here we reconstruct the past ~150-year ecosystem evolution history of Lake Erhai in Yunnan province, southwestern China, which is facing severe damage in lake ecosystem due to eutrophication after AD 1996. Our objectives are to 1) see whether there is an early warning signal in biomarker data for transitions in the ecological system, 2) probe the controlling factors on the evolution of the ecological dynamics, and 3) identify the anthropogenic effects on the ecosystem evolution in Lake Erhai since industry era.

According to our results, both bulk organic carbon/nitrogen contents and molecular biomarker occurrences clearly demonstrate a natural background with low *in-situ* productions before AD 1970s, an early stage of eutrophication during AD 1970s-1990s and accelerated eutrophication after AD 1990s, tentatively suggesting potential early warning signals 10-30 years before clear regime shift. Sterol results also show different distribution patterns before and after AD 1970s, suggesting that ecological transition of algae species at that time due to the changes in the trophic status. This ecological transition can also be observed in odd-even preference of short-chain n-alkanes, from even-number domination before AD 1930s to odd-number domination after AD 1970s, tentatively suggesting more contribution of cyanobacterial.

Relative terrestrial vs. aquatic input indicated by the bulk $\delta^{13}C_{org}$ values and the average chain length of *n*-alkanes, *n*-alkanols, indicates a relatively high and stable terrestrial input before AD 1950s. The relative terrestrial input depleted during AD 1950s-1990s and increased after AD 1990s, even though the input of both terrestrial and aquatic organics to sediments continuously increased after AD 1970s. In this sense, we propose that relative terrestrial vs. aquatic input seems to be primarily controlled by the human-controlled hydrological parameters (lake level, discharge) instead of the eutrophication condition.

The bulk $\delta^{13}C_{org}$ and $\delta^{15}N$ values show strong positive correlate in sediments before AD 1970 ($r^2$=0.70, n=26). This strong correlation turned into a negative one after AD 1970s, suggesting a shift in the nitrogen source such as drainage from farm fields and urban wastewater due to accelerated agricultural and industrial activities. The increasing input of coprostanol and epi-coprostanol also supports an accumulated effect of sewage and cattle faeces flowing into the lake ecological system. Increasing ratio of coprostanol vs. epi-coprostanol toward the top sediment further indicates more urban wastewater/sewage over cattle faeces in the recent years. Therefore, we believe that anthropogenic contamination largely accounts for lake's trophic state and ecological dynamics. When the nutrient input crossed the tipping point after the AD 1990s, it triggered the eutrophication, resulting in an ecological disaster in Lake Erhai.