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Stable isotope perspective on pollution budget of Inle Lake, Myanmar

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Many lakes around the world are experiencing increasing eutrophication arising from the intensification of farming and agriculture. Eutrophication is frequently associated with contributions from several sources of pollution. Many of these sources are directly associated with agriculture activates, e.g., fertilizer application, manure discharge, and land use changes but they are also frequently accompanied by non-agricultural pollution sources, e.g., municipal or industrial pollutions. Traditional hydro-chemical techniques are insufficient to evaluate the relative contributions of inputs from different types of human activities. Therefore, in this study, we combined conventional hydro-chemical analyses of major ions with the stable isotope analyses of water molecule δ2H(H_2O) and δ18O(H_2O), sulphates δ34S(SO4) and δ18O(SO4) and nitrates δ15N(NO_3) and δ18O(NO_3) to estimate agro-pollutant inputs to Inle Lake. Inle Lake is a freshwater lake located in the Nyaungshwe Township of Shan State in Myanmar. It is the second largest lake in Myanmar (area 116 km2, average depth < 4 m), however, the open water area is progressively decreasing. The Lake is one of the major tourist attractions of the country and well-known for its floating gardens. In 2015 it has been added to World Network Biosphere Reserves of The United Nations.
During preliminary sampling campaigns in 2018 water samples were collected from several rivers and creeks (17 samples) and the Lake (12 samples). All samples were freshwater and had TDS values that varied between 122 and 730 mg/L, whereas δ18O(H_2O) values varied between 4.79 ‰ and -7.58 ‰Ṫhe lack of statistically significant correlations between Total Dissolved Solids (TDS) and δ18O(H_2O) suggested that local differences in solute inputs rather than evaporation were driving the variation in TDS between sub-catchments. The NamLat River discharging from the agricultural area to the north and inflowing to the Lake via canals that pass through several villages and Nyaungshwe city contributes ∼37% of the water to the Lake budget and likely is the major source of pollution. However, the river δ15N(NO_3) and δ18O(NO_3) values are in the range typical for manure and municipal wastewater, not fertilizers. The second largest river, Balu River, contributes ∼22% water to the Lake. Its uppermost part of catchment was characterized by δ34S(SO4) ∼5.1 ‰ similar to the potentially less polluted upper parts of the Namlat catchment. However, the δ34S(SO4) in the river significantly changed downstream to -1.6 ‰Ṫhese very low values are also reflected in the change of the δ34S(SO4) value in the Lake from 16.0 ‰ above the Balu river inflow to 12.0 ‰ below the inflow, at the outflow from the lake. These results suggest that sulfur budget in the southern part of the lake can be primarily dominated by industrial pollutions from Tigyit Region. The major challenge is to clarify the ambiguous stable isotope signatures resulting from the overlapping values of different sources. However, to a large extent, this issue can be addressed using denser sampling to first determine pollution budgets in individual subcatchments.

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