Climatic Records During Last 1500 Years in the Sediments of Lake Nakatsuna, Central Japan

Danda Pani Adhikari[1], Fujio Kumon[2]

[1] Environmental System Sci., Shinshu Univ, [2] Environmental Sci., Shinshu Univ.

Sediment cores from Lake Nakatsunako record a climate-modulated history around the lake during the last 1500 years. The data derived from the analysis of organic and inorganic fractions of the sediments indicate the exiestence of a relatively dry and warm climatic phase in AD 10-13 centuries and a somewhat complex period of dry and cool phase in AD 15-19 centuries. These two phases are separated by a short period of pronounce wet climatic interval.

Lake Nakatsunako is a small lake (0.125 km2) located near the Japanese Alps at 820 m altitude and tend to be sensitively affected by the climatic change in local and regional scale. Three sediment cores (304-342 cm) were extracted from the central part of the lake by piston corer and analyzed at 1 cm interval for C, N and sand content analysis. Lithologic changes tend to be similar in all the cores. The sediment is generally non-bioturbated mud with some turbidite layers characterized by coarser grain size. The age and sedimentation rates were determined by AMS radiocarbon dating.

Sediments are mainly silty-clay with abundant organic materials. Density decrease downwards with some short-term fluctuations and 2 major jumps. There is a good agreement among the peaks in the density profile, visual observation, X-ray photograph and sand contents. TOC is from 8 to 13 per cent, and C to N weight ratio ranges from 12 to 15 These values indicate admixing of phytoplankton and terresterial plant materials but the former stand out dominant. The density, sand content, and C and N content enable to divide the sediment into the following three parts. Lower interval (AD 520-1295): low density and low coarse fraction with lower accumulation rate (1.7 mm/y, 50 mg/cm2/y) and higher TOC (12 per cent, 8.5 mg/cm2/y); middle interval (AD 1295-1420): higher density and highest coarse fraction content with highest accumulation rate (8.48mm/y, 271 mg/cm2/y) and lower TOC (10 per cent, 27 mg/cm2/y), and the upper interval (AD 1420-Present): highest density and intermediate in coarse fraction content with lowest accumulation rate (1.34 mm/y, 47 mg/cm2/y) and lowest TOC (8 per cent, 4 mg/cm2/y).

Some basic assumption has been made in order to explain the facts. At a particular site, variation in clastic sediment size distribution with time is largely controlled by the surrounding hydrologic condition, which itself vary under climatic control. When sediment-laden high discharge enter a lake it plunge below the lake water as a turbid underflow and much more sediment held in suspension supported by turbulence. In the mean time, coarse grains move close to the bed and/or drop down from suspension. As the lake water residence period reduce during flooding, part of the fine particles removed in suspension from the lake through discharge. The combine effects make the sediment more coarser. If the flood sweep abundant terrestrial plant materials with sediments, the rapid burial may enhance the TOC content and elevate C to N ratio.

On the basis of similar reasoning, both the reduced competency to carry coarse fraction and extended lake water residence period during low discharge condition make sediment enriched in fine fraction. Moreover, if the climate is warm enough, the available plant detritus would be more degradable and thus have relatively higher TOC and C to N ratio. On contrary, the TOC content may decline under the influence of cold climatic condition although the supply remains unchanged.

If the assumptions mentioned above are valid, the organic C, N and the synchronous siliciclastic sediment are the potential paleoclimatic proxy and hence the observed 3 intervals represent 3 major climatic phases. The minimum coarse fraction and the sediment accumulation rates coupled with high TOC and C to N ratio in the lower interval in general and the marked paucity in the coarse fraction in the upper part of this interval in particular indicate the prevalence of dry and warm climatic condition, which correspond to the "Mediaeval Warm Period". On contrary, the ubiquitous nature of coarse fraction and the highest sediment accumulation rate along with turbidite horizons indicate rapid burial and hence wet period. The marked reduced trend in the C content and the coarse fraction in the upper interval indicate the changed climatic condition. With lacking precision, part of this interval presumably indicate the so called "Little Ice Age".