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Impacts of Human Activities on Shallow Eutrophic Lake

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Abstract

Mercury and its derivatives are dangerous environmental contaminants that may have a biomagnification effect on aquatic ecosystems and human health. Lake sediments can be used to reconstruct previous contamination levels and so identify anthropogenic or natural influences. In this study, the history of Mercury (Hg) deposition in sediments from China's Chao Lake, a shallow eutrophic lake, over the previous 100 years is examined. According to the findings, the history of Hg deposition during the past 100 years can be divided into three stages. Prior to the 1960s, there was little variation in the Hg concentrations in the sediment cores and little regional variation. Since the 1960s, the concentration of Hg has been steadily rising, with the western half of the lake region showing a higher concentration of contamination than the eastern half. Due to several centralised human-input sources, of the lake region. By examining relationships between Hg and heavy metals (Fe, Co, Cr, Cu, Mn, Pb, and Zn), stable carbon and nitrogen isotopes (d13C and d15N), nutrients, particle sizes, and meteorological parameters, the effects of anthropogenic factors and hydrological change are highlighted. The findings demonstrate that Hg pollution become more severe after the 1960s, mostly as a result of hydrological change, increased regional urbanisation, and the spread of human Hg sources.

Keywords: Mercury; Hydrological; Urbanisation; Eutrophic; Aquatic

Introduction

Additionally, it is discovered that evaporation, wind speed, and temperature combine to affect how Hg behaves in the environment and how it interacts with the environment. Due to the limitations of monitoring technology and financial restraints, direct long-term water quality monitoring was not started in the majority of China's lakes until the 1980s. As sediment cores preserve metal fluxes in aquatic systems and can be a useful tool for reconstructing contaminant histories and environmental fates, they can act as a valuable archive in the absence of long-term water quality monitoring data. Over the past century, mercury levels in lake sediment cores have considerably grown. In the United States, Lake Ballinger and Lake Whittington has both been the subject of investigations into mercury contamination of lake sediments have explored the effects of climate change on mercury buildup in a remote lake on China's southern Tibetan Plateau. The majority of current research has been concentrated on using mercury isotopes in lake sediments to identify previous anthropogenic mercury contamination or to assess mercury cycling. Anthropogenic eutrophication has affected Chao Lake, a semi-enclosed shallow eutrophic lake in China, over the past three decades, and it has been a source of widespread public concern since the 1980s. Few studies have specifically focused on mercury, despite the fact that a lot of research has been done on Chao Lake to address its historical records of numerous heavy metals, nutrients, polychlorinated biphenyls, polycyclic aromatic hydrocarbons, and organ chlorine pesticides. Understanding the Hg profiles of similar lakes in the Yangtze River Basin can be aided by research on Chao Lake [1].

The goals of this study are as follows to fill this knowledge gap: to investigate variations in the mercury supply to the lake and in the mercury by applying statistical analysis to indicators such as heavy metals Iron (Fe), Cobalt (Co), Chromium (Cr), Copper (Cu), Manganese (Mn), Lead (Pb), Zinc (Zn), and Mercury), Nutrients (Total Nitrogen (TN), Total Phosphorus (TP), Total Organic Carbon (TOC), d13C, and d15 N), and grain size, to resolve significant anthropogenic factors. distribution within the lake over the past approximately 100 years using sediment core Through an investigation of the relationships between Hg concentrations and temperature, precipitation, wind speed, and evaporation in the Chao Lake basin, this study also investigates this lacustrine ecosystem in the context of climate variability. Chao Lake is a 780 km2 shallow natural lake located in China (117°160–117°510 N, 31°250–31°430 E). Eutrophication and metal contamination have been brought on by intensified human activity in Chao Lake. The lake's water level has been managed since the dam's completion in 1963, and after the lake was impounded, the natural hydrological cycles were disrupted. Due to varying amounts of pollution in various areas, the two sample locations were chosen. The sample sites also have to have limited effects from disturbances, such as bottom-scouring or re-suspension, and a likelihood of long-term sediment buildup. Using a columnar sampler, the sediment cores were obtained in 2009. (50 cm long and 8 cm in diameter). Two 30-cm sediment cores were used. The following was the sample pretreatment process: The samples were homogenised after being freeze-dried, using a 0.125 mm screen and an agate mortar and pestle. Following that, the materials were digested with a Hydro Chloric Acid (HCl) and Nitric Acid (HNO_3) mixture. After extracting the samples with 1 molL1 HCl and heating them for 2 hours at 500°C, TP was calculated. An elemental analyzer was used to examine TN. After removing inorganic carbon with 1 molL1 HCl, TOC was measured using a TOC analyzer. Using six replicates of a homogenised sample, the analytical precision was less than 3% for TN and 5% for TOC [2, 3].

Following microwave digestion in a solution of HNO_3, HCl, and Hydro Fluoric Acid, heavy metals were found using inductively coupled plasma mass spectrometry. The precision of the heavy

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metal assays was estimated using the industry-standard reference sediment. Between 85% and 110 percent of Cr, Cu, Pb, Mn, Zn, and Co were recovered. Using a Hg detector and cold vapour atomic fluorescence spectrometry, the total Hg content of samples and blanks was determined. The average recovery of Hg was 98.3%. As a result, there was good agreement between the certified values and analytical values. The Paleoecological Investigation of Recent Lake Acidification (PIRLA) technique was used to ascertain the background Hg levels in the sediments of Chao Lake. Since it makes it easier to distinguish between anthropogenic and natural sources of heavy metals, the enrichment factor is frequently used to evaluate heavy metal pollution in sediments. The EF was used to assess the level of Hg contamination in the sediments of Chao Lake. Furthermore, to assess the impact of human-caused heavy metal contamination, the Geo Accumulation Index (Igeo) was used. The CN 05.1 grid observation data collection, which was created using the anomaly technique during interpolation with the horizontal resolution of 0.25°C, provided the meteorology data [4-6].

Discussion

The traditional agriculture of the entire watershed did not employ chemical fertilizers. Before the 1950s, no discernible increasing trends in Hg concentration were discovered in the two sediment cores; the lone modest increase seen in the 1930s may have been brought on by the First Chinese Civil Revolutionary War or the Second Sino-Japanese War. Before the 1960s, the two sediment cores' almost constant concentrations of Hg reveal the succession of a natural lake system with minor influences from human input in agreement with the amounts of nutrients, heavy metals, and persistent organic components in the sediment cores At various historical stages, the Hg level in the CL1 core is significantly higher than that of the CL2 core. A heavier Hg input has been observed in the western lake region, which is influenced by Hefei, than in the eastern lake region, which is surrounded by the smaller city of Chaohu, as a result of the distribution of the majority of the population and industry in the Anhui Province's capital city. Therefore, compared to the CL2 site, the impact of human sources of Hg, such as urban, industrial, and agricultural runoff, has been stronger in the CL1 sample site. Numerous studies have demonstrated that the trends in pollution observed in sediment cores are frequently greatly impacted by the local/regional urbanisation level. Hg accumulation in sediment cores is influenced by Hg emissions in the lake catchment, sedimentary rates, and sediment logical conditions of the lake. Therefore, Hg depositional fluxes rather than Hg concentrations are a better indicator of the buildup of Hg in sediments. The following equation was used to compute the Hg depositional fluxes [7-9].

Conclusion

Using the SPSS 18.0 programme, the data normality and Pearson correlations were examined (SPSS Statistics, IBM Corporation, USA). The Kolmogorov-Smirnov test was used to determine whether the data distribution was normal. At the 0.05 level of significance, the data on the content of Hg and heavy metals, nutrients, and grain size were normalised. The total Hg concentrations found in the two sediment cores showed a consistent pattern of variation, with peak concentrations occurring as the concentration rose from the bottom layers to the surface or subsurface layers. A relatively stable stage before the 1960s, a gradual increase from the 1960s to the 1980s, and a rapid increase from the 1980s to the present can be seen in the Hg concentrations that have accumulated in cores CL1 and CL2. Prior to the 1960s, the amounts of total Hg in dry sediment for CL1 and CL2 were 52.4 to 69.9 ngg1 and 43.5 to 68.8 ngg1, respectively. The Hg background values for the lake sediments exhibited little variation between the two sample sites based on the PIRLA technique are displayed by the two sample sites' mean values. The sediments from Chao Lake have a background level of mercury. According to the findings, background Hg levels were present in the lake sediment cores during the first stage [10].

Conflict of Interest

The authors declare no conflict of interest.

Acknowledgement

None

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