Recent lake level variations in Lake Haubi, central Tanzania, interpreted from pollen and sediment studies

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Received 12 August 1998; accepted 15 December 1998

Key words: lake levels, lake sediments, palaeoclimate, pollen, Tanzania, East Africa

Abstract

Variations in pollen assemblages and in physical and chemical composition of a dated sediment record from the small Lake Haubi in north central Tanzania, reveal lake level fluctuations since the late 19th century. Lake Haubi changed from a seasonally inundated swamp to a lake in the beginning of the 20th century. With the exception of 1942–44, when it dried out completely, it remained water filled until 1994 when it again turned into a swamp. The lake level fluctuations in Lake Haubi are largely in phase with fluctuations of the larger East African lakes levels during the 20th century, and are therefore interpreted as being mainly controlled by regional climatic fluctuations. However, the initial formation of Lake Haubi at the turn of the century was likely due to local catchment specific causes, e.g. changes in land use, as the rapid increase in the water level at this time does not correspond to other lake level records from the region.

Introduction

The large lakes of East Africa have gained increasing interest over the last decades as important sources of regional limnological, ecological and climatological information about past environmental change (Johnson, 1993; Johnson & Odada, 1997). However, studies of large lakes often demand substantial logistical support, and their large catchments exhibit a wide range of environmental change, which may make it difficult to interpret the sediment record. The less well studied medium and small sized lakes can also provide important information useful for palaeoenvironmental reconstruction. Small lakes can easily be studied even with limited logistical resources, and the fact that they are small make them sensitive to even relatively minor environmental changes. By comparing reconstructed lake level records from small lakes with proxy records from the larger East African lakes, the response in lake levels due to local environmental changes may be separated from regional climatic changes. When levels in most lakes in a region change simultaneously, the changes can only be a response to climatic change (Harrison, 1988). Instrumental records of East African lake levels are few, hence historical and geological evidence must often be used for lake level reconstructions, even for recent time periods. In this study, the pollen assemblage and sediment character of the small Lake Haubi, located in the Kondoa District in north central Tanzania, have been used to reconstruct fluctuations of the lake level since the late 19th century. An absolute chronology for the Haubi sediment record has previously been established through analyses of $^{210}\text{Pb}$ and $^{137}\text{Cs}$ (El-Daoushy & Eriksson, 1998).

Lake Haubi dried out in 1994, and this has become an issue in the ongoing debate about the environmental effects of a soil conservation programme in the Kondoa District. It is necessary to evaluate the relative importance of climate and man on induced environmental changes, including lake level changes, especially in semi-arid climates where open water resources are limited.
Physical setting

Lake Haubi (4°47'S, 35°57'E) is situated in the Irangi Hills in Kondoa District, north central Tanzania (Figure 1). It was a proper lake until 1994, when it dried out completely and became a densely vegetated swamp. The lake, located at an altitude of c. 1670 m a.s.l., had a size of 2.1 km² in 1987. The maximum water depth was 160 cm in October 1991 (Figure 2), 130 cm in July 1992 and 20 cm in February 1994. The catchment is 33.4 km² and is located in more elevated parts of the Irangi Hills. The pediment slopes in the catchment are 1–5 kilometers long and are dissected by numerous gullies, which in some areas form extensive badlands. Downhill, the gullies become broader, more shallow and eventually they merge into large sandfans, which in turn terminate at the shore of Lake Haubi. The lake sediment consists mainly of clay; the sandfans, the existence of a seasonal/permanent water body and the extensive reeds surrounding Lake Haubi, have facilitated the thorough sorting of the sediments. The sedimentation rate in the lake increased from around 1 cm/yr (1 g cm⁻² yr⁻¹) in the early 19th century to between 2 and 5 cm yr⁻¹ (2–3 g cm⁻² yr⁻¹) in the latter part of the 20th century (Figure 3), and is one of the highest recorded sedimentation rates in East Africa (e.g. Barton & Torgersen, 1988; Verschuren, 1994; Mohammed et al., 1995).

The Irangi Hills range in altitude from around 1200 m a.s.l. in the lower southeastern parts to above 2100 m a.s.l. in the northeast. The bedrock consists mainly of Precambrian feldspathic gneisses and schists (Quennell et al., 1956; Selby & Mudd, 1965). Soils occur in catena sequences along the hillslopes (Payton & Shishira, 1994; Yanda, 1995). The Irangi Hills have been uplifted relative to the vast Maasai plain to the east; this uplift has taken place in association with the formation of the East African Rift System (Aitken, 1950; James, 1956), a process which is still ongoing. Therefore, the geomorphology and drainage pattern of the Irangi Hills are largely controlled by tectonic structures (Eriksson, in press).

The climate of the Irangi Hills is semi-arid with a rainy season lasting from November to May. Rainfall is highly unpredictable and variations between individual years are large. However, interannual fluctuations of rainfall are markedly uniform over East Africa and appear to be governed by the movement of the Inter Tropical Convergence Zone (ITCZ) (Nicholson, 1997). Furthermore, rainfall fluctuations show strong links to the El Niño-Southern Oscillation (ENSO) phenomenon, with rainfall tending to be above average during ENSO years.

The median annual precipitation over the hydrological year (Nov–Oct) for Kondoa town was 641 mm from 1931–1995, and was 848 mm for Haubi mission from 1956–1989. Haubi mission is located at a higher altitude (1670 m a.s.l.) than Kondoa town (1350 m a.s.l.) and is subjected to orographically enhanced precipitation (Figure 4). The mean annual potential evaporation has been measured at 2093 mm (1936–1948) for Kondoa town (Woodhead, 1968). There is a surplus of water from December to April, and a