Environmental change

Climate change in East Africa

The isotopic record from Ethiopian lakes

by Melanie Leng, *Keyworth*

Tim Cullen, BGS © NERC

Melanoides tuberculates. *A freshwater snail found in Ethiopia.*

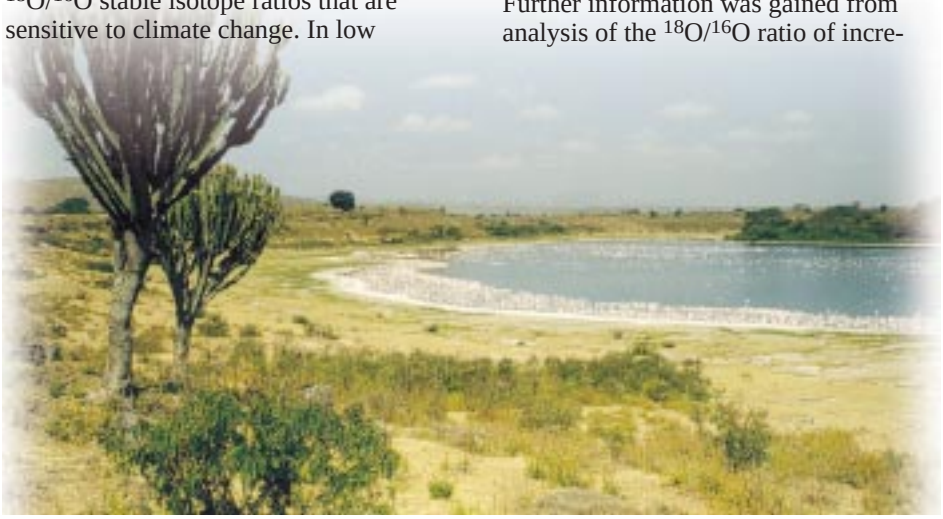
Are recent weather extremes a result of random climatic variability or are they part of a natural cycle of climate variation? This is a crucial question as climate variation continues to have dramatic consequences, particularly on developing societies. If the fluctuations are cyclical then we should to be able to predict them. Instrumental records only go back about 100 years, so to look at patterns of climate variability over a longer time-scale we need to examine the tracers of climate preserved in older sequences.

The best known records of global change come from isotopes in polar ice and oceanic sediment cores, but these records fail to represent significant climate changes on the continents, especially in areas which remained ice-free. Lake sediment archives are particularly important in this respect since they contain components which have $^{18}O/^{16}O$ stable isotope ratios that are sensitive to climate change. In low latitudes, for example, the $^{18}O/^{16}O$ ratio is dependent on the composition of the oxygen isotope ratio in the lake water, the changing isotope ratio is in itself largely dependent on the amount of evaporation from the surface waters — and a function of climatic aridity.

Several lakes in Ethiopia have provided isotope data allowing past climate reconstruction. Perhaps the most important to date is Lake Tilo, a small caldera lake in the semi-arid savannah region of the Ethiopian Rift Valley. The sediments deposited in the lake provide a climatic record going back 10 000 years, revealing how the climate has changed in this area. The isotopic composition of carbonate minerals in the sediments show that from 10 000 to 5200 years ago the lake water isotopic composition was similar to that of rainwater. The lake was full and overflowing during this period, and rainfall was considerably higher than today. Further information was gained from analysis of the $^{18}O/^{16}O$ ratio of incrementally-grown carbonate from freshwater snail shells found within the same sequences. Snail shells from 9000 years ago show that the Atlantic monsoon had a greater influence in the Ethiopian climate by bringing heavier rainfall for longer periods into north tropical Africa. A dramatic change in climate occurred 5200 years ago, leading to the development of arid conditions throughout tropical Africa. From 2500 years ago, laminated sediments were deposited in the lake; analyses of these laminations has revealed drought and flood events on a 20–50 year cycle.

Ethiopia is dominantly a subsistence economy and, like many other parts of the developing world, is particularly susceptible to the ravages of extreme climate. Floods and droughts and the terrible suffering they bring have been graphically illustrated in living memory. By understanding the past climate variation, in particular by investigating annual and interannual variation, we hope to be able to provide information on past cyclicity. This is probably the only way we can start to predict the extreme climatic events that have such a devastating effect on these agriculture-based societies.

This work is being done in collaboration with Henry Lamb (University of Wales), Angela Lamb (Liverpool John Moores University), and Mohammed Umer (University of Addis Ababa, Ethiopia).



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Lake Tilo a caldera lake in the Ethiopian Rift Valley.