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Figure 1 | Prolonged drought in eastern Africa. This photograph was taken in northern Kenya in July 2022, during the worst drought to hit the region in 40 years. The frequency of droughts in eastern Africa has doubled in the past two decades.

Climate science

Past climate unravels eastern African paradox

Rachel L. Lupien

Analyses of sediment from a lake in eastern Africa reveal the relationship between temperature and moisture over the past 75,000 years, and hint at why climate-model projections in the Horn of Africa are at odds with modern trends. **See p.336**

Climate models predict that eastern Africa will get wetter in response to future global warming[1]. But although mean temperatures in the region have increased by at least 1 °C since 1973, drought frequency has doubled in the past two decades[1] (Fig. 1). The increase in droughts has had a severe impact on agriculture and other economic sectors, and exemplifies the 'eastern African climate paradox'. On page 336, Baxter *et al.*[2] attempt to resolve this paradox by analysing palaeoclimate data that uncover the relationship between aridity and temperature, which is linked to atmospheric carbon dioxide levels, over the past 75,000 years. Their findings imply that droughts in eastern Africa will become more frequent, sustained and extreme with future warming.

To understand how global warming affects water and its climatic processes (the hydroclimate), researchers simulate future climates using models that are constructed on the basis of physics, known climate processes and previous climate states. However, eastern Africa is particularly complex, owing to its extremely varied landscape and diverse seasonality, and the several atmospheric boundaries that converge over it. Using palaeoclimate data to reconstruct past climates can help to quantify potential regional climate responses to increasing global temperatures[3]. But reconstructions of past regional temperatures that are quantitative, continuous and accurately dated have been difficult to create, so nuanced comparisons between hydroclimate and temperature across large timescales and length scales are rare.

One way of obtaining high-resolution reconstructions involves using biomarkers called glycerol dialkyl glycerol tetraethers (GDGTs), which are produced by archaea and bacteria[4] and have been used extensively in palaeoclimate research on eastern Africa[5,6]. The compounds exist as one of two types, branched and isoprenoid, which are sourced from different parts of a lake system. If the probable sources of each type of GDGT are known[7], the ratio between the two types can serve as a measure of the lake's water level and the extent to which waters from different parts of the lake are mixed. This ratio thus quantifies the effective moisture or hydroclimate indirectly, as long as there are sufficient quantities of both types of GDGT to obtain robust ratios. Branched GDGTs can also act as a 'palaeothermometer' — past abundances of this type can be compared with modern measurements as a proxy for temperature, although the season in which the compounds were produced is difficult to pinpoint, as is the actual temperature[8], so this method tracks only relative changes.

Baxter and colleagues present a reconstruction that couples extraordinarily high-resolution temperature and hydroclimate data and is derived from GDGTs from Lake Chala, a crater lake straddling the border between Kenya and Tanzania. An international drilling operation, DeepCHALLA, extracted a long core from the lake, containing sediment deposited during the transition from the most recent glacial period to the current interglacial period, which started 11,700 years ago. The core is presumed to contain annual laminations, small sequences of fine layers deposited each year, that date back thousands of years — a rare acquisition in this region, and particularly so in the context of tropical, terrestrial sediment archives, which are notoriously difficult to date.

Equipped with biomarker data of unprecedented resolution, Baxter and colleagues demonstrated that the correlation between temperature and moisture switched from positive to negative at the glacial–interglacial transition, when CO_2 concentrations rose above 250 parts per million (p.p.m.) — well below more modern values of 420 p.p.m. (ref. 9). And by showing that Lake Chala is representative of a larger region, they concluded that these findings hold for the Greater Horn of Africa.

The authors suggest that the hydroclimate was limited by the amount of thermal energy in the climate system during the glacial period, but this relationship changed around the transition to the interglacial period, when the hydroclimate instead became dependent on the amount of moisture in the system. Before the switch, high temperatures generated moisture in the atmosphere, mainly through monsoons. But temperatures in the interglacial period have peaked at levels higher than those of the glacial period; above a certain threshold, these high temperatures compromise the supply of moisture and inhibit precipitation. The change therefore shifted the warm-makes-wet paradigm to a warm-makes-dry paradigm.

There is much debate about how eastern African palaeoclimatology is affected by external factors, including low-latitude solar radiation; nearby sea surface temperatures and gradients; and high-latitude-driven processes, such as oceanic circulation and the waxing and waning of ice sheets in the Northern Hemisphere. For example, Baxter and colleagues uncovered droughts in eastern Africa during the glacial period that coincided with large groups of icebergs moving into the North Atlantic Ocean. The authors suggest that the droughts might have been caused by reduced Indian Ocean sea surface temperatures associated with the ice events.

However, other records[10] from the Pleistocene era (from 2.6 million to 11,700 years ago) suggest that tropical solar radiation consistently caused variation in the regional monsoonal hydroclimate over longer time periods than those studied by Baxter and co-workers. This implies that droughts might have been caused by external factors further back in the geological record other than North Atlantic ice or associated changes in sea surface temperature. Baxter *et al.* add to growing evidence that the relative impact of these factors on regional hydroclimate can change over time[10]. And, most importantly, they identify mechanisms behind these threshold shifts.

Disentangling the temperature–hydroclimate relationship in eastern Africa helps to reconcile model-based predictions of increased hydrological activity with the intense and frequent droughts that have occurred in the past few centuries. Baxter and colleagues' work suggests that the region will become drier as temperatures increase, because the warmer air will limit the supply of evaporative moisture — a mechanism that will be further enhanced by land–atmosphere feedbacks. It remains unclear, however, why climate models with realistic CO_2 levels, moisture–temperature relationships and landscape features continue to predict increased precipitation and decreased droughts[1]. Perhaps improved modelling is needed to better understand the interaction between the monsoon system and the transport of moisture to and across this varied, tropical region.

Palaeoclimate reconstructions are crucial for understanding future transitions through varying climate conditions[3]. Although Baxter *et al.* posit a straightforward explanation for the paradigm shift that they have uncovered, confidence in this mechanism, and the specific CO_2 threshold that they suggest, would certainly be bolstered by further study into past warm intervals for which there are good CO_2 estimates, such as the Eemian period (between 127,000 and 106,000 years ago). The DeepCHALLA archive could help in this respect, because it offers a window into the climate as early as 250,000 years ago. And as Baxter and colleagues' study shows, the archive promises data of exceptionally high resolution, which can lead to fresh insight into past and future climates.

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Ageing

A molecular driver of cognitive decline

Bart J. L. Eggen

When DNA is misplaced inside cells, the cGAS–STING molecular system triggers inflammation. It emerges that stimulation of this mechanism in microglial cells of the brain during ageing contributes to cognitive decline. **See p.374**

First mentioned in the fifth century BC by the father of history, Herodotus, the water of the mythical fountain of youth is said to restore youthfulness and confer immortality. Clearly, people have long been fascinated by the idea of delaying — or, even better, reversing — ageing. It is safe to say, however, that progress towards this goal has been slow. In the meantime, societies are ageing rapidly: by 2030, one in 6 people will be over 60, and between 2020 and 2050, the number of people over 80 is expected to