NATURE | NEWS

Ocean sediments suggest dry future for Horn of Africa

Reduced rainfall in East Africa linked to anthropogenic climate change.

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A severe drought hit the Horn of Africa in 2011.

The Horn of Africa is growing drier, threatening food security for millions of people — and this change is driven by global warming, according to an analysis published on 9 October in *Science Advances*[1]. The finding casts doubt on projections suggesting that the region will become wetter as global temperatures rise.

Jessica Tierney, a molecular palaeoclimatologist at the University of Arizona in Tucson, and her colleagues extracted regional temperature and precipitation records from deep-sea sediment cores drilled from the Arabian Sea. They show that twentieth-century drying in the region is unusual in the context of nearly 2,000 years of rainfall, and that it is linked with recent warming trends.

“You have to conclude there has been an anthropogenic contribution to the decline in rainfall,” says Chris Funk, a research geographer at the University of California, Santa Barbara. That contradicts prior studies[2] that have associated the drying trend with the natural variability of Pacific Ocean surface temperatures.

Pirates at sea

Understanding past climate change in the Horn of Africa is difficult. Instrumental records and natural records of climate are rare — there are no permanent lake basins and scarcely any trees in the area.

So to reconstruct these historical patterns, co-author Peter deMenocal, a palaeoclimatologist at the Lamont–Doherty Earth Observatory in Palisades, New York, sailed with a team to the Gulf of Aden. The team drilled into the sea floor and collected cores from a depth of 869 metres.

The journey was perilous. The team embarked in early 2001, just before piracy, terrorism and political unrest made the region dangerous for scientific work. The ship operated without radio, lights or radar along the coast of Somalia and Yemen, and received updates on pirate attacks by fax.

Winds transport large quantities of dust from the region into the gulf, depositing about 32 centimetres of sediment every 1,000 years.

Tiny fossilized organisms and other material trapped in these layers provide a detailed account of past climates, allowing researchers to reconstruct conditions in five-year increments from 1850 to 2000, and every 10 years prior to 1850. “It’s an enormously high sedimentation rate. A lot of mud per unit time gives great records,” says deMenocal.

Leaf history

Back in the lab, Tierney deciphered changes in the region’s temperature and rainfall from ad 100 to 2000. To reconstruct past sea-surface temperatures, she and her colleagues looked to tiny marine microorganisms — types of archaea — that alter the chemical structure of their membranes as the water temperatures cool or warm.

The team deduced information about aridity using the chemical composition of leaf waxes from terrestrial plants, which mix with dust and become trapped in sediment. “Plants are kind of a rain gauge. The waxes that they make record drought stress on land,” says Tierney.

Rain that falls during dry periods is rich in deuterium, a heavy isotope of hydrogen. Leaf waxes that contain higher levels of deuterium thus signal dry spells.

Tierney found that deuterium levels decreased during the Little Ice Age (1450–1800), the wettest period of the past 2,000 years in the region. But they rose sharply during the twentieth century, in step with local sea-surface temperatures — a sign of aridity. “It has been this dry before, but the rate of change is unusual,” says Tierney. Short bouts of dryness appear in the record around ad 700 and 900, but this aridity is more variable than the steady increase in dryness observed through the twentieth century.

“The relationship seems to have held up quite robustly,” says Funk.

Dry prospects

East Africa has experienced spring droughts in 8 of the past 16 years[3], which have contributed to hundreds of thousands of deaths and widespread food insecurity. Yet global climate models project a wetter East Africa by 2100.

The region has two rainy seasons, agriculturally important “long rains” from March to May, and “short rains” from September to November. Global climate models suggest that the short rains will become more intense as an atmospheric pattern over the Indian and Pacific oceans, called the Walker circulation, becomes weaker in response to global warming.

But these models have overestimated the impact of the Walker circulation on the short rains and underestimate the changes during the long-rain season, says Tierney. Others say that the Walker circulation may become stronger.

For now, regional models and observations may do a better job of predicting the impact of global warming on rainfall in the region. One such modelling study projects increased aridity by mid-century, and the subsequent collapse of some of East Africa’s crop-growing seasons[4].

“We can’t assume the Horn will get wetter — the palaeoclimate data certainly don’t suggest that,” says Tierney. “We need to work harder to understand what the long rains are going to do.”

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References

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