

THE CONVERSATION

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How a changing landscape and climate shaped early humans

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Lucy, born 3.2m years ago. Pat Sullivan/AP

It should not be a surprise that East Africa was a hotbed of evolution, because over the last five million years everything about the landscape has changed.

The extraordinary forces of **plate tectonics** and a changing climate have transformed East Africa from a relatively flat, forested region to a mountainous fragmented landscape dominated by the rapid appearance and disappearance of huge, deep-water lakes. And from this highly variable landscape emerged an ape smart enough to question its own existence.

A cradle rocked by tectonics

Twenty million years ago the Indian and Asian continental plates clashed and pushed up the massive **Tibetan plateau**. In summer this plateau acts as a huge heat engine, absorbing solar energy which it transfers to the atmosphere, causing immense convection currents. With all this hot air rising, air is sucked in from all round, including moist air from the Indian Ocean that produces intense South East Asian monsoons.

This has a knock on affect of drawing moisture away from the African continent, and it was this that began the progressive drying out of East Africa. In terms of human evolution, this distinct split between the climate of Asia and Africa coincides with the split between Asian

and African apes, the latter eventually evolving into us.

At the same time as the peaks of Tibet were thrusting upwards, the rifting process began in Ethiopia and gradually moved south finishing in Mozambique about one million years ago. This rifting was caused by a hotspot of magma under northern East Africa heating the crust causing it to split down the middle like an overdone apple pie.

The rifting process produced a deep, wide, hanging valley half a mile above sea level with uplifted shoulders or mountain ranges on either side rising up to two miles high. The effects of the Rift Valley formation on the local climate was dramatic.

The East Rift's mountains prevented moist air from the Indian Ocean from passing over East Africa, causing the region to dry even further. The topography of East Africa completely changed: from a homogeneous flat region covered in moist forest, to a mountainous landscape with plateaus and deep rift valleys, where vegetation varied from cloud forest to desert scrub.

Evolution, our coping strategy

Presented with fragmented vegetation and greater distances between sources of food may have led to the evolution of human bipedalism – walking upright on two legs – around six million years ago. These highly successful early bipedal hominins such as *Ardipithecus ramidus* or *Australopithecus afarensis*, were nevertheless relatively small-brained, with a cranial capacity of about 450cm³ compared with modern humans with over 1,500cm³.

The development of the East African Rift valley fragmented the landscape and formed a large number of separate lake basins. The mountainous landscape makes these basins very sensitive to small changes in rainfall. Martin Trauth of Potsdam University and colleagues found geological evidence that deep, freshwater lakes existed around 2.6 million, 1.8 million and 1 million years ago – key dates in human evolutionary history.

During each of these periods the local climate of East Africa varied over a 20,000-year cycle, from extreme aridity to very wet conditions. So our ancestors may have had an idyllic environment, cruelly taken away as the lake dried up over a few generations. Thousands of years later the lake would return and the cycle would begin again. The 20,000-year cycle is driven by changes in the Earth's orbit around the sun, which affects the amount of sunlight received during any particular season. In East Africa it had a significant influence on the timing and duration of the two wet seasons.

The recent study published in the journal PloS ONE by Susanne Shultz of Manchester University and me statistically links for the first time the emergence of new hominin species, expanding brain capacity, and the movement out of Africa to the appearance and disappearance of deep freshwater lakes (confirming the original work by Martin Trauth and myself).

The most profound period for human evolution occurs at about 1.8 million years ago, a period which records the highest diversity of hominin species, including the appearance of *Homo rudolfensis* and *Homo erectus* with a substantially larger brain capacity of 900cm³, and the first major dispersal of our ancient human ancestors out of East Africa into Eurasia. During this period, the ephemeral deep-freshwater lakes appeared and disappeared along the whole length of the East Africa Rift valley, causing fundamental environmental changes that pushed these new species out of Africa.

We have now started to put together a coherent picture of how the changing East African landscape has driven human evolution over the last ten million years. The region has altered beyond all recognition, from flat and forested to one filled with spectacular, two-mile-high mountains, savannahs and tropical forests. By priming the land to form lake basins that were sensitive to small changes in rainfall, extreme climate pulses of alternately arid and wet period occurred and had a profound effect on all the animals living in East Africa. The powerful forces of plate tectonics and climate variability ultimately led to our hominid ancestors' development and their dispersal from Africa, to the Caucasus, the Fertile Crescent, and ultimately the rest of the world.