

Paper Number: 5555

Scholes, R.J¹

¹GCSRI, University of the Witwatersrand, Private Bag Wits, 2050

bob.scholes@wits.ac.za

It has become clear that humans, especially over the past century, have had a profound impact on Earth system processes and the global climate, to the extent that the present era has been dubbed the 'Anthropocene'. This paper explores the several-million year interaction between human development and Earth system processes. It develops the hypothesis that Earth system processes, including climate changes, were responsible for the development of the hominin and hominid branches of the evolutionary tree in the first place, especially at three critical junctures in the paleo-history of our lineage. I propose that over the past four million years, human ancestors, African savannas and the global climate have co-developed, with each influencing the other in powerful ways.

The slow cooling of the global climate over the past 50 My, attributed to falling atmospheric carbon dioxide concentration (CO₂) driven by uplift of the Himalayas; the opening of the Drake passage and the closure of the Panama Isthmus and the Tethys sea; and the northward movement of Africa to its current position astride the equator, and its uplift, combined to establish a novel climate over much of Africa about 7 My ago: sub-humid, hot and strongly wet-dry seasonal. This climate regime caused the moist tropical forests covering much of Africa and where the great apes lived to shrink and fragment. The multi-month annual dry period dramatically increased fire frequency, opening a habitat for C4 grasses, well adapted to heat, low carbon dioxide, and drought. Grasses are both highly tolerant of dry season fire, and the main fuel for its easy ignition and spread. The newly-dominant grassy ecosystems allowed a rapid radiation of specialized large mammal herbivores, which co-evolved with the grasses. Carnivores which ate the herbivores followed, and scavengers eating their leftovers. The quintessentially-African ecosystem we now know as savanna appears.

Several primate evolutionary experiments explored this new habitat, involving bipedalism, progressively larger brains and smaller guts. The strong, periodic glacial-interglacial fluctuations of the Pleistocene (which were manifest as pluvial-interpluvial cycles in Africa) acted as a speciation pump. Early tool-making hominids learned to use fire by 1-2 My, and since then have been the dominant ignition source. Two cycles glacial ago anatomically-modern *Homo sapiens* appear in Africa. One cycle ago, during the glacial period, this species developed language and culture. Some of the best records have been documented from the Southern Cape littoral, a wide plain exposed by the low sea level, at a time when life for hominids in the Northern Hemisphere must have been very challenging.

Thus equipped to innovate and transfer information between individuals and generations, *Homo sapiens* was able to exploit the warming and rising CO₂ associated with the emergence from the last glacial period to develop crop and pastoral agriculture, in several locations about 10ky ago. The larger group sizes, more sedentary habits and increasing specialization of individuals led to the development (and repeated failure) of advanced civilizations. Eventually this led to the Industrial Revolution three centuries ago. The resultant human population explosion, and even greater increase in per capita

resource use, is now nudging the global climate out of the Holocene pattern under which human civilizations developed.

