

## CLIMATIC CHANGE IN DESERTS

Past, Present and Future

This book reconstructs climatic changes in deserts and their margins at a variety of scales in space and time. It draws on evidence from land and sea, including desert dunes, wind-blown dust, river and lake sediments, glacial moraines, plant and animal fossils, isotope geochemistry, speleothems, soils and prehistoric archaeology. The book summarises the Cenozoic evolution of the major deserts of the Americas, Eurasia, Africa and Australia and the causes of historic floods and droughts. The book then considers the causes and consequences of desertification and proposes four key conditions for achieving ecologically sustainable use of natural resources in arid and semi-arid areas. *Climatic Change in Deserts* is an invaluable reference for researchers and advanced students interested in the climate and geomorphology of deserts, including geographers, geologists, ecologists, archaeologists, soil scientists, hydrologists, climatologists and natural resource managers.

MARTIN WILLIAMS is Emeritus Professor at the University of Adelaide, Australia. His particular contributions to the field involve using evidence from a wide variety of disciplines to reconstruct prehistoric environments, ranging from the habitats occupied by early hominids in the Afar Rift of Ethiopia to the Neolithic occupation in the Sahara and the Nile Valley to the late Pleistocene wetlands in the arid Flinders Ranges of South Australia. He is a recipient of the Cuthbert Peek Medal from the Royal Geographical Society, the Sir Joseph Verco Medal from the Royal Society of South Australia, the Distinguished Geomorphologist Medal from the Australia and New Zealand Geomorphology Group, and the Farouk El Baz Award for Desert Research from the Geological Society of America. He is the author of more than two hundred research papers (twelve in *Nature*), and has edited and authored twelve books, including *Landform Evolution in Australasia* (with J.L. Davies, 1978), *The Sahara and the Nile* (with Hugues Faure, 1980) and *Quaternary Environments* (with David Dunkerley, Patrick De Deckker, Peter Kershaw and John Chappell, 1993, 1998).

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Past, Present and Future

MARTIN WILLIAMS

*The University of Adelaide*



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## Preface

The aridity, which makes life in deserts so difficult, has also preserved abundant evidence of a more humid past. For instance, scattered across the Sahara are numerous prehistoric occupation sites and rock paintings left behind by the Neolithic pastoralists who once roamed this now inhospitable land. Several thousand years older than the Neolithic art are the rock engravings and paintings of elephants, giraffes and other large herbivores that now inhabit the African savanna. Likewise, in the deserts that stretch from Arabia into Russia, China and India, deep rivers once flowed and freshwater lakes filled what are now dry salt pans. The same holds true for the Kalahari, the Atacama and the deserts of Australia and North America, prompting widespread curiosity about the climatic history of our deserts.

Apart from a natural concern over possible future changes in the earth's climate and their impact on the often poor communities of the semi-arid world, there are a number of reasons why a careful evaluation of what we currently know about the climatic history of the arid and semi-arid lands is both timely and worthwhile. One reason stems from plate tectonics, another from isotope geochemistry. An accurate long-term perspective on global climatic change has become possible as a result of recent advances in our understanding of world tectonic history. The combined evidence from deep-sea drilling, seismic investigations and paleomagnetic studies has allowed reconstruction of sea-floor spreading history and of continental apparent polar wandering curves. The data from land and sea are impressive and persuasive. The timing of late Cenozoic ice build-up in the two hemispheres is now known reasonably well, as are some of the associated changes in oceanic and atmospheric circulation, which are in turn related to the origin and expansion of the deserts.

Reconstruction of changes or fluctuations in oceanic circulation patterns used to depend very largely on sediment and microfossil studies. Analysis of the oxygen isotopic composition of the calcareous tests of suitable benthic and planktonic foraminifera now provides an additional and powerful means of assessing changes in ocean water temperature and salinity at depth and near the surface. After allowing for

local effects, it is also possible to use this technique to estimate changes in global ice volume. Times of lowest world temperature (glacial maxima) were times of greatest aridity in the tropical deserts and their margins, with massive export of desert dust offshore, even to central Antarctica.

Against this general background, this volume has three main aims. One is to examine critically the various lines of evidence from geology, biology and archaeology that have been used to reconstruct climatic change within the arid and semi-arid lands that now occupy some 36 per cent of the land area of the globe. If we include the dry subhumid regions of the world, since they, too, were once more arid than today, we are dealing with nearly 50 per cent of the land area of the Earth.

We also discuss Antarctica – the largest and driest of our cold deserts – and the Arctic, because they have long exerted a powerful influence on global climate. The second aim is to trace systematically the climatic history of the deserts from the inception of Cenozoic aridity some 30 million years ago through the fluctuations of the past 2.5 million years of Quaternary time until the droughts and floods of the present day. The final aim is inherently more speculative, but worthwhile withal, because it seeks to use the insights from our study of past events to envisage how human societies are likely to interact with possible future climatic changes in the desert world.



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Over the years, many friends and colleagues across the globe have been generous with information and ideas about the desert world, often showing me first hand those starkly beautiful landscapes they have studied with such dedication. Dick Grove first suggested that I might like to replace him on an expedition to Jebel Arkenu in south-east Libya during the northern summer of 1962, an expedition that was organised by Captain (later Lieutenant-Colonel) David Hall RE from the Royal Military Academy, Sandhurst. Claudio Vita-Finzi gave me sage advice on desert travel based on his unequalled knowledge of the northern Libyan Desert.

A second expedition to south-east Libya the following summer, again led by David Hall, provided a welcome change from soil surveys along the Blue and White Nile rivers in Sudan, and enabled us to map and name two hitherto unexplored sandstone plateaux north-east of Tibesti volcano. The contrast between the harsh Saharan summer and the widespread evidence of a prehistoric human presence in that region from Early Stone Age times onwards led me to ask myself when, why and how often had the Sahara been a green and pleasant land and why it was no longer.

A move to Australia in late 1964 and a drive across the 'Red Centre' during a time of severe drought made me wonder about the causes of such droughts; the consequences were all too visible. One cattle owner told me that his eight-year-old son had never seen rain, reminding me of the road through Kufra Oasis, built of salt, in a land where rain fell once in fifty years. Later visits to the Thar Desert of north-western India, the Taklamakan Desert of western China, the Alashan Desert of Inner Mongolia, the Kalahari and Namib Deserts of southern Africa, the Afar Desert of Ethiopia, not to mention Arizona and the Grand Canyon, interspersed with recurrent visits to the drier parts of Ethiopia, Sudan, Niger and Kenya, and more sporadic visits to Algeria, Djibouti, Egypt, Somalia, Mauritania, Tunisia, Jordan and Israel, enabled me to continue my efforts to make sense of when and why our arid lands were once able to support more abundant life than they can today. Almost inevitably, such work led me to consider the causes and consequences of, and possible solutions

to, desertification processes, including the tantalizing question of how to distinguish between human impacts, whether direct or indirect, and ‘natural’ influences.

None of this research would have been possible without the support and encouragement of my companions and colleagues who shared my passion for desert landscapes. Many weeks of joint fieldwork with Desmond Clark in Niger, Sudan, Ethiopia and India; with Don Adamson in Australia, Sudan and Ethiopia; and with Mike Talbot in Niger and Australia forged ineffable memories. *Valete* Mike, Don and Desmond – you shared the joys as well as the hardships, and I remain the better for having known you.

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