

The SAGE
Handbook of

Environmental Change



Volume 1

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The SAGE
Handbook of
Environmental Change



Volume 1

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Matthew Baylis holds the Chair of Veterinary Epidemiology at the University of Liverpool. For 20 years he has studied vector-borne diseases of animals and humans, including African animal trypanosomosis, African horse sickness, bluetongue, Japanese encephalitis and plague. In recent years he has focussed on the impacts of climate on such diseases, and the role that climate change may play in disease emergence and spread. Much of this work is undertaken through the Liverpool University Climate and Infectious Diseases of Animals (LUCINDA) group, which he heads.

Martin Beniston studied Environmental Science at the University of East Anglia and Atmospheric Physics at the University of Reading before obtaining his PhD in Atmospheric Modelling at P&M Curie University in Paris. He has undertaken atmospheric and climate research in France, Germany, Canada and later in Switzerland, where he shared his work between ETH in Zurich and the vice-chairmanship of an 'Impacts' working group of the IPCC (awarded the 2007 Nobel Peace Prize). Appointed full professor at Fribourg University in 1996, he moved in 2006 to become Director of the Institute for Environmental Sciences at the University of Geneva. He has close to 150 papers on topics related to climate change and impacts, including 4 books and a further 9 edited volumes with international publishers. Since 2008, he is the coordinator of a major European project related to water and climate in vulnerable mountain regions (www.acqwa.ch).

Helen Bennion is a Principal Research Associate at the Environmental Change Research Centre, University College London. The central focus of her research is to understand the causes, timing and magnitude of ecological change (principally caused by nutrients and climate change) in aquatic systems so we may better manage these ecosystems in the future. She is internationally recognised in the field of palaeolimnology with major contributions to the development of diatom models for assessing lake eutrophication, development of multi-proxy approaches for understanding ecological changes in lakes over decadal to centennial timescales, innovative methods for employing the lake sediment record to assess reference conditions and restoration targets, and the use of the sediment record for understanding climate-nutrient interactions. She has published eight book chapters on topics such as diatoms as indicators of environmental change and palaeoecological assessments of environmental change. She became an elected member of the International Advisory Committee of the International Paleolimnology Association in 2008.

André Berger is Emeritus Professor and senior scientist at Université Catholique de Louvain. He was Chairman of the International Climate Commission of IUGG, Chairman of the International Paleoclimate Commission of INQUA, and President of the European Geophysical Society. He is Honorary President of the European Geo-Sciences Union and fellow of the American Geophysical Union. He has made notable contributions to the astronomical theory of paleoclimates, pioneered the development of the Earth models of intermediate complexity and showed the possible human impacts on the natural course of climate at the geological

time scale. He has edited 12 books on climatic variations and has published more than 200 papers on this subject.

Richard A. Betts leads the Climate Impacts research team in the Meteorological Office Hadley Centre. He has worked as a climate modeller for over 18 years, and has pioneered a number of key scientific developments on ecosystem-climate feedbacks and an integrated view of climate change impacts. He was involved in development of the first coupled climate-carbon cycle general circulation model, and in subsequent advances in this field. He has a particular interest in processes of climate change and its impacts beyond the radiative effect of greenhouse gases, including anthropogenic land cover change and the effects of changes in atmospheric composition on plant physiology. He was a lead author on the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) and the Millennium Ecosystem Assessment, in both cases assessing the influence of ecosystems and anthropogenic land cover change on climate. He is now a lead author on the IPCC Fifth Assessment Report, contributing to the assessment of the impacts of climate change on terrestrial ecosystems.

Paul Bishop has been Professor of Physical Geography in the University of Glasgow since 1998. His undergraduate degree is from the School of Earth Sciences at Macquarie University in Sydney, as are his PhD and recently awarded DSc. His research focuses principally on long-term landscape evolution, with a key interest being the ways in which tectonics and surface processes interact, as mediated by bedrock rivers. Low-temperature thermochronology and cosmogenic nuclide analysis are key techniques for that research, which has always been undertaken with teams of post-doctoral researchers and PhD students.

Simon P. E. Blockley is a Quaternary scientist working on the chronology of past climate change and human adaptation. He work principally studying the timing and nature of abrupt climate change over the last 100,000 years and the role of climate change in the adaptation and later evolution of humans in the past. He has published numerous articles on both climate change and Palaeolithic archaeology. His main specialisation is high precision dating of both environmental records including radiocarbon dating, statistical age modelling techniques and particularly the use of volcanic marker horizons as tools to date and link sites together. His most recent work in this area has looked at the potential role of climate in the transition from the middle to upper Palaeolithic and the end of the Neanderthals and most recently the role of climate in the origin of agriculture at the end of the last glacial period.

Stella M. Blockley took a first degree and in Archaeology, and MSc in Human Osteology and Palaeopathology and a PhD in Archaeology at the University of Bradford. She then worked as a postdoctoral researcher in archaeology at Royal Holloway, University of London. She is now a teacher of science and independent researcher.

Keith R. Briffa is a professor and currently Deputy Director of the Climatic Research Unit, part of the School of Environmental Sciences at the University of East Anglia, Norwich, U.K. His primary research interests are in the general area of late Holocene climate change, with a geographical emphasis on Europe and northern Eurasia. His specialism is dendroclimatology, the use of tree-ring data for the purposes of climate reconstruction. He has been responsible for a number of methodological developments within this field and produced various detailed regional reconstructions of summer temperature patterns across the Northern Hemisphere spanning centuries to millennia, widely used in the study of regional and Hemispheric mean



temperature change. Besides tree-ring research, his interests encompass the study of recent climate change based on instrumental records, and the application of various palaeoclimate data for describing 'natural' climate variability and its relationships with possible forcing factors. He was a Lead Author of Chapter 6 (Palaeoclimatology) of the Fourth Assessment Report of Working Group 1 of the Intergovernmental Panel on Climate Change. He has served on various national and international Scientific Steering Committees and on the editorial boards of the journals *Holocene*, *Boreas* and *Dendrochronologia*.

Mark B. Bush is Professor and Chair of the Conservation Biology and Ecology Program at the Florida Institute of Technology. His undergraduate and post-graduate training were at the University of Hull, UK. He has more than 30 years experience of working on the biogeography and paleoecology of tropical systems. His research focuses on fossil pollen and charcoal analysis of Neotropical settings and environmental reconstructions of past climates, fire histories, and vegetation communities. He also investigates pre-Columbian influences on the environment and responses to past climate change.

Ian Candy is a Senior Lecturer in Physical Geography at the Department of Geography, Royal Holloway, University of London. His main interests are understanding the cause and impact of long-term climate change on surface processes and landscapes using a range of techniques including sedimentology, micro-morphology, radiometric dating and oxygen and carbon isotopic analysis. In particular, he is interested in understanding the role of climate change and landscape evolution in early human occupation and migration in Europe and North Africa. This has led to fieldwork throughout the British Isles, France, Germany, Spain, Crete, Libya, Morocco and Jordan. Ian is Editor of the Elsevier Journal *Proceedings of the Geologists' Association*.

Frank M. Chambers is Professor in Physical Geography and Head of the Centre for Environmental Change and Quaternary Research at the University of Gloucestershire. His principal research interests are in (i) the magnitude, rate and direction of climatic change, especially the generation and interpretation of Holocene 'proxy'-climate records; (ii) the nature of late Quaternary environmental change, as reconstructed from lakes and mires; (iii) assessment of human impact on the landscape during the Holocene, including the application of palaeoecological techniques to assist in habitat- and landscape conservation, with an emphasis on mires and moorland; (iv) dating techniques used in Quaternary palaeoecology.

Chris Cocklin is Deputy Vice-Chancellor (Research & Innovation) at James Cook University, Australia. His research interests are in resources and environmental policy, agriculture and rural communities, global environmental change, sustainable development, and corporate environmental management. He was appointed by the Intergovernmental Panel on Climate Change (IPCC) as a lead author of the Fourth Assessment Report. Professor Cocklin is a member of the Queensland Premier's Advisory Council on Climate Change.

Ben Daley is Lecturer in Environmental Management in the Centre for Development, Environment and Policy at the School of Oriental and African Studies (SOAS), University of London. His research focuses on environmental change and environmental history, and he has lectured in geography, environmental management and sustainable development. His research has focused on the environmental history of the Great Barrier Reef and coastal Queensland; he has also worked on a variety of other environmental issues, including climate change and the environmental impacts of air transport and of tourism. He is the Academic Director of the MSc Sustainable Development programme at SOAS.



Siwan M. Davies is Reader in Physical Geography at Swansea University. She is a graduate of Oxford University and completed her PhD and MSc at Royal Holloway University of London. Her research involves using volcanic ash layers as marker horizons (tephrochronology) to provide independent chronological control for testing hypotheses relating to abrupt climatic changes that occurred over the last 150,000 years. She is currently involved with tracing these horizons in the Greenland ice-cores as well as in North Atlantic marine sediments.

Alastair G. Dawson is a graduate of the University of Aberdeen (BSc Hons), Louisiana State University (MSc) and the University of Edinburgh (PhD). He was appointed Professor of Quaternary Science in 1998 at Coventry University. Since 2005 he has been Professor at the University of Aberdeen where he is Assistant Director of the Aberdeen Institute for Coastal Science and Management (AICSM). He is the author of numerous papers on climate change research, His book, *Ice Age Earth* is highly acclaimed and recently, 'So Foul and Fair: A history of Scotland's weather and climate' has received international recognition. In addition to his research interests in climate change, Alastair has undertaken coastal change research for many years. Since 1987 he has published widely in the field of tsunami geoscience.

Anne de Vernal is Professor in the Department of Earth and Atmospheric Sciences of the Université du Québec à Montréal (UQAM), where she teaches paleontology and 'Global Changes' on time scales ranging from centuries to millions of years. Since 2006, she is director of the Geochemistry and Geodynamics Research Center GEOTOP. Anne de Vernal is acknowledged for her contributions in the field of marine palynology and paleoceanography. She participated to several expeditions in the North Atlantic, Arctic and sub-Arctic basins to explore the climate and oceanographic history of the last million of years.

John A. Dearing is currently Professor of Physical Geography in the School of Geography at the University of Southampton, UK. For over 30 years he has studied long-term interactions between human activity and environmental change through magnetic and other analyses of lake sediments. More recently, he has focused his research on how we can learn from the past about the functioning and management of contemporary socio-ecological systems, particularly with regards complex and nonlinear effects. This research lies at the heart of his involvement with the IGBP-PAGES Focus 4 programme 'Past Human-Climate-Ecosystem Interactions', which he currently chairs.

Tim Denham (PhD 2004 Australian National University) is a Monash Research Fellow at Monash University, Victoria, Australia. Over the last decade, his research has focused on the emergence and transformation of agriculture in the highlands of Papua New Guinea, including the development of a practice-centred method for the investigation of early agriculture. Recently his spheres of interest have broadened to include: global perspectives on early agriculture; the Holocene histories of Island Southeast Asia, Melanesia and Australia; and, the contribution of archaeology to understanding current environmental problems. He was the lead author and organizer of PNG's successful nomination of the Kuk Swamp site to UNESCO's World Heritage List (2008).

Marianne S. V. Douglas is a Professor in the Department of Earth and Atmospheric Sciences at the University of Alberta, Edmonton, Canada. A biologist by training, her PhD (1993, Queen's University, Canada) focussed on paleo- and environmental change in the High Arctic. After completing two years of postdoctoral research at the University of Massachusetts,



Amherst, she moved to the Geology Department at the University of Toronto where she held a Canada Research Chair (Tier 1) in Global Change. In 2006 she relocated to the University of Alberta to take up the directorship of the Canadian Circumpolar Institute. Her research interests continue to focus on environmental change in both polar regions.

Georgina Endfield is a Reader in Environmental History in the School of Geography, University of Nottingham. Her research focuses on mainly on the environmental and climate history of colonial Mexico and nineteenth century central, southern and eastern Africa. She has published her research in journals across the disciplines of geography, history, archaeology and the history of science and is the author of *Climate and Society in Colonial Mexico: A Study in Vulnerability* (Blackwell, 2008).

Erich Fischer is a Senior Scientist at the Institute for Atmospheric and Climate Science, ETH Zurich, Switzerland. His research focuses on climate extremes, their driving processes, their changes under increasing greenhouse gas concentrations, associated projection uncertainties. He further collaborates with private and public partners in order to understand the potential impacts of climatic extremes. A second research interest includes the climate response to volcanic eruptions.

Jane Francis is Professor of Palaeoclimatology and Dean of the Faculty of Environment at the University of Leeds, UK. A geologist by training from the University of Southampton, she was a NERC Postdoctoral Fellow in London; palaeobotanist at the British Antarctic Survey; Australian Research Fellow at the University of Adelaide; lecturer at the University of Leeds and a Royal Society Leverhulme Trust Senior Research Fellow. Her interests include ancient climates and she studies fossil plants from the Arctic and Antarctica to decipher high-CO₂ climates of the past. She was awarded the Polar Medal for her contribution to British polar research.

David Frank is a dendroclimatologist at the Swiss Federal Research Institute WSL. His research interests include regional to hemispheric-scale climate variability, the impacts of climate change on intraseasonal to multicentennial tree growth, the global carbon cycle and methods of climate reconstruction. He has published on a wide variety of global climate change related topics in over 60 peer-reviewed articles and has collected tree-ring data from the boreal forests of Alaska to the tropical forests of New Caledonia.

Sherilyn C. Fritz is the George Holmes University Professor at the University of Nebraska–Lincoln, with appointments in the Department of Geosciences and School of Biological Sciences. Her research interests are in long-term environmental change, particularly using fossil record to reconstruct natural patterns of climate variation and to evaluate human impact on lakes. She has major research projects in the North American Great Plains and northern Rocky Mountains and in the tropical Andes and Amazon Basin of South America. Fritz serves on the editorial board of three major journals in geosciences and is co-director of the University of Nebraska's Water Resources Research Initiative.

René D. Garreaud is an Associate Professor in the Department of Geophysics at the Universidad de Chile. His research focuses on dynamic and synoptic climatology and its links to past, present and future climate variability in South America and the surrounding oceans, with emphasis on the climate of the Andes. His work is based on the analysis and diagnosis of both observations and computer-based simulations. He has participated in several field experiments



in South America and published over 30 peer-reviewed articles and book chapters. He received his PhD in 1999 from the University of Washington at Seattle, WA, USA.

Peter Gell is Professor of Environmental Science and Director of the Centre for Environmental Management at the University of Ballarat, Australia. He leads the Water theme within IGBP PAGES Focus IV 'Human-Climate-Environmental Interactions'. Within that focus he contributes to Limpacs as co-leader of the 'Salinity, Climate Change and Salinisation' working group. He applies fine resolution paleolimnology to establish the historical range of variability in wetland systems to quantify the degree of human impact on catchments and climates. He also uses river diatom assemblages as a means of auditing the benefits of catchment restoration programs.

Ian D. Goodwin is Associate Professor in Climate and Coastal Risk at Macquarie University. Ian has 30 years research experience in the fields of climatology, paleoclimatology and climate change science, coastal and marine geoscience, coastal oceanography, polar glaciology environmental geoscience, environmental hazard definition and impact management within Australia and overseas, specifically in South Pacific Islands and Antarctica. His papers have documented and provide new mechanisms for coastal evolution, sea-level change and ENSO, the impact of glacio-isostasy on coastlines, wave climate change and its impact on forcing regional shoreline alignment rotation and sediment transport variability, longshore sand transport on coasts in the south-west Pacific, south-eastern Australia, and on high-resolution synoptic climate reconstructions for Antarctica and the extratropical Southern Hemisphere. He has developed an integrated approach to researching: earth system archives using ice cores, corals and sediments; earth system processes using the sedimentary record and the instrumental record; regional climate change; and, the modelling, prediction and management of hydrological and coastal change.

Iain Gordon completed his PhD in Zoology from Cambridge University with postdoctoral research on the management of wetlands for biodiversity conservation in the Camargue, France. During the next 15 years of his career at the Macaulay Institute in Scotland he built a research team of 65 scientists to specialise in understanding and mitigating rural land management impacts on biodiversity and ecosystem services. He joined the Commonwealth Scientific and Industry Research Organization (CSIRO) in Australia six years ago to lead the Rangeland and Savannas group, based in Townsville where he led CSIRO's Building Resilient Biodiversity Assets Theme. Iain returned to Scotland in 2010 and is now chief executive and director of The James Hutton Institute. He has an extensive academic record as evidenced by his substantial list of publications in international peer reviewed journals (over 180), four books (two in the past two years), editorial positions on seven international journals.

Jemma L. Gornall gained her PhD from the University of Aberdeen in 2005. She worked as a Post-doctoral researcher for three years studying the effects of climate change on high latitude ecosystems. She has worked as a climate impacts research scientist at the UK Meteorological Office Hadley Centre for the last three years. Her research facilitates a more integrated approach to the assessment of climate change impacts in areas, such as agriculture, natural ecosystems, water resources, glaciers, urban areas and human health.

William D. Gosling is a Lecturer in Earth and Environmental Sciences at The Open University with a special interest in human, climate and environment interactions during the Quaternary

in the tropics. He employs a multiproxy approach to help understand past environmental change, with particular focus on vegetation reconstruction based upon pollen analysis. Major projects include the investigation of Lakes Titicaca (Bolivia/Peru) and Bosumtwi (Ghana); two of only a handful of terrestrial tropical records to span multiple glacial-interglacial cycles.

Stephan Harrison's main research interests lie in geomorphological responses to climate change, especially in mountain regions. He has worked for 12 field seasons on the glaciers of Patagonia studying their fluctuation histories since the Last Glacial Maximum and the geomorphological impact of recent glacier retreat on valley-side slopes. He also has research interests in the philosophy of physical geography. He has written on the ontology of quantum theory as an argument against realist philosophy in geography, and argued for the identification of emergent properties in landscapes as an alternative to the reductionist model-building paradigm. He is a co-author, with Steve Pile and Nigel Thrift, of *Patterned Ground: Entanglements of Nature and Culture* which was published in 2004.

Alan Haywood is Professor of Palaeoclimate Modelling at The University of Leeds, Leeds, UK. He is also principal investigator for palaeoclimate within the National Centre for Atmospheric Science. His expertise is in climate modelling. With an Earth science background he brings an understanding of the geological record to modelling that provides a robust interpretation of the geological data used to initialise models. His research focuses on understanding the processes that governed past climates. In particular, his interests and expertise lie in the synthesis of palaeoenvironmental data and its use within climate, ice sheet and vegetation modelling exercises. From 2003 to 2007 he was a Principal Investigator at the British Antarctic Survey, charged with the development and management of a multi-million pound research programme, Greenhouse to Ice-house Evolution of the Antarctic Cryosphere and Palaeoenvironment. In 2007 he was the recipient of a USGS Mendenhall Fellowship award that forms part of the PRISM project (Pliocene Research Interpretations and Synoptic Mapping). In 2008 he was awarded a Philip Leverhulme Prize in recognition of his contribution to palaeoclimatology. In 2011, he was awarded an EU ERC award for Pliocene climate modelling. He has published more than 60 papers on climate and environmental modelling.

Daniel Hill is a Postdoctoral Research Associate in Climate Change at the British Geological Survey. His main research focus is on modelling the climate of the Pliocene Epoch and applying an integrated Earth system approach to studying past climate. Having previously worked extensively with ice sheet models, he has recently been awarded an Early Career Fellowship by the Leverhulme Trust to apply the latest Hadley Centre climate and Earth system models to key palaeoclimates, to be hosted by the School of Earth and Environment at the University of Leeds.

Wim Z. Hoek is Lecturer of Quaternary Geology and Geomorphology at the Department of Physical Geography, Utrecht University. His research is focused on the late Weichselian and early Holocene climate and associated environmental changes, including dating and correlation. He is actively involved in the INTIMATE project, which aims to synthesise ice-core, marine and terrestrial records that span the Last Termination (c.60–8 ka cal. BP). He is editor-in-chief of the *Netherlands Journal of Geosciences*, and serves on the editorial boards of *Quaternary Geochronology* and *Proceedings of the Geologists' Association*.

William R. Howard is a research scientist currently at the Office of the Chief Scientist in Canberra Australia, and a Visiting Fellow at Australian National University. He works on

marine climate change, with particular emphasis on ocean acidification and its impacts on the past, current, and future ocean. He is particularly interested in the ocean carbon cycle and the responses of marine ecosystems to climate change. His work focuses on the insights into climate change that can be inferred from ocean sediment records as a baseline for pre-industrial conditions and as a tool for understanding the impacts of large-magnitude climate changes of the scale anticipated in the coming centuries. His expertise is in palaeoecology and low-temperature isotopic geochemistry.

Jed O. Kaplan is a Swiss National Science Foundation Professor in the Environmental Engineering Institute at the Ecole Polytechnique Fédérale de Lausanne. His research focuses on the development and application of global vegetation models to study the role of land cover in the Earth system. Another focus is on studying how preindustrial anthropogenic deforestation affected the global carbon cycle, and how early civilizations influenced large-scale patterns in vegetation cover through soil erosion and irrigation. He is also involved in projects on reconciling the ice core record of past atmospheric N₂O concentrations and paleoecological data-model assimilation for land cover reconstructions.

Reto Knutti is Professor for Climate Physics at the Institute for Atmospheric and Climate Science at ETH Zurich, Switzerland. His research focuses on changes in the global climate system caused by the growing emissions of anthropogenic greenhouse gases like carbon dioxide. He uses numerical models of different complexity to quantify uncertainties in climate projections and he develops methods to constrain important feedback processes in the climate system by comparing observations with model results. Reto Knutti is a lead author of the fourth and fifth assessment report of the Intergovernmental Panel on Climate Change (IPCC).

Tatiana V. Kuznetsova is Associate Professor in the Department of Paleontology at the Moscow State University, where she teaches diverse courses in paleontology. In 1995 she received her PhD for the research “Eopleistocene horses of Asia.” Her main research interests lie in Quaternary geology and biostratigraphy, late Pleistocene and Holocene history of mammoth Fauna, and the origin and evolution of Equidae. She is a member of the international working group studying DNA of the extinct species of Mammoth Fauna and is participating in the project “The collapse of the mammoth steppe ecosystem.”

Sietse O. Los is a Reader in Remote Sensing in the Department of Geography, Swansea University (UK). His research interests are in satellite observation of global vegetation, land-cover change, the global carbon and hydrological cycles and interactions between the atmosphere and biosphere. He previously worked with the Global Inventory Modeling and Monitoring System (GIMMS) group at NASA Goddard Space Flight Center in the US and was Acting Director and Programme Manager of the Natural Environment Research Council (NERC) Climate & Land-Surface Systems Interaction Centre (CLASSIC) in the UK.

Paul Markwick is Technical Director at GETECH Group plc., and holds visiting Research Fellowships at the University of Leeds and University of Bristol. He graduated from Oxford University in 1987 and received his PhD from the University of Chicago in 1996. His active research interests include global tectonics, the reconstruction of global palaeolandscapes and palaeodrainage, palaeoclimatology and palaeoceanography. He is currently working on developing process-based models to predict lithofacies character and distribution using palaeogeography and Earth System Models, and on completing a set of Mesozoic – Cenozoic palaeolandscape maps of Antarctica.



Shawn Marshall is a Professor of Glaciology and a Canada Research Chair in Climate Change at the University of Calgary. He studies glacier-climate processes, glacier dynamics, and the role of Quaternary and contemporary ice sheets in the global climate system. His research includes field and modelling studies in western and Arctic Canada, Iceland, and Greenland.

Joseph A. Mason's research is focused on the interpretation of landforms, sediments and soils in aeolian and hillslope systems as products of geomorphic processes, climate change and human impacts. Toward this end, he has investigated the stratigraphy and paleoenvironmental significance of loess and hillslope deposits in the central U.S.A. He and his colleagues have also studied the chronology of dune activity and dunefield geomorphology in the Great Plains and China, to assess long-term and recent changes in moisture, wind regime and human impacts. Mason is Professor of Geography at the University of Wisconsin-Madison, where he received his PhD in 1995.

John A. Matthews is Emeritus Professor of Physical Geography at Swansea University, Wales, UK, where he was also Director of the Swansea Radiocarbon Dating Laboratory. His main research interests are in Holocene environmental change, with particular reference to glacier and climatic variations, landscape change and dating techniques. While based at the Universities of London, Edinburgh, Cardiff and Swansea, Professor Matthews has led 40 Jotunheimen Research Expeditions to southern Norway for which he received the Ness Award of the Royal Geographical Society in 1988 and was honoured by an invitation to meet the King and Queen of Norway at a State Banquet at Buckingham Palace in 2005. As founding editor of *The Holocene* he has edited well over 100 issues of this interdisciplinary journal dedicated to recent environmental change. His publications include 150 papers in a wide range of scientific journals and seven books, including *The Ecology of Recently-Deglaciated Terrain* (Cambridge University Press, 1992); *The Encyclopaedic Dictionary of Environmental Change* (Arnold, 2001) and *Geography: A Very Short Introduction* (Oxford University Press, 2008).

Claire McDonald is a Research Associate in Statistical Ecology at the Centre for Ecology and Hydrology. After studying zoology at the University of Glasgow (BSc Hons) and then biodiversity and conservation at the University of Leeds (MSc), Claire discovered her interest in ecological interactions and drivers of environmental change. She completed a PhD at the University of Leeds examining insect trace fossils from Antarctica and comparing this evidence of insect life with modern analogues in Chile. Claire has undertaken fieldwork in a variety of places such as Chile, Svalbard, Greece, the Azores, Thailand, Kenya and Tanzania. Her current role involves understanding environmental change through statistical analyses.

Matt McGlone is a senior research scientist at Landcare Research, a Government-owned environmental research institute based at Lincoln, New Zealand. His main research interests are: Pleistocene-Holocene palaeoecology, with particular reference to climate change, fire, wetlands and the New Zealand subantarctic; environmental change resulting from prehistoric settlement; biogeography of the New Zealand region; and plant traits and adaptation. His publications include over 130 papers and two books. He is a Fellow of the Royal Society of New Zealand.

H. Jay Melosh is a Regents Professor at the Lunar and Planetary Laboratory, University of Arizona. He is considered an expert on the subject of impact cratering, a field he has studied and published about for 30 years. He is also a Science Team Member on NASA's Deep Impact mission that successfully impacted an instrument package into Comet Tempel 1 on 4 July 2005.



He received an AB degree in Physics from Princeton University in 1969 and a PhD in Physics and Geology from Caltech in 1973. His principal research interests are impact cratering, planetary tectonics, and the physics of earthquakes and landslides. His recent research includes studies of the giant impact origin of the moon, the K/T impact that extinguished the dinosaurs, the ejection of rocks from their parent bodies and the origin and transfer of life between planets. Professor Melosh is Fellow of the Meteoritical Society, the Geological Society of America, the American Geophysical Union and American Association for the Advancement of Science. He was awarded the Barringer Medal of the Meteoritical Society in 1999, the Gilbert prize of the Geological Society of America in 2001, the Hess medal of the American Geophysical Union in 2008 and was a Guggenheim Fellow in 1996–1997. Asteroid #8216 was named ‘Melosh’ in his honour. He was elected to the National Academy of Sciences in 2003. He has published approximately 150 technical papers, edited two books and is the author of a major monograph, *Impact Cratering: A Geologic Process* (Oxford University Press, 1989). He is currently preparing a graduate level textbook entitled *Planetary Surface Processes*.

Craig Miller is a Scientist and Environmental Consultant working to integrate social and ecological knowledge in the quest for sustainable development, sustainable livelihoods, and a healthy environment. He has a background in conservation and restoration ecology, but has more recently worked with Australian dairy farmers to reduce their vulnerability to the complex dynamics of the climate-commodity system, rural Indonesian groups to identify adaptation options for sustainable livelihoods in the face of climate change, and a watershed management board in the Philippines seeking water security from a contested watershed subject to a variable climate and increasing population. His research philosophy is transdisciplinary and integrative, and he is continuing to learn how best to apply system dynamics methods to the process of integrating scientific theory and stakeholder knowledge to address complex and/or disputed problems.

Cary J. Mock is a climatologist in the Geography Department at the University of South Carolina. His research and teaching interests are in synoptic climatology, historical climatology and environments and late Quaternary paleoclimatology. His synoptic and paleoclimatic research has focused on the western United States and Beringia, which includes the application of modern synoptic climate analogs to aid in data/model comparisons. His historical climate research has dealt with climate reconstructions of the last several centuries for various areas over North America, and most recently, he has worked on historical hurricane reconstructions for the Atlantic Basin and the Western Pacific Ocean.

Katie Moon is a PhD candidate at James Cook University, Australia. Her research focus is on the social dimensions of policy development and implementation for the conservation of biodiversity on privately managed land. Prior to commencing her research career, Katie worked in the environmental policy arena for 10 years within Australia and Europe, both in government and the private sector. She was responsible for regional and national environmental policy development in the UK, and for the implementation of environmental policy in Australia.

Andrew P. Morse is a Reader in Climate Impacts in the School of Environmental Science, University of Liverpool. He works on the impacts of climate variability and climate change on human and animal health. He is best known for his work in integrating impacts models, especially dynamic malaria models, into seasonal scale ensemble prediction systems. Most recently he has started to work on climate change model outputs integrating the same impact models using probabilistic approaches to bound the uncertainties in such projections.

Raimund Muscheler is Research Fellow of the Royal Swedish Academy of Sciences and is working at the Department of Earth and Ecosystem Sciences at Lund University. His research focuses on cosmogenic radionuclides measured in tree rings, sediments and ice cores. This field comprises topics such as solar and geomagnetic modulation of galactic cosmic rays, the production and atmospheric transport of ^{10}Be and the effects of changes in the carbon cycle on atmospheric radiocarbon. Reliable reconstructions of past changes in solar activity and the influence of solar activity variations on climate are among his main interests.

Donald R. Nelson is Assistant Professor in the Department of Anthropology at the University of Georgia, USA, and Visiting Fellow at the Tyndall Centre for Climate Change Research at the University of East Anglia, UK. He works with communities in water-stressed regions and focuses on water resources management, drought mitigation, and rural development. He places strong emphasis on participatory methods and local planning processes as a way to promote human well being and adaptation to changing social and biophysical environments.

Kevin J. Noone is Professor of Chemical Meteorology at the Department of Applied Environmental Sciences and the Stockholm Resilience Centre at Stockholm University, and is Director of the Swedish Secretariat for Environmental Earth System Sciences (SSEESS) at the Royal Swedish Academy of Sciences. He was Executive Director of the International Geosphere-Biosphere Programme from 2004–2008. He has a background in Chemical Engineering, and Civil and Environmental Engineering, Oceanography, Meteorology Atmospheric Physics. His primary research interests at present are in the area of atmospheric chemistry & physics, the effects of aerosols and clouds on air quality and the Earth's climate, and Earth System Science for Sustainability. Kevin has headed up of a number of large international field experiments, and is (or has been) a member of a number of international committees and boards, currently including chairing the European Academies Science Advisory Council's Environment Steering Panel and is vice-Chair of the International Group of Funding Agencies. He is author/coauthor of more than 120 scientific articles and 10 book chapters.

Patrick Nunn is Professor and Head of School of Behavioural, Cognitive and Social Sciences at the University of New England. His research interests are in Pacific Islands and include Quaternary-to-future climate change, plate-boundary tectonics, geomythology and geoarchaeology. In addition to more than 195 peer-reviewed publications, he has written several books including *Oceanic Islands* (Blackwell, 1994); *Environmental Change in the Pacific Basin* (Wiley, 1999); *Climate, Environment and Society in the Pacific during the Last Millennium* (Elsevier, 2007) and *Vanished Islands and Hidden Continents of the Pacific* (University of Hawai'i Press, 2009). In 2003 he was awarded the Gregory Medal for 'outstanding service to science in the Pacific'.

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Alison J. Smith combines her interests in aquatic biology and Quaternary paleoenvironments through the study of nonmarine Quaternary records of hydrologic and climatic change. She applies her expertise in ostracode paleoecology and biogeography to the reconstruction of past histories of aquatic environments throughout North America. She completed her BA in Anthropology at Wheaton College, Massachusetts, and holds the degrees of Master of Philosophy in Archaeology from Cambridge University, Master of Science in Geology from the University of Delaware, and a PhD in Geology from Brown University. She is currently a Professor in the Geology Department at Kent State University in Ohio, where she also holds adjunct faculty status in Biological Sciences. Professor Smith has published 36 technical papers and book chapters, is manager and co-author of the North American Ostracode Database (NANODE), an online database of modern ostracode biogeography and ecology, has served on the American Quaternary Society Council and is currently a member of the US National Committee for INQUA.

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Andrew J. Wiltshire is a climate impacts scientist at the Meteorological Office Hadley Centre. He uses his extensive expertise in land surface modelling to better understand the impacts of climate change and climate variability on global water resources. In particular Andrew's research focuses on the impacts of the secondary drivers of climate change such as the direct CO₂ effect on plant water use.

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