



Late Quaternary Environmental Change

Physical and Human Perspectives

Second Edition

M. BELL

Professor of Archaeological Science, the University of Reading

M.J.C. WALKER

Professor of Quaternary Science, the University of Wales, Lampeter



Contents

Preface to Second Edition	xi	<i>Chironomids</i>	29
Acknowledgements	xii	<i>Cladocera</i>	30
		<i>Ostracods</i>	30
		<i>Foraminifera</i>	30
		<i>Charred particles (charcoal)</i>	30
1 Environmental change and human activity	1	Sedimentary evidence	31
Introduction	1	Peat	32
Earth science, geography and archaeology	2	Lake sediments	32
Changing perspectives in science	5	Cave sediments	33
The causes of environmental change: cycles, pattern and chance	6	Glacial sediments	35
Questions of scale: space and time	9	Periglacial deposits	35
Environmental change and human perception	11	Slope deposits	36
Scope and structure of the book	14	Alluvial deposits	36
Note on dates	16	Aeolian deposits	38
		Palaeosols	39
		Coastal deposits and landforms	39
		Marine sediments	40
		Ice cores	41
		Isotopic evidence	42
2 Evidence for environmental change	17	Microfossils in deep-ocean sediments	42
Introduction	17	Ice cores	43
Scientific methodology	17	Speleothems	43
Inductivism	17	Tree rings	43
Falsification	19	Peat	44
Multiple working hypotheses	20	Lake sediments and other isotopic studies	45
Chaos theory	20	Historical evidence	46
Uniformitarianism	21	Weather records	46
Fossil evidence	22	Weather-dependent natural phenomena	47
Macrofossils	23	Phenological records	47
<i>Plant remains</i>	23	Instrumental records	48
<i>Mollusca</i>	24	Assessment of proxy data sources	49
<i>Fossil insects</i>	24	Uniformitarianism	50
<i>Mammalian remains</i>	26	Equifinality	50
Microfossils	27	Taphonomy	50
<i>Pollen and spores</i>	27	Preservation and contamination	51
<i>Rhizopods or testate amoebae</i>	27	Climatic inferences from historical data	51
<i>Diatoms</i>	28		

Climatic inferences from other proxy data	52	<i>Tropical lake data</i>	82
Dating of proxy records	52	<i>Lake sediment data</i>	82
Radiometric dating	53	Modifications to the astronomical theory	82
<i>Radiocarbon dating</i>	53	Patterns of short-term climatic change	85
<i>Uranium-series dating</i>	54	The Lateglacial climatic oscillation	85
<i>Optical dating</i>	55	The early Holocene amelioration	88
<i>Other radiometric methods</i>	56	The Climatic Optimum (the Hypsithermal)	89
Incremental dating	57	The late Holocene deterioration	91
<i>Dendrochronology</i>	57	The historical period	93
<i>Lichenometry</i>	58	Cyclical climatic change during the Holocene	95
<i>Laminated lake sediments</i>	58	Causes of short-term climatic change	95
<i>Annual layers in glacier ice</i>	59	Solar output variations	96
Age equivalence	60	<i>Quantitative changes in solar output</i>	96
<i>Tephrochronology</i>	60	<i>Qualitative changes in solar output</i>	99
<i>Palaeomagnetism</i>	60	Volcanic aerosols	100
<i>Oxygen isotope chronology</i>	61	Geomagnetism	102
Artefact dating	61	Ocean circulation	103
Notes	63	Atmospheric trace gases	107
		Notes	107
3 Natural environmental change	64		
Introduction	64	4 Consequences of climatic change	109
Patterns of long-term climatic change	64	Introduction	109
Evidence for long-term climatic change	65	The last glaciers in the northern temperate zone	109
The nature of long-term climatic change	67	Europe	109
Climatic changes in the North Atlantic region during the last cold stage	69	The British Isles	109
Greenland	70	North America	110
North Atlantic	72	Iceland and Greenland	111
Europe	72	Deglaciation: the ocean record	111
The British Isles	73	The Lateglacial: Europe	112
Northern United States, Canada and the Arctic	74	The Lateglacial: North America	113
Causes of long-term climatic change	75	Holocene glacier activity	113
The astronomical theory	77	Periglacial activity	113
Elements of the astronomical theory	78	Europe	114
<i>The precession of the equinoxes</i>	78	North America	115
<i>The obliquity of the ecliptic</i>	79	Sea-level change	116
<i>The eccentricity of the orbit</i>	79	Components of sea-level change	116
Evidence in support of the astronomical theory	80	Glacio-isostatic changes	117
<i>Deep-sea cores</i>	80	Glacio-eustatic changes	120
<i>Coral reef sequences</i>	81	Vegetational and pedological changes	123
<i>Pollen data</i>	81	Models of vegetational and pedological change	124
<i>Loess/palaeosol sequences</i>	81	The 'cryocratic' phase	125
<i>Ice-core data</i>	81	The 'protocratic' phase	126
		The 'mesocratic' phase	130

The 'oligocratic' phase	130	Late Pleistocene extinctions	186
Palaeohydrological changes	131	Holocene island extinctions	191
The fluvial record	131	Burning by hunter-gatherers	193
Glaciofluvial deposits	133	Mesolithic forest clearance in the	
Glacial lakes	133	British Isles and continental Europe	194
Periglacial palaeohydrology	135	The transition to agriculture in central	
Lateglacial palaeohydrology	136	and north-west Europe	197
Holocene palaeohydrology	137	The elm decline	199
5 People in a world of constant		Clearance by early farmers	203
 change	140	Early farmers in the circum-Alpine	
Introduction	140	zone	205
How people cope	140	Woodland management	205
Environmental change and human		Woodland clearance in the Americas	207
evolution	144	Biological consequences of clearance	
People and the Lateglacial/Holocene		and farming	210
transition	147	Holocene pedogenesis	212
The origins of agriculture	150	Blanket bogs and raised mires	216
Introduction	150	The development of moorland	219
South-west Asia	152	The development of heathland	221
America	156	The origins of grasslands	223
<i>Mesoamerica</i>	156	Disturbance, human agency and	
<i>South America</i>	158	the structuration of landscape	224
<i>North America</i>	158	7 People, climate and erosion	226
Coastal wetlands	159	Introduction	226
The Baltic	159	Valley sediments in North America	230
'Doggerland', the Netherlands and		Mediterranean valleys	232
north Germany	161	Central and eastern continental Europe	234
The Severn Estuary and Somerset		British Isles: colluviation in chalk	
Levels	164	landscapes	235
Coastal change: causes and		British Isles: river valleys	237
consequences	166	Aeolian sediments	239
Geohazards	168	Lakes	240
Volcanism	169	Erosion and flood: perception and	
Tsunamis and earthquakes	172	response	243
Asteroids, comets and meteorites	173	8 The role of the past in a sustainable	
Coping with the cold	174	 future: environment and heritage	
The Little Optimum and Little Ice Age	177	 conservation	244
Vinland and Greenland	177	Introduction	244
Iceland	179	A time perspective for sustainability	
Britain and European mainland	180	and biodiversity	244
6 Cultural landscapes, human agency		Archaeological sites in the	
 and environmental change	182	landscape	245
Introduction	182	Palaeoenvironmental studies and	
Environmental disturbance factors	183	nature conservation	246

Environmental management and archaeological assessment	249	<i>Nitrous oxide</i>	264
<i>In situ</i> preservation	250	<i>Ozone</i>	265
National strategies for conservation	251	<i>Halocarbons and halogenated compounds</i>	265
International dimensions and World Heritage	252	The role of aerosols	266
Wetland conservation	254	Consequences of the greenhouse effect	266
Presenting the past	256	Global temperature changes	267
Integrated perspectives	257	Global precipitation changes	269
Notes	258	Sea-level changes	270
		Hydrological changes	272
		Effects on agriculture	273
9 The impact of people on climate	259	Effects on forest ecosystems	273
Introduction	259	The ozone layer	274
The greenhouse effect	259	Acid deposition	275
Atmospheric carbon dioxide	260	Bibliography	277
Other atmospheric trace gases	262	Index	337
<i>Methane</i>	263		