

Contents

<i>Preface</i>	<i>page</i> xiii
<i>Acknowledgments and apologies</i>	xv
Chapter 1 Introduction	1
Reading list	3
Chapter 2 The natural Earth	4
2.1 The history of the natural Earth	4
2.2 The physical controls on the environment	7
2.2.1 Energy	7
2.2.2 The greenhouse effect	9
2.2.3 The biological influence on the reflectivity and color of the Earth	15
2.2.4 The circulation of the air	16
2.2.5 The circulation of the seas	19
2.2.6 Rainfall	22
2.3 The chemical controls on the environment	23
2.3.1 The air	23
	vii

viii	<i>Contents</i>
2.3.2 Geological recycling and the environment	28
2.3.3 The carbon cycle on the surface of the Earth	33
2.4 The processing factories of the Earth's air-conditioning system	36
2.4.1 Oceans and the water cycle	36
2.4.2 The rainforests	37
2.4.3 Boreal forest	43
2.4.4 Other land regions: tropical dry forest, savanna, tundra	45
2.5 The Gaia hypothesis	45
2.6 The interconnectedness of nature	46
2.7 The possibility of change	47
Reading list	50
Chapter 3 The causes of change	51
3.1 The impact of humanity	51
3.2 The atmospheric results of industrialization	53
3.3 Carbon dioxide	54
3.4 Methane	62
3.4.1 Fossil sources of methane	64
3.4.2 Nonfossil sources of methane	66
3.4.3 The causes of the rise in atmospheric methane	67
3.5 Other trace gases and atmospheric components	69
3.5.1 Carbon monoxide	69
3.5.2 Nitrogen oxides	70
3.5.3 The chlorofluorocarbons	71
3.5.4 Ozone	74
3.5.5 Arctic haze	80
3.5.6 Acid rain	82
3.5.7 Trace metals and ammonia	85
3.5.8 Hydroxyl	88
3.6 The causes and extent of floral and faunal change	90
3.6.1 Humanity, vegetation, and animals	90
3.6.2 Changes in the Earth's vegetation and animal population	92
3.7 A summary of vegetation change	94
3.7.1 Amazonia	94
3.7.2 Central America	97
3.7.3 The Southeast Asian forest	98
3.7.4 Madagascar	99
3.7.5 Canadian and Soviet forest	99
3.7.6 Humanity and vegetation in Zimbabwe: an African example	101
3.8 The scope of deforestation	106
3.9 The extinction of species	106
3.10 Inferences	106
3.11 The problem of observation: Landsat	107
Reading list	108

<i>Contents</i>	ix
Chapter 4 The consequences of change	109
4.1 Forcing the climate: feedbacks from atmospheric change	110
4.1.1 Cloud feedback	112
4.2 Is the Earth warming?	112
4.2.1 The Arctic geotherms	115
4.3 Predictions of the future	115
4.4 The problems of prediction	117
4.5 The physical effects on the oceans	118
4.6 The regional effects of change	122
4.6.1 The Arctic	125
4.6.2 Soil moisture	125
4.7 The response of vegetation	128
4.7.1 The impact on vegetation of increases in CO ₂	129
4.7.2 North America	132
4.7.3 South America	133
4.7.4 Europe	133
4.7.5 Asia	134
4.7.6 Africa	137
Reading list	138
Chapter 5 To manage the planet	140
5.1 Judging the problem	140
5.2 The cost of the commons	143
5.3 Attempting to calculate social cost	145
5.4 The industrial atmosphere	147
5.5 Energy	148
Reading list	150
Chapter 6 Reducing our impact: the means to generate and conserve energy	151
6.1 Controlling greenhouse emissions	152
6.1.1 Setting practicable targets for emissions	155
6.2 Conservation of energy	156
6.2.1 Conserving by price	157
6.2.2 Conserving by legislation	158
6.2.3 Conserving by town planning	161
6.3 The energy competition and the greenhouse	167
6.4 The chlorofluorocarbons and their effects on energy policy	168
6.5 The coal industry	174
6.6 Oil, natural gas, and hydrogen	177
6.7 Hydroelectric and tidal power	184
6.8 Solar and biomass power, winds, and waves	187
6.9 Geothermal energy	191
6.10 Nuclear power	191
6.10.1 Historical background and reactor design	191
6.10.2 Reactor types	196

x	Contents
6.10.3 Nuclear safety and accidents	200
6.10.4 Nuclear waste	207
6.10.5 Economics of nuclear power	209
6.10.6 Fuel reserves	212
6.10.7 Proliferation	213
6.10.8 The future of nuclear power	214
6.11 Clean energy: the move toward a managed greenhouse	216
6.12 Conclusion	224
Reading list	226
Chapter 7 Managing the Earth's vegetation	227
7.1 The impact of agricultural policy on the biosphere	228
7.2 Europe and the Common Agricultural Policy	234
7.3 North America	237
7.4 Soviet Union	238
7.5 African savanna	239
7.5.1 Restoring the African land	241
7.5.2 Pilanesberg: an example	243
7.6 The rainforest nations	245
7.6.1 The tropical and subtropical forest	247
7.7 The regional distribution of deforestation	248
7.7.1 Asia	248
7.7.2 Africa	248
7.7.3 South and Central America	250
7.8 Conservation	250
7.9 Financing an end to deforestation	254
7.10 Hogsback: macroenvironmental policy and microenvironmental management	258
7.11 Government and vegetation	263
Reading list	267
Chapter 8 The management of man	268
8.1 Population	268
8.2 The Save study: population, resources, and attitudes	270
8.3 Education	272
8.4 Health	277
8.5 Old-age pensions	281
8.6 The status of women	282
8.7 Implementation: the 1950 Earth model	284
8.8 Multilateral policy: GATT to GATE?	285
8.9 The G-7 meetings: G-12?	288
8.10 The Commonwealth and Francophonie	288
8.11 The European Community	289
8.12 Nation-states, bilateral arrangements, and development aid	290
Reading list	293

<i>Contents</i>	xi
Chapter 9 Summary: a new global economy	294
9.1 The control of climate	295
9.2 The response to challenge	296
9.3 The implementation of change	298
9.4 A note of optimism	299
<i>Appendix: Atmospheric chemistry</i>	302
A.1 Some short-term processes	302
A.1.1 Methane and carbon monoxide	304
A.1.2 Polluted air	305
A.1.3 Ammonia	305
A.1.4 Reduced sulfur species	306
A.2 Composition of the lower atmosphere (troposphere)	306
A.3 Mass of the atmosphere	307
A.4 Solar irradiance	307
<i>Further reading</i>	308
<i>Index</i>	345