

|Chris Park|

the
Environment | Principles and Applications
second edition



Contents

| | | | |
|--|-----------|---|-----------|
| List of colour plates | xv | <i>Population size and growth</i> | 40 |
| List of black and white plates | xvi | <i>Population growth</i> | 42 |
| List of figures | xviii | <i>The demographic transition</i> | 43 |
| List of tables | xxiii | Population distribution | 44 |
| List of boxes | xxvi | <i>World population</i> | 44 |
| Preface | xxxiv | <i>Urban growth</i> | 47 |
| Acknowledgements | xxxv | Carrying capacity and limits to growth | 48 |
| Part I INTRODUCTION | 1 | <i>Carrying capacity</i> | 48 |
| 1 ENVIRONMENT IN CRISIS | 3 | <i>Optimists and pessimists</i> | 50 |
| <i>Learning objectives</i> | 3 | Population prospects to 2050 | 51 |
| <i>Emphases</i> | 3 | <i>Millennium milestones</i> | 51 |
| <i>Overview</i> | 4 | <i>Trends and changes</i> | 51 |
| The environmental crisis | 4 | <i>United Nations population projections</i> | 52 |
| <i>Symptoms</i> | 5 | Population policies | 53 |
| <i>The crisis in context</i> | 9 | <i>National initiatives</i> | 53 |
| <i>The Rio Earth Summit</i> | 13 | <i>International initiatives</i> | 54 |
| <i>Monitoring and analysis</i> | 17 | Summary | 56 |
| Central themes | 20 | Further reading | 57 |
| <i>Environmental hazards and disasters</i> | 21 | 3 ENVIRONMENTAL SYSTEMS | 58 |
| <i>Global environmental change</i> | 23 | <i>Learning objectives</i> | 58 |
| <i>Sustainable development</i> | 26 | River Nile Case Study | 58 |
| <i>Environmentalism</i> | 27 | <i>The River Nile</i> | 58 |
| Summary | 30 | <i>The Aswan High Dam</i> | 62 |
| Further reading | 30 | <i>Lessons from Aswan</i> | 68 |
| 2 POPULATION AND ENVIRONMENT | 33 | Systems | 69 |
| <i>Learning objectives</i> | 33 | <i>What is a system?</i> | 69 |
| Demographic factors and processes | 33 | <i>Environmental systems</i> | 72 |
| <i>Population composition</i> | 33 | <i>System dynamics</i> | 77 |
| <i>Demographic forces</i> | 34 | <i>Response to change – adjustment and feedback</i> | 78 |
| | | <i>Implications</i> | 82 |

| | | | |
|--|------------|--|------------|
| Biogeochemical cycles | 86 | Applications | 132 |
| <i>General structure of the cycles</i> | 86 | <i>Radon gas</i> | 132 |
| <i>Induced changes</i> | 89 | <i>Underground storage of nuclear waste</i> | 135 |
| <i>The nitrogen cycle</i> | 89 | <i>Hot springs and geysers</i> | 139 |
| <i>The carbon cycle</i> | 91 | <i>Geothermal energy</i> | 139 |
| <i>The sulphur cycle</i> | 94 | Summary | 143 |
| <i>Implications of biogeochemical cycles</i> | 95 | Further reading | 143 |
| Summary | 97 | 6 DYNAMIC EARTH | 145 |
| Further reading | 97 | <i>Learning objectives</i> | 145 |
| 4 SPACESHIP EARTH | 99 | Plate tectonics | 145 |
| <i>Learning objectives</i> | 99 | <i>Drifting continents</i> | 146 |
| Images of the universe | 99 | <i>Sea-floor spreading</i> | 148 |
| <i>Spaceship Earth</i> | 99 | <i>Crustal plates</i> | 150 |
| <i>Views of the universe</i> | 100 | Earth movements and mountain building | 154 |
| Structure of the universe | 104 | <i>The face of the Earth</i> | 154 |
| <i>The universe: structure and composition</i> | 104 | <i>Warping</i> | 155 |
| <i>The solar system</i> | 105 | <i>Folding</i> | 157 |
| Dynamics of the universe | 109 | <i>Faulting</i> | 157 |
| <i>Origin and evolution of the universe</i> | 109 | Earthquakes | 160 |
| <i>Planet in motion</i> | 113 | <i>Shocks, waves and zones</i> | 160 |
| Earth as a living organism | 119 | <i>Experience and damage</i> | 166 |
| <i>The Gaia hypothesis</i> | 119 | <i>Coping with earthquakes</i> | 170 |
| <i>Climate control</i> | 120 | <i>Prediction and risk assessment</i> | 171 |
| <i>Implications of Gaia</i> | 121 | <i>Earthquakes induced by human activities</i> | 172 |
| Summary | 122 | Volcanoes | 173 |
| Further reading | 122 | <i>Impacts and locations</i> | 173 |
| Part II THE LITHOSPHERE | 123 | <i>Volcanic materials</i> | 176 |
| 5 STRUCTURE OF THE EARTH | 125 | <i>Intrusive vulcanism</i> | 177 |
| <i>Learning objectives</i> | 125 | <i>Extrusive vulcanism</i> | 179 |
| Surface of the earth | 125 | <i>Volcano hazards</i> | 186 |
| <i>Size, shape and character</i> | 125 | <i>Volcano prevention and prediction</i> | 187 |
| <i>Relief</i> | 127 | Summary | 190 |
| Interior of the Earth | 128 | Further reading | 190 |
| <i>Structure and behaviour</i> | 128 | 7 EARTH MATERIALS | 192 |
| <i>Core</i> | 130 | <i>Learning objectives</i> | 192 |
| <i>Mantle</i> | 130 | Rocks and minerals | 192 |
| <i>Crust</i> | 130 | <i>Minerals</i> | 192 |
| | | <i>Igneous rocks</i> | 194 |
| | | <i>Sedimentary rocks</i> | 196 |

| | | | |
|---|------------|--|--|
| <i>Metaphorphic rocks</i> | 201 | | |
| <i>The rock cycle</i> | 202 | | |
| Weathering | 204 | | |
| <i>Denudation</i> | 204 | | |
| <i>Disintegration</i> | 205 | | |
| <i>Decomposition</i> | 208 | | |
| Erosion | 210 | | |
| <i>Erosion processes</i> | 210 | | |
| <i>Mass movement</i> | 213 | | |
| Summary | 220 | | |
| Further reading | 221 | | |
| Part III THE ATMOSPHERE | 223 | | |
| 8 THE ATMOSPHERE | 225 | | |
| <i>Learning objectives</i> | 225 | | |
| <i>Atmosphere and life</i> | 225 | | |
| Atmosphere – composition and structure | 226 | | |
| <i>Composition of the atmosphere</i> | 226 | | |
| <i>Structure of the atmosphere</i> | 228 | | |
| The energy system | 231 | | |
| <i>Sunlight</i> | 231 | | |
| <i>Energy from the Sun</i> | 232 | | |
| <i>The Earth's energy budget</i> | 235 | | |
| <i>The natural greenhouse effect</i> | 238 | | |
| <i>Solar energy resources</i> | 239 | | |
| Air pollution and environmental change | 241 | | |
| <i>Air pollution</i> | 241 | | |
| <i>Major pollution incidents</i> | 245 | | |
| <i>Low-level ozone</i> | 247 | | |
| <i>Stratospheric ozone depletion</i> | 249 | | |
| <i>Acid rain</i> | 251 | | |
| <i>Greenhouse gases</i> | 255 | | |
| <i>Global warming</i> | 261 | | |
| Summary | 269 | | |
| Further reading | 269 | | |
| 9 ATMOSPHERIC PROCESSES | 271 | | |
| <i>Learning objectives</i> | 271 | | |
| Atmospheric temperature | 271 | | |
| <i>Temperature</i> | 271 | | |
| <i>Measuring temperature</i> | 272 | | |
| <i>Solar energy and temperature</i> | 274 | | |
| <i>Temperature and air stability</i> | 276 | | |
| Atmospheric pressure and wind | 278 | | |
| <i>Atmospheric pressure</i> | 278 | | |
| <i>Variations in pressure</i> | 279 | | |
| <i>Wind</i> | 280 | | |
| <i>Wind movement</i> | 280 | | |
| <i>Global wind circulation</i> | 284 | | |
| <i>Wind energy</i> | 288 | | |
| Atmospheric moisture and precipitation | 291 | | |
| <i>Water in the atmosphere</i> | 291 | | |
| <i>Humidity</i> | 292 | | |
| <i>Products of condensation</i> | 293 | | |
| <i>Clouds</i> | 294 | | |
| <i>Precipitation</i> | 296 | | |
| <i>Rainfall</i> | 299 | | |
| Summary | 300 | | |
| Further reading | 300 | | |
| 10 WEATHER SYSTEMS | 301 | | |
| <i>Learning objectives</i> | 301 | | |
| Importance of weather | 301 | | |
| <i>Weather and people</i> | 301 | | |
| <i>Weather extremes</i> | 303 | | |
| Air masses and fronts | 304 | | |
| <i>Air masses</i> | 304 | | |
| <i>Fronts and frontal systems</i> | 307 | | |
| <i>Depressions</i> | 309 | | |
| <i>Anticyclones</i> | 311 | | |
| Storms | 312 | | |
| <i>Storm events</i> | 312 | | |
| <i>Thunderstorms</i> | 313 | | |
| <i>Tornadoes</i> | 315 | | |
| <i>Hurricanes</i> | 317 | | |
| Summary | 324 | | |
| Further reading | 324 | | |
| 11 CLIMATE | 325 | | |
| <i>Learning objectives</i> | 325 | | |
| Climate | 325 | | |

| | | | |
|---|------------|---------------------------------------|------------|
| <i>Importance of climate</i> | 325 | <i>Irrigation</i> | 395 |
| <i>Controls of climate</i> | 327 | <i>Large dams</i> | 396 |
| Global climate | 332 | Water resource problems | 399 |
| <i>Climate classification and regions</i> | 333 | <i>Wetlands and drainage</i> | 399 |
| <i>Tropical climates</i> | 336 | <i>Salinity</i> | 401 |
| <i>Mid-latitude climates</i> | 337 | <i>Water quality and pollution</i> | 406 |
| <i>Sub-polar and arctic climates</i> | 340 | <i>Eutrophication</i> | 409 |
| Climate change | 340 | Floods and floodplains | 410 |
| <i>Evidence</i> | 340 | <i>Floodplains</i> | 410 |
| <i>Patterns</i> | 342 | <i>Floods</i> | 411 |
| <i>Causes</i> | 345 | Summary | 417 |
| Summary | 347 | Further reading | 417 |
| Further reading | 348 | 14 DRYLANDS | 419 |
| Part IV THE HYDROSPHERE | 349 | <i>Learning objectives</i> | 419 |
| 12 THE HYDROLOGICAL CYCLE | 351 | Drought | 419 |
| <i>Learning objectives</i> | 351 | <i>Defining drought</i> | 419 |
| The hydrosphere | 351 | <i>Causes of drought</i> | 421 |
| <i>Significance of water</i> | 351 | <i>Experiencing drought</i> | 423 |
| <i>The global water cycle</i> | 352 | <i>Coping with drought</i> | 425 |
| Drainage basins | 355 | Deserts | 426 |
| <i>The drainage basin</i> | 355 | <i>The nature of deserts</i> | 426 |
| <i>The drainage basin water cycle</i> | 357 | <i>Desert landscapes</i> | 430 |
| <i>River networks</i> | 360 | Desertification | 434 |
| River systems | 364 | <i>Definition and awareness</i> | 434 |
| <i>River processes</i> | 364 | <i>The process of desertification</i> | 435 |
| <i>River channel geometry</i> | 369 | <i>Causes of desertification</i> | 436 |
| <i>River channel patterns</i> | 371 | <i>Coping with desertification</i> | 439 |
| <i>Channel slope</i> | 375 | Summary | 440 |
| <i>Channel equilibrium and change</i> | 376 | Further reading | 440 |
| <i>Deltas</i> | 382 | 15 COLD AND ICE | 442 |
| Summary | 384 | <i>Learning objectives</i> | 442 |
| Further reading | 384 | Cold environments | 442 |
| 13 WATER RESOURCES | 386 | <i>Snow and ice</i> | 442 |
| <i>Learning objectives</i> | 386 | <i>Cold climates</i> | 444 |
| Water resource use | 388 | The Arctic and Antarctica | 447 |
| <i>Demand for water</i> | 388 | <i>The Arctic</i> | 447 |
| <i>Hydropower</i> | 393 | <i>Antarctica</i> | 448 |

| | | | |
|--|------------|---|------------|
| Glaciation | 451 | <i>Definition</i> 519 | |
| <i>Ice ages</i> 451 | | <i>Ecology</i> 523 | |
| <i>Causes of glaciation</i> 454 | | Biodiversity | 524 |
| <i>Glaciers and ice formation</i> 456 | | <i>Classification</i> 524 | |
| <i>Glacial erosion</i> 460 | | <i>How many species are there?</i> 525 | |
| <i>Glacial deposition</i> 463 | | <i>Significance of biodiversity</i> 527 | |
| <i>Meltwater</i> 467 | | Evolution and extinction | 529 |
| Summary | 470 | <i>Evolution</i> 529 | |
| Further reading | 471 | <i>Applications of evolution</i> 531 | |
| 16 OCEANS AND COASTS | 472 | <i>Evolution of life on Earth</i> 533 | |
| <i>Learning objectives</i> 472 | | <i>Extinction</i> 536 | |
| The oceans | 472 | Conservation | 539 |
| <i>Importance of the oceans</i> 472 | | <i>Conservation theory</i> 539 | |
| <i>Structure of the oceans</i> 474 | | <i>Conservation practice</i> 541 | |
| <i>Properties of ocean water</i> 477 | | <i>Protected areas</i> 542 | |
| <i>Ocean currents</i> 479 | | <i>Protected species</i> 547 | |
| <i>El Niño</i> 482 | | Summary | 548 |
| <i>Tides</i> 483 | | Further reading | 548 |
| Ocean resources | 485 | 18 ECOSYSTEMS, SUCCESSION AND BIOMES | 551 |
| <i>Wet commons</i> 485 | | <i>Learning objectives</i> 551 | |
| <i>Fishing</i> 486 | | Ecosystems | 551 |
| <i>Ocean mineral resources</i> 489 | | <i>The ecosystem concept</i> 551 | |
| <i>Ocean energy resources</i> 490 | | <i>Ecosystem structure</i> 552 | |
| <i>Ocean pollution</i> 493 | | <i>Ecosystem dynamics</i> 559 | |
| <i>Ocean management</i> 495 | | <i>Evaluation and application</i> 566 | |
| Coasts | 496 | Succession | 571 |
| <i>Importance of the coast</i> 496 | | <i>Concept of succession</i> 571 | |
| <i>Coastal forms and processes</i> 497 | | <i>Dynamics of succession</i> 571 | |
| <i>Estuaries</i> 504 | | <i>Products of succession</i> 574 | |
| <i>Coastal management</i> 504 | | Global patterns of vegetation | 576 |
| <i>Beach management</i> 507 | | <i>Biomes</i> 576 | |
| <i>Coastal hazards</i> 508 | | <i>Cold climates</i> 578 | |
| <i>Sea-level change</i> 511 | | <i>Temperate grassland</i> 580 | |
| Summary | 514 | <i>Temperate forest</i> 581 | |
| Further reading | 515 | <i>Hot climates</i> 583 | |
| Part V THE BIOSPHERE | 517 | <i>Tropical forests</i> 586 | |
| 17 THE BIOSPHERE | 519 | Global warming and biome changes | 590 |
| <i>Learning objectives</i> 519 | | Summary | 591 |
| Life on Earth | 519 | Further reading | 592 |

| | | | |
|--|------------|-----------------------------------|------------|
| 19 SOILS | 593 | Part VI REFLECTIONS | 615 |
| <i>Learning objectives</i> | 593 | | |
| Nature and development of soils | 594 | 20 RETROSPECT AND PROSPECT | 617 |
| <i>Soil composition</i> | 594 | <i>Learning objectives</i> | 617 |
| <i>Soil properties</i> | 597 | Back to the future | 617 |
| <i>Soil formation and profiles</i> | 600 | <i>Continuity and change</i> | 618 |
| <i>Soil-forming processes</i> | 602 | <i>Causes and complications</i> | 619 |
| Classification and distribution | 604 | <i>Perspectives and prognoses</i> | 619 |
| <i>Soil mosaics</i> | 604 | <i>Improvements and progress</i> | 622 |
| <i>Soil classification</i> | 604 | Future prospects | 623 |
| Managing soil resources | 608 | <i>Priority areas</i> | 623 |
| <i>Soils under threat</i> | 608 | <i>Dealing with uncertainty</i> | 625 |
| <i>Land evaluation</i> | 609 | <i>New approaches</i> | 626 |
| <i>Soil erosion and conservation</i> | 609 | <i>New and emerging problems</i> | 631 |
| Summary | 613 | Final reflections | 633 |
| Further reading | 613 | Summary | 634 |
| | | Further reading | 635 |
| | | <i>Bibliography</i> | 637 |
| | | <i>Glossary</i> | 647 |
| | | <i>Index</i> | 655 |