

# CONTENTS

<i>List of boxes</i>	<i>page xi</i>
<i>List of figures and tables</i>	xiii
<i>Preface</i>	xix
<i>Units</i>	xxi
<b>1 PEOPLE AND LAND</b>	<b>1</b>
1.0 Introduction	1
1.1 Population densities and land use	1
Variations in population densities	3
Land use	4
1.2 History of world population and growth rates	5
1.3 Variation in population characteristics in the modern world	11
Birth, fertility, and growth rates	11
Life expectancy and age distributions	14
Policy questions	15
1.4 Population and wealth	15
Policy questions	17
1.5 Too many people? A comparison of lesser-developed countries with industrial countries	17
Education and employment	17
Income and wealth	20
Women	20
Policy questions	21
1.6 Too many people? A discussion of the population of the United States	21
Population in the 20th century	21
Occupations and life-styles	22
Income and race	25
Policy questions	26
1.7 Population control	26
Carrying capacity	26

Quality of life	27
Population control	28
Policy questions	29
<i>Problems</i>	31
<i>References</i>	32
<b>2 FOOD</b>	33
2.0 Introduction	33
2.1 Human dietary requirements	34
Water	34
Carbohydrates	34
Fats (lipids)	34
Proteins	37
Specific elements – minerals	37
Special chemicals	38
Policy questions	40
2.2 Crop production	40
Energy and plant food	40
Requirements for crop production	42
Grain production	45
Nongrain plants	49
Policy questions	52
2.3 Animal production	52
The commons	52
Animal raising	53
Policy questions	55
2.4 Fishing	55
The nurture of fish	55
The fishing industry	59
Animals and fish in human nutrition	61
Policy questions	63
2.5 Money and agriculture	63
Environmental issues	63
Money	65
The future	68
Policy questions	69
<i>Problems</i>	69
<i>References</i>	70
<b>3 NATURAL HAZARDS</b>	71
3.0 Introduction	71
3.1 Earth's engines of change and their consequences	73
The consequences of change and the recognition of hazards	76
3.2 Thinking about risk	78
Natural hazards as a societal risk	79
Policy questions	81
3.3 Earthquakes	82
Causes and kinds of earthquakes	83
Destruction associated with earthquakes	83

---

Risk analysis and prevention of earthquake destruction	87
Policy questions	89
3.4 Volcanic eruptions	89
The nature of volcanic eruptions	89
Volcanic hazards	91
Risk and prediction	93
Policy questions	96
3.5 Tsunamis	96
Policy questions	97
3.6 River floods	98
Seasonal floods	98
Randomly occurring floods	99
Floods induced by human activity	104
Policy questions	104
3.7 Coastal flooding and erosion	104
Coastlines at risk	106
Human activity and the coastline	112
Policy questions	113
3.8 Landslides and related processes	113
Causes of rapid downslope movement of earth materials	116
Human influences on downslope movement	118
Policy questions	119
3.9 Who pays for natural disasters?	119
Policy questions	121
3.10 Conclusion	121
<i>Problems</i>	122
<i>References</i>	123
<b>4 WATER</b>	125
4.0 Introduction	125
4.1 Abundance of water	126
Global considerations	126
The (mostly) freshwater budget	127
Regional considerations of freshwater availability	130
4.2 Human uses of water	131
Where do we get water?	132
What do we do with water?	135
Choices versus necessities in water use	137
Policy questions	138
4.3 The surface water resource	138
Amount of surface runoff	138
Drainage basins and watersheds	139
Extraction of water for human use and the construction of dams	141
The Colorado: A parable of a river	143
Policy questions	145
4.4 The groundwater resource	145
The geology of groundwater	147
Extraction of groundwater	150
A case study of groundwater use: The High Plains aquifer	151

Policy questions	155
4.5 Water quality	155
Drinking water	155
Other uses	159
Policy questions	160
4.6 What do societies do to control and apportion water?	160
Who owns the water?	161
Policy questions	165
<i>Problems</i>	165
<i>References</i>	167
<b>5 ENERGY</b>	168
5.0 Introduction	168
5.1 Temperature, energy, heat, and power	169
5.2 Types of energy sources	171
Direct energy	171
Electricity	173
Stored energy	177
Policy questions	179
5.3 Fossil fuels	180
Products of decay of organic matter	180
Combustion	180
Geology of oil and natural gas	182
Distribution and reserves of oil and gas	187
Production, consumption, and transportation of oil	189
Oil shale and tar sand	193
Geology and distribution of coal	197
Policy questions	199
5.4 Nuclear power	200
Radioactive decay	200
Fission	201
Fusion	202
Nuclear reactors and bombs	202
Fuel supplies for reactors	205
Policy questions	206
5.5 Present and future energy use	206
Energy and the economy	206
Present energy use	207
Future energy use	209
Policy questions	211
<i>Problems</i>	211
<i>References</i>	212
<b>6 MINERAL RESOURCES</b>	214
6.0 Introduction	214
6.1 Definition and characteristics of mineral resources	215
Sustainable versus nonsustainable resources	215
Scarcity of resources	217
Resource and reserve inventories	218

---

Fixed location of mineral resources	221
Discovery risk	221
Policy questions	223
6.2 Classification and formation of mineral deposits	223
Classification	223
Geological ore-forming processes	225
6.3 Location of nonfuel mineral resources	233
Policy questions	235
6.4 Methods of mining ore and preparing it for market	235
Policy questions	239
6.5 Legal and property issues	240
Regalian versus accessory rights to minerals	240
The problem of the public lands in the United States	241
Policy questions	245
6.6 Thoughts on minerals and the future	245
<i>Problems</i>	245
<i>References</i>	246
<b>7 WASTE AND POLLUTION</b>	247
7.0 Introduction	247
7.1 Dispersal of waste in soil, surface water, groundwater, and air	248
7.2 Bulk waste	249
Policy questions	254
7.3 Hazardous chemicals	254
Industrial chemicals	255
Pesticides and herbicides	257
Disposal of hazardous waste	261
Policy questions	265
7.4 Radioactive waste	267
Dangers of radioactive waste	267
High-level nuclear waste	269
Low-level waste	273
Policy questions	274
7.5 Biologically active waste	274
Sewage	274
Excess nutrients (eutrophication)	277
Policy questions	279
7.6 Air pollution	279
Acid rain	280
Smog	280
Policy questions	284
7.7 Summary and conclusions	284
Bulk waste	284
Hazardous chemicals	284
Radioactive waste	284
Biologically active waste	284
Air pollution	285
<i>Problems</i>	285
<i>References</i>	286

---

<b>8 GLOBAL CHANGE</b>	287
8.0 Introduction	287
8.1 History and controls of climate and atmosphere	288
Control of atmospheric composition	291
Control of climate	293
8.2 Human activity and the recent history of atmosphere and climate	297
Recent history of the atmosphere and climate	297
Possible effects of human activity	301
Possible consequences of global warming	302
Policy questions	304
8.3 Extinctions and species diversity	305
Extinction of the megafauna	305
Modern species diversity	307
Extinctions and endangered species	308
Deforestation	313
Policy questions	316
8.4 Chemical modification of the earth's surface	317
Chlorofluorocarbons (CFCs) and the ozone layer	318
Lead	321
Policy questions	323
8.5 Summary and conclusions	323
Problems	324
References	325
<b>9 A FINAL WORD</b>	327
People and land	327
Food	327
Natural hazards	328
Water	328
Energy	328
Mineral resources	328
Waste and pollution	329
Global change	329
A final word	329
<i>Author index</i>	331
<i>Subject index</i>	335