

# Sustainable Development: Science, Ethics, and Public Policy

Edited by

John Lemons

*Department of Life Sciences,  
University of New England,  
Biddeford, ME, U.S.A.*

and

Donald A. Brown

*United Nations Organizations,  
Environmental Protection Agency,  
Office of International Activities,  
Washington, DC, U.S.A.*

**Bibliothek**

**INSTITUT FÜR WASSERBAU  
UND WASSERWIRTSCHAFT**

**TECHNISCHE HOCHSCHULE DARMSTADT  
PETERSENSTR. 13, 64287 DARMSTADT  
Tel. 0 61 51/16 21 43 · Fax: 16 32 43**

Juv.-Nr. : 2905



**KLUWER ACADEMIC PUBLISHERS**  
DORDRECHT / BOSTON / LONDON

## CONTENTS

Acknowledgements	vii
<b>Chapter 1 Introduction</b>	<b>1</b>
<i>Donald A. Brown and John Lemons</i>	
1. The International Acceptance of the Concept of Sustainable Development	1
2. The Rio de Janeiro Documents	2
2.1. The Climate Convention	2
2.2. The Biodiversity Convention	3
2.3. The Forest Principles	3
2.4. The Rio Declaration	3
2.5. Agenda 21	3
2.6. Other International Agreements Concerned With Sustainable Development	5
2.7. The U.N. Commission on Sustainable Development	6
3. Other Sustainable Development Activities	7
3.1. National Sustainable Development Programs	7
3.2. Subnational Sustainable Development Programs	8
3.3. The Need to Examine the Limits of Science, Economics, and Law in Sustainable Development Decisionmaking	8
4. The Purpose of This Book	9
<b>Chapter 2 The Role of Science in Sustainable Development and Environmental Protection Decisionmaking</b>	<b>11</b>
<i>John Lemons and Donald A. Brown</i>	
1. Agenda 21 and Science	11
2. The Need to Increase Scientific Understanding of Sustainable Development Problems	12
3. Two Methodological Approaches to the Use of Science in Sustainable Development Problems	14
4. Scientific Uncertainty and Values	16
4.1. Scientific Uncertainty Created By Analytical Tools	17

	4.2. Scientific Uncertainty and Complex Systems	18
	4.3. Scientific Uncertainty and Ethics	20
	5. Additional Value-Laden Dimensions of Science	21
	5.1. Separation of Facts and Values	22
	5.2. The Need to Synthesize Research Methods and Information	23
	5.3. Metaphysical Assumptions Embedded in Scientific Methods	23
	5.4. Science and the Burden of Proof	25
	6. Scientists and Decisionmakers	26
	7. Science and Environmental Assessment	27
	7.1. Some Goals of NEPA	27
	7.2. Assessing the Status of Science in Environmental Impact Assessment	28
	7.3. Improving Environmental Impact Statements	32
	8. The Role of Scientists	35
Chapter 3	<b>The Role of Ethics in Sustainable Development and Environmental Protection Decisionmaking</b>	39
	<i>Donald A. Brown</i>	
	1. Ethical Statements Defined and Distinguished From Scientific Statements	39
	2. Types of Ethical Theories	40
	2.1. Utilitarianism	41
	2.2. Rights and Duties Theories	43
	2.3. Theories of Justice	44
	2.4. Anthropocentric Versus Biocentric Ethics	45
	2.5. The Role of Religion	46
	3. Distributive Justice and the Good Life	47
	4. The Ethical Assumptions of Agenda 21	48
	5. Theoretical Versus Applied Ethics	49
Chapter 4	<b>The Role of Economics in Sustainable Development and Environmental Protection</b>	52
	<i>Donald A. Brown</i>	
	1. Introduction	52
	2. Ethics, Efficiency, and Sustainable Development	54
	2.1. Arguments for the Use of Market Mechanisms in Sustainable Development Policymaking	54

2.1.1.	Efficiency	54
2.1.2.	Liberty	55
2.2.	Criticisms of the Use of Market Mechanisms in Sustainable Development Policymaking	55
2.2.1.	Failure to Cover Market Externalities	55
2.2.2.	The Propensity of Market Valuation to Treat Environmental Entities as Commodities	57
2.2.3.	The Failure to Produce Public Goods	58
2.2.4.	Ethical Limitations of Preference Utilitarianism	58
2.2.5.	The Problem of Discounting for the Future	60
3.	Limits of Cost-Benefit Analysis	61
4.	Problems With Systems of National Accounting	61
Chapter 5	<b>The Role of Law in Sustainable Development and Environmental Protection Decisionmaking</b>	64
	<i>Donald A. Brown</i>	
1.	Introduction—Law and Sustainable Development	64
2.	The Role of Law in Sustainable Development Decisionmaking	65
3.	The Science-Law Interface	67
3.1.	The Precautionary Principle	67
3.2.	Scientific Evidence in Legal Proceedings	68
3.2.1.	Tort Actions	68
3.2.2.	Administrative Action	69
3.2.3.	Mathematical Models and Environmental Decisions	71
3.2.4.	The Duty of the Government to Speculate About Uncertain Environmental Impacts in Environmental Impact Statements	72
4.	Economics-Law Interface	73
5.	The Role of Citizens in Moving Toward Sustainable Development Law	75
Chapter 6	<b>Conservation of Biodiversity and Sustainable Development</b>	77
	<i>John Lemons and Pamela Morgan</i>	
1.	Introduction	77
2.	Goals of Sustainable Development and Conservation of Biodiversity	79
2.1.	The Needs of Humans and Ecosystems	79
2.2.	Sustaining Biodiversity and Socioeconomic Sustainability	81

3.	Guidelines for Management of Biodiversity	82
4.	The Status of Science and Scientific Uncertainty	85
4.1.	Scientific Knowledge About Biodiversity	87
4.2.	The Status of Ecology as a Basis for Management	95
4.3.	Implications of Scientific Uncertainty and Cost-Benefit Analysis	96
4.4.	Recommendations to Improve Scientific Capabilities	97
5.	Linkages Among Sustainability Problems	98
6.	Value-Laden Issues of Science and Decisionmaking	100
7.	Ethical Principles to Guide Decisionmakers	101
8.	Conclusion	104
Chapter 7	<b>Climate Change and Sustainable Development</b>	110
	<i>John Lemons, Rudolf Heredia, Dale Jamieson, and Clive Spash</i>	
1.	Introduction	110
2.	Scientific Assessment of Climate Change	112
2.1.	Warming of the Earth-Atmosphere System	112
2.2.	Methods to Model Climate	113
2.3.	Projected Climate Scenarios	115
2.4.	Problems of Detection	115
2.5.	Environmental Impacts	116
2.5.1.	Assessing Greenhouse Gas Emissions and a Greenhouse Gas Index	116
2.5.2.	Global Ecology	117
2.5.3.	Human Health and Disease	120
2.5.4.	Population Settlements	121
2.5.5.	Agriculture, Livestock, and Fisheries	121
2.5.6.	Water Resources	123
2.5.7.	Sea Level Rise	123
2.6.	Climate Linkages	124
3.	Ethics and Climate Change	127
3.1.	Global Environmental Justice	127
3.2.	Future Generations	129
3.3.	Nonhumans	130
3.4.	Ethics and Economics	130
3.5.	Scientific Uncertainty	131
3.6.	Ethical National Policy	132

3.7. Individual Responsibility	133
4. Greenhouse Economics	133
4.1. Cost-Benefit Analysis of Greenhouse Gas Control	134
4.2. Uncertain Futures	136
4.3. Noncompensatory Choices	137
4.4. Responsibilities to Future Generations	138
4.5. Future Prospects	141
5. A Third World Perspective	141
5.1. The Burden of Risk and the Price of Change	142
5.2. Equity-Based Ecological Development	144
5.3. Intergenerational Responsibility	145
5.4. Environmental and Financial Debt	146
5.5. Environmental Rights and Ecological Duties	148
5.6. Present Perceptions and Future Promise	148
6. Conclusion	149
<b>Chapter 8 Protection of Marine and Freshwater Resources</b>	<b>158</b>
<i>Larry Canter, Konrad Ott, and Donald A. Brown</i>	
1. Scientific Issues in Sustainable Water Resource Programs	158
1.1. Introduction	158
1.2. Background Information on Freshwater Resources	159
1.3. Summary of Agenda 21 Program Areas	161
1.4. Uncertainties Related to Protection of Freshwater Resources	166
1.4.1. Uncertainties in the Planning Process	166
1.4.2. Uncertainties in Technical Analyses	172
1.4.3. Uncertainties in Forecasts	174
1.4.3.1. Reservoir Water Quality Modeling Complexities—An Example	182
1.4.3.2. Aquatic Ecosystem Modeling	184
1.4.3.3. Uncertainties in Forecasting—A Summary	186
1.4.4. Uncertainties Related to Monitoring	186
1.4.5. Uncertainties in Health Impact Issues	190
1.4.6. Uncertainties Related to Climate Changes	194
1.5. Water Resources Management Strategy	195
2. Ethical Issues in Sustainable Water Resources	201
2.1. Ethical Principles in Agenda 21 Provisions Dealing With Water Resources	201

2.2.	Human Versus Ecosystem Needs	203
2.3.	Intranational and International Distributive Justice and Water Resources	204
2.4.	Future Generations and Water Resources	205
2.5.	Scientific Uncertainty and Water Resources Projects	206
2.6.	Economic Analysis of Water Resources Projects	207
2.6.1.	Market Externalities and Willingness to Pay	208
2.6.2.	Conflicts Between Ability to Pay and the Need to Protect Ecosystems	208
2.6.3.	Limits of Cost-Benefit Analysis Applied to Water Resource Projects	209
3.	Summary	210
Chapter 9	<b>Toxic Substances and Agenda 21: Ethical and Policy Issues in the Science and its Implementation</b>	215
	<i>Carl F. Cranor</i>	
1.	Introduction	215
2.	The Unknown Threat of Unevaluated Substances	215
3.	Agenda 21	217
4.	The Scientific Tools for Assessing the Risks From Carcinogens	217
5.	Predicting Risks from Animal Bioassays	219
6.	Normative Implications of the Scientific Uncertainties in Inferences from Animal Studies	229
7.	Problems in the Statistics of Human Epidemiological Studies and Animal Bioassays	231
7.1.	Discovering Risks	232
7.2.	Practical Evidence-Gathering Problems	233
7.3.	Theoretical Difficulties	234
7.4.	Interpreting Epidemiological Studies	241
7.5.	Public Policy Issues	242
8.	Implications for Agenda 21	246
Chapter 10	<b>Nuclear Waste and Agenda 21</b>	254
	<i>Kristin Shrader-Frechette</i>	
1.	Introduction	254
2.	The U.N. Mandates, Their Scientific Context, and the Appeal to Ignorance	254

3.	Nuclear Waste and Hydrogeological Uncertainty	257
4.	The U.N. Mandates and the Historical/Legal Context	260
5.	U.N. Mandates and the Ethical Context	262
6.	U.N. Mandates and the Equity Rationale	264
7.	Policy Implications of the U.N. Mandates	266
8.	Achieving Environmental Protection Through NMRS	267
Chapter 11	<b>Summary of the Scientific, Ethical, and Public Policy Recommendations for Sustainable Development</b> <i>John Lemons and Donald A. Brown</i>	275
	Index	279