

Contents

Preface	v
EcoSummit Participant List	vii
Introduction: Understanding and Solving Environmental Problems in the 21st Century: Toward a new, integrated “hard problem science” R. Costanza and S.E. Jørgensen	1
References	3
<i>Chapter 1</i>	
Integrated Assessment and Modeling – Science for Sustainability	
G. Harris	5
Abstract	5
1. Introduction	6
2. The global context	6
3. Changes to the enterprise of scientific research	7
4. “Clean and green” drivers on policy and markets	10
5. The science of IA and IAM – integration and synthesis	11
6. IAM and ESM – the science of the future?	14
References	16
<i>Chapter 2</i>	
The Potential for Integrated Assessment and Modeling to Solve Environmental Problems: Vision, Capacity, and Direction	
P. Parker, R. Letcher, A. Jakeman, with M.B. Beck, G. Harris, R.M. Argent, M. Hare, C. Pahl-Wostl, A. Voinov, M. Janssen, P. Sullivan, M. Scoccimarro, A. Friend, M. Sonnenshein, D. Barker, L. Matejcek, D. Odulaja, P. Deadman, K. Lim, G. Larocque, P. Tarikhi, C. Fletcher, A. Put, T. Maxwell, A. Charles, H. Breeze, N. Nakatani, S. Mudgal, W. Naito, O. Osidele, I. Eriksson, U. Kautsky, E. Kautsky, B. Naeslund, L. Kumblad, R. Park, S. Maltagliati, P. Girardin, A. Rizzoli, D. Mauriello, R. Hoch, D. Pelletier, J. Reilly, R. Olafsdottir, S. Bin	19
Abstract	19
1. Introduction	20

2. Integration	21
3. Visions of the future	23
3.1. Optimistic view	23
3.2. Pessimistic view	24
4. Evolution of IAM	25
5. IAM current position: Points of agreement	26
6. Case studies	28
7. Model complexity	29
8. Validation	29
9. Integrated Assessment	31
10. Agent-based models	32
11. Communication	33
12. Values in models	34
13. Future of IAM	34
14. Links to other groups	36
15. Conclusion	37
References	38

Chapter 3

Complex Adaptive Hierarchical Systems

B.C. Patten, B.D. Fath, J.S. Choi, S. Bastianoni, S.R. Borrett,
S. Brandt-Williams, M. Debeljak, J. Fonseca, W.E. Grant, D. Karnawati,
J.C. Marques, A. Moser, F. Müller, C. Pahl-Wostl, R. Seppelt,
W.H. Steinborn and Y.M. Svirezhev

Abstract	41
1. The new confrontation – biocomplex wholeness	42
1.1. Complexity	43
1.2. Adaptation and hierarchy	46
2. Measuring the organizational complexity of CAHSystems	53
2.1. Measuring the complexity of genomes and organisms – biocomplexity	54
2.2. Exergy-based orientors in a natural (virgin) forest	57
2.3. Exergy and information of solar radiation	62
2.4. Emergy and exergy	65
2.5. Integration of orientors	69
2.6. Adaptation and hierarchy, again	72
3. Systemicity	73
3.1. Eco-anthropic CAHSystems	73
3.2. A polycentric approach to integrated assessment	75
3.3. Eco-geological assessment towards sustainable coastal development in Yogyakarta, Indonesia – scale adjustment to observe and analyze CAHSystems	77

4. Concluding thoughts	82
Glossary	82
References	87

Chapter 4

Complex Adaptive Hierarchical Systems	
B.C. Patten, B.D. Fath, J.S. Choi, with S. Bastianoni, S.R. Borrett, S. Brandt-Williams, M. Debeljak, J. Fonseca, W.E. Grant, D. Karnawati, J.C. Marques, A. Moser, F. Müller, C. Pahl-Wostl, R. Seppelt, W.H. Steinborn and Y.M. Svirezhev	95
Abstract	95
1. Introduction	95
2. About theory	96
3. About applications	97
4. About modeling	98
5. Conclusions	99
References	99

Chapter 5

Ecosystem Services, Their Use and the Role of Ecological Engineering: State of the Art	
A. Dakers	101
Abstract	101
1. Introduction	102
2. Defining ecosystem services	103
3. Humankind's relationship with the natural environment	105
3.1. Anthropocentric or ecocentric valuing	105
3.2. Ecosystem relationships – embeddedness	105
3.3. Valuing ecosystem services	109
4. The use and misuse of ecosystem services	109
5. Designing and engineering to restore a sustainable relationship with ecosystems	110
5.1. Making better use of ecosystem services	110
5.2. Frontline projects	111
5.3. Players involved in achieving better use of ecosystem services	111
5.4. Engineer as designer	112
6. Ecological engineering	114
6.1. Case Study 1: Ministry of Transport in the Netherlands	115
6.2. Case Study 2: Oxelösund Våtmark, Sweden	116
6.3. Case Study 3: Donaumoos – Germany	116
6.4. Case Study 4: Kaja, Ås, Norway	116
6.5. Case Study 5: Aremark	117

6.6. Case Study 6: Kågeröd Recycling Project	117
6.7. Case Study 7: Ruswil, Switzerland	117
6.8. Case Study 8: Calcutta Wastewater-fed Aquaculture	118
6.9. Case Study 9: Stensund Aquaculture Centre	119
6.10. Case Study 10: Water Enhancement Programme, Christchurch	120
6.11. Case study evaluation	121
7. Under-utilization of ecosystem services	122
8. Conclusions	123
Acknowledgements	124
References	124

Chapter 6

Ecosystem Services

B. Guterstam, A. Werker, with M. Adamsson, D. Barker, A. Brüll, A. Dakers, S. Gossling, J. Heeb, S. Loisel, U. Mander, D. Melaku Canu, R. Roggenbauer, M. Roux, G.D. Santopietro, D. Stuart, M. Trudeau, H.D. van Bohemen	127
Abstract	127
1. Introduction	127
2. Ecosystem services	129
3. Key questions and common ground	132
4. The role of ecosystems services tomorrow	134
5. Conclusions	137
References	137

Chapter 7

Science and Decisionmaking

V.H. Dale	139
Abstract	139
1. Science and decisionmaking	140
2. Scientists' role in decisionmaking	140
3. Three case studies	141
3.1. Mount St. Helens	141
3.2. Tennessee Cedar Barrens	143
3.3. The Brazilian Amazon	144
3.4. Lessons learned	145
4. Characteristics of scientists and decisionmakers influence how they interact	146
5. Questions about the relationship between science and decisionmaking	149
Acknowledgements	150
References	151

Chapter 8

Science and Decisionmaking

E.J. Rykiel Jr., with J. Berkson, V.A. Brown, W. Krewitt, I. Peters, M. Schwartz, J. Shogren, D. Van der Molen, R. Blok, M. Borsuk, R. Bruins, K. Cover, V. Dale, J. Dew, C. Etnier, L. Fanning, F. Felix, M. Nordin Hasan, H. Hong, A.W. King, N. Krauchi, K. Lubinsky, J. Olson, J. Onigkeit, G. Patterson, K.S. Rajan, P. Reichert, K. Sharma, V. Smith, M. Sonnenschein, R. St-Louis, D. Stuart, R. Supalla and H. van Latesteijn	153
Abstract	153
1. Introduction	153
1.1. Working definitions	153
1.2. Multiple roles of science	154
1.3. The role of scientists in controversial issues	155
1.4. Scientists and activism	156
1.5. Education of scientists	156
1.6. Science based on holism	157
2. Increasing the effectiveness of the individual environmental scientist	158
2.1. Pathways to involvement in decisionmaking	158
2.2. Changing the environmental science curriculum	159
3. Case studies	160
3.1. Integrating science and economics for environmental policymaking in Europe	161
3.2. Lake management and demand-driven research in the Netherlands	162
4. Conclusions	163
Acknowledgements	164
References	165

Chapter 9

Ecosystem Health and Human Health

L. Vasseur, D.J. Rapport, J. Hounsell	167
Abstract	167
1. Introduction	167
2. Ecosystems, humans, and the concept of health	168
2.1. Ecosystems	169
2.2. Health	170
3. Ignoring the link	172
4. Climate change	175
5. Agrosystems and food production	178
6. Biodiversity and declining productive capacity	181
7. Discussion	183
Acknowledgements	185
References	185

Chapter 10

Ecosystem Health and Human Health: Healthy Planet, Healthy Living	
L. Vasseur, P.G. Schaberg, J. Hounsell, with P.O. Ang Jr., D. Cote, L.D. Duc, J.S. Ebenezer, D. Fairbanks, B. Ford, W. Fyfe, R. Gordon, Y. Guang, J. Guernsey, A. Hadi Harman Shaa, A. Hamilton, W. Hart, H. Hong, J. Howard, B. Huang, Y. Huang, D. Karnawati, R. Lannigan, S. Lawrence, Z. Li, Y. Liu, D. Malley, L. McLean, R. McMurtry, V. Mercier, N. Mori, M. Munawar, M.A. Naragdao, K. Okamoto, D. Rainham, D. Riedel, E. Rodriguez, M. Saraf, H. Savard, N. Scott, A. Singleton, R. Smith, H. Taylor, N.T. Hoang Lien, S. Xing and H. Xuan Co	189
Abstract	189
1. Introduction	190
2. Linkages between ecosystem health and human health	193
2.1. Air quality	193
2.2. Water resources	194
2.3. Food resources	196
2.4. Soils	197
2.5. Biodiversity	197
2.6. Other models	198
3. Sources of solutions	199
4. Priority actions	202
5. Barriers to effective action	205
5.1. Sustenance needs	205
5.2. Little connection to the land	206
5.3. Resistance to change	206
5.4. Ignorance	207
5.5. Low critical mass	207
6. Measures, indicators, or metrics of progress	208
7. Conclusions	213
Acknowledgements	217
References	217

Chapter 11

Quality of Life and the Distribution of Wealth and Resources	
R. Costanza, J. Farley and P. Templet	221
Abstract	221
1. How is Quality of Life (QOL) defined?	221
2. How has Quality of Life been measured?	225
2.1. Economic income, economic welfare, and human welfare	225
2.2. Level and pattern of economic activity: gross national product	225
2.3. Sustainable economic income	228
2.4. Measuring economic welfare	231

2.5. Assessing human welfare directly	234
3. A comparison of two approaches to fairness in the distribution of wealth and resources	237
3.1. Fairness across individuals in space	237
3.2. Fairness across individuals in time	240
3.3. Fairness across countries in space and time	247
4. Can we measure fairness?	248
5. What is the relationship between fairness and QOL?	251
6. Principles for achieving a sustainable, fair, and high-QOL society	253
References	255

Chapter 12

Quality of Life and the Distribution of Wealth and Resources

J. Farley, R. Costanza, P. Templet, with M. Corson, Ph. Crabbé, R. Esquivel, K. Furusawa, W. Fyfe, O. Loucks, K. MacDonald, L. MacPhee, L. McArthur, C. Miller, P. O'Brien, G. Patterson, J. Ribemboim and S.J. Wilson	259
Abstract	259
1. How do we define Quality of Life (QOL)?	259
1.1. What are human needs?	260
1.2. Satisfiers and wants	260
1.3. Implications of our definition for improving QOL	262
1.4. QOL and the four capitals	263
2. How can we measure QOL?	264
2.1. Are objective measures suitable?	264
2.2. Operationalizing human needs assessment as a measure of QOL	266
2.3. Ecosystem services: indicators to integrate with QOL	267
2.4. The implications of using HNA as a measure of QOL	267
3. Development of indicators of fairness in the distribution of wealth and resources	269
3.1. Natural capital and market failures	270
3.2. The elimination of poverty	273
3.3. Maximum income level	274
3.4. Geographical fairness	275
4. Approaches to measuring fairness	277
4.1. Ecosystem health and functioning markets	278
4.2. Poverties and pathologies	279
4.3. Wealth and power	279
4.4. A Quality of Life Gini Coefficient?	281
5. Implications of the relationship between fairness and QOL	282
5.1. Positional wealth	283
5.2. Income inequality as a detriment to QOL	283

5.3. Do we still need incentives to produce?	284
6. How do we achieve sustainable, fair, and high QOL?	284
6.1. Current world setting	285
6.2. Policy suggestions	289
6.3. Natural capitalism, increased efficiency, industrial ecology, and dematerialization	290
7. Conclusion	297
Appendix. The Sustainability Bill of Rights	298
References	298
Conclusions	
S.E. Jørgensen and R. Costanza	303
References	307
Author Index	309
Subject Index	319