

Perspectives on Global Change

The TARGETS Approach

Edited by

Jan Rotmans

and Bert de Vries

National Institute of Public Health and the Environment (RIVM), The Netherlands



CONTENTS

Foreword	xi
Preface	xiii
1 Global change and sustainable development	1
<i>Jan Rotmans, Marjolein B.A. van Asselt, and Bert J.M. de Vries</i>	
1.1 Introduction	3
1.2 Global change	4
1.3 Sustainable development	9
1.4 Integrated assessment	11
1.5 This book	13
Part One The TARGETS model	
2 Concepts	15
<i>Jan Rotmans, Bert J.M. de Vries, and Marjolein B.A. van Asselt</i>	
2.1 Introduction	17
2.2 The conceptual model and the basic concepts	18
2.3 Pressure-State-Impact-Response (PSIR)	22
2.4 Integration	25
2.5 Presentation	29
2.6 Transitions	30
3 The TARGETS model	33
<i>Jan Rotmans, Marjolein B.A. van Asselt, Bert J.M. de Vries, Arthur H.W. Beusen, Michel G.J. den Elzen, Henk B.M. Hilderink, Arjen Y. Hoekstra, Marco A. Janssen, Heko W. Köster, Louis W. Niessen, and Bart J. Strengers</i>	
3.1 Introduction	35
3.2 Integrated assessment modelling	35
3.3 Aggregation, calibration and uncertainty	39
3.4 Description of the TARGETS1.0 submodels	45
3.5 Submodel linkages in the TARGETS1.0 model	51
3.6 Future work	53
4 The Population and Health submodel	55
<i>Louis W. Niessen, and Henk B.M. Hilderink</i>	
4.1 Introduction	57
4.2 Health transitions	58
4.3 Modelling population and health	62
4.4 Model description	65
4.5 Calibration and validation	76
4.6 Conclusions	78

5	The energy submodel: TIME	83
	<i>Bert J.M. de Vries, and Marco A. Janssen</i>	
5.1	Introduction	85
5.2	Energy issues	87
5.3	Position within TARGETS	89
5.4	The energy demand module	92
5.5	The fuel supply modules	95
5.6	The electric power generation module	100
5.7	Calibration	102
5.8	Conclusions	106
6	The water submodel: AQUA	107
	<i>Arjen Y. Hoekstra</i>	
6.1	Introduction	109
6.2	Water policy issues	110
6.3	An integrated approach to water policy issues	112
6.4	Model description	114
6.5	Calibration and validation	130
6.6	Conclusions	134
7	The land and food submodel: TERRA	135
	<i>Bart J. Strengers, Michel G.J. den Elzen and Heko W. Köster</i>	
7.1	Introduction	137
7.2	Model description	139
7.3	Calibration	153
7.4	Conclusions	158
8	The biogeochemical submodel: CYCLES	159
	<i>Michel G.J. den Elzen, Arthur H.W. Beusen, Jan Rotmans, and Heko W. Köster</i>	
8.1	Introduction	161
8.2	The global carbon and nitrogen cycles and related feedbacks	163
8.3	Model description	168
8.4	Calibration	179
8.5	Conclusions	184
9	Indicators for sustainable development	187
	<i>Jan Rotmans</i>	
9.1	Introduction	189
9.2	Indicators and indices	190
9.3	Linkages between indicators and models	193
9.4	A model-based indicator framework	194
9.5	Practical implementation of TARGETS1.0	196
9.6	Linkage with existing indicator programmes	202

10	Uncertainties in perspective	205
	<i>Marjolein B.A. van Asselt, and Jan Rotmans</i>	
10.1	Introduction	207
10.2	Model routes	209
10.3	Framework of perspectives	211
10.4	Methodology	219
Part Two Exploring images of the future		
11	Towards integrated assessment of global change	223
	<i>Jan Rotmans, Bert J.M. de Vries, Marjolein B.A. van Asselt, Arthur H.W. Beusen, Michel G.J. den Elzen, Henk B.M. Hilderink, Arjen Y. Hoekstra, and Bart J. Strengers</i>	
11.1	Introduction	225
11.2	Experimental set-up and uncertainty analysis	226
11.3	Economic scenarios	231
11.4	The hierarchist utopia: a reference future	232
12	Population and health in perspective	239
	<i>Henk B.M. Hilderink and Marjolein B.A. van Asselt</i>	
12.1	Controversies related to population and health	241
12.2	Population and health uncertainties	242
12.3	Perspectives on population and health	243
12.4	Three images of the future	247
12.5	The plausibility of the projections	250
12.6	Risk assessment	252
12.7	Population, health and global change	256
12.8	Conclusions	261
13	Energy systems in transition	263
	<i>Bert J.M. de Vries, Arthur H.W. Beusen, and Marco A. Janssen</i>	
13.1	Introduction	265
13.2	Major controversies and uncertainties	266
13.3	Perspectives on world energy	270
13.4	Simulation results for the three utopias	274
13.5	Uncertainties and dystopias: some more model experiments	284
13.6	Conclusions	289

14	Water in crisis?	291
	<i>Arjen Y. Hoekstra, Arthur H.W. Beusen, Henk B.M. Hilderink, and Marjolein B.A. van Asselt</i>	
14.1	Introduction	293
14.2	Questions related to water	293
14.3	Major controversies and uncertainties	295
14.4	Perspectives on water	300
14.5	Water in the future: three utopias	304
14.6	Possible water futures: the broader scope	312
14.7	Risk assessment	314
14.8	Water policy and global change	315
15	Food for the future	319
	<i>Bart J. Strengers, Michel G.J. den Elzen, Heko W. Köster, Henk B.M. Hilderink, and Marjolein B.A. van Asselt</i>	
15.1	Introduction	321
15.2	Main issues and uncertainties	322
15.3	Perspectives on land and food	324
15.4	Simulation results for the three utopias	328
15.5	Uncertainties and dystopias: some more model experiments	337
15.6	Risk assessment	341
15.7	Conclusions	343
16	Human disturbance of the global biogeochemical cycles	345
	<i>Michel G.J. den Elzen, Arthur H.W. Beusen, Jan Rotmans, and Marjolein B.A. van Asselt</i>	
16.1	Introduction	347
16.2	Controversies and uncertainties	348
16.3	Perspectives on the global carbon and nitrogen cycle and climate system	353
16.4	Three images of the future: utopias	357
16.5	Risk assessment: dystopias	364
16.6	Conclusions	370
17	The larger picture: utopian futures	371
	<i>Bert J.M. de Vries, Jan Rotmans, Arthur H.W. Beusen, Michel G.J. den Elzen, Henk B.M. Hilderink, Arjen Y. Hoekstra, and Bart J. Strengers</i>	
17.1	Introduction	373
17.2	Inclusion of feedbacks in integrated experiments	374
17.3	Wishful thinking: three utopian futures	376
17.4	Economic growth in the three utopias	379
17.5	Transitions in utopian futures	384
17.6	Into the 22nd century: towards a sustainable state?	391
17.7	Conclusions	393

18	Uncertainty and risk: dystopian futures	395
	<i>Bert J.M. de Vries, Jan Rotmans, Henk B.M. Hilderink, Arthur H.W. Beusen, Michel G.J. den Elzen, Arjen Y. Hoekstra, and Bart J. Strengers</i>	
18.1	Introduction	397
18.2	Dystopian tendencies	398
18.3	Systematic exploration of dystopias	403
18.4	Additional explorations: policy timing and overconsumption	408
18.5	Uncertainty and risk	413
18.6	Conclusions	415
19	Global change: fresh insights, no simple answers	417
	<i>Bert J.M. de Vries, Jan Rotmans, Arthur H.W. Beusen, Michel G.J. den Elzen, Henk B.M. Hilderink, Arjen Y. Hoekstra, Marco A. Janssen, Louis W. Niessen, Bart J. Strengers, and Marjolein B.A. van Asselt</i>	
19.1	Introduction	419
19.2	Synthesis of the results	420
19.3	World in transition	428
19.4	Epilogue	431
	References	435
	Acronyms, units and chemical symbols	457
	Index	460