Developments in Environmental Modelling 18

Introduction to Environmental Management

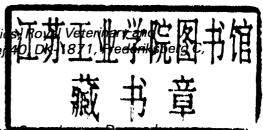
Edited by

P.E. Hansen

Department of Mathematics and Physic Agricultural University, Thorvaldsenvej Denmark

S.E. Jørgensen

Langkaer Vaenge 9, DK-3500 Vaerløse, Coponhag





ELSEVIER
Amsterdam — London — New York — Tokyo 1991

ELSEVIER SCIENCE PUBLISHERS B.V.
Sara Burgerhartstraat 25
P.O. Box 211, 1000 AE Amsterdam, The Netherlands

Distributors for the United States and Canada:

ELSEVIER SCIENCE PUBLISHING COMPANY INC. 655, Avenue of the Americas New York, NY 10010, U.S.A.

Library of Congress Cataloging-in-Publication Data

```
Introduction to environmental management / edited by P.E. Hansen, S.E. Jørgensen.

p. cm. -- (Developments in environmental modelling; 18)
Includes bibliographical references and index.
ISBN 0-444-88469-6 (hardback: acid-free-paper). -- ISBN
0-444-88532-3 (pbk.: acid-free-paper)
1. Environmenal protection. 2. Agriculture--Environmental aspects. I. Hansen, P. E. II. Jørgensen, Sven Erik, 1934-
III. Series.
TD170.I584 1990
363.7--dc20
91-14791
CIP
```

ISBN 0-444-88469-6

© Elsevier Science Publishers B.V., 1991

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior written permission of the Publisher, Elsevier Science Publishers B.V., P.O. Box 211, 1000 AE Amsterdam, The Netherlands.

Special regulations for readers in the USA – This publication has been registered with the Copyright Clearance Center Inc. (CCC), Salem, Massachusetts. Information can be obtained from the CCC about conditions under which photocopies of parts of this publication may be made in the USA. All other copyright questions, including photocopying outside of the USA, should be referred to the Publisher.

No responsibility is assumed by the Publisher for any injury and/or damage to persons or property as a matter of products liability, negligence or otherwise, or from any use or operation of any methods, products, instructions or ideas contained in the material herein.

This book is printed on acid-free paper.

Printed in The Netherlands

Developments in Environmental Modelling

- ENERGY AND ECOLOGICAL MODELLING edited by W.J. Mitsch, R.W. Bossermann and J.M. Klopatek, 1981
- 2. WATER MANAGEMENT MODELS IN PRACTICE: A CASE STUDY OF THE ASWAN HIGH DAM by D. Whittington and G. Guariso, 1983
- 3. NUMERICAL ECOLOGY by L. Legendre and P. Legendre, 1983
- 4A. APPLICATION OF ECOLOGICAL MODELLING IN ENVIRONMENTAL MANAGEMENT PART A edited by S.E. Jørgensen, 1983
- 4.B APPLICATION OF ECOLOGICAL MODELLING IN ENVIRONMENTAL MANAGEMENT PART B edited by S.E. Jørgensen and W.J. Mitsch, 1983
- ANALYSIS OF ECOLOGICAL SYSTEMS: STATE-OF-THE-ART IN ECOLOGICAL MODELLING edited by W.K. Lauenroth, G.V. Skogerboe and M. Flug, 1983
- MODELLING THE FATE AND EFFECT OF TOXIC SUBSTANCES IN THE ENVIRONMENT edited by S.E. Jørgensen, 1984
- MATHEMATICAL MODELS IN BIOLOGICAL WASTE WATER TREATMENT edited by S.E. Jørgensen and M.J. Gromiec, 1985
- FRESHWATER ECOSYSTEMS: MODELLING AND SIMULATION by M. Straškraba and A.H. Gnauck, 1985
- FUNDAMENTALS OF ECOLOGICAL MODELLING by S.E. Jørgensen, 1986
- AGRICULTURAL NONPOINT SOURCE POLLUTION: MODEL SELECTION AND APPLICATION edited by A. Giorgini and F. Zingales, 1986
- MATHEMATICAL MODELLING OF ENVIRONMENTAL AND ECOLOGICAL SYSTEMS edited by J.B. Shukla, T.G. Hallam and V. Capasso, 1987
- 12. WETLAND MODELLING edited by W.J. Mitsch, M. Straškraba and S.E. Jørgensen, 1988
- 13. ADVANCES IN ENVIRONMENTAL MODELLING edited by A. Marani, 1988
- MATHEMATICAL SUBMODELS IN WATER QUALITY SYSTEMS edited by S.E. Jørgensen and M.J. Gromiec, 1989
- 15. ENVIRONMENTAL MODELS: EMISSIONS AND CONSEQUENCES edited by J. Fenhann, Larsen, G.A. Mackenzie and B. Rasmussen, 1990
- 16. MODELLING LIECOTOXICOLOGY edited by S.E. Jørgensen, 1990
- 17. MODELLING IN ENVIRONMENTAL CHEMISTRY edited by S.E. Jørgensen, 1991

EDITORS' PREFACE

This volume grew out of a course in environmental management, launched at the Royal Veterinary and Agricultural University in Copenhagen in 1971 and held every year since then Among the many persons who have contributed to the creation and maintenance of this course and of the Danish lecture notes for it, let us mention just two: the late Prof. Niels-Haarløv for his inspiring enthusiasm in the initial phase, the 1970's, and Assoc. Prof. Marta Willems for her unselfish and conscientious contribution in the 1980's.

Two circumstances have left their stamp on the book. Firstly, it was written for a course which was, and still is, intended to give an *overview* of environmental management in a broad sense, not to go deep into any specific area. Secondly, to some extent *agriculture* is its home ground - had it been conceived at, say, a technical university, the weight attributed to the various subjects might have been different. It is our hope that versatility has neither led to shallowness nor been disfigured by a lack of balance.

Since the book will still have as an important purpose to serve as a textbook for the RVAU course mentioned above, and since some of its chapters had to be dominated by Danish matters, one may ask (and some did ask) if it could not just as well have been published once again in Danish - why did it have to come out in English? It is our belief that this question sticks too much to the past. A specific environmental problem may be local or national, but the entire area is rapidly becoming more and more influenced by international considerations, and this must inevitably be reflected in teaching, especially at university level. Though the book can hardly stand alone as a textbook for a similar course in another country, we believe it may serve as a relevant reference and source of information for teachers in the area, in particular (but not exclusively) in the EC countries. Besides, it is hoped that the book will induce contacts between the authors - most of whom are from the RVAU, while the rest work at Danish environmental institutions or other universities - and their colleagues abroad.

Undoubtedly, the book will be found to have some shortcomings. Let us mention a few of those that we are aware of.

The order in which the various subjects are treated is debatable, and it is certainly not necessary to read the book linearly, nor do we suggest that a course should go through the subjects this way. The rough idea was that Chapters 2 - 7 present the relevant basic

disciplines in and close to *natural science*, Chapters 8 - 10 do the same for *social science*, and finally Chapters 11 - 13 treat a discipline (ecology) and two subjects which are more *specific* to the field of environmental science.

Due to circumstances out of our control, we did not succeed in providing, as originally intended, a chapter on *noise*, nor one on the environmental aspects of various *forms of agriculture* (including 'ecological agriculture'). Besides, as explained by Prof. Wulff in Chapter 10, the treatment of Danish environmental law does not go as much into the detail of the actual legislation as might be expected, for the simple reason that this legislation is at present (spring 1991) about to be changed, yet no final bill has been passed. Should this book achieve a second edition, we hope to be able to supply these requirements.

The various chapters are characterized more by their authors and subjects than by the mild attempt of standardization on our side. Note that the references are listed at the end of each chapter, because they are, to a large extent, relevant to one chapter only. Papers in a Scandinavian language (Danish, Swedish, Norwegian) are indicated, both in the text and in the reference lists, by an asterisk, e.g., Petersen (1985*).

Finally we want to thank all those who have contributed to the realization of this volume or who have otherwise been helpful. Among these, let us mention Fritz Ingerslev, Helle Kürstein, Lene Duvier, Svend Tage Jakobsen, Børge Bundgaard, the late Jørgen Hyttel, and the staff at Elsevier, Amsterdam. See also the 'Acknowledgment' notes added by some of the authors at the end of their chapter. We encourage readers to communicate to us all errors and misprints they find, and all criticisms and points of view they might come up with. This will be of great value to us in connection with a possible reedition in the future.

Copenhagen, April 1991

Poul Einer Hansen Sven Erik Jørgensen

LIST OF CONTRIBUTORS

AUTHORS

- B. Bügel Mogensen, Department of Environmental Chemistry,
 - National Environmental Research Institute, Mørkhøj Bygade 26 H, DK-2860 Søborg.
- J. Eilenberg, Department of Ecology and Molecular Biology, RVAU.
- A. Helweg, Institute of Weed Control (Danish Research Service for Soil and Plant Science), Flakkebjerg, DK-4200 Slagelse.
- S.E. Jørgensen, Department of Chemistry,
 - National School of Pharmacy, Universitetsparken 2, DK-2100 Copenhagen Ø.
- L. Kamp Nielsen, Freshwater-Biological Laboratory (Copenhagen University), Helsingørsgade 51, DK-3400 Hillerød.
- S. Kjeldsen-Kragh, Department of Economics and Natural Resources, RVAU.
- E. Lund, Department of Veterinary Microbiology, RVAU.
- H. Philipsen, Department of Ecology and Molecular Biology, RVAU.
- J. Primdahl, Department of Economics and Natural Resources, RVAU.
- K. Rasmussen, Department of Chemistry, RVAU.
- H. Saxe, Department of Terrestrian Ecology,
 - National Environmental Research Institute, Vejlsøvej 11, DK-8600 Silkeborg.
- S. Storgaard Jørgensen, Department of Chemistry, RVAU.
- J.C. Streibig, Department of Agricultural Sciences, RVAU.
- H. Wulff, Department of Economics and Natural Resources, RVAU.
- L. Øgaard, Department of Ecology and Molecular Biology, RVAU.

EDITORS

- P.E. Hansen, Department of Mathematics and Physics, RVAU.
- S.E. Jørgensen, Department of Chemistry,

National School of Pharmacy, Universitetsparken 2, DK-2100 Copenhagen Ø.

All addresses are in Denmark. RVAU = The Royal Veterinary and Agricultural University, Bülowsvej 13, DK-1870 Frederiksberg C.

CONTENTS

Editors' preface	v
Table of conten	its vii
Contributors >	cvii

Chapter 1 INTRODUCTION

Sven Erik Jørgensen

1.	1	Multidianinliname challange	-
1,	Ţ	Multidisciplinary challenge	- 4

- 1.2 The environmental fields 3
- 1.3 Environmental management 4
- 1.4 The environmental crisis 6
- 1.5 Classification of pollution problems and abatement 9
 References 11

Chapter 2 SOIL POLLUTION

Søren Storgaard Jørgensen and Kjeld Rasmussen

- 2.1 Introduction 13
- 2.2 Soil constituents and physico-chemical processes 14
 - 2.2.1 Cation exchange and adsorption properties 15
 - 2.2.2 Water in soils 16
 - 2.2.3 Soil acidification 16
 - 2.2.4 Natural leaching processes in Eastern and Western Denmark 17
- 2.3 Plant nutrients in soils. Amounts and chemical processes 18
 - 2.3.1 Soil chemistry of calcium, magnesium, and potassium 19
 - 2.3.2 Soil chemistry of some micronutrients 20
 - 2.3.3 Soil chemistry of nitrogen, phosphorus, and sulfur 20
- 2.4 Nutrient balances, illustrated by the case of Danish agricultural soils 23
 - 2.4.1 Elements other than nitrogen 23
 - 2.4.2 Nitrogen balance 24
- 2.5 Nitrogen pollution 26
 - 2.5.1 Extent of the problem 26
 - 2.5.2 Nitrogen in drainage and groundwaters 28
 - 2.5.3 Preventive measures 29
- 2.6 Natural and anthropogenic soil acidification 29
- 2.7 Toxic elements ('heavy metals') in soils 31
 - 2.7.1 Element sources in an industrial society 32

2.8	2.7.2 Lead, mercury, cadmium, and nickel 33 Agricultural use of non-agricultural wastes 35 2.8.2 Sewage sludge 36 2.8.2 Compost 37 2.8.3 Fly ash and desulfurization products 38 Pollution caused by radioactive fall-out 38 References 39
Chap	oter 3 AIR POLLUTION Henrik Saxe
3.1	Introduction 41 3.1.1 The problem 41 3.1.2 The historical perspective 41 3.1.3 The definition 42 3.1.4 Specific air pollutants 42
3.2	•
3.3	Sources and emission 43
	3.3.1 Particulates 44
	3.3.2 Gases 46
3.4	Concentrations in the environment 47
	3.4.1 Concentration cycles 47
	3.4.2 Mean concentrations and percentiles 47
3.5	Transmission 49
	3.5.1 Dispersion 49
	3.5.2 Long range transport 52
	3.5.3 Two examples of import/export of air pollutants 53
3.6	Chemical transformations 53
	3.6.1 Homogeneous reactions and photochemistry 53
	3.6.2 Heterogeneous reactions, acid rain 53
3.7	Deposition 54
3.8	Uptake 55
3.9	Threshold doses for effects 58
	3.9.1 The principle of visible and invisible injuries 58
	3.9.2 Quantitative and qualitative injuries 58
3.10	Effects of carbon monoxide 59
3.11	Effects of carbon dioxide 60
3.12	Effects of sulfur dioxide 60
	3.12.1 Vegetation: Invisible and visible injuries 60
	3.12.2 Human health 65
	3.12.3 Erosion of buildings and art objects 66
3.13	Effects of oxides of nitrogen 67
	3.13.1 Vegetation 67

- 3.13.2 Human health 68
- 3.13.3 Erosion of materials 69
- 3.14 Effects of ozone and other photooxidants 69
 - 3.14.1 Deterioration of materials 69
 - 3.14.2 Vegetation 70
 - 3.14.3 Human health 71
 - 3.14.4 Reduction in visibility 72
- 3.15 Effects of acidification 72
 - 3.15.1 Terrestrial ecosystems 73
 - 3.15.2 Aquatic ecosystems 74
 - 3.15.3 Human health 75
 - 3.15.4 Erosion of materials 75
- 3.16 Effects of particulates 75
 - 3.16.1 Vegetation 76
 - 3.16.2 Human health 76
 - 3.16.3 Soiling of surfaces 77
- 3.17 Effects of radiation 78
- 3.18 Effects of combined pollutants 79
- 3.19 Indoor air pollution 80
 - 3.19.1 Open fires 80
 - 3.19.2 Tobacco-smoking 81
 - 3.19.3 Indoor ozone 82
- 3.20 Forest decline 82
 - 3.20.1 Natural forest decline 82
 - 3.20.2 Smoke-induced forest decline 84
 - 3.20.3 Novel forest decline 86
 - 3.20.4 Causes of European novel decline, and 'the ecological view' 90
- 3.21 The greenhouse effect 92
 - 3.21.1 The normal and the enhanced greenhouse effect 92
 - 3.21.2 Carbon dioxide, CO₂ 94
 - 3.21.3 Methane, CH₄ 95
 - 3.21.4 Nitrous oxide, N₂O 96
 - 3.21.5 Tropospheric ozone, O₃ 96
 - 3.21.6 Stratospheric ozone, O₃ 96
 - 3.21.7 Halocarbons, CFC-11, CFC-12 and others 97
 - 3.21.8 The relative importance of individual greenhouse gases 97
 - 3.21.9 The enhanced greenhouse effect changes global climate 97
 - 3.21.10 Other anthropogenic effects on global climate 100
 - 3.21.11 Can we reduce the changes in climate? 101
- 3.22 The stratospheric ozone 'layer' 102
 - 3.22.1 Origin 102
 - 3.22.2 Predictions of deterioration 102
 - 3.22.3 Antarctica 103

	3.22.4 The Arctic region 103 3.22.5 High northern latitudes 104 3.22.6 Effects of depletion of total ozone 105 3.22.7 The future of the ozone layer? 105 National and international regulations, and abatement 106 3.23.1 National regulations 106 3.23.2 International regulations 108 3.23.3 Abatement 108 Will and ethics 109 References 109	
Cha	oter 4 WATER POLLUTION Lars Kamp Nielsen	
4.1	The management of surface waters 115	
4.2	Aquatic ecology 118	
	4.2.1 The hydrological cycle 120	
4.3	Watercourses 120	
	4.3.1 The autotrophic components 124	
	4.3.2 The heterotrophic components 124	
	4.3.3 The oxygen balance 127	
	4.3.4 Effects of organic pollution 129	
	4.3.5 Biological indices 130	
	4.3.6 Ochre pollution 133	
	4.3.7 Water abstraction 136	
	4.3.8 Regulation and maintenance of streams 136	
	4.3.9 Recipient quality planning and state for Danish streams 138	
4.4	Lakes 138	
	4.4.1 The physics of lakes 138	
	4.4.2 The eutrophication process 141	
	4.4.3 Nitrogen and phosphorus 142	
	4.4.4 Mass balances 144	
	4.4.5 Empirical models 145	
	4.4.6 Recovery of lakes 156	
4.5	Restoration of streams and lakes 158	

х

4.6 Coastal waters 164

References 174

4.6.1 Hydrography of the Kattegat and the Belt Sea 164

4.6.4 Recipient quality planning for coastal waters in Denmark 174

4.6.2 The eutrophication of coastal waters 1674.6.3 Oxygen depletion and bottom fauna 171

Chapter 5 WATER MANAGEMENT AND WATER RESOURCES

Sven Erik Jørgensen

- 5.1 The properties of water 177
- 5.2 The hydrological cycle 177
- 5.3 Structure of the hydrosphere 178
- 5.4 The basic difference between aquatic and terrestrial ecosystems 181
- 5.5 Waste water 181
- 5.6 Water resources 183
- 5.7 Water and waste-water management 184 References 188

Chapter 6 PESTICIDES

Chapter 6.1 LEGISLATION, CONTROL AND CONSUMPTION IN DENMARK Betty Bügel Mogensen

- 6.1.1 Introduction 189
- 6.1.2 Act on chemical substances and products. Definition of pesticides 189
- 6.1.3 Statutory order on chemical pesticides 189
 - 6.1.3.1 Classification, packaging and labelling 193
 - 6.1.3.2 Sales and storage 193
 - 6.1.3.3 Use and disposal 193
- 6.1.4 Consumption 194
- 6.1.5 Control of residues in food and feedstuffs. Conclusion 195 Appendix: Acts and statutory orders 196

Chapter 6.2 DEGRADATION AND TRANSPORT

Arne Helweg

- 6.2.1 Introduction 197
- 6.2.2 A brief history of pesticides 198
- 6.2.3 The distribution of pesticides in the environment 199
 - 6.2.3.1 Pesticides in the atmosphere and in precipitation 199
 - 6.2.3.2 Pesticides in surface water and groundwater 199
 - 6.2.3.3 Adsorption and transport 201
 - 6.2.3.4 Pesticides in the crop 202
- 6.2.4 Degradation of pesticides 202
 - 6.2.4.1 Description of the degradation 205
 - 6.2.4.2 Influence of the soil environment on degradation 207
- 6.2.5 Conclusion 208

References 209

Chapter 6.3 ECOLOGICAL ASPECTS OF INSECT PEST CONTROL

Jørgen Eilenberg, Holger Philipsen and Leif Øgaard

- 6.3.1 Introduction 211
- 6.3.2 What is an insect pest? 211
- 6.3.3 Interaction between insects and plant coevolution 212
- 6.3.4 The use and gain of insecticide application 212
 - 6.3.4.1 Routine treatment 217
- 6.3.5 Ecological aspects of insecticides 218
 - 6.3.5.1 The influence of chemical agents on beneficials 219
 - 6.3.5.2 Insecticide resistance 220
- 6.3.6 Methods for reducing insecticide consumption 224
 - 6.3.6.1 Techno-cultural measures 225
 - 6.3.6.2 Prognosis and forecasting
 - as a basis of control adapted to needs 225
 - 6.3.6.3 Biocontrol 227
 - 6.3.6.4 Biotechnical control 231
 - 6.3.6.5 Integrated control 232
- 6.3.7 The risks of microbial control 233
- 6.3.8 Conclusion concerning microbial control 235
 References 235

Chapter 6.4 ECOLOGICAL ASPECTS OF CHEMICAL WEED CONTROL

Jens Carl Streibig

- 6.4.1 Introduction 239
- 6.4.2 Weeds 239
 - 6.4.2.1 Harmful and beneficial effects of weeds 241
- 6.4.3 A brief history of chemical weed control 241
- 6.4.4 The herbicides 242
 - 6.4.4.1 Herbicide selectivity and mode of action 243
 - 6.4.4.2 Herbicide use 244
- 6.4.5 Herbicide impact on the agroecosystem 246
 - 6.4.5.1 Herbicides and the weed flora 246
 - 6.4.5.2 Herbicide resistance in plants 250
 - 6.4.5.3 Herbicides and the fauna 253
- 6.4.6 New trends in weed control 254
- 6.4.7 Outlook for the future 254
- 6.4.8 Concluding remarks 255
 - References 255

Chapter 7 GENE-TECHNOLOGY

Ebba Lund

- 7.1 Introduction 257
- 7.2 The development of molecular biology 257
- 7.3 Some definitions 259
- 7.4 General examples of results obtained by gene-technology 260
- 7.5 A survey of the applications of gene splicing 262
 - 7.5.1 Applied microbiology 262
 - 7.5.2 Gene splicing applied in plants 262
 - 7.5.3 Application of gene splicing methods in animals and humans 263
- 7.6 Risk assessment 263
 - 7.6.1 Pathogens 264
 - 7.6.2 Physical containment 265
 - 7.6.3 Biological containment 265
 - 7.6.4 GILSP (Good Industrial Large Scale Practice) 265
 - 7.6.5 Deliberate release 266
- 7.7 Ethical problems 268
- 7.8 Inventors' rights and patents 269
- 7.9 Glossary 270

References 273

Chapter 8 COUNTRYSIDE PLANNING

Jørgen Primdahl

- 8.1 Introduction 275
 - 8.1.1 Countryside change 275
- 8.2 Countryside planning in Denmark 276
 - 8.2.1 Background 277
 - 8.2.2 The present planning system 279
 - 8.2.3 Comprehensive physical planning 280
- 8.3 Sectorial planning 281
 - 8.3.1 Raw materials plans 281
 - 8.3.2 Water-catchment plans 282
 - 8.3.3 Water-quality plans 284
 - 8.3.4 Agriculture plans 285
 - 8.3.5 Conservation plans 285
- 8.4 Case: Countryside planning in Viborg County 286
 - 8.4.1 The plan 286
 - 8.4.2 The planning process 287
 - 8.4.3 Implementation 289
- 8.5 Evaluation in countryside planning 289
 - 8.5.1 McHarg's ecological planning method 290

	8.5.3 Alexander's pattern language 293		
8.6	The countryside of tomorrow 296		
	8.6.1 The European language 297		
	8.6.2 The local landscape 298		
	References 298		
Chaj	pter 9 ENVIRONMENTAL ECONOMICS		
	Søren Kjeldsen-Kragh		
9.1	The different areas of environmental economics 301		
9.2	What does economic theory tell us? 301		
9.3	Is it possible to find the optimal level of pollution? 303		
	9.3.1 Seen from a total perspective 303		
	9.3.2 From the perspective of the individual enterprise 305		
	9.3.3 Conclusion 306		
9.4	Means of control in pollution prevention 306		
9.5	Definition of the objective 307		
	9.5.1 What are the criteria for the scope of the order or the size of the tax? 307		
	9.5.2 What consideration should be given to foreign environmental requirements? 308		
	9.5.3 To what extent should we differentiate		
	between already existing and new enterprises? 308		
9.6	Advantages of tax instruments 309		
9.7	Problems connected with tax instruments 310		
9.8	Conclusion on administrative versus economic instruments 312		
9.9	Not all environmental problems can be solved at once 313		
9.10	How to ensure a fair analysis of the individual environmental problem? 314		
	9.10.1 Lack of knowledge of the curves 314		

Chapter 10 DANISH ENVIRONMENTAL LAW

8.5.2 Lynch's spatial and visual analysis 292

Helge Wulff

9.10.4 Conclusion 318

References 318

- 10.1 Introduction 319
- 10.2 The judge-made law 319
- 10.3 Easements 320
- 10.4 The law of torts 321
- 10.5 Legislation on pollution control 321
 - 10.5.1 The Environmental Protection Act and other statutes 321

9.10.2 What can be done to overcome the problems? 3159.10.3 The analysis must not become too partial 317

	10.5.2	The Environmental Protection Act: Objects and principles	322
	10.5.3	The authorities of The Environmental Protection Act 323	
	10.5.4	Pollution of soil and subsoil 323	
	10.5.5	Pollution of surface water 324	
	10.5.6	Heavily polluting enterprises 324	
	10.5.7	Other enterprises and activities 325	
	10.5.8	Pollution from animal husbandry, etc. 325	
10.6	Land us	se control in the open spaces 326	
	10.6.1	Planning legislation 326	
	10.6.2	Legislation on the conservation of landscapes	
		and areas of scenic beauty 329	
	10.6.3	Water law 330	
	10.6.4	Forest legislation 331	
	10.6.5	Legislation on raw materials 332	
	10.6.6	Other legislation 332	
10.7	General	views on Danish environmental law 332	
	10.7.1	Property rights and environmental law 332	
	10.7.2	The internationalization of environmental law 334	
	10.7.3	Rules and regulations 336	
	10.7.4	The authorities 337	
	10.7.5	The control of the administrative system 338	
	10.7.6	Instruments of environmental law 339	
	10.7.7	The citizen and environmental law 340	
	10.7.8	Public confidence in environmental law 340	
	Referen	ces 341	

Chapter 11 ECOLOGICAL ASPECTS

Sven Erik Jørgensen

- 11.1 How to consider the ecological aspects? 343
- 11.2 Feed-backs in ecosystems 344
- 11.3 Adaptation and the ecological niche 345
- 11.4 Conditions for life 346
- 11.5 Species diversity and the development of ecosystems 352
- 11.6 Stability and structure 360
- 11.7 Ecological buffer capacity 361

References 364

Chapter 12 ENVIRONMENTAL IMPACT ASSESSMENT

Sven Erik Jørgensen

- 12.1 What is E.I.A.? 367
- 12.2 E.I.A. methods 368

- 12,2.1 Checklists 368
- 12.2.2 Environmental Quality Index (EQI) 371
- 12.2.3 Overlay mapping 375
- 12.2.4 Network 375
- 12.2.5 Systems diagram 375

References 376

Chapter 13 ENVIRONMENTAL MANAGEMENT MODELLING

Sven Erik Jørgensen

- 13.1 Modelling in environmental management 377
- 13.2 Modelling elements 379
- 13.3 The modelling procedure 382
- 13.4 Types of models 388
- 13.5 Conclusions 394 References 395

INDEX 397

xvi