
Contents

1	Climate Change: A Threat of the <i>Era</i>	1
1.1	Climate Change: An Overview	1
1.2	Causes of Climate Change	2
1.2.1	Natural Factors	3
1.2.2	Human Influences on Climate Change	9
1.3	Effects of Climate Change	12
1.3.1	Effects on Weather	14
1.3.2	Effects on Ocean	15
1.3.3	Effects on Human Health	20
1.3.4	Effects on Economic Profile	21
1.3.5	Challenges to IPCC Reports	24
	Important References	30
	Internet References	31
2	Mangroves: A Unique Gift of Nature	33
2.1	Mangroves: An Overview	33
2.1.1	Mangroves: A Multivalued Ecosystem	37
2.2	Threats to Mangrove Ecosystem	41
2.3	Conservation of Mangroves: Case Study of Indian Sundarbans	47
2.3.1	Encouragement Towards Alternative Livelihood Scheme	48
2.3.2	Afforestation	50
2.3.3	Introduction of Silviculture System	51
2.3.4	Ecological Rehabilitation of the Sundarbans Under the Integrated Wasteland Project	53
2.3.5	Captive Breeding Programmes	53
2.3.6	Conservation Policies	54
	Important References	56
	Internet References	59
	Annexure 2A.1: Spatial Variation of Stored Carbon in <i>Avicennia alba</i> of Indian Sundarbans	61
2A.1.1	Introduction	61
2A.1.2	Material and Methods	62
2A.1.2.1	Study Site Description	62
2A.1.2.2	Above-Ground Stem Biomass (AGSB) Estimation	62

2A.1.2.3	Above-Ground Branch Biomass (AGBB) Estimation	64
2A.1.2.4	Above-Ground Leaf Biomass (AGLB) Estimation	64
2A.1.2.5	Below-Ground Biomass (BGB) Estimation	64
2A.1.2.6	Carbon Estimation	64
2A.1.2.7	Soil Organic Carbon (SOC) Estimation.....	65
2A.1.2.8	Statistical Analysis.....	65
2A.1.3	Results and Discussion	65
2A.1.3.1	Relative Abundance	65
2A.1.3.2	Above-Ground Biomass (AGB).....	65
2A.1.3.3	Below-Ground Biomass (BGB).....	66
2A.1.3.4	Total Biomass	66
2A.1.3.5	Stored Carbon in <i>A. alba</i> Biomass	67
2A.1.3.6	Soil Organic Carbon	67
2A.1.4	Conclusion	69
	References of Annexure 2A.1	70

Annexure 2A.2: Influence of Anthropogenic and Natural Factors on the Mangrove Soil of Indian Sundarbans Wetland

		71
2A.2.1	Introduction.....	71
2A.2.2	Materials and Methods	72
2A.2.2.1	The Study Area	72
2A.2.2.2	Sampling and Analysis	73
2A.2.3	Results.....	73
2A.2.3.1	Soil Organic Carbon	73
2A.2.3.2	Soil pH.....	73
2A.2.3.3	Soil Salinity	76
2A.2.4	Discussion.....	76
2A.2.4.1	Soil Organic Carbon	76
2A.2.4.2	Soil pH.....	83
2A.2.4.3	Soil Salinity	83
2A.2.5	Conclusions.....	84
	References of Annexure 2A.2	84

Annexure 2A.3: Carbon Content in Phytoplankton Community of a Tropical Estuarine System.....

		87
2A.3.1	Introduction.....	88
2A.3.2	Methods	88
2A.3.2.1	Study Sites	88
2A.3.2.2	Salinity	89
2A.3.2.3	Cell Volume.....	90
2A.3.2.4	Cell Carbon.....	90
2A.3.2.5	Statistical Analysis.....	90
2A.3.3	Results.....	90
2A.3.3.1	Salinity	90
2A.3.3.2	Cell Volume.....	90
2A.3.3.3	Cell Carbon.....	91
2A.3.4	Discussion.....	96
2A.3.5	Conclusion	98
	References of Annexure 2A.3	104

3	How Mangroves Resist Natural Disaster?	107
3.1	Natural Disaster: Some Case Studies	108
3.1.1	Cyclone	108
3.1.2	Tsunami: An Incidence That Opened the Eyes of Millions	113
3.2	Resistance of Mangroves Against Cyclone and Tidal Surges	115
3.2.1	Wave Attenuation Properties of Mangroves	116
3.2.2	Sediment Trapping Properties of Mangroves	118
3.3	Migration of Mangroves in Response to Sea-Level Rise	120
3.3.1	Environmental Factors That Affect Mangrove Response to Sea Level	121
3.3.2	The Oscillating Mangrove Coordinates	125
	Important References	127
	Internet Reference	129
4	Impact of Climate Change on Mangroves	131
4.1	Effect of Climatic Factors on Mangroves	132
4.1.1	Effect of Rise in Temperature	132
4.1.2	Effect of Alteration of Precipitation Pattern	134
4.1.3	Effect of Rise in CO ₂ Concentration	134
4.2	Effect of Physico-Chemical Variables on Mangroves	135
4.2.1	Effect of Sea-Level Rise	135
4.2.2	Effect of Alteration of Aquatic Salinity	136
4.2.3	Effect of Alteration of Ocean Circulation Pattern	139
4.3	Mangrove Resistance to Climate Change: Some Case Studies	144
4.3.1	Sediment Accretion and Erosion	145
4.3.2	Biotic Contributions	146
4.3.3	Below-Ground Primary Production	146
4.3.4	Autocompaction	147
4.3.5	Fluctuations in Water Table Levels and Pore Water Storage	148
4.3.6	Approaches to Increase the Mangrove Resistance and Resilience	149
4.3.7	Fortification	152
4.3.8	Establishment of Protected Areas (PA)	153
4.3.9	Mangrove Rehabilitation	154
4.3.10	Regional Monitoring Network	154
4.3.11	Awareness Programmes	155
	Important References	155
5	Climate Change and Plankton Spectrum of Mangrove Ecosystem	161
5.1	Plankton Community of Tropical Mangroves	161
5.1.1	Phytoplankton	161
5.1.2	Zooplankton	163
5.2	Importance of Plankton	165
5.3	Impact of Climate Change on Plankton Community	177
	Important References	190
	Internet References	190

6	Climate Change and Its Impact on Brackish Water Fish and Fishery	191
6.1	Major Categories of Fishes in the Marine and Estuarine Waters.....	191
6.1.1	Osteichthyes.....	192
6.1.2	Chondrichthyes	196
6.2	Impact of Climate Change on Fish and Fishery.....	196
6.2.1	Effect on Biogeographic Distribution.....	197
6.2.2	Effect on Fish Community Structure	198
6.2.3	Effect on Fish Stock Dynamics and Larval Recruitment.....	202
6.2.4	Effect on Fish Diet (Prey) Spectrum.....	202
6.2.5	Effect on Reproductive System.....	204
6.2.6	Effect on Osmoregulation of Migratory Fishes	205
6.2.7	Effect on Heavy Metal Toxicity	206
6.2.8	Effect on Fish Disease.....	207
6.2.9	Effect on Protein Synthesis	209
6.3	Managing Fish and Fisheries	211
	Important References	215
	Internet Reference	217
7	Climate Change and Livelihood: Are We Approaching Towards an Inevitable Change?	219
7.1	Influence of Climate Change on Livelihood	220
7.1.1	Direct Impact of Climate Change on Livelihood Assets.....	221
7.1.2	Indirect Impact of Climate Change on Livelihood Assets.....	221
7.2	Indian Subcontinent: A Unique Test Bed.....	222
7.2.1	Effect on Agriculture.....	224
7.2.2	Effect on Fishery	224
7.2.3	Effect on Groundwater Resource.....	227
7.2.4	Effect on Coastal Natural Resources	227
7.3	Adaptation: A Way to Get Rid	230
7.3.1	Major Components of Adaptation.....	230
7.3.2	Levels of Adaptation	240
	Important References	242
	Internet References	244
8	Brackish-Water Aquaculture: A New Horizon in Climate Change Matrix	245
8.1	Brackish-Water Aquaculture: An Overview.....	245
8.1.1	Reasons for Collapse in India	247
8.1.2	Indian Supreme Court Judgement: Consequences.....	247
8.1.3	Remedial Measures	247
8.2	Shrimp Culture.....	249
8.2.1	Culturable Shrimp Species.....	252
8.2.2	Water Quality Management: A Vital Component of Successful Shrimp Culture.....	256
8.2.3	Shrimp Diseases.....	261
8.2.4	Host.....	261

8.2.5	Environment.....	261
8.2.6	Pathogen.....	261
8.3	Oyster Culture.....	268
8.3.1	Major Types of Edible Oysters	268
8.3.2	Importance of Oysters.....	269
	Important References.....	276

Annexure 8A.1: Sustainable Freshwater Aquaculture in Mangrove-Dominated Indian Sundarbans

	Using Floral-Based Feed.....	279
8A.1.1	Introduction.....	280
8A.1.2	Objectives	281
8A.1.3	Physiography of the Study Area	282
8A.1.4	Materials and Methods	282
8A.1.4.1	Selection of Pond.....	282
8A.1.4.2	Pond Preparation and Water Filling.....	282
8A.1.4.3	Stocking of Seeds	283
8A.1.4.4	Feed Preparation and Feeding Rate	283
8A.1.4.5	Analysis of Physico-chemical Parameters.....	284
8A.1.4.6	Monitoring of Zootechnical Parameters	286
8A.1.4.7	Protein Estimation	287
8A.1.4.8	Statistical Analysis.....	287
8A.1.5	Results.....	287
8A.1.5.1	Physico-chemical Parameters	287
8A.1.6	Discussion.....	294
8A.1.7	Summary.....	297
8A.1.8	A Way Forward.....	297
	References of Annexure 8A.1	298

Annexure 8A.2: Study on the Role of Mangrove-Based

	Astaxanthin in Shrimp Nutrition	301
8A.2.1	Preface	301
8A.2.2	Project Task.....	302
8A.2.3	Objectives	302
8A.2.4	Introduction.....	302
8A.2.4.1	Astaxanthin: An Overview.....	303
8A.2.5	Physiography of the Study Area	304
8A.2.6	Materials and Methods	306
8A.2.6.1	First Phase: May 2007–April 2008: Screening of Mangroves for Astaxanthin	306
8A.2.6.2	Second Phase: May 2008–April 2009: Shrimp Nutrition.....	307
8A.2.6.3	Third Phase: May 2009–April 2010: Shrimp Tissue and Water Quality Analysis.....	307
8A.2.7	Results and Discussion	308
8A.2.7.1	Astaxanthin Level in Mangroves	308
8A.2.7.2	Shrimp Nutrition and Growth.....	309
8A.2.7.3	Water Quality.....	310
8A.2.8	Looking Ahead.....	311
	References of Annexure 8A.2	312

Annexure 8A.3: Seasonal Variation of Biochemical Composition in Edible Oyster (<i>Saccostrea cucullata</i>) of Indian Sundarbans	317
8A.3.1 Introduction.....	317
8A.3.2 Materials and Methods	318
8A.3.2.1 Phase 1: Collection of Oysters.....	318
8A.3.2.2 Phase 2: Analysis of Hydrobiological Parameters.....	318
8A.3.2.3 Phase 3: Biochemical Analysis.....	319
8A.3.3 Results and Discussion	319
References of Annexure 8A.3	322

Sensitivity of Mangrove Ecosystem to Changing Climate

Mitra, A.

2013, XIX, 323 p. 113 illus., 46 illus. in color.,

ISBN: 978-81-322-1509-7