

Contents

List of Figures	xv
List of Tables	xix
Preface	xxi
1 Sustainability Principles and Dimensions	1
1.1 Introduction	1
1.2 Sustainability and Dimensions	2
1.3 History of Sustainability	6
1.4 Need for Sustainability	7
1.5 Benefits of Sustainability	9
1.6 Past, Present and Future	12
1.6.1 Past Views	12
1.6.2 Present and Future Trends	13
1.7 Challenges vs. Solutions	15
1.7.1 Challenges in Achieving Sustainability	15
1.7.2 Solutions for Sustainability	17
1.8 What is Sustainable Land Use?	19
1.9 Significance of Sustainable Land Use	21
1.10 Conclusion	23
References	24
2 Understanding Land Use Patterns	25
2.1 Introduction	25
2.2 Factors Affecting Land Use Pattern	26
2.3 Types of Land Use Pattern	28
2.4 Land Use Pattern vs. Land Use Cover	33
2.5 Why Land Use Patterns Must Be Studied	35
2.6 Relevant Departments and Stakeholders in Land Use Pattern Research	37

2.7	Use of Technology for Mapping Land Use Patterns	40
2.8	Conclusion	42
	References	43
3	Principles of Sustainable Land Use	45
3.1	Introduction	45
3.2	Balancing Economic, Social, and Environmental Objectives	46
3.3	Integrating Traditional and Modern Practices	50
3.4	Social and Cultural Considerations	52
3.5	Economic Viability of Sustainable Practices	56
3.6	Potential of Job Creation in Sustainable Land Use	58
3.7	Educational Initiatives	60
3.8	What are the Different Levels of Educational Initiatives?	62
3.9	Policy Integration	62
3.10	Conclusion	64
	References	64
4	Economic Aspects of Sustainable Land Use	67
4.1	Introduction	67
4.2	Foundations of Sustainable Land Use Economics	68
4.3	Economics of Land Use Change	71
4.4	Economic Impacts of Land Use Change	72
4.5	Policy Framework	73
4.6	Economics of Sustainable Urban Development	75
4.7	Challenges in Balancing Economic Goals with Sustainability	76
4.8	Strategies for Mitigating Conflicts between Economic and Environmental Objectives	78
4.9	Potential for Economic Prosperity through Sustainable Land Use	81
4.10	Conclusion	83
	References	83
5	Social Impacts of Sustainable Land Use Patterns	85
5.1	Introduction	85
5.2	Scope of Social Impact	86
5.3	Importance of Considering Social Impacts	88
5.4	Promoting Community Well-Being through Sustainable Land Use	89
5.5	Cultural Heritage Conservation in Land Use Planning	92
5.6	Importance of Social Cohesion in Land Use Planning	96
5.7	Identifying Key Challenges in Addressing Social Impacts	97

5.8	Social Factors Affecting Land Use Patterns	100
5.9	Conclusion	101
	References	102
6	Environmental Impact of Land Use Patterns	105
6.1	Introduction	105
6.2	Environmental Aspects of Land Use Patterns	107
6.3	Environmental Consideration in Land Use Planning	112
6.4	Environmental Consequences of Land Use Decisions	114
6.5	Integration of Environmental Policies	115
6.6	Ecosystem Services	120
6.7	Benefits of Ecosystem Services	124
6.8	Land Use Patterns Affect the Delivery of Ecosystem Services	125
6.9	Sustainable Land Use Enhances Ecosystem Services	127
6.10	Conclusion	129
	References	130
7	Technology in Land Use Planning	133
7.1	Introduction	133
7.2	Role of Technology in Decision-Making	136
7.3	Evolution of Technology	139
7.3.1	Mapping Techniques Before 20th Century	139
7.3.2	Aerial Photography (Early to Mid-20th Century)	139
7.3.3	Satellite Remote Sensing (Late 20th Century)	139
7.3.4	Geographic Information Systems (GIS) in the Late 20th Century	140
7.3.5	Machine Learning (ML) and Artificial Intelligence (21st Century)	141
7.3.6	Unmanned Aerial Vehicles (UAVs) or Drones (21st Century)	142
7.3.7	Utilization of Open Data (21st Century)	143
7.4	Technology in Determining Land Use Patterns	143
7.4.1	Data Collection and Monitoring	143
7.4.2	Spatial Analysis and Modelling	144
7.4.3	Natural Resource Management	144
7.4.4	Urban Planning and Infrastructure Development	144
7.4.5	Community Engagement and Decision-Making	145
7.5	Various Technologies Used for Land Use Patterns	145
7.5.1	Remote Sensing	146
7.5.2	Geographic Information Systems (GIS)	150
7.5.3	Global Positioning System (GPS)	151
7.5.4	Unmanned Aerial Vehicles (UAVs)/Drones	153

7.5.5	Machine Learning and Artificial Intelligence	154
7.5.6	Blockchain Technology	155
7.6	Equitable Benefits from Technological Innovations	156
7.7	Disadvantages of Technology	157
7.8	Conclusion	159
	References	160
8	Policy Framework for Sustainable Land Use	163
8.1	Introduction	163
8.2	Why is Policy Framework Necessary?	165
8.3	Beneficiary	167
8.4	National and International Land Use Policies	169
8.5	Role of Policies in Guiding Sustainable Land Use	172
8.6	Key Elements of the Policy Framework for Land Use	175
8.7	Zoning	179
8.8	Zoning Approaches That Promote Sustainability	186
8.9	Conclusion	189
	References	189
9	Challenges in Implementing Sustainable Land Use Patterns	193
9.1	Introduction	193
9.2	Challenges in Implementing Sustainable Land Use Patterns	197
9.3	Economic Interests vs. Environmental Conservation	203
9.3.1	Economic Interest	203
9.3.2	Environmental Conservation	204
9.4	What is the Resistance to Change in Sustainable Land Use Patterns?	206
9.5	Strategies for Overcoming Resistance	211
9.6	Dilemma of Immediate Economic Gains vs. Long-Term Sustainability	215
9.6.1	Immediate Economic Gains	215
9.6.2	Long-Term Sustainability	217
9.7	Conclusion	220
	References	221
10	Case Studies of Successful Sustainable Land Use	223
10.1	Introduction	223
10.2	Case Study I: Successful Sustainable Land Use in Costa Rica's Osa Peninsula	225
10.2.1	Background	225
10.2.2	Challenges	225
10.2.3	Solution	226

10.2.4	Results	227
10.2.5	Summary	229
10.3	Case Study II: Restoring and Promoting Sustainable Land Use in the Loess Plateau, China	229
10.3.1	Background	229
10.3.2	Challenges	229
10.3.3	Solution	230
10.3.4	Results	232
10.3.5	Summary	234
10.4	Case Study III: Sustainable Agroforestry in Murang'a County, Kenya	235
10.4.1	Background	235
10.4.2	Challenges	235
10.4.3	Solution	236
10.4.4	Results	237
10.4.5	Summary	241
10.5	Case Study IV: Sustainable Land Management Practices in the Sahel Region of Africa	241
10.5.1	Background	241
10.5.2	Challenges	242
10.5.3	Solution	242
10.5.4	Results	244
10.5.5	Summary	246
10.6	Case Study V: Sustainable Grazing Management in the Great Plains, USA	246
10.6.1	Background	246
10.6.2	Challenges	247
10.6.3	Solution	248
10.6.4	Results	249
10.6.5	Summary	253
10.7	Case Study VI: Sustainable Land Use and Watershed Management in Ralegan Siddhi, Maharashtra, India	253
10.7.1	Background	253
10.7.2	Challenges	254
10.7.3	Solution	254
10.7.4	Results	257
10.7.5	Summary	259
10.8	Case Study VII: Sustainable Agriculture and Land Use in Sikkim, India	259
10.8.1	Background	259
10.8.2	Challenges	259

10.8.3	Solution	261
10.8.4	Results	264
10.8.5	Summary	265
10.9	Conclusion	266
	References	266
11	Community Engagement in Land Use Decision-Making	269
11.1	Introduction	269
11.2	Participatory Planning	271
11.3	Theoretical Underpinnings of Participatory Methods	271
11.3.1	Workshops	272
11.3.2	Town Hall Meetings	272
11.3.3	Citizen Forums	273
11.4	Involvement of Communities in Decision-Making	273
11.5	Importance of Locals in Decision-Making	279
11.6	Strategies to Overcome	282
11.7	Incorporating Local Knowledge in Decision-Making	287
11.8	Digital Platforms for Engaging Communities in Land Use Decisions	289
11.9	Role of Social Media in Shaping Public Opinion on Land Use	292
11.10	Effectiveness of Community Input in Decision-Making	293
11.11	Quantitative and Qualitative Metrics for Evaluation	296
11.12	Challenges in Incorporating Feedback	297
11.13	Conclusion	299
	References	299
12	Remote Sensing Techniques for Land Use Pattern Extraction	301
12.1	Introduction	301
12.2	Remote Sensing Technique	303
12.3	Necessity and Importance	306
12.3.1	Environmental Monitoring	306
12.3.2	Natural Resource Management	307
12.3.3	Disaster Management and Response	307
12.3.4	Climate Change Monitoring	307
12.3.5	Agriculture and Food Security	308
12.3.6	Infrastructure Planning and Development	308
12.3.7	Public Health	308
12.3.8	Scientific Research	309
12.3.9	Policy and Decision-Making	309
12.3.10	Global Connectivity and Collaboration	309
12.4	Satellite Imagery in Identifying Shifts in Land Use Patterns	310

12.4.1	Tracking the Process of Urbanization	310
12.4.2	Utilization of Agricultural Land	311
12.4.3	Assessment of the Environmental Impact	312
12.4.4	Deforestation and Reforestation Analysis	312
12.4.5	Coastal Areas Change Analysis	313
12.4.6	Research on Climate Change	313
12.4.7	Identification of Illicit Actions	314
12.4.8	Monitoring Biodiversity and Habitats	315
12.4.9	Emergency Management and Rehabilitation	315
12.5	Satellites System and Their Capabilities	316
12.5.1	Earth Observation Satellites Capabilities	316
12.5.2	Navigation Satellites Functionalities	317
12.5.3	Weather Satellites Functionalities	317
12.5.4	Radar Satellites Functionalities	318
12.5.5	Communication Satellites Functionalities	319
12.6	Satellite Series	319
12.6.1	Landsat Satellite Series	319
12.6.2	Sentinel Satellite Series	319
12.6.3	SPOT Satellite Series	325
12.6.4	MODIS Satellite Series	328
12.7	Conclusion	329
	References	330
13	Satellite Image Analysis	333
13.1	Introduction	333
13.1.1	Image Acquisition	334
13.1.2	Data Preprocessing	334
13.1.3	Image Enhancement	334
13.1.4	Classification and Examination	335
13.1.5	Data Integration	335
13.1.6	Visual Representation and Analysis	335
13.2	Applications of Satellite Image Processing	335
13.3	Image Acquisition	336
13.3.1	Optical Imaging	336
13.3.2	Thermal Imaging	337
13.3.3	Microwave and Radar Imaging	337
13.3.4	Light Detection and Ranging (LiDAR)	338
13.4	Preprocessing Techniques	338
13.4.1	Radiometric Correction	338
13.4.2	Atmospheric Correction	339
13.4.3	Geometric Correction	339

13.4.4	Reduction of Noise	340
13.5	Image Enhancement Techniques	340
13.5.1	Contrast Enhancement	341
13.5.2	Spatial Filtering	342
13.5.3	Transformations and Filtering in the Frequency Domain	342
13.5.4	Colour Enhancement	343
13.5.5	Advanced Enhancement Techniques	343
13.6	Classification Techniques	343
13.6.1	Supervised Classification	344
13.6.2	Unsupervised Classification	345
13.7	Change Detection Techniques	346
13.8	Spectral Analysis Techniques	346
13.8.1	Spectral Indices	347
13.8.2	Spectral Unmixing	349
13.9	Machine Learning and Artificial Intelligence Techniques	351
13.9.1	AI and ML	351
13.9.2	Deep Learning	351
13.10	Conclusion	355
	References	356
14	Artificial Intelligence and Machine Learning in Land Feature Extraction	359
14.1	Introduction	359
14.2	Role of AI and ML in Land Use Analysis	362
14.2.1	Automated Land Cover Classification	363
14.2.2	Change Detection and Monitoring	364
14.2.3	Predictive Modeling	365
14.2.4	Incorporating Socioeconomic Data	366
14.3	Benefits of AI and ML in Land Use Analysis	367
14.4	Challenges and Considerations	370
14.5	Conclusion	374
	References	374
15	Land Use Pattern of Cities	377
15.1	Introduction	377
15.2	Need for Identifying Areas	379
15.3	Land Use Pattern for Bhopal and Raipur	380
15.3.1	Source of Data	382
15.3.2	Methodology	382
15.3.3	Results	384

15.4	Conclusion	389
	References	390
16	Geospatial Analysis of Land Use Patterns for Enhancing Sustainable Development Initiatives	393
16.1	Introduction	393
16.2	Study Area and Data	396
16.2.1	Study Area	396
16.2.2	Source of Data	397
16.3	Methodology	398
16.4	Results and Discussion	400
16.4.1	Land Use Pattern	400
16.4.2	Change Detection	402
16.4.3	Accuracy Assessment	403
16.4.4	SDG Alignment	404
16.5	Conclusion	405
	References	406
17	Assessment of Urban Cities by Analysing Land Use Patterns via Satellite Images for Sustainable Development Goals	409
17.1	Introduction	409
17.2	Literature Review	412
17.3	Study Area	425
17.3.1	Bhopal	426
17.3.2	Indore	426
17.3.3	Raipur	426
17.4	Source of Data	427
17.4.1	Source of Satellite Images	427
17.4.2	Source of Ground Data	427
17.5	Methodology	428
17.5.1	Methodology for Land Use Pattern Analysis	428
17.5.2	Methodology of Development of Composite Index	430
17.6	Results and Discussion	433
17.6.1	Analysis of Land Use Pattern	433
17.6.2	Change in Land Use Pattern Analysis	436
17.6.2.1	Analysis of Water Bodies for the Cities	437
17.6.2.2	Analysis of Agricultural Land	437
17.6.2.3	Analysis of Urban Area	438
17.6.2.4	Analysis of Open Area	439
17.6.2.5	Analysis of Forest Cover	439
17.6.3	Composite Sustainability Index	440
17.6.4	Future CSI Prediction	441

17.7	Conclusion	443
	References	444
18	Ethics and Values in Land Use	451
18.1	Introduction	451
18.2	Significance of Values in Land Use Decisions	453
18.2.1	Environmental Responsibility	453
18.2.2	Fairness	455
18.2.3	Justice	456
18.3	Incorporating these Values into Land Use Planning	457
18.4	Balancing Economic Interests with Ethical Values	459
18.4.1	Economic Growth vs. Environmental Degradation	459
18.4.2	Profit Maximization vs. Equity and Fairness	460
18.4.3	Long-Term Sustainability vs. Short-Term Gains	460
18.4.4	Corporate Interests vs. Community Interests	461
18.4.5	Expediency vs. Transparency and Accountability	461
18.5	Methods for Harmonizing Economic Interests and Moral Principles	462
18.6	Morality and Land Use Ethics	464
18.7	Interplay between Personal and Collective Morality	464
18.8	Environmental Justice	466
18.9	Conclusion	466
	References	467
	Index	469