

Contents

1	Introduction	1
1.1	Scope and Structure of the Book	1
1.2	Main Questions Addressed and the Purpose of the Book	3
1.3	Overall Definitions and Theoretical Backgrounds	5
1.3.1	Defining Planning, Scenarios, Strategies and Initiatives	5
1.3.2	Systems from the System Science Point of View	8
1.3.3	Models and Modelling	10
1.3.4	Mixed Method Methodologies, a Pragmatic View	12
1.3.5	Pre-existing Concepts of Uncertainty in Planning and Modelling	15
1.3.6	Planning and Decision Making in Different Information Availability Conditions	16
1.3.7	Theories for Uncertainty Analysis and Representation	17
	References	21
2	Energy Infrastructure Planning in Cities and Territories, Quality Factors of Methods for Infrastructure Planning	25
2.1	Introduction	25
2.2	Integrated Energy Planning in Cities and Territories	26
2.3	Energy Systems in City and Territory, a Sociotechnical Infrastructure	27
2.4	Defining Typology of Application or Use Cases	28
2.4.1	Use Case I: Decentralised Multi-model Based IEPCT	28
2.4.2	Use Case II: Integrated-Model Based IEPCT	29
2.5	Modelling in IEPCT	29
2.5.1	Models and Different Degrees of Formalisation	29
2.6	Overall Requirements and Quality Factors of Energy Planning and Modelling Methods	31
2.7	Summary and Open Problems	34
	References	35

3	3-Domain Modelling	39
3.1	Introduction	39
3.2	3-Domain Metasystem	40
3.3	3-Domain Modelling: Different Approaches for Different Domains	43
3.3.1	Introduction	43
3.3.2	Data-Driven Modelling	44
3.3.3	Process-Driven Modelling	45
3.3.4	Judgmental-Driven Modelling	46
3.4	Defining Modelling Approaches for Different Modelling Domains and Use Cases.	47
3.4.1	General	47
3.4.2	Modelling Approaches for Targeted Domain	48
3.4.3	Data Driven Modelling Approaches for Neighbouring and Distant Domains	51
3.4.4	Modelling the Distant Domain and Its Impact to Other Domains	59
3.5	Summary of Modelling Approches for Different Use Cases and Domains.	62
3.6	3-Domain Modelling in Context of Multi Method Research.	63
	References.	63
4	Conceptual Basis of Uncertainty in IEPCT	67
4.1	Why Be Explicit About Uncertainty in IEPCT?	67
4.2	Typology of Uncertainty	68
4.2.1	Linguistic Uncertainty	69
4.2.2	Epistemic Uncertainty	69
4.2.3	Variability Uncertainty	70
4.2.4	Decision Making Uncertainty	70
4.2.5	Procedural Uncertainty.	70
4.2.6	Levels of Uncertainty	71
4.3	Incorporating Uncertainty in Current IEPCT Studies	71
4.4	Conclusion	71
	References.	72
5	Multi-method Approaches for Uncertainty Analysis	73
5.1	Introduction	73
5.1.1	IEP in Cities and Territories, Specific Conditions	74
5.2	Analysis Sophistication Degrees	74
5.2.1	Introduction	74
5.2.2	Appropriate Analytical Degrees in IEPCT Context	76
5.3	Quality Factors of Methods for Uncertainty Analysis	77
5.3.1	Technical Quality Factors.	77
5.3.2	Organisational Capability.	77
5.3.3	Satisfaction by Planning Participants.	78

5.4	Methods and Methodologies for Uncertainty Assessment: A Review	79
5.4.1	Evaluation Criteria	79
5.4.2	List of the Reviewed Methods and Methodologies	80
5.4.3	Summary of Evaluation Results of Reviewed Methods	80
5.5	Multi Method Approaches for Uncertainty Analysis	81
5.5.1	Introduction	81
5.5.2	Fuzzy Scenario Based Uncertainty Analysis for Use Case-I.	81
5.5.3	Probabilistic, Random Sampling Based Uncertainty Analysis (PR SUA) Approach for Use Case-II	90
5.6	A Review of Methods and Methodologies for Uncertainty Analysis	98
5.6.1	Correlations and Copulas	98
5.6.2	Expert Elicitation	100
5.6.3	Fuzzy Inference	102
5.6.4	Innovative Multimethod Approach (IMMA)	104
5.6.5	Inverse Modelling.	106
5.6.6	Interval Prediction (IP) in Data Driven Models	107
5.6.7	Monte Carlo Simulation	110
5.6.8	Multiple Model Simulation (MMS) of Process Driven Models	111
5.6.9	Multiple Model Simulation (MMS) of Data Driven Models	113
5.6.10	Scenario Analysis and Fuzzy Clustering	115
5.6.11	Sensitivity Analysis	121
5.6.12	Tests of Complex Models for Model Uncertainty	123
5.6.13	NUSAP and PRIMA Methodologies	125
5.7	Summary	127
	References	128
6	Implementation of Discussed Uncertainty Analysis Approaches in Case Studies.	131
6.1	Selection of Application Studies	131
6.2	An Example of Use Case I: Singapore.	132
6.2.1	Development of the “Singapore Sustainable Growth” Model.	132
6.2.2	Uncertainty Analysis	138
6.3	An Example of Use Case II: Mexico City	152
6.3.1	Modelling Mexico City’s Waste-to-Energy System.	152
6.3.2	Uncertainty Analysis	157
	References	161

7 Evaluation and Discussion 163

7.1 Evaluation and Discussion of the 3-Domain Modelling
Concept and Different Modelling Approaches. 163

7.1.1 General 163

7.1.2 Modelling Approaches for Targeted Domain 164

7.1.3 Modelling Approaches for Neighbouring Domain. 165

7.1.4 Modelling Approaches for Distant Domain 166

7.2 Evaluation and Discussion of Uncertainty Analysis Approaches . . 166

7.2.1 General 166

7.2.2 Evaluation of FSUA Multi Method Approach
and Discussion 167

7.2.3 Evaluation of PRSUA Multi Method Approach
and Discussion 169

7.2.4 Comparative Assessment of Proposed Approaches 172

References 172

8 Overall Conclusion and Future Research. 173

8.1 Overall Synthesis and Conclusions 173

8.2 Synthesis and Conclusions of Chaps. 1 and 2 173

8.3 Synthesis and Conclusions of Chap. 3 174

8.4 Synthesis and Conclusion of Chap. 4. 175

8.5 Synthesis and Conclusions of Chaps. 5, 6 and 7 175

8.6 Future Work 177

Appendix A: Descriptive Analysis, Modelling of Historical Data. 179

Appendix B: Some Empirical Results of Use Case I-Singapore 183

Appendix C: Some Empirical Results of Use Case II-Mexico 193

**Appendix D: Comparison Different Extrapolation,
Data Driven Methods and Intervals 199**

Index. 205

Three Domain Modelling and Uncertainty Analysis
Applications in Long Range Infrastructure Planning

Mirakyan, A.; De Guio, R.

2015, XX, 206 p. 90 illus., 41 illus. in color., Hardcover

ISBN: 978-3-319-19571-1