

Contents

List of contributors ix

Preface xi

Acknowledgments xiii

1. Water reuse from treated wastewater: insights gained from the Italian demonstration case studies of the Wider-Uptake EU project

Giorgio Mannina, Alida Cosenza and Hazal Gulhan

1.1 Introduction 1

1.2 A water reuse regulations 2

1.3 Italian demonstration case studies 4

1.4 Reclaimed water quality indices 9

1.5 Scenario analysis for Palermo University case study 9

1.6 The influence of operating conditions 10

1.7 Mathematical modeling 10

1.8 Conclusions and perspectives 12

Acknowledgments 12

References 12

2. Resource recovery from waste activated sludge by polyhydroxyalkanoate production

Giorgio Mannina and Antonio Mineo

2.1 Introduction 15

2.2 The circular bioeconomy approach: integrating the polyhydroxyalkanoate production in the wastewater treatment plants 17

2.3 The University of Palermo case study within the Wider Uptake project 19

2.4 Conclusions and perspectives 27

Acknowledgments 28

References 28

3. Reducing the sewage sludge production by applying oxic settling anaerobic and intermittent aeration process

Daniele Di Trapani, Paulo Marcelo Bosco Mofatto, Alida Cosenza and Giorgio Mannina

3.1 Introduction 33

3.2 A sewage sludge reduction processes 34

3.3 UNIPA demonstration case study 35

3.4 Layout comparison 39

3.5 Influence of operating conditions 40

3.6 Influence of plant configuration 45

3.7 Layout comparison on score level 47

3.8 Conclusions and perspectives 48

Acknowledgments 49

References 49

4. Slow-release fertilizers by biochar and zeolite enriched by treated wastewater for nutrient recovery

Sofia Maria Muscarella, Luigi Badalucco, Giorgio Mannina, Sara Paliaga and Vito Armando Laudicina

4.1 Introduction 53

4.2 Zeolite and biochar as nutrient adsorbents from treated wastewater 55

4.3 Mechanisms of nutrient adsorption by zeolite and biochar 59

4.4 Nitrogen and phosphorus in the soil–plant system 66

4.5 Nitrogen and phosphorus in wastewater 68

4.6 Nutrient-enriched zeolite as slow-release fertilizer 69

4.7 Nutrient-enriched biochar as slow-release fertilizer 72

4.8 Modeling nutrient desorption from zeolite and biochar 74

4.9 Conclusions and perspectives 76

Acknowledgments 77

References 77

5. Water reuse for greening urban areas: insights gained from the Czech Republic demonstration case study

Vadim Strogonov, Iveta Růžičková, Jaroslav Pollert, Solomon Ofori and Jiří Wanner

5.1	Introduction	85
5.2	Why water reuse and what prevents it	86
5.3	Minimum requirements for water reuse	89
5.4	Law Limits in Czech Republic	92
5.5	Research of the water reuse	94
5.6	Cooperation with public and stakeholders	109
5.7	Current water reuse projects in the Czech Republic	111
5.8	Conclusions and perspectives	112
List of abbreviations		114
References		115

6. Fuel production from sewage sludge: insights from a demonstration in Ghana

Gordon Akon-Yamga, Wilhemina Quaye, George O. Essegbe, William O. Oduro, Ahmed Issahaku, Justina A. Onumah, Portia A. Williams and Abdalla Mahama

6.1	Introduction	117
6.2	Wood-based charcoal in Ghana	119
6.3	Circular bioeconomy to the rescue	121
6.4	Production of biochar from sludge: the Ghana demonstration	122
6.5	Non-technical barriers and challenges	126
6.6	Policy implications and recommendations	127
6.7	Conclusions and perspectives	129
References		130

7. Circularity and efficiency assessment of resource recovery solutions

Anurag Bhamhani and Zoran Kapelan

7.1	Introduction	133
7.2	Circularity assessment	134
7.3	Efficiency assessment	138
7.4	Case study	145
7.5	Conclusions and perspectives	152
Appendix A		153
References		154

8. Transition to circular economy in the water sector: the case study of Corleone, Italy

Hazel Gulhan, Alida Cosenza, Daniele Di Trapani, Antonio Mineo, Paulo Marcelo Bosco Mofatto and Giorgio Mannina

Abbreviations		157
8.1	Introduction	158
8.2	Corleone wastewater treatment plant	158
8.3	The circular economy transition idea	159
8.4	Sewage sludge reduction: the influence of operating conditions	160
8.5	Greenhouse gases emissions	162
8.6	Plant performance	163
8.7	Mathematical modeling	165
8.8	Conclusions and perspectives	168
Acknowledgments		168
References		168

9. Roadmap development and preliminary applications to foster the transition to the circular economy in the water sector: the case study of Corleone

Daniele Di Trapani, Alida Cosenza, Hazel Gulhan and Giorgio Mannina

9.1	Introduction	171
9.2	Roadmap approach for the transition towards circular economy: an overview	172
9.3	A proposal for a roadmap approach in the water sector	172
9.4	The roadmap database	177
9.5	Preliminary application of roadmap to the case study of Corleone (Italy)	179
9.6	Conclusions and perspectives	180
Acknowledgments		181
Abbreviations		181
References		181

10. Governance assessment and business models for reuse of treated wastewater in agriculture: an Italian case study

Alida Cosenza and Giorgio Mannina

10.1	Introduction	183
10.2	Governance assessment and business model development for the circular economy based on water resources	184

- 10.3 Italian case study—Corleone 186
- 10.4 Business model exploration in the Corleone case study 188
- 10.5 Conclusions and perspectives 191
- Acknowledgments 191
- References 192

11. Assessing water smartness and sustainability: the case study of Corleone (Italy)

Hazal Gulhan, Alida Cosenza, Karen Nessler Seglem, Herman Helness and Giorgio Mannina

- 11.1 Introduction 193
- 11.2 The approach within WIDER UPTAKE 193
- 11.3 Framework testing application: the case study of Corleone 195
- 11.4 Conclusions and perspectives 214
- Acknowledgments 215
- Abbreviations 215
- References 215

12. Scenario analysis toward the implementation of a roadmap for transitioning to a circular economy in the case study of Corleone

Alida Cosenza, Daniele Di Trapani, Rita Ugarelli, Herman Helness and Giorgio Mannina

- 12.1 Introduction 217
- 12.2 Approach within Wider Uptake 218
- 12.3 Case study 219
- 12.4 Interactions with key actors 220
- 12.5 Scenario analysis and alternative solutions 221
- 12.6 Main outcomes and recommendations 226
- 12.7 Conclusions and perspectives 227
- Acknowledgments 228
- References 228

Index 231