Contents

Introduction xi

Chapter 1. Monitoring Coastal Bathymetry Using Multispectral Satellite Images at High Spatial Resolution 1
Bertrand LUBAC

1.1. Definition, context and objective 1
1.2. Description of the methodology 3
1.2.1. Step 1: selection and preprocessing of MSI images 5
1.2.2. Step 2: calibration of the bathymetry inversion model 7
1.2.3. Step 3: preparation and application of the masks 8
1.2.4. Step 4: characterization of the morphological evolution of the main sedimentary structures 9
1.3. Practical application 10
1.3.1. Software and data 10
1.3.2. Step 1: extraction of the region of interest and preprocessing 13
1.3.3. Step 2: calculation of bathymetry 20
1.3.4. Step 3: preparation and application of masks 25
1.3.5. Step 4: characterization of the morphological evolution of the main submarine sedimentary structures 31
1.4. Bibliography 33

Chapter 2. Contribution of the Integrated Topo-bathymetric Model for Coastal Wetland Evolution: Case of Geomorphologic and Biological Evolution of Ichkeul Marshes (North Tunisia) 35
Zeineb KASSOUK, Zohra LILI-CHABAANE, Benoit DEFFONTAINES, Mohammad EL HAJJ and Nicolas BAGHDADI

2.1. Coastal wetland dynamic 35
2.2. Ichkeul marshes wetland 36

2.3. Object-oriented classification method integrating the topo-bathymetric terrain model . . . 39
2.3.1. Construction of the topo-bathymetric DTM . . . 40
2.3.2. Image preprocessing . . . 44
2.3.3. Segmentation . . . 48
2.3.4. Classification . . . 49
2.3.5. Limitations of the methodology . . . 51
2.3.6. Case example of topo-bathymetric transect with the associated vegetation communities . . . 51
2.3.7. Conclusion . . . 53
2.4. From a practical point of view in QGIS . . . 53
2.4.1. Software and data . . . 53
2.4.2. Computation of the topo-bathymetric DTM . . . 55
2.4.3. Image preprocessing . . . 58
2.4.4. Segmentation . . . 65
2.4.5. Classification . . . 71
2.5. Bibliography . . . 76

Chapter 3. Reservoir Hydrological Monitoring by Satellite Image Analysis . . . 77
Paul PASSY and Adrien SELLES

3.1. Context and scientific issue . . . 77
3.1.1. Scientific issue . . . 77
3.1.2. Physical and human context . . . 77
3.1.3. The importance of water resources in Central India . . . 78
3.2. Methods and data set . . . 78
3.2.1. Methods . . . 78
3.2.2. Data set . . . 79
3.2.3. Data set preparation . . . 80
3.3. Extraction and quantification of the Singur reservoir area . . . 82
3.3.1. Calculation of the AWEI Index . . . 82
3.3.2. Construction of the water–land binary raster . . . 83
3.3.3. Vectorization of the binary raster . . . 84
3.3.4. Selection of water polygons . . . 85
3.3.5. Calculation of the water area of the reservoir . . . 86
3.4. Characterization of vegetation . . . 88
3.4.1. Choosing an indicator of the state of vegetation . . . 88
3.4.2. Calculation of the SAVI on the study area . . . 88
3.4.3. Creating a land–water mask . . . 89
3.4.4. Statistics of the SAVI land surface index . . . 90

3.5. Automation of the processing chain via the construction of a QGIS model 91
3.5.1. Model setting 91
3.5.2. Construction of the chain of treatments for the extraction of the reservoir 92
3.6. Conclusions. 103
3.7. Bibliography 103

Chapter 4. Network Analysis and Routing with QGIS 105
Hervé PELLA and Kenji OSE

4.1. Introduction. 105
4.2. General notions 105
4.2.1. Definition of a network 105
4.2.2. Network topology. 106
4.2.3. Topological relationships 107
4.2.4. Graph traversal – example of the shortest path (Dijkstra) 109
4.3. Examples of development and analysis of hydrographic networks . . . 109
4.4. Thematic analysis 111
4.4.1. Introduction 111
4.4.2. Useful data. 112
4.4.3. Step 1: verification of network consistency 113
4.4.4. Step 2: routes organization 119
4.4.5. Step 3: alignment of points on a network. 121
4.4.6. Step 4: network classification. 123
4.4.7. Step 5: stations characterization 124
4.4.8. Step 6: distance calculation between observation points. 129
4.4.9. Step 7: upstream path and drainage basins calculation 133
4.4.10. Step 8: downstream path. 135
4.4.11. Step 9: calculation of availability areas 140
4.5. Bibliography 144

Chapter 5. Representation of the Drainage Network in Urban and Peri-urban Areas Using a 2D Polygonal Mesh Composed of Pseudo-convex Elements 145
Pedro SANZANA, Sergio VILLAROEL, Isabelle BRAUD, Nancy HITSCHFELD, Jorge GIRONAS, Flora BRANGER, Fabrice RODRIGUEZ, Ximena VARGAS and Tomas GOMEZ

5.1. Definitions and context. 145
5.1.1. General context and objectives. 145
5.1.2. Derivation of input GIS layers 148
5.1.3. Identification of badly-shaped HRUs and methodology to improve the model mesh quality 149

5.2. Implementation of the TriangleQGIS module and general methodology . . . 153
5.2.1. Used technologies . . . 153
5.2.2. Context and general methodology . . . 153
5.2.3. Structure of the QGIS plugin . . . 155
5.2.4. Basic used library: MeshPy . . . 156
5.2.5. Installation of the plugin in Windows . . . 156
5.2.6. Installation of the virtual box, QGIS plugin and Geo-PUMMA . . . 160
5.3. Illustration of the TriangleQGIS plugin and some Geo-PUMMA scripts . . . 167
5.3.1. Insertion of nodes for long and thin polygons . . . 168
5.3.2. Triangulation using the TriangleQGIS plugin . . . 169
5.3.3. Dissolution of tirangulated elements . . . 178
5.3.4. Effect of the model mesh improvement . . . 181
5.4. Acknowledgments . . . 182
5.5. Bibliography . . . 183

Chapter 6. Mapping of Drought . . . 185
Mohammad EL HAJJ, Mehrez ZRIBI, Nicolas BAGHDADI and Michel LE PAGE

6.1. Context . . . 185
6.2. Satellite data . . . 186
6.2.1. MODIS products . . . 186
6.2.2. Land cover map . . . 187
6.3. Drought index based on satellite NDVI data . . . 187
6.4. Methodology . . . 188
6.4.1. Preprocessing of MOD13Q1 images (step 1) . . . 189
6.4.2. Delimitation of drought zones (steps 2–5) . . . 189
6.4.3. Calculate the area of agricultural, urban and forest zones affected by the drought (step 6) . . . 190
6.5. Implementation of the application via QGIS . . . 191
6.5.1. Download MODIS MOD13Q1 data . . . 191
6.5.2. Preprocessing of MODIS MOD13Q1 data (step 1) . . . 193
6.5.3. Calculate VCI index (steps 1 and 2) . . . 195
6.5.4. Delimitation of drought zones (steps 2–5) . . . 199
6.5.5. Calculation of agricultural, forest and urban areas affected by drought (step 6) . . . 204
6.5.6. Visualization of results (step 7) . . . 206
6.6. Drought map . . . 212
6.7. Bibliography . . . 213

Chapter 7. A Spatial Sampling Design Based on Landscape Metrics for Pest Regulation: The Millet Head Miner Case Study in the Bambey Area, Senegal 215
Valérie SOTI

7.1. Definition and context 215
7.2. The spatial sampling methodology 217
7.2.1. Step 1: quantification of landscape metrics. 218
7.2.2. Step 2: sampling plan production 221
7.2.3. Step 3: exportation of selected sampling sites to a GPS 223
7.3. Practical application. 223
7.3.1. Software and data. 223
7.3.2. Step 1: landscape variables calculation 224
7.3.3. Step 2: sampling plan production 232
7.3.4. Step 3: integrating sampling points into a GPS device 238
7.3.5. Limits of the method 241
7.4. Bibliography 242

Chapter 8. Modeling Erosion Risk Using the RUSLE Equation. . . . 245
Rémi ANDREOLI

8.1. Definition and context 245
8.2. RUSLE model 246
8.2.1. Climatic factor: rainfall aggressiveness R 248
8.2.2. Topographic factor: slope length and gradient. 249
8.2.3. Soil types and land cover factors. 251
8.2.4. Estimation of soil losses A 254
8.2.5. Limits of the method considered 254
8.3. Implementation of the RUSLE model 255
8.3.1. Software and data. 255
8.3.2. Step 1: R factor calculation 257
8.3.3. Step 2: LS factor calculation 263
8.3.4. Step 3: preparation of the K factor. 274
8.3.5. Step 4: C factor creation. 275
8.3.6. Step 5: soil loss A calculation from the RUSLE equation 280
8.4. Bibliography 281

List of Authors 283

Index 285

Scientific Committee 289