

COVID-19 Pandemic,
Geospatial Information,
and Community
Resilience
Global Applications and Lessons

Abbas Rajabifard
Greg Foliente
Daniel Paez

Contents

Foreword	xv
Acknowledgments	xvii
Editors	xix
List of Contributors	xxi
I Setting the Scene	1
1 The Role and Value of Geospatial Information and Technology in a Pandemic	3
<i>Abbas Rajabifard, Daniel Paez and Greg Foliente</i>	
1.1 Introduction	3
1.2 Critical Role of Location Information	4
1.3 Impact of COVID-19 on the Sustainable Development Goals (SDGs)	4
1.4 Digital Innovation During a Pandemic	5
1.5 Collaboration and Engagement	6
1.6 Opportunities Emerging from the Pandemic	6
1.7 Moving Forward from the Pandemic	7
1.8 This Book, Objectives, Chapter Outline	7
II Technical and Techno-Social Solutions	11
2 Land Administration and Authoritative Geospatial Information: Lessons from Disasters to Support Building Resilience to Pandemics	13
<i>Keith Clifford Bell and Vladimir V. Evtimov</i>	
2.1 Introduction	13
2.2 Emergencies – Disasters and Pandemics	14
2.3 Economic and Financial Impacts of Disasters and Pandemics	14
2.4 Overview of WB-FAO Partnership	16
2.5 Resilience Enablement Through LAS and NSDI	17
2.6 COVID-19: Specific Challenges	20
2.7 Pragmatic Rapid Assessment of LAS and NSDI Maturity in Resilience Contexts	23
2.8 Build Back Better	27
2.9 Concluding Remarks	28
3 Open Geospatial Data for Responding to the COVID-19 Challenge	31
<i>Maria Antonia Brovelli and Serena Coetzee</i>	
3.1 Introduction	31
3.2 What Data Is Useful for Responding to the COVID-19 Challenge?	33
3.3 What is the Availability of such Open Data With Global Coverage?	35
3.4 Discussion and Conclusion	47

4	Remote Sensing and Computational Epidemiology	55
	<i>Mohammad Reza Mobasheri</i>	
4.1	Introduction	55
4.2	Remote Sensing and Health	56
4.3	Remote Sensing Methods to Predict Health-related Outbreaks	58
4.4	Vegetated Area Mapping	61
4.5	Water Body Mapping	61
4.6	Land Surface Temperature	62
4.7	Air Temperature	62
4.8	Relative Humidity	63
4.9	Results and Analysis	63
4.10	Discussion	64
4.11	Cholera Case Study	65
4.12	Conclusions	65
5	The Potential of Drone Technology in Pandemics	69
	<i>David R. Green, Alex R. Karachok and Billy J. Gregory</i>	
5.1	Introduction	69
5.2	Developments in Drone Technology	70
5.3	The Impact of COVID-19	71
5.4	Summary and Conclusions	75
6	The Role of Neighbourhood Social and Built Environments on Social Interactions and Community Wellbeing Through the COVID-19 Pandemic	79
	<i>Piret Veeroja and Greg Foliente</i>	
6.1	Introduction	79
6.2	Pre COVID-19	80
6.3	During COVID-19	81
6.4	Post COVID-19	83
6.5	Concluding Comments	84
7	Social Vulnerability to COVID-19: Preliminary Indicators and Research Agenda	87
	<i>Farhad Laylavi</i>	
7.1	Introduction	87
7.2	Social Vulnerability and Pandemics	88
7.3	Social Vulnerability Indicators	89
7.4	Discussion and Conclusion Remarks	94
8	Informal Road Detection and Uncertainty in Remote Sensing	101
	<i>Renate Thiede and Inger Fabris-Rotelli</i>	
8.1	Introduction	101
8.2	Literature	103
8.3	Uncertainty Measures in Remote Sensing	104
8.4	Road Extraction Algorithm	106
8.5	Accuracy Assessment	107
8.6	Application	109
8.7	Discussion	117
8.8	Conclusion and Future Work	118

9 Management and Analysis of Maritime Geospatial Data During COVID-19: Case Studies, Opportunities and Challenges	123
<i>Rafael Ponce Urbina, Orhun Aydin and Steve Snow</i>	
9.1 Introduction	123
9.2 Case Studies	130
9.3 Conclusions	134
10 City Design and the Transmission of COVID-19	137
<i>Mark Stevenson, Jason Thompson, Branislava Godic and Thanh Ho</i>	
10.1 The Pandemic that is COVID-19	137
10.2 Using Spatial Data to Identify Global City Design	139
10.3 Relationship Between City Design and COVID-19	142
10.4 Conclusion	143
11 Sensing Community Resilience Using Social Media	145
<i>Felicia N. Huang, Kelly Lim, Evan Sidhi and Belinda Yuen</i>	
11.1 Introduction	145
11.2 Previous Research	146
11.3 Methods	148
11.4 Results	149
11.5 Conclusion	157
12 Role of the Professional Body in a Pandemic	161
<i>Lesley Arnold, Zaffar Sadiq Mohamed-Ghouse and Tony Wheeler</i>	
12.1 Introduction	161
12.2 Serving Surveying and Spatial Science Professionals	162
12.3 COVID-19 Member Survey	163
12.4 Moving Back to Normality	168
12.5 Conclusion	168
13 OpenStreetMap Data Use Cases During the Early Months of the COVID-19 Pandemic	171
<i>Peter Mooney, A. Yair Grinberger, Marco Minghini, Serena Coetzee, Levente Juhasz and Godwin Yeboah</i>	
13.1 Introduction	171
13.2 Background and Related Work	173
13.3 Methodology and Research Approach	173
13.4 Use of OSM Data for COVID-19	175
13.5 Collection of OSM Data for COVID-19	178
13.6 Academic Research with OSM During the COVID-19 Response	179
13.7 Conclusions and Future Work	180
14 Utilization of Geospatial Network Analysis Technique for Optimal Route Planning During COVID-19 Pandemic	187
<i>Pravin Kokane, Mohd. Ammar Ashraf and Vinita Shinkar</i>	
14.1 Introduction	187
14.2 Literature Review	188
14.3 Methodology and Materials	189
14.4 Results and Discussion	190
14.5 Conclusion	193

15 Formalizing Informal Settlements to Empower Residents Against COVID-19 and Other Disasters	195
<i>Chryssy Potsiou</i>	
15.1 Introduction	195
15.2 The Need for Geospatial Data and Tools to Improve Decision-making	196
15.3 Measures Taken by Governments to Manage the Pandemic	198
15.4 How to Formalize Informal Construction to Empower Residents	199
16 Spatially Enabled COVID-19: A Review of Applications and Systems	203
<i>Abbas Rajabifard, Yiqun Chen, Yibo Zhang and Katie Potts</i>	
16.1 Introduction	203
16.2 Tracing Apps	204
16.3 Map-Based Dashboard	205
16.4 Conclusion	209
17 COVID-19 Spatiotemporal Hotspots and Prediction Based on Wavelet and Neural Network	211
<i>Neda Kaffash Charandabi and Amir Gholami</i>	
17.1 Introduction	211
17.2 Materials and Methods	212
17.3 Results of Proposed Model	215
17.4 Discussion	222
17.5 Conclusion	224
III Regional, Country and Local Applications	227
18 London in Lockdown: Mobility in the Pandemic City	229
<i>Michael Batty, Roberto Murcio, Iacopo Iacopini, Maarten Vanhoof and Richard Milton</i>	
18.1 The 2020 Pandemic in Britain	229
18.2 Defining Essential Workers	231
18.3 The Movement Patterns of Essential and Non-Essential Workers	236
18.4 Drilling Down Into Individual Locations in London	240
18.5 Conclusions and Next Steps: A More Integrated Analysis	243
19 Americas' Geospatial Response to COVID-19	245
<i>Rosario Casanova, Paloma Merodio Gómez, Álvaro Monett Hernández and Andrea Ramírez Santiago</i>	
19.1 Introduction	245
19.2 Overview On the Regional Geospatial Response to COVID-19	247
19.3 Gaps and Challenges	251
19.4 Conclusions	252
20 Spatio-Temporal Information Management to Control the COVID-19 Epidemic: Country Perspectives in Europe	255
<i>Marije Louwsma and Hartmut Müller</i>	
20.1 Introduction	255
20.2 Spatiotemporal Spread of Infectious Diseases	256
20.3 NUTS The European Union's Spatial Reference for Statistical Data	257
20.4 COVID-19 Pandemic Data Using the NUTS System	257
20.5 Shortcuts and Challenges of COVID-19 Data Provision	261
20.6 Discussion	262
20.7 Conclusions	264

21 Practicing Online Higher Education Facilitated by ICT in China: In the Context of COVID-19 Pandemic	267
<i>Zhixuan Yang</i>	
21.1 Introduction	267
21.2 Literature Review	268
21.3 Practice of Online Higher Education in China	271
21.4 Conclusion	274
22 Time-Series Analysis of COVID-19 in Iran: A Remote Sensing Perspective	277
<i>Nadia Abbaszadeh Tehrani, Abolfazl Mollalo, Farinaz Farhanj, Nooshin Pahlevanzadeh and Milad Janalipour</i>	
22.1 Introduction	277
22.2 Materials and Methods	278
22.3 Results and Discussion	283
22.4 Conclusion	287
23 Creating a Set of High-Resolution Vulnerability Indicators to Support the Disaster Management Response to the COVID-19 Pandemic in South Africa	291
<i>Alize Le Roux, Antony K. Cooper, Chantel Ludick, Kathryn A. Arnold and Gerbrand Mans</i>	
23.1 Background	291
23.2 Government Structures in South Africa	292
23.3 The Green Book	293
23.4 SARS-CoV-2 and COVID-19 in South Africa	293
23.5 The COVID-19 Vulnerability Dashboard	294
23.6 Challenges	300
23.7 Conclusions and the Way Forward	301
24 Rapid Development of Location-based Apps: Saving Lives during a Pandemic – the South Korean Experience	305
<i>Bola Michelle Ju, Lesley Arnold and Kathrine Kelm</i>	
24.1 Introduction	305
24.2 Location-based Apps	307
24.3 Real-time Data Processing Systems	313
24.4 COVID-19 Response Success Factors	316
24.5 Conclusion	317
25 Spatial Analysis of Urban Parks and COVID-19: City of Whittlesea, Victoria, Australia	321
<i>Sultana Nasrin Baby, Adrian Murone, Shuddhasattwa Rafiq, and Khlood Ghalib Alrasheedi</i>	
25.1 Introduction	321
25.2 Urban Parks	322
25.3 Study Area	323
25.4 Methodology	323
25.5 Results Discussion and Limitations	331
25.6 Conclusions	331
26 The Economic Impact of COVID-19 in Pacific Island Countries and Territories	335
<i>Phil Bright and David Abbott</i>	
26.1 Introduction	335
26.2 Socio-economic Context	336
26.3 Coming of COVID-19 and How It Is Reported in the Pacific Region	336
26.4 Mapping COVID-19 in the Pacific	337
26.5 What Is Being done to Monitor the Impact of COVID-19 via Economic Statistics?	340

26.6	What We Can Learn from COVID-19 for Future Pandemics or Other Disasters?	343
26.7	Building Preparedness Through Better Data	344
27	Promoting Resilience While Mitigating Disease Transmission: An Australian COVID-19 Study	347
	<i>Freya M. Shearer, Niamh Meagher, Katitza Marinkovic Chavez, Lauren Carpenter, Alana Pirrone, Phoebe Quinn, Eva Alisic, James M. McCaw, Colin MacDougall, David J. Price and Lisa Gibbs</i>	
27.1	Introduction	347
27.2	Early Phase of the Australian Epidemic and the Public Health Response	348
27.3	Understanding the Response of Australians to COVID-19	349
27.4	Overview of Data Collection and Analysis	349
27.5	Geographic Variation in COVID-19 Epidemiology and Public Health Response	350
27.6	Findings	351
27.7	Discussion and conclusions	357
27.8	COVID-19 Developments and Further Research	359
28	Impacts of COVID-19 Lockdown Restrictions on Housing and Public Space Use and Adaptation: Urban Proximity, Public Health, and Vulnerability in Three Latin American Cities	363
	<i>Raul Marino, Elkin Vargas and Mariana Flores</i>	
28.1	Introduction	363
28.2	Case Studies Context Summary	365
28.3	Research Methodology	367
28.4	Results	369
28.5	Discussion	375
28.6	Conclusions and Future Work	379
29	Use of Geospatial Information and Technologies in Understanding the COVID-19 Pandemic in Canada: Examples and Critical Discussion	385
	<i>David J. Coleman and Prashant Shukle</i>	
29.1	Introduction	385
29.2	Context	386
29.3	Institutional and Technical Responses	388
29.4	Discussion	390
29.5	Towards the Future	390
30	Geospatial Intelligence in Dealing with COVID-19 Challenges in Czechia	393
	<i>Milan Konecny, Jiri Hladik, Jiri Bouchal, Lukas Herman and Tomas Reznik</i>	
30.1	Introduction	393
30.2	Visual Analytics of COVID-19-related Health Statistics in Czechia	394
30.3	Tracking and Analysis of People's Movement	395
30.4	Decision Support Systems for Public Administration	395
30.5	Conclusions and Discussion	397
31	COVID-19 in France: A Multiphase and Multidimensional Approach to a Complex Societal Imbalance	399
	<i>Carmen Martin and François Pérés</i>	
31.1	Introduction	399
31.2	Observation	399
31.3	Multidimensional Analysis	403
31.4	Conclusion	409
IV	Stakeholder Perspectives	411

32 Digital Earth: A World Infrastructure for Sustaining Resilience in Complex Pandemic Scenarios	413
<i>Richard Simpson</i>	
32.1 Spatial Information During a Pandemic	413
32.2 A New Paradigm of Thinking	414
32.3 Digital Earth	415
32.4 Conclusion	416
33 COVID-19: The Open Data Pandemic	417
<i>Jamie Leach</i>	
33.1 Unlocking the Value of Data	417
33.2 From Data Sharing to Open Science	417
33.3 The Future	418
34 The Challenge of Mapping COVID-19 Data	419
<i>Menno-Jan Kraak</i>	
34.1 The Mapping Challenge	419
34.2 How-to	419
34.3 Case in Point	420
34.4 From Data to Insights... to Actions	421
35 Better Engagement to Build Smarter, Resilient Communities	423
<i>Alice Kesminas</i>	
35.1 Introduction	423
35.2 Learning from Experience	424
35.3 Extending Anonymisation to “Big” Geospatial Data	424
35.4 Building Trust for Future Resilience	425
36 How the Coronavirus Could Change Urban Planning	427
<i>Frank Friesecke</i>	
36.1 Introduction	427
36.2 Present: Urban Development in Corona Times	428
36.3 Future: The Smart, Participatory and Resilient City	428
36.4 Rethinking urban planning	431
36.5 Conclusion	433
37 Toward Agile Strategies for Enhancing Community Resilience Following the COVID-19 Pandemic: An Interview Study	435
<i>Hossein Mokhtarzadeh</i>	
37.1 Introduction	435
37.2 Method	436
37.3 Results	436
37.4 Discussion and Conclusion	437
38 COVID-19 Pandemic in Finland: Converting a Forced Digitalisation into an Opportunity	439
<i>Kirsikka Riekkinen</i>	
38.1 Many Dimensions of Resilience	439
38.2 The Importance of Open Geographic Data and Social Inclusion	440
38.3 Lessons Learnt from Finland	441

39 What's the Future of Greek Cities in the Post-COVID-19 Period? New Perspectives on Urban Resilience and Sustainable Mobility	443
<i>Efthimios Bakogiannis, Charalampos Kyriakidis and Chryssy Potsiou</i>	
39.1 Introduction: A Brief Review of the Pandemic	443
39.2 Initial Ideas About an "Anti-social" Planning Policy	444
39.3 Case Studies	446
39.4 What's Happening in Greece? The Case Study of Athens	447
39.5 Brief Discussion	450
39.6 Conclusions	450
40 COVID-19 Pandemic Challenges and Impacts on the SDGs 2030: Indian Perspective	455
<i>Saied Pirasteh, Hishmi Jamil Husain and Tammineni Rajitha</i>	
40.1 Introduction	455
40.2 COVID-19 Impact on SDGs	456
40.3 Analysis and Interpretation	463
40.4 Summary and Conclusion	466
41 The Value of a Policy-Responsive Research Funding Model: The Geohealth Laboratory Collaboration in New Zealand	469
<i>Malcolm Campbell, Jesse Wiki, Lukas Marek, Matthew Hobbs, Matthew Wilson and Simon Kingham</i>	
41.1 What Is the GeoHealth Laboratory?	469
41.2 The Funding Model	470
41.3 The Work Programme	470
41.4 Conclusion	472
42 Pandemic and the City: A Melbourne Perspective for Community Resilience	475
<i>Mark Allan</i>	
42.1 Introduction	475
42.2 Growth of Inner-City Melbourne	476
42.3 Reshaping Cities	476
42.4 Melbourne's Response to COVID-19	476
42.5 Impacts of COVID-19 on Central Melbourne's Liveability	477
42.6 Planning to Co-Exist With COVID-19	477
43 Spatial Modelling Concepts for Controlling COVID-19 Risk in Saudi Arabia	481
<i>Hassan M. Khormi</i>	
43.1 Introduction	481
43.2 GIS-based Mapping and Modelling	482
43.3 The Current Spatial Distribution of COVID-19 in Saudi Arabia (SA)	482
43.4 Conclusion	485
44 COVID-19 in Spain and the Use of Geospatial Information	487
<i>Carmen Femenia-Ribera and Gaspar Mora-Navarro</i>	
44.1 COVID-19 and the State of Emergency in Spain	487
44.2 Geospatial Information Use	488
44.3 Conclusions	490
45 Lessons Learned from COVIDSafe: Understanding Conditions for Successful Implementation of Track and Trace Technologies	491
<i>Nathaniel Carpenter and Anna Dabrowski</i>	
45.1 Introduction	491
45.2 Do track and Trace Mechanisms Work?	491

45.3 The Failures of COVIDSafe: Technology or User?	492
45.4 Enhancing Implementation Through Education	493
45.5 Lessons from Australia: Enhancing Contact Tracing	493
46 Sustainable Transport as a Key Pillar to Community Resilience During the COVID-19 Pandemic	495
<i>Arturo Ardila-Gomez</i>	
46.1 Introduction	495
46.2 Sustainable Transport and the Call for a Green Recovery	496
46.3 Providing Safe Mobility to Those Who Need It	497
46.4 Conclusions	500
V The Future Direction	505
47 Preparing for the Next Pandemic: Geospatial Information for Enhanced Community Resilience	507
<i>Greg Foliente, Daniel Paez and Abbas Rajabifard</i>	
47.1 Introduction	507
47.2 Key Lessons from COVID-19	508
47.3 The Road Ahead: The Only Certainty in the Future is Change	510
47.4 Strategies to Face the Next Crisis and Build Community Resilience	511
Index	515