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UNIVERSIDADE D
COIMBRA

João Pedro Medina Monteiro

FORM AND FUNCTION

BENCHMARKING REAL AND IDEAL CITIES

VOLUME 2

PhD Thesis in Doctoral Program in Spatial Planning, supervised by Professor João Manuel Coutinho Rodrigues, Professor Nuno Miguel Marques de Sousa, and Professor Eduardo Manuel Ferreira Almeida da Natividade de Jesus, submitted to the Department of Civil Engineering of the Faculty of Science and Technology of the University of Coimbra.

December 2023

Faculty of Sciences and Technology, University of Coimbra
Department of Civil Engineering

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Fundação
para a Ciência
e a Tecnologia

“Maps are a way to organize wonder.” - Peter Steinhart

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

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1. OUTLINE

This is thesis is divided into two volumes. Volume I, organized as a collection of scientific papers, is the main body of the thesis and volume II is reserved for the supplementary materials. Volume II was created to reduce the size of Volume I and functions only as the collection of all the supplementary materials from the chapters in Volume I.

As mentioned in volume I, maps are extremely important to convey the data used and results obtained in the different instances that form this thesis. Different journals, editors, and reviewers input result in heterogenous maps layouts. For this thesis, maps were all remade to have the same layout and graphic appearance. Nevertheless, a map representing the same results might have different scales, as each scale has been adapted to the context of each paper. As previously mentioned, there will be maps repetitions throughout the thesis that could not be avoided. Due to size and orientation of some maps and tables, to improve readability paper orientation may vary, resulting in a not so straight-forward readability when printed.

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2. CHALLENGES AHEAD ON SUSTAINABLE CITIES: AN URBAN FORM AND TRANSPORT SYSTEM REVIEW

2.1. Table II.2.1. Built environment related research articles in Spatial and Transport Planning

Table II.2.1. Built environment related articles.

Authors	Publication date	Location of Research	Article topic
Acker, V.V.; Derudder, B.; Witlox, F.	2013	Flanders, Belgium	Active mobility
Adams, S.; Boateng, E.; Acheampong, A.O.	2020	Sub-Saharan Africa	Developing countries urban energy challenges
Aguiléra, A.; Voisin, M.	2014	Paris, France	Transport and the built environment
Ahern, J.	2013	Unspecified	Eco-districts and built environment towards clean energy
Ahmed, K.S.	2003	Dhaka, Bangladesh	Active mobility
Akbari, H.; Kolokotsa, D.	2016	Worldwide	Urban public spaces
Akbari, H.; Matthews, H.D.	2012	Worldwide	Urban public spaces
Al-Obaidi, K.M.; Hossain, M.; Alduais, N.A.M.; Al-Duais, H.S.; Omrany, H.; Ghaffarianhoseini, A.	2022	Unspecified	Urban geometry, IOT and buildings energy consumption
Alahmad, M.; Hasna, H.; Sordiashie, E.	2011	Unspecified	Transport and the built environment, vehicle electrification
Alcazar, S.S.; Olivieri, F.; Neila, J.	2016	Madrid, Spain	Urban heat island
Alford, G.; Whiteman, J.	2009	Melbourne, Australia	Transport and the built environment
Ali-Toudert, F.; Mayer, H.	2007	Ghardaia, Algeria	Active mobility
Ali-Toudert, F.; Mayer, H.	2006	Unspecified	Active mobility, street canyons
Almulhim, A.I.; Bibri, S.E.; Sharifi, A.; Ahmad, S.; Almatar, K.M.	2022	Gulf countries	Developing countries urban energy challenges
Alshehry, A.S.; Belloumi, M.	2017	Saudi Arabia	Developing countries urban energy challenges
Amado, M.; Poggi, F.; Amado, A.R.	2016	Lisbon, Portugal	Urban sprawl
Amado, M.; Poggi, F.; Ribeiro Amado, A.; Breu, S.	2018	Oeiras, Portugal	Urban geometry and buildings energy consumption
Anderson, J.E.; Wulfhorst, G.; Lang, W.	2015	Unspecified	Urban form and policies
Andersson, B.; Place, W.; Kammerud, R.; Scofield, M.P.	1985	USA	Street canyons
Aram, F.; Higueras García, E.; Solgi, E.; Mansournia, S.	2019	Unspecified	Urban heat island
Aram, F.; Solgi, E.; Holden, G.	2019	Hamadan, Iran	Urban heat island
Artmann, M.; Inostroza, L.; Fan, P.	2019	Unspecified	Urban sprawl
Asarpota, K.; Nadin, V.	2020	Unspecified	Urban form
Azevedo, J.A.; Chapman, L.; Muller, C.L.	2016	Birmingham, UK	Urban heat island
Bajracharya, A.R.; Shrestha, S.; Skotte, H.	2020	Kathmandu,, Nepal	Urban public spaces

Authors	Publication date	Location of Research	Article topic
Banister, D.; Watson, S.; Wood, C.	1997	Unspecified	Urban trips and network design
Baruti, M.M.; Johansson, E.; Åstrand, J.	2019	Unspecified	Urban form
Battista, G.; Carnielo, E.; De Lieto Vollaro, R.	2016	Rome, Italy	Urban heat island
Berawi, M.A.; Ibrahim, B.E.; Gunawan; Miraj, P.	2019	Indonesia	Densification and compactification
Besir, A.B.; Cuce, E.	2018	Worldwide	Urban heat island
Bleviss, D.L.	2021	Worldwide	Active mobility
Boakye, K.; Bovbjerg, M.; Schuna, J.; Branscum, A.; Mat-Nasir, N.; Bahonar, A.; Barbarash, O.; Yusuf, R.; Lopez-Jaramillo, P.; Seron, P.; et al.	2023	Worldwide	Active mobility
Bourbia, F.; Awbi, H.B.	2004	Unspecified	Active mobility
Bracco, S.; Delfino, F.; Ferro, G.; Pagnini, L.; Robba, M.; Rossi, M.	2018	Savona, Italy	Eco-districts and built environment towards clean energy
Brandt, L.; Derby Lewis, A.; Fahey, R.; Scott, L.; Darling, L.; Swanston, C.	2016	Chicago, USA	Urban heat island
Brown, R.D.; Vanos, J.; Kenny, N.; Lenzholzer, S.	2015	Worldwide	Urban heat island
Bucher, D.; Buffat, R.; Froemelt, A.; Raubal, M.	2019	Switzerland	Active mobility
Buyadi, S.N.A.; Mohd, W.M.N.W.; Misni, A.	2015	Selangor, Malaysia	Urban heat island
Buyana, K.; Byarugaba, D.; Sseviiri, H.; Nsangi, G.; Kasaija, P.	2019	Africa	Developing countries urban energy challenges
Byrne, J.; Taminiau, J.; Kurdgelashvili, L.; Kim, K.N.	2015	Seoul, South Korea	Urban geometry and buildings energy consumption
C40 Cities	2023	Worldwide	Urban form
Cajot, S.; Peter, M.; Bahu, J.-M.; Guignet, F.; Koch, A.; Maréchal, F.	2017	Switzerland	Urban form
Cao, X.; Yang, W.	2017	Guangzhou, China	Transport and the built environment, urban trips and network design
Caputo, P.; Pasetti, G.	2015	Italy	Urban form
Carboni, A.; Pirra, M.; Costa, M.; Kalakou, S.	2022	Europe	Active mobility
Carter, J.G.	2018	England	Urban public spaces
Castro, L.F.C.; Freitas, B.B.; Carvalho, P.C.M.	2021	Unspecified	Urban form
Cervero, R.	1996	San Francisco, USA	Urban trips and network design
Cervero, R.; Murakami, J.	2010	USA	Transport and the built environment
Charalampopoulos, I.; Tsiros, I.; Chronopoulou-Sereli, A.; Matzarakis, A.	2013	Athens, Greece	Urban heat island
Chen, Y.; Hong, T.; Piette, M.A.	2017	San Francisco, USA	Eco-districts and built environment towards clean energy
Cheng, V., Steemers, K., Montavon, M., Compagnon, R.	2006	Worldwide	Urban geometry and buildings energy consumption
Chilvers, J.	2008	UK	Urban form
Chow, W.T.L.; Brazel, A.J.	2012	Phoenix, USA	Urban heat island
Christiansen, L.B.; Cerin, E.; Badland, H.; Kerr, J.; et al.	2016	Worldwide	Active mobility

Authors	Publication date	Location of Research	Article topic
Clark, T.A.	2013	USA	Densification and compactification
Coaffee, J.; Therrien, M.-C.; Chelleri, L.; Henstra, D.; Aldrich, D.P.; Mitchell, C.L.; Tsenkova, S.; Rigaud, É.; Participants, T.	2018	Unspecified	Urban form
Collaço, F.M. de A.; Simoes, S.G.; Dias, L.P.; Duic, N.; Seixas, J.; Bermann, C.	2019	São Paulo, Brazil	Urban form
Collier, M.J.; Nedović-Budić, Z.; Aerts, J.; Connop, S.; Foley, D.; Foley, K.; Newport, D.; McQuaid, S.; Slaev, A.; Verburg, P.	2013	Unspecified	Urban form, urban sprawl and policies
Conticelli, E.; Proli, S.; Tondelli, S.	2017	Italy	Densification and compactification
COP 27	2022	Worldwide	Urban energy consumption data
Cop 27	2022	Worldwide	Urban energy consumption data
Costamagna, F.; Lind, R.; Stjernström, O.	2019	Umeå, Sweden	Urban public spaces
Couto, R.; Duarte, F.; Magalhães, A.	2022	Unspecified	Urban public spaces
Covenant of Mayors	2023	Europe	Urban form
Croce, S.; Vettorato, D.	2021	Unspecified	Eco-districts and built environment towards clean energy
Csuzi, I.; Csuzi, B.	2017	Unspecified	Vehicle electrification and the built environment
Daniel, M.; Lemonsu, A.; Viguié, V.	2018	Paris, France	Urban heat island
Das, M.; Das, A.; Momin, S.	2022	India	Urban heat island
Davidson, K.; Nguyen, T.M.P.; Beilin, R.; Briggs, J.	2019	New York City, USA and Melbourne, Australia	Urban form and policies
De Lotto, R.; Micciché, C.; Venco, E.M.; Bonaiti, A.; De Napoli, R.	2022	Italy	Eco-districts and built environment towards clean energy
de Nazelle, A.; Nieuwenhuijsen, M.J.; Antó, J.M.; Brauer, M.; Briggs, D.; Braun-Fahrlander, C.; Cavill, N.; Cooper, A.R.; Desqueyroux, H.; Fruin, S.; et al.	2011	Worldwide	Active mobility
De Pascali, P.; Bagaini, A.	2019	Unspecified	Urban form
Derix, C.	2012	Unspecified	Urban form
Dias, A.M.; Lopes, M.; Silva, C.	2022	Unspecified	Active mobility
Dias, D.; Pina, N.; Tchepel, O.	2019	Coimbra, Portugal	Transport and the built environment
Ding, C.; Cao, X.; Wang, Y.	2018	Washington, USA	Public transport
Ding, C.; Lin, Y.; Liu, C.	2014	Washington, USA	Urban trips and network design
Ding, C.; Liu, C.; Lin, Y.; Wang, Y.	2014	Maryland, USA	Transport and the built environment
Ding, C.; Liu, C.; Zhang, Y.; Yang, J.; Wang, Y.	2017	Baltimore, USA	Urban trips and network design
Ding, G.; Guo, J.; Pueppke, S.G.; Yi, J.; Ou, M.; Ou, W.; Tao, Y.	2022	CHina	Transport and the built environment
Dingil, A.E.; Schweizer, J.; Rupi, F.; Stasiskiene, Z.	2019	Worldwide	Transport and the built environment
Dittmar, H.; Ohland, G.	2004	Unspecified	Densification and compactification
Duarte, F.; Ferreira, A.	2016	Unspecified	Urban public spaces
Duarte, F.; Ferreira, A.; Fael, P.	2018	Unspecified	Urban public spaces
Dupras, J.; Marull, J.; Parcerisas, L.; Coll, F.; Gonzalez, A.; Girard, M.; Tello, E.	2016	Montreal, Canada	Urban sprawl

Authors	Publication date	Location of Research	Article topic
Dydkowski, G.	2020	Poland	Transport and the built environment
Eicker, U.; Monien, D.; Duminil, É.; Nouvel, R.	2015	Munich, Germany	Densification and compactification
Eldeeb, G.; Mohamed, M.; Páez, A.	2021	Hamilton, Canada	Transport and the built environment
Emmanuel, R.; Johansson, E.	2006	Colombo, Sri Lanka	Active mobility
Energy Information Administration	2023	USA	Urban energy consumption data
Engelfriet, L.; Koomen, E.	2018	China	Transport and the built environment
European Comission	2022	Europe	Vehicle electrification and the built environment
Ewing, R.	1997	Los Angeles, USA	Transport and the built environment
Ewing, R.; Handy, S.; Brownson, R.C.; Clemente, O.; Winston, E.	2006	Unspecified	Active mobility
Falahatkar, S.; Rezaei, F.	2020	Iran	Densification and compactification
Farhadi, H.; Faizi, M.; Sanaieian, H.	2019	Tehran, Iran	Urban heat island
Fatone, S.; Conticelli, E.; Tondelli, S.	2012	Italy	Densification and compactification
Fernández-Rodríguez, A.; Fernández-Cardador, A.; Cucala, A.P.; Falvo, M.C.	2019	Italy and Spain	Transport and the built environment, vehicle electrification
Ferrari, S.; Zagarella, F.; Caputo, P.; Bonomolo, M.	2019	Unspecified	Urban form
Ferreira, H.; Rodrigues, C.M.; Pinho, C.	2020	Porto, Portugal	Urban trips and network design
Formolli, M.; Lobaccaro, G.; Kanters, J.	2021	Europe	Eco-districts and built environment towards clean energy
Fremouw, M.; Bagaini, A.; De Pascali, P.	2020	Unspecified	Urban form
Frumkin, H.	2002	Unspecified	Urban sprawl
Fu, J.; Wang, Y.; Zhou, D.; Cao, S.-J.	2022	Xi'na, China	Urban heat island
Fujii, H.; Iwata, K.; Managi, S.	2017	Worldwide	Urban sprawl, The D-variables of compact planning
Gago, E.J.; Roldan, J.; Pacheco-Torres, R.; Ordóñez, J.	2013	Unspecified	Urban heat island
Gattuso, D.; Cassone, G.C.; Malara, M.	2018	Reggio Calabria, Italy	Transport and the built environment
Gebel, K.; Bauman, A.E.; Sugiyama, T.; Owen, N.	2011	Australia	Active mobility
Geertman, S.; Stillwell, J.	2004	Unspecified	Urban form
Georgakis, Ch.; Santamouris, M.	2006	Athens, Greece	Street canyons
GhaffarianHoseini, A.; Tookey, J.; GhaffarianHoseini, A.; Naismith, N.; Bamidele Rotimi, J.O.	2016	Africa	Developing countries urban energy challenges
Giannopoulou, K.; Santamouris, M.; Livada, I.; Georgakis, C.; Caouris, Y.	2010	Athens, Greece	Active mobility
Gil-García, I.C.; García-Cascales, M.S.; Molina-García, A.	2022	Unspecified	Urban geometry and buildings energy consumption
Giménez-Gaydou, D.A.; Cupido dos Santos, A.; Mendes, G.; Frade, I.; Ribeiro, A.S.N.	2019	Coimbra, Portugal	Active mobility
Givoni, B.	1991	Unspecified	Urban heat island
Givoni, B.; Organization (WMO), W.M.	1989	Worldwide	Urban geometry and buildings energy consumption
Glaeser, E.L.; Kahn, M.E.	2010	USA	Urban sprawl

Authors	Publication date	Location of Research	Article topic
Gonçalves Duarte Santos, G.; Birolini, S.; Homem de Almeida Correia, G.	2023	Portugal	Vehicle electrification and the built environment
Gossop, C.	2011	Unspecified	Urban form and policies
Gough, M.; Lotfi, M.; Castro, R.; Madhlopa, A.; Khan, A.; Catalão, J.P.S.	2019	Cape Town, South Africa	Urban geometry and buildings energy consumption
Gunawardena, K.R.; Wells, M.J.; Kershaw, T.	2017	Unspecified	Urban heat island
Guo, J.; Bissuel, C.; Courtot, F.	2021	China	Urban form
Gyurov, V.; Bezhanov, N.	2019	Varna, Bulgaria	Vehicle electrification and the built environment
Hamstead, Z.A.; Farmer, C.; McPhearson, T.	2018	USA	Urban heat island
Handy, S.L.; Boarnet, M.G.; Ewing, R.; Killingsworth, R.E.	2002	Florida, USA	Active mobility
Hankey, S.; Marshall, J.D.	2010	USA	Transport and the built environment
Hannan, S.; Sutherland, C.	2015	Durban, South Africa	Developing countries urban energy challenges
Harlan, S.L.; Brazel, A.J.; Prashad, L.; Stefanov, W.L.; Larsen, L.	2006	Phoenix, USA	Urban heat island
Heres-Del-Valle, D.; Niemeier, D.	2011	California, USA	Urban trips and network design
Hickman, R.; Banister, D.	2014	Unspecified	Transport and the built environment
Hoehner, C.M.; Brennan Ramirez, L.K.; Elliott, M.B.; Handy, S.L.; Brownson, R.C.	2005	USA	Active mobility
Hong, J.; Goodchild, A.	2014	Unspecified	Urban sprawl
Howard, E.	2010	Unspecified	Urban sprawl
Hsieh, S.; Schüler, N.; Shi, Z.; Fonseca, J.A.; Maréchal, F.; Schlueter, A.	2017	Singapore	Urban sprawl
Hu, J.; Yu, X.B.	2019	USA	Urban public spaces
Huang, C.; Yang, J.; Jiang, P.	2018	China	Urban heat island
Huang, H.; Li, Q.; Yang, Y.; Zhang, L.; Dong, Z.	2022	China	Urban form
Huchzermeyer, M.	Not specified	Worldwide	Developing countries urban energy challenges
Hukkalainen, M.; Virtanen, M.; Paiho, S.; Airaksinen, M.	2017	Finland	Urban form
ICLEI Europe	2023	Europe	Urban form
IEA	2023	Worldwide	Vehicle electrification and the built environment
International Energy Agency	2022	Worldwide	Urban energy consumption data
International Energy Agency	2023	Worldwide	Transport and the built environment, vehicle electrification
Jackson, R.J.	2003	USA	Urban sprawl
Jacobs, J.	1992	USA	Urban form, urban sprawl
Jamei, E.; Rajagopalan, P.; Seyedmahmoudian, M.; Jamei, Y.	2016	Unspecified	Urban public spaces
Jank, R.	2017	Europe	Urban form and policies
Jha, A.; Preonas, L.; Burlig, F.	2021	India	Urban energy consumption data
Jin, J.	2019	Chicago, USA	Urban sprawl
Johansson, E.	2006	Fez, Morocco	Active mobility

Authors	Publication date	Location of Research	Article topic
Johansson, E.; Spangenberg, J.; Gouvêa, M.L.; Freitas, E.D.	2013	São Paulo, Brazil	Active mobility
John, R.	2020	Dar Es Salaam, Tanzania	Developing countries urban energy challenges
Juvara, M.	2022	Worldwide	Urban energy consumption data
Kadaverugu, A.; Kadaverugu, R.; Chintala, N.R.; Gorthi, K.V.	2021	Hyderabad, India	Urban heat island
Kakar, K.A.; Prasad, C.S.R.K.	2020	Kabul, Afghanistan	Urban sprawl
Kaloustian, N.; Diab, Y.	2015	Beirut, Lebanon	Urban heat island
Karan, E.; Mohammadpour, A.; Asadi, S.	2016	Unspecified	Vehicle electrification and the built environment
Kastner-Klein, P.; Berkowicz, R.; Britter, R.	2004	Unspecified	Street canyons
Kaza, N.	2020	USA	Densification and compactification
Keirstead, J.; Jennings, M.; Sivakumar, A.	2012	Unspecified	Urban geometry and buildings energy consumption
Kenworthy, J.R.	2006	Worldwide	Eco-districts and built environment towards clean energy
Kenworthy, J.R.; Laube, F.B.	1996	Worldwide	Transport and the built environment
Khan, M.; M. Kockelman, K.; Xiong, X.	2014	Seattle, USA	Transport and the built environment
Kim, K.; Yi, C.; Lee, S.	2019	Seoul, South Korea	Urban heat island
Kiprop, V.	2017	Unspecified	Street canyons
Klemm, W.; Heusinkveld, B.G.; Lenzholzer, S.; van Hove, B.	2015	Utrecht, Netherlands	Urban heat island
Kosai, S.; Yuasa, M.; Yamasue, E.	2020	Japan	Urban trips and network design
Koutra, S.; Becue, V.; Gallas, M.-A.; Ioakimidis, C.S.	2018	Unspecified	Eco-districts and built environment towards clean energy
Kumar, P.; Morawska, L.; Martani, C.; Biskos, G.; Neophytou, M.; Di Sabatino, S.; Bell, M.; Norford, L.; Britter, R.	2015	Unspecified	Street canyons
Lai, D.; Liu, W.; Gan, T.; Liu, K.; Chen, Q.	2019	Unspecified	Urban geometry and buildings energy consumption
Lawrence, D.P.	2000	Unspecified	Urban form
Layman, C.C.; Horner, M.W.	2010	Leon County, USA	Urban trips and network design
Le Corbusier	1972	Unspecified	Urban sprawl
Lee, J.H.; Lim, S.	2018	South Korea	Densification and compactification
Leichenko, R.	2011	Unspecified	Urban form
Leng, H.; Chen, X.; Ma, Y.; Wong, N.H.; Ming, T.	2020	Harbin, China	Street canyons
Li, H.; Harvey, J.; Kendall, A.	2013	California, USA	Urban heat island
Li, S.; Zhao, P.	2017	Beijing	Urban trips and network design, public transport
Li, X.-X.; Liu, C.-H.; Leung, D.Y.C.; Lam, K.M.	2006	Unspecified	Street canyons
Li, X.; Zhou, W.; Ouyang, Z.	2013	Beijing, China	Urban heat island
Li, Z.; Quan, S.J.; Yang, P.P.-J.	2016	Macau	Urban geometry and buildings energy consumption
Liddle, B.	2014	Unspecified	Densification and compactification
Lim, X.	2019	Unspecified	Urban public spaces
Lin, L.; Moudon, A.V.	2010	Unspecified	Active mobility
Litman, T.	2005	Worldwide	Transport and the built environment
Liu, X.; Huang, B.; Li, R.; Wang, J.	2021	Shenzhen, China	Urban form and policies

Authors	Publication date	Location of Research	Article topic
Liu, X.; Sweeney, J.	2012	Dublin, Ireland	Transport and the built environment
Liu, Y.; Huang, L.; Onstein, E.	2020	Norway	Transport and the built environment
Lobaccaro, G.; Acero, J.A.	2015	Bilbao, Spain	Urban heat island
Lobaccaro, G.; Croce, S.; Lindkvist, C.; Munari Probst, M.C.; Scognamiglio, A.; Dahlberg, J.; Lundgren, M.; Wall, M.	2019	Worldwide	Eco-districts and built environment towards clean energy
Loeffler, R.; Österreicher, D.; Stoeglehner, G.	2021	Vienna, Austria	Densification and compactification
Lombardi, P.; Trossero, E.	2013	Europe	Eco-districts and built environment towards clean energy
Lu, I.J.; Lin, S.J.; Lewis, C.	2007	Taiwan, Germany, Japan, South Korea	Transport and the built environment
Luqman, M.; Rayner, P.J.; Gurney, K.R.	2023	Worldwide	Densification and compactification
Lyu, G.; Bertolini, L.; Pfeffer, K.	2016	Beijing, China	Densification and compactification
Ma, L.; Dill, J.	2015	Portland, USA	Active mobility
Ma, Y.; Yang, Y.; Jiao, H.	2021	Wuhan, China	Urban form
Mackey, C.W.; Lee, X.; Smith, R.B.	2012	Chicago, USA	Urban heat island
Mandeli, K.	2019	Jeddah, Saudi Arabia	Urban public spaces
Marrone, P.; Fiume, F.; Laudani, A.; Montella, I.; Palermo, M.; Fulginei, F.R.	2023	Rome, Italy	Eco-districts and built environment towards clean energy
Mastrucci, A.; Baume, O.; Stazi, F.; Leopold, U.	2014	Rotterdam, Netherlands	Eco-districts and built environment towards clean energy
Matzarakis, A.; Rutz, F.; Mayer, H.	2007	Crete, Greece	Active mobility
Maya-Drysdale, D.; Krog Jensen, L.; Vad Mathiesen, B.	2020	Europe	Urban form
McPherson, E.G.; Simpson, J.R.; Peper, P.J.; Maco, S.E.; Xiao, Q.; Hoefer, P.J.	2003	Unspecified	Urban heat island
Mele, C.; McLeskey, M.H.	2018	Unspecified	Urban form and policies
Mendiola, L.; González, P.; Cebollada, À.	2014	Biscay	Urban trips and network design
Meng, T.; Hsu, D.; Han, A.	2017	New York, USA	Eco-districts and built environment towards clean energy
Mills, D.E.	1981	Unspecified	Urban sprawl
Mohsin, M.M.; Beach, T.; Kwan, A.	2017	Bristol, UK	Developing countries urban energy challenges
Monteiro, J.; Carrilho, A.C.; Sousa, N.; Oliveira, L.K. de; Natividade-Jesus, E.; Coutinho-Rodrigues, J.	2023	Belo Horizonte, Brazil and Coimbra, Portugal	Urban form
Monteiro, J.; Para, M.; Sousa, N.; Natividade-Jesus, E.; Ostorero, C.; Coutinho-Rodrigues, J.	2023	Coimbra, Portugal	Transport and the built environment, urban sprawl, densification and compactification
Monteiro, J.; Sousa, N.; Natividade-Jesus, E.; Coutinho-Rodrigues, J.	2023	Coimbra, Portugal	Transport and the built environment, urban sprawl
Monteiro, J.; Sousa, N.; Natividade-Jesus, E.; Coutinho-Rodrigues, J.	2023	Coimbra, Portugal	Active mobility, urban sprawl
Monteiro, J.; Sousa, N.; Natividade-Jesus, E.; Coutinho-Rodrigues, J.	2022	Coimbra, Portugal	Urban form, urban sprawl
Monteiro, J.; Sousa, N.; Pais, F.; Coutinho-Rodrigues, J.; Natividade-Jesus, E.	2023	Worldwide	Urban form

Authors	Publication date	Location of Research	Article topic
Moraci, F.; Errigo, M.F.; Fazia, C.; Burgio, G.; Foresta, S.	2018	Rotterdam, Netherlands	Urban form
Morrissey, J.; Moore, T.; Horne, R.E.	2011	Unspecified	Urban geometry and buildings energy consumption, street canyons
Motavalli, J.	2021	Unspecified	Vehicle electrification and the built environment, urban form
Moyer, A.N.; Hawkins, T.W.	2017	Pennsylvania, USA	Urban heat island
Muñoz, P.; Zwick, S.; Mirzabaev, A.	2020	Austria	Densification and compactification
Naess, P.	2010	Hangzhou, China	Urban sprawl
Nahlik, M.J.; Chester, M.V.	2014	Los Angeles, USA	Transport and the built environment, densification and compactification
Nasri, A.; Zhang, L.	2014	Washington, D.C. and Baltimore	Transport and the built environment, densification and compactification
Natividade-Jesus, E.	2022	Unspecified	Transport and the built environment
Nechyba, T.J.; Walsh, R.P.	2004	Unspecified	Urban sprawl
Nelson, A.C.	2017	Unspecified	Urban sprawl, The D-variables of compact planning
Net Zero by 2050	2021	Worldwide	Eco-districts and built environment towards clean energy
Neuman, M.	2005	Unspecified	The D-variables of compact planning
Newman, P.	2006	Worldwide	Transport and the built environment
Newman, P.W.G.; Kenworthy, J.R.	1989	Worldwide	Transport and the built environment
Ng, E.; Chen, L.; Wang, Y.; Yuan, C.	2012	Hong Kong	Active mobility
Nkosi, N.P.; Dikgang, J.;	2018	South Africa	Urban energy consumption data
Norton, B.A.; Coutts, A.M.; Livesley, S.J.; Harris, R.J.; Hunter, A.M.; Williams, N.S.G.	2015	Melbourne, Australia	Urban heat island
O'Malley, C.; Piroozfar, P.; Farr, E.R.P.; Pomponi, F.	2015	London, UK	Urban heat island
Oh, M.; Jang, K.M.; Kim, Y.	2021	Seoul, South Korea	Urban geometry and buildings energy consumption, street canyons
Oh, M.; Kim, Y.	2019	South Korea	Urban geometry and buildings energy consumption
Oke, T.R.	1987	Unspecified	Urban heat island
Okeil, A.	2010	Unspecified	Urban heat island
Olgyay, V.	2015	Unspecified	Urban geometry and buildings energy consumption
Osman, T.; Divigalpitiya, P.; Osman, M.M.	2016	Cairo, Egipt	Urban sprawl
Ozgun, K.	2020	Sidney, Australia	Urban public spaces
Paatero, J.V.; Lund, P.D.	2007	Helskinki, Finland	Eco-districts and built environment towards clean energy
Pacheco-Torgal, F.	2015	Worldwide	Urban heat island
Pasichnyi, O.; Levihn, F.; Shahrokni, H.; Wallin, J.; Kordas, O.	2019	Stockholm, Sweeden	Eco-districts and built environment towards clean energy
Patel, Z.; Greyling, S.; Simon, D.; Arfvidsson, H.; Moodley, N.; Primo, N.; Wright, C.	2017	Cape Town, South Africa	Developing countries urban energy challenges
Pei, A.	2023	Worldwide	Active moblity
Perea-Moreno, M.-A.; Hernandez-Escobedo, Q.; Perea-Moreno, A.-J.	2018	Worldwide	Urban form
Perini, K.; Magliocco, A.	2014	Italy	Active mobility

Authors	Publication date	Location of Research	Article topic
Petersen, J.-P.; Heurkens, E.	2018	Europe	Urban form
Pieterse, D.E.; Parnell, S.	Not specified	Africa	Developing countries urban energy challenges
Pietrzak, O.; Pietrzak, K.	2021	Szczecin, Poland	Vehicle electrification and the built environment
Pisano, C.	2020	Italy and Spain	Active mobility
Pisello, A.L.	2017	Unspecified	Urban public spaces
Pisello, A.L.; Taylor, J.E.; Xu, X.; Cotana, F.	2012	USA	Densification and compactification
Pizzo, B.	2015	Unspecified	Urban form
Pretty, J.; Toulmin, C.; Williams, S.	2011	Africa	Developing countries urban energy challenges
Priyadarsini, R.; Hien, W.N.; Wai David, C.K.	2008	Singapore	Densification and compactification
Qin, Y.	2015	California, USA	Urban public spaces
Quan, S.J.; Li, C.	2021	Unspecified	Urban form
Ratti, C.; Baker, N.; Steemers, K.	2005	Europe	Urban geometry and buildings energy consumption, street canyons
Redweik, P.; Catita, C.; Brito, M.	2013	Lisbon, Portugal	Urban geometry and buildings energy consumption
Regina de Casas Castro Marins, K.	2014	São Paulo, Brazil	Public transport
Reinhart, C.F.; Cerezo Davila, C.	2016	Worldwide	Urban form
Resch, E.; Bohne, R.A.; Kvamsdal, T.; Lohne, J.	2016	Europe	Densification and compactification
Rickwood, P.; Glazebrook, G., Searle, G.	2008	Unspecified	Urban form
Riley, C.	2019	Unspecified	Vehicle electrification
Rode, P.; Keim, C.; Robazza, G.; Viejo, P.; Schofield, J.	2014	Europe	Densification and compactification
Rodríguez-Álvarez, J.	2016	Europe	Densification and compactification
Rodríguez, D.A.; Evenson, K.R.; Diez Roux, A.V.; Brines, S.J.	2009	USA	Active mobility
Roger-Lacan, C.	2019	Unspecified	Eco-districts and built environment towards clean energy
Rosso, F.; Fabiani, C.; Chiatti, C.; Pisello, A.L.	2019	Unspecified	Urban public spaces
Rosso, F.; Jin, W.; Pisello, A.L.; Ferrero, M.; Ghandehari, M.	2016	Unspecified	Urban public spaces
Rosso, F.; Pisello, A.L.; Cotana, F.; Ferrero, M.	2016	Italy	Urban public spaces
Rydin, Y.; Thomas, S.; Beddington, J.	2010	UK	Urban form
Santamouris, M.	2013	Unspecified	Urban heat island
Santamouris, M.	2014	Unspecified	Urban heat island
Santos, P.	-	Unspecified	Buildings and materials
Santos, T.; Deus, R.; Rocha, J.; Tenedório, J.A.	2021	Algarve, Portugal	The D-variables of compact planning
Sarrat, C.; Lemonsu, A.; Masson, V.; Guedalia, D.	2006	Paris, France	Urban heat island
Saunders, M.J.; Kuhnimhof, T.; Chlond, B.; da Silva, A.N.R.	2008	Unspecified	Transport and the built environment
Shahidan, Mohd.F.; Shariff, M.K.M.; Jones, P.; Salleh, E.; Abdullah, A.M.	2010	Malaysia	Urban heat island

Authors	Publication date	Location of Research	Article topic
Shashua-Bar, L.; Hoffman, M.E.	2000	Tel-Aviv, Israel	Active mobility
Shashua-Bar, L.; Potchter, O.; Bitan, A.; Boltansky, D.; Yaakov, Y.	2010	Tel Aviv, Israel	Urban heat island
Shashua-Bar, L.; Tzamir, Y.; Hoffman, M.E.	2004	Israel	Active mobility
Shen, Q.; Chen, P.; Pan, H.	2016	China	Public transport
Shi, F.; Liao, X.; Shen, L.; Meng, C.; Lai, Y.	2022	China	Transport and the built environment
Shim, G.-E.; Rhee, S.-M.; Ahn, K.-H.; Chung, S.-B.	2006	South Korea	Transport and the built environment, urban trips and network design
Shirgaokar, M.; Deakin, E.; Duduta, N.	2013	Jinan, China	Urban geometry and buildings energy consumption
Sikder, S.K.; Eanes, F.; Asmelash, H.B.; Kar, S.; Koetter, T.	2016	Dhaka, Bangladesh	Urban form
Silva, M.; Leal, V.; Oliveira, V.; Horta, I.M.	2018	Porto, Portugal	Densification and compactification
Silva, M.; Oliveira, V.; Leal, V.	2017	Porto, Portugal	Transport and the built environment
Silva, M.C.; Horta, I.M.; Leal, V.; Oliveira, V.	2017	Porto, Portugal	Urban geometry and buildings energy consumption
Sousa, N.; Almeida, A.; Coutinho-Rodrigues, J.	2020	Europe	Vehicle electrification and the built environment
Sousa, N.; Monteiro, J.; Natividade-Jesus, E.; Coutinho-Rodrigues, J.	2022	Coimbra, Portugal	Urban sprawl
Sousa, N.; Monteiro, J.; Natividade-Jesus, E.; Coutinho-Rodrigues, J.	2022	Coimbra, Portugal	The D-variables of compact planning
Srivanit, M.; Hokao, K.	2013	Japan	Active mobility
Starace, F.; Tricoire, J.-P.	2021	Worldwide	Urban energy consumption data
Steemers, K.	2003	Worldwide	Densification and compactification
Stelzer, V.; Immendoerfer, A.; Winkelmann, M.	2014	Europe	Urban form and policies
Stevens, M.R.	2017	Unspecified	Urban sprawl, The D-variables of compact planning
Stone, B.; Mednick, A.C.; Holloway, T.; Spak, S.N.	2007	USA	Urban sprawl
Strasser, H.	2015	Salzburg, Austria	Urban form and policies
Strømann-Andersen, J.; Sattrup, P.A.	2011	Copenhagen, Denmark	Urban geometry and buildings energy consumption, street canyons
Swilling, M.; Annecke, E.	2006	South Africa	Developing countries urban energy challenges
Talbi, B.	2017	Tunisia	Developing countries urban energy challenges
Taleghani, M.; Tenpierik, M.; van den Dobbelsteen, A.; de Dear, R.	2013	Netherlands	Urban geometry and buildings energy consumption, street canyons
Taminiau, J.; Byrne, J.; Kim, J.; Kim, M.; Seo, J.	2021	East Asia	Eco-districts and built environment towards clean energy
Tchepel, O.; Monteiro, A.; Dias, D.; Gama, C.; Pina, N.; Rodrigues, J.P.; Ferreira, M.; Miranda, A.I.	2020	Coimbra, Portugal	Urban geometry and buildings energy consumption
Toboso-Chavero, S.; Nadal, A.; Petit-Boix, A.; Pons, O.; J.	2019	Unspecified	Urban form
Tonnelat, S.	2008	Worldwide	Urban public spaces
Tsangas, M.; Papamichael, I.; Zorpas, A.A.	2023	Unspecified	Urban form
U.S. Department of Transportation	2010	United States	Active mobility

Authors	Publication date	Location of Research	Article topic
UN Habitat	2023	Worldwide	Urban energy consumption data
United Nations	2018	Worldwide	Urban energy consumption data
United Nations	2023	Worldwide	Urban energy consumption data
United Nations	2021	Worldwide	Urban energy consumption data
Urban Sprawl in Europe - Joint EEA-FOEN Report	N/A	Europe	Urban sprawl
Vailshery, L.S.; Jaganmohan, M.; Nagendra, H.	2013	Bangalore, India	Active mobility
Van der Borght, R.; Pallares Barbera, M.	2023	Latin America	Transport and the built environment
van Esch, M.M.E.; Looman, R.H.J.; de Bruin-Hordijk, G.J.	2012	Netherlands	Street canyons
Vance, C.; Hedel, R.	2007	Germany	Transport and the built environment
Vardoulakis, S.; Fisher, B.E.A.; Pericleous, K.; Gonzalez-Flesca, N.	2003	Unspecified	Street canyons
Vartholomaios, A.	2017	Thessaloniki, Greece	Urban geometry and buildings energy consumption
Vonk, G.; Ligtenberg, A.	2010	Unspecified	Urban form
Wang, D.; Zhou, M.	2017	China	Urban sprawl
Wang, H.; Ou, X.; Zhang, X.	2017	China	Developing countries urban energy challenges
Wang, P.; Yang, Y.; Ji, C.; Huang, L.	2023	Nanjing, China	Urban heat island
Wang, S.; Lu, C.; Liu, C.; Zhou, Y.; Bi, J.; Zhao, X.	2020	China	Vehicle electrification and the built environment
Wang, S.; Wang, J.; Fang, C.; Li, S.	2019	China	Densification and compactification
Wang, Y.; Yang, L.; Han, S.; Li, C.; Ramachandra, T.V.	2017	Xi'an and Bangalore	Urban trips and network design
Wang, Z.-H.	2022	Unspecified	Urban heat island
Weijs-Perrée, M.; Dane, G.; van den Berg, P.	2020	Eindhoven, Netherlands	Urban public spaces
Weisz, H.; Steinberger, J.K.	2010	Unspecified	The D-variables of compact planning
White, I.; O'Hare, P.	2014	Unspecified	Urban form
Wong, P.P.-Y.; Lai, P.-C.; Low, C.-T.; Chen, S.; Hart, M.	2016	Hong Kong	Urban heat island
Woo, Y.-E.; Cho, G.-H.	2018	Seoul, South Korea	Urban sprawl
Wu, W.; Xue, B.; Song, Y.; Gong, X.; Ma, T.	2023	Ningbo, China	Transport and the built environment, urban sprawl
Xiong, R.; Zhao, H.; Huang, Y.	2024	Guiyang, China	Active mobility
Xu, X.; Sun, S.; Liu, W.; García, E.H.; He, L.; Cai, Q.; Xu, S.; Wang, J.; Zhu, J.	2017	Beijing, China	Urban heat island
Xue, X.; Ren, Y.; Cui, S.; Lin, J.; Huang, W.; Zhou, J.	2015	Xiamen, China	ransport and the built environment
Yan, H.; Wu, F.; Dong, L.	2018	Beijing, China	Urban heat island
Yang, W.; Cao, X.	2018	Guangzhou, China	Urban trips and network design
Yang, W.; Li, T.; Cao, X.	2015	China	Transport and the built environment, The D-variables of compact planning
Yao, X.; Kou, D.; Shao, S.; Li, X.; Wang, W.; Zhang, C.	2018	China	Densification and compactification
Yezioro, A.; Capeluto, I.G.; Shaviv, E.	2006	Unspecified	Urban heat island
Yıldırım, H.H.Y.; Gültekin, A.B.; Tanrıvermiş, H.	2017	Europe	Urban form

Authors	Publication date	Location of Research	Article topic
Zahabi, S.A.H.; Miranda-Moreno, L.; Patterson, Z.; Barla, P.; Harding, C.	2012	Montreal, Canada	Vehicle electrification and the built environment, urban sprawl
Zamanifard, H.; Alizadeh, T.; Bosman, C.; Coiacetto, E.	2019	Brisbane, Australia	Urban public spaces
Zanon, B.; Verones, S.	2013	Italy	Urban form and policies
Zhao, P.; Lü, B.; Roo, G. de	2011	Beijing	Urban trips and network design
Zheng, S.; Kroll; A.	2023	Wordwide	Active mobility
Zhu, P.; Wang, K.; Ho, S.-N. (Rita); Tan, X.	2023	Hong Kong	Transport and the built environment
Zölch, T.; Maderspacher, J.; Wamsler, C.; Pauleit, S.	2016	Munich, Germany	Urban heat island

3. Planning cities for pandemics: Review of urban and transport planning lessons from COVID-19

3.1. Table II.3.1. COVID-19 related research articles in Spatial and Transport Planning

Table II.3.1. Extensive description of the multiple aspects found in COVID-19 research papers related to spatial and transport planning.

						Spatial planning					Transport planning					
	Location	COVID-19 Timeline	Past pandemics, their impacts and timeline	COVID-19 impact on urban areas	COVID-19 consequences on mental health and safety perception	General urban planning considerations	Lessons learned from the COVID-19 pandemic	Urban planning as a tool to fight the COVID-19 and future pandemics	Green areas as physical and mental safety nets during COVID-19 lockdown	The impact of density, compactness, and world connection on the spread of COVID-19	General urban transport considerations	Travel patterns under COVID-19 lockdown	The role of accessibility and proximity	Public transport and COVID-19	Active mobility and COVID-19	COVID-19 and the environment flip side
Abdullah et al., 2020	Malaysia															X
Acuto, 2020	Global	X						X								
Ahsan, 2020	Turkey							X		X						
Allam & Jones, 2020a	Global		X				X	X								
Aloi et al., 2020	Santander										X	X				
Amit et al., 2021	Bangladesh				X											
Antunes, 2021	Global							X	X							
Astroza et al., 2020	Chile											X		X		
Awad-Núñez et al., 2021	Spain					X					X				X	
Badii et al., 2020	Florence											X				
Badr et al., 2020	USA	X										X				
Baldasano, 2020	Barcelona/Madrid															X
Barbarossa, 2020	Italy			X											X	
Bolay, 2006	Slums					X										
Borkowski et al., 2021	Poland										X	X				
Brinkley, 2020	Singapore		X				X									
Brooks et al., 2020	USA										X				X	
Büchel et al., 2022	United Kingdom														X	
Budd & Ison, 2020	Basel/Zurich					X					X				X	
Buehler & Pucher, 2021	Global										X				X	
Buehler and Pucher (2022)	Europe/USA		X	X							X	X			X	
Carozzi et al., 2020	USA										X		X			
Carrión et al., 2021	New York City									X						
Cartenì et al., 2020	Italy	X		X								X				
Cheng et al., 2021	Nanjing City						X		X							
Cheshmehzangi, 2021	Global									X					X	X
Corburn et al., 2020	Slums									X						
Dantas et al., 2020	Rio de Janeiro															X
De Vos, 2020	Global										X				X	
Desai, 2020	Global									X						
Dhilon, 2020	India					X					X					
Dong et al., 2021	China													X		
Eisenmann et al., 2021	Germany											X		X		
Eltarabily & Elgheznawy, 2020	Global		X				X									
Espejo et al., 2020	Global															X
Fatmi, 2020	British Columbia											X				
Füller, 2016	Hong Kong		X													

						Spatial planning					Transport planning					
	Location	COVID-19 Timeline	Past pandemics, their impacts and timeline	COVID-19 impact on urban areas	COVID-19 consequences on mental health and safety perception	General urban planning considerations	Lessons learned from the COVID-19 pandemic	Urban planning as a tool to fight the COVID-19 and future pandemics	Green areas as physical and mental safety nets during COVID-19 lockdown	The impact of density, compactness, and world connection on the spread of COVID-19	General urban transport considerations	Travel patterns under COVID-19 lockdown	The role of accessibility and proximity	Public transport and COVID-19	Active mobility and COVID-19	COVID-19 and the environment flip side
Fumagalli et al., 2021	Curitiba											X		X		
Gama et al., 2020	Portugal															X
Gargoum and Gargoum, 2021	Global	X		X							X	X				
Goetsch & Quiros, 2020	Global					X					X					
Guitíerrez et al., 2020	Global														X	
Hamidi et al., 2020	USA									X						
Harrington & Hadjiconstantinou, 2022	UK														X	
Hatef et al., 2020	USA									X						
Hays, 2005	New York		X													
Hong et al., 2020	Global									X						
Hörcher et al., 2021	Global											X		X		
Huet, 2020	Europe					X					X					
Ibert et al., 2022	Global			X			X									
Javid et al., 2020	Global	X		X												
Jenelius & Cebecauer, 2020	Sweden											X		X		
Klein, 2020	New York								X							
Koehl, 2020	Global													X	X	
Kraus & Koch, 2021	Europe														X	
Krecl et al., 2020	São Paulo															X
Krishna & Kummitha, 2020	Global			X												
Kumar et al., 2015	Global										X					
Lai et al., 2020	Global		X							X						
Lak et al., 2020	Global										X				X	
Laverty et al., 2020	UK										X				X	
Lian et al., 2020	Global															X
Lock, 2020	Australia														X	
Lui, 2020	China									X						
Mahato et al., 2020	India															X
Marques et al., 2021	Rio de Janeiro				X		X		X							
Martínez & Short, 2021	Global		X	X						X						
Mayer, 1999	Global					X										
Mazza et al., 2020	Italy				X											
Meyer & Elrahman, 2020	Global														X	
Molloy et al., 2020	Switzerland											X		X		
Mouratidis & Yiannakou, 2022	Greece												X			
Mouratidis, 2022	Norway									X			X			
Muhammad et al., 2020	Global															X
Musselwhite et al., 2020	Global	X		X						X					X	
Nakada and Urban, 2020	São Paulo															X
Nanisetti, 2020	India		X													

						Spatial planning					Transport planning					
	Location	COVID-19 Timeline	Past pandemics, their impacts and timeline	COVID-19 impact on urban areas	COVID-19 consequences on mental health and safety perception	General urban planning considerations	Lessons learned from the COVID-19 pandemic	Urban planning as a tool to fight the COVID-19 and future pandemics	Green areas as physical and mental safety nets during COVID-19 lockdown	The impact of density, compactness, and world connection on the spread of COVID-19	General urban transport considerations	Travel patterns under COVID-19 lockdown	The role of accessibility and proximity	Public transport and COVID-19	Active mobility and COVID-19	COVID-19 and the environment flip side
Nelson, 2020	Global					X					X				X	
Nikiforiadis et al., 2020	Thessaloniki														X	
Obongha and Ukam, 2020	Nigeria									X						
Osservatorio Audimob, 2020	Italy											X				
Paital, 2020	Global							X								
Parr et al., 2020	Global											X				
Patel, 2020	India									X						
Peng et al., 2020	Wuhan									X						
Poortinga, 2021	UK						X		X							
Przybylowski et al., 2021	Gdansk													X		
Ro, 2020	Global					X					X					
Rojas-Ruedas & Morales-Zamora, 2021	Global			X		X	X	X			X					X
Rubin et al., 2020	Global				X							X			X	
Salama, 2020	Global						X	X		X						
Samedi et al., 2021	Global South				X									X		
Sasidharan et al., 2020	London															X
Scorrano and Danielis, 2021	Trieste											X			X	
Setti et al., 2020	Bergamo															X
Shabbir & Ahmad, 2010	Pakistan										X					
Shaer et al., 2021	Shiraz					X					X					
Sharifi & Khavarian-Garmsir, 2020	India												X			X
Sharma et al., 2020	Global										X					X
Singh et al., 2020	Global				X						X	X		X	X	
Slater et al., 2020	Global						X	X	X							
Sui & Prapavessis, 2020	Canada					X					X					
Teixeira & Lopes, 2020	New York															
Teixeira et al., 2021	Lisbon											X		X	X	
Tešić & Lukić, 2020	Global			X			X	X								
Thomas et al., 2021	New Zealand													X		
Thombre & Agarwal, 2021	India											X		X		
Tirachini & Cats, 2020	Global											X		X		
Tomikawa et al., 2021	Tokyo				X											
Ugolini et al., 2020	Europe						X					X				
UN, 2018	Global					X										
Valenzuela-Levi et al., 2021	Santiago Chile											X				
Venter et al., 2021	Norway				X				X							
Waka Kotahi NZ Transport Agency, 2020	New Zealand													X		

						Spatial planning					Transport planning					
	Location	COVID-19 Timeline	Past pandemics, their impacts and timeline	COVID-19 impact on urban areas	COVID-19 consequences on mental health and safety perception	General urban planning considerations	Lessons learned from the COVID-19 pandemic	Urban planning as a tool to fight the COVID-19 and future pandemics	Green areas as physical and mental safety nets during COVID-19 lockdown	The impact of density, compactness, and world connection on the spread of COVID-19	General urban transport considerations	Travel patterns under COVID-19 lockdown	The role of accessibility and proximity	Public transport and COVID-19	Active mobility and COVID-19	COVID-19 and the environment flip side
WHO, 2020	Global	X		X										X		
Wood, 2020	Global					X					X					
Xie et al., 2020	Chengdu						X	X	X			X				
Xu et al., 2020	China															X
Zhang & Zhang, 2021	Global											X			X	
TOTAL	-----	7	9	12	8	14	13	10	8	17	25	26	4	17	25	17

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4. Benchmarking city layouts – A methodological approach and an accessibility comparison between a real city and the Garden City

4.1. Garden City living space calculation

Garden City living space per inhabitant was calculated as follows.

- Measure all the Garden City land plots areas allocated to residential buildings;
- To ensure space for a fluid and spacious movement, a gap between buildings was assumed, consisting of a 2 m strip for gardens, plus 4 m for a sidewalk and 2 m for a cycling lane. This area was removed from the land plot area of above, yielding the implantation area;
- After considering gap space, the area left on the residential land plots had associated floor area ratios of 1.3 and 1.8 (ratio of a building's total floor area to the area of the land plot upon which it is built), which are the two values stated in the municipal city plan of Coimbra for residential areas. Howard suggested the most central residential buildings to be more spacious, thus a ratio of 1.3 was assumed for these land plots. Residential buildings in the outward ring would be more compact and for these land plots a ratio of 1.8 was assumed;
- The total construction area for residential purposes on one Garden City is 2,145,825 m2, obtained by multiplying the implantation area by the corresponding floor area ratio. Considering the three Garden Cities and dividing by 104,643 inhabitants yields an average 61.5 m2 living space available per in habitant;
- For each land plot, multiplying its implantation area by area ratio and dividing by 61.5 yields the number of inhabitants in that land plot, which ranges from 27 in the inner rings to 43 in the outer rings.

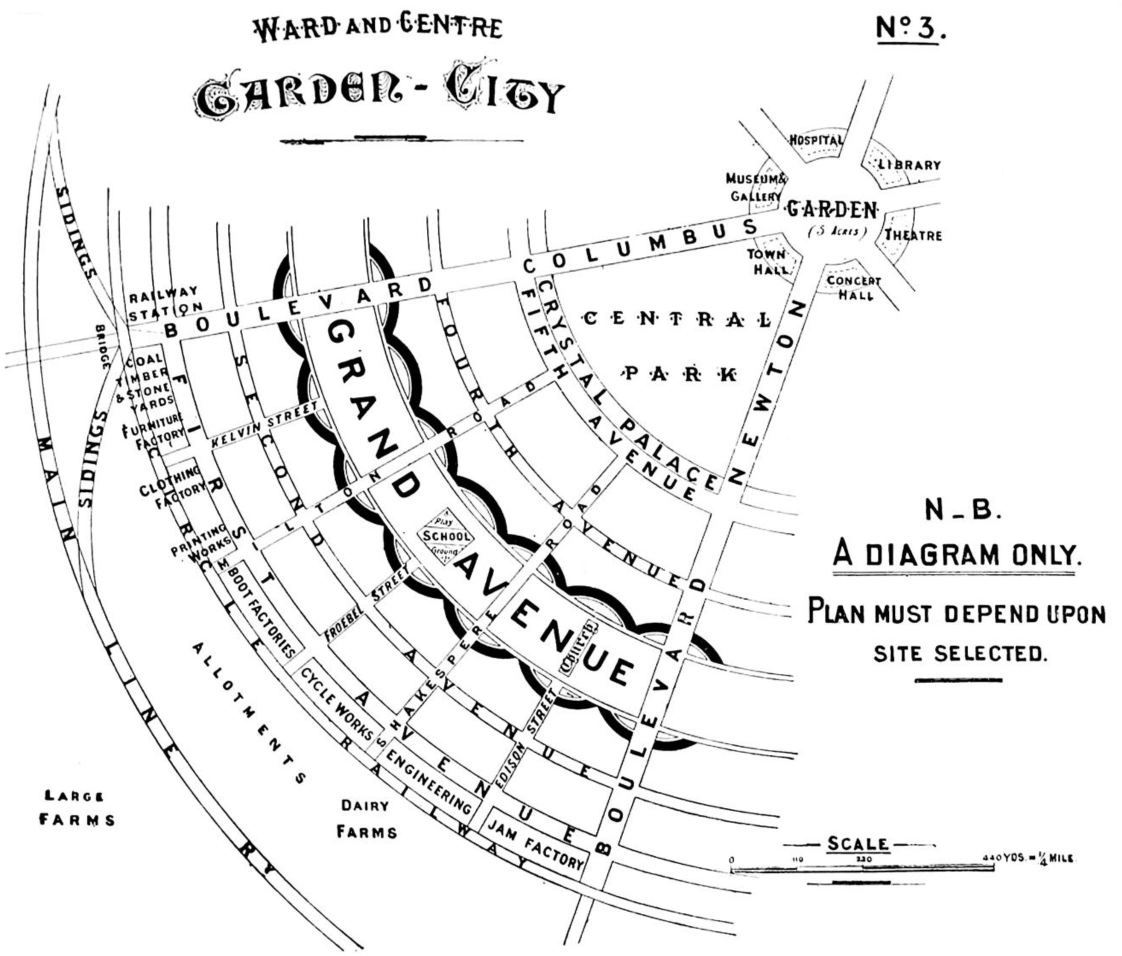


Figure II.4.1 – (a) Layout of a Garden City ward [1].

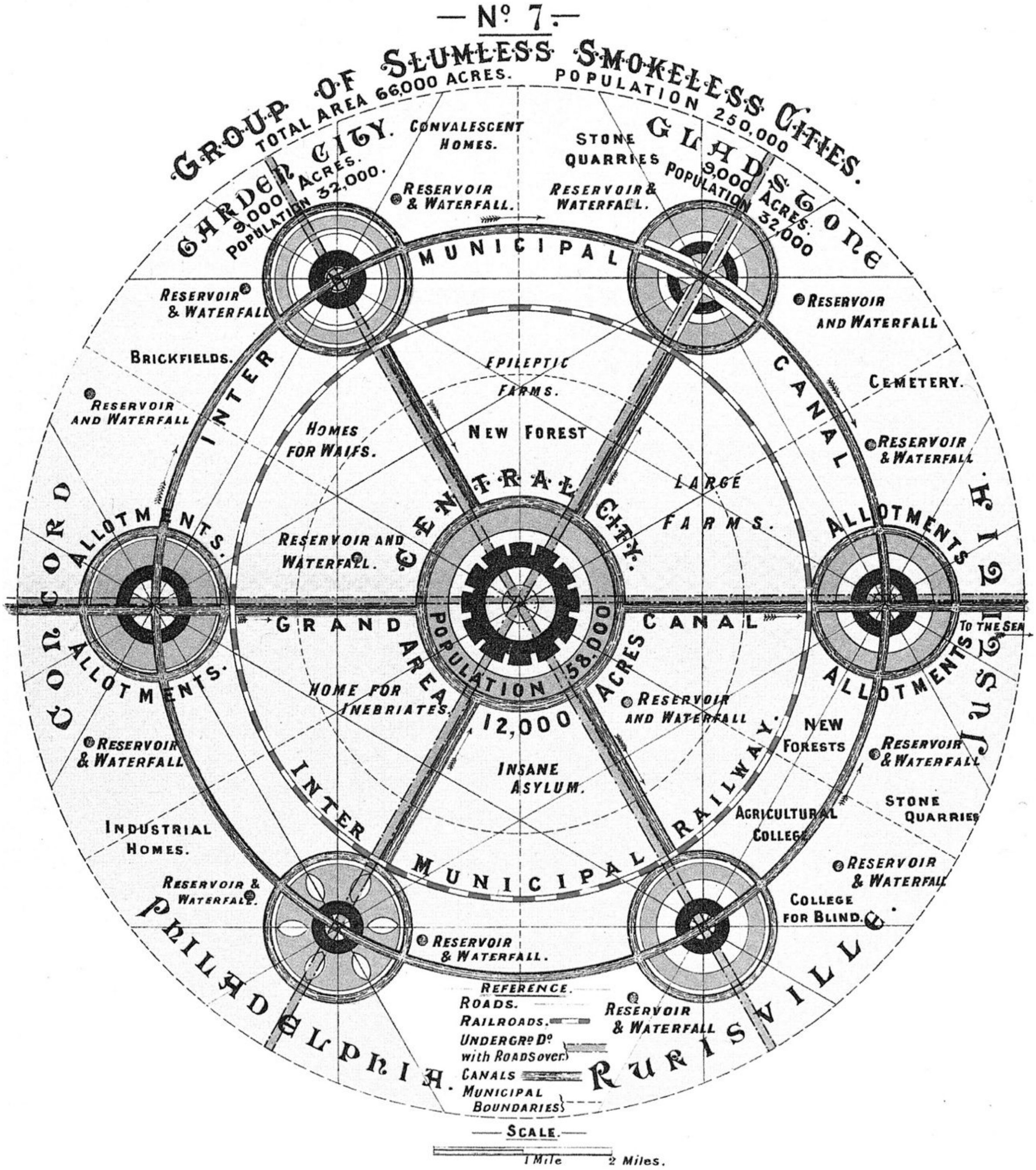
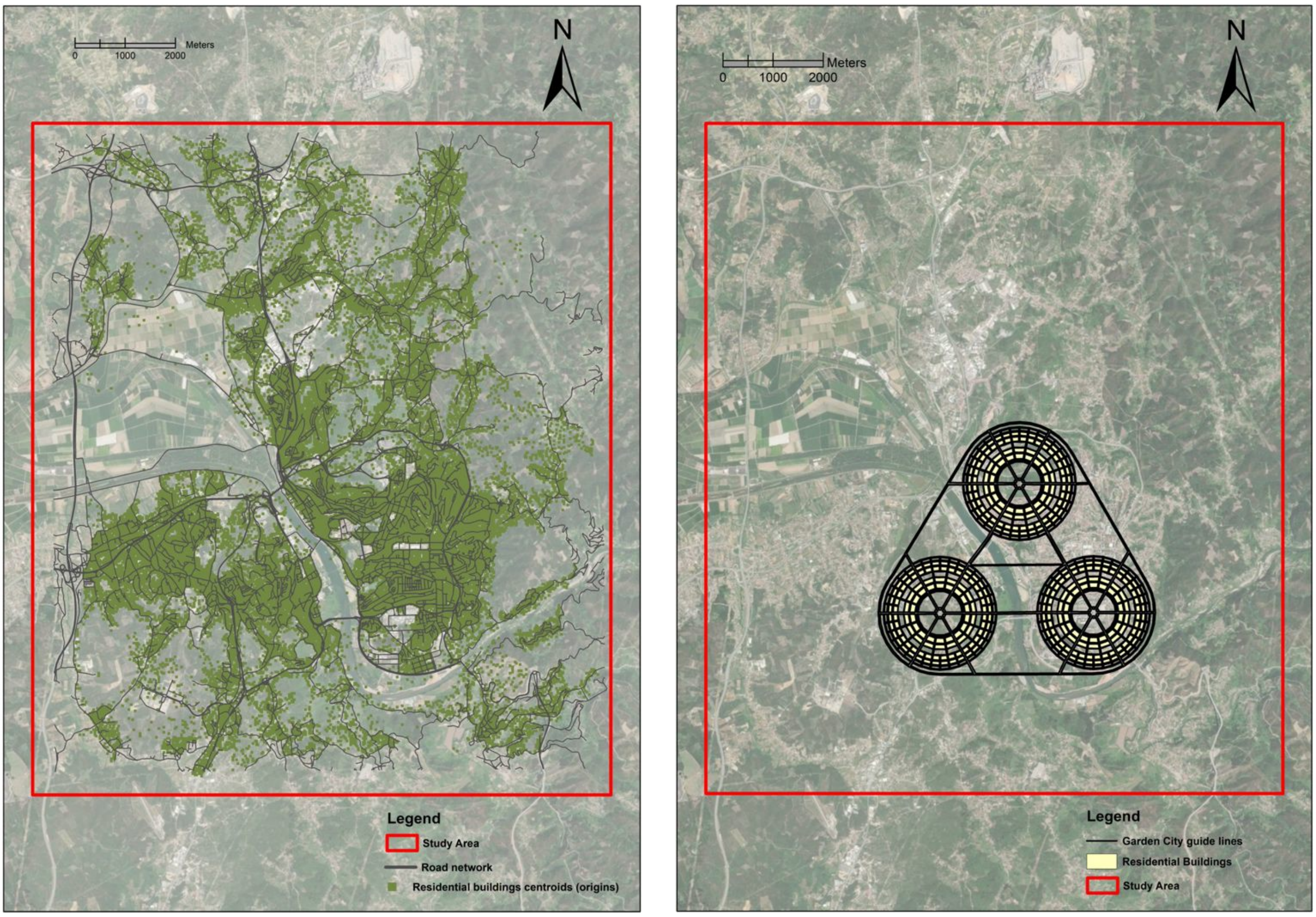


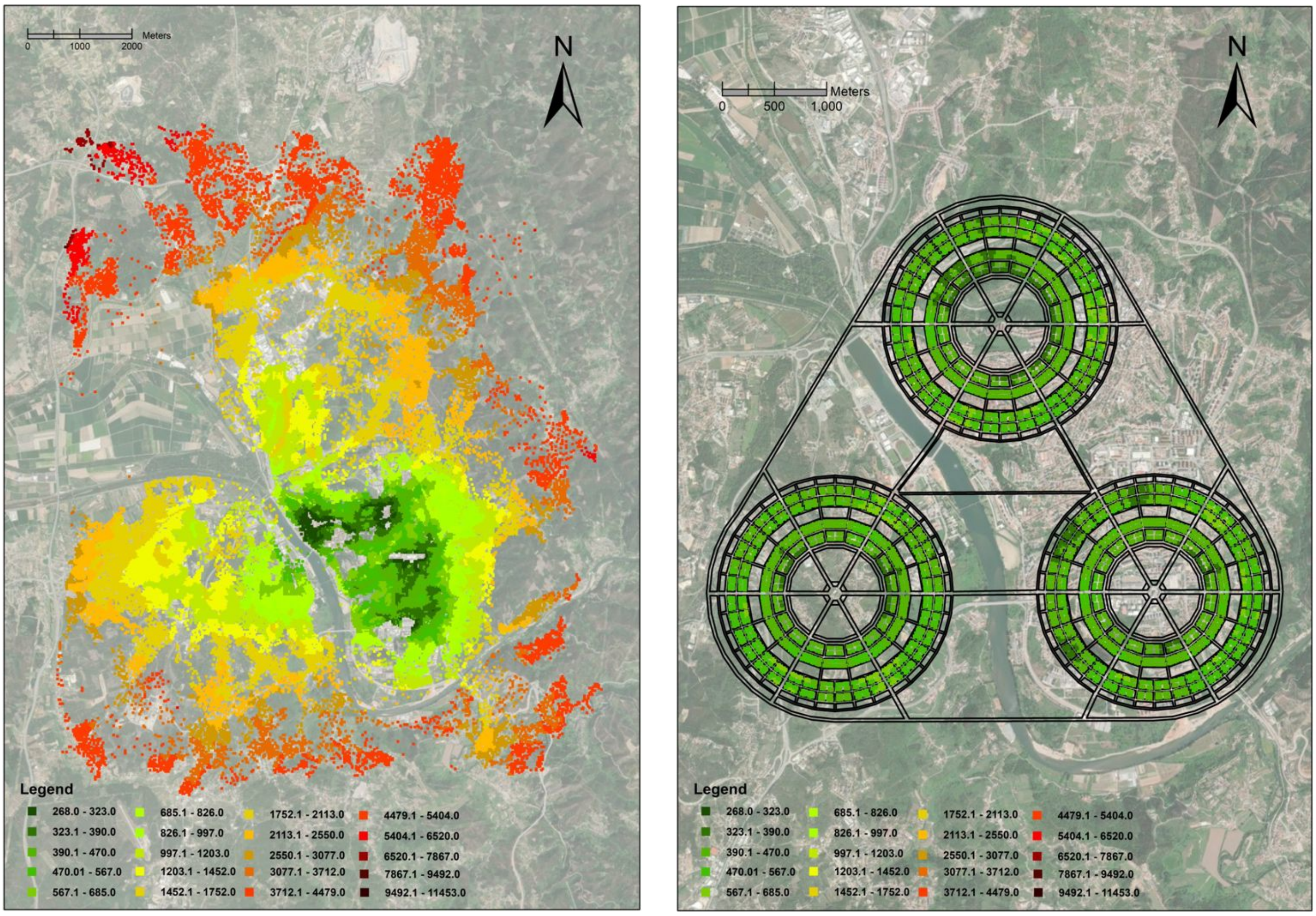
Figure II.4.1 (continuation) – (b) Social City [1].

4.2. Supplemental maps



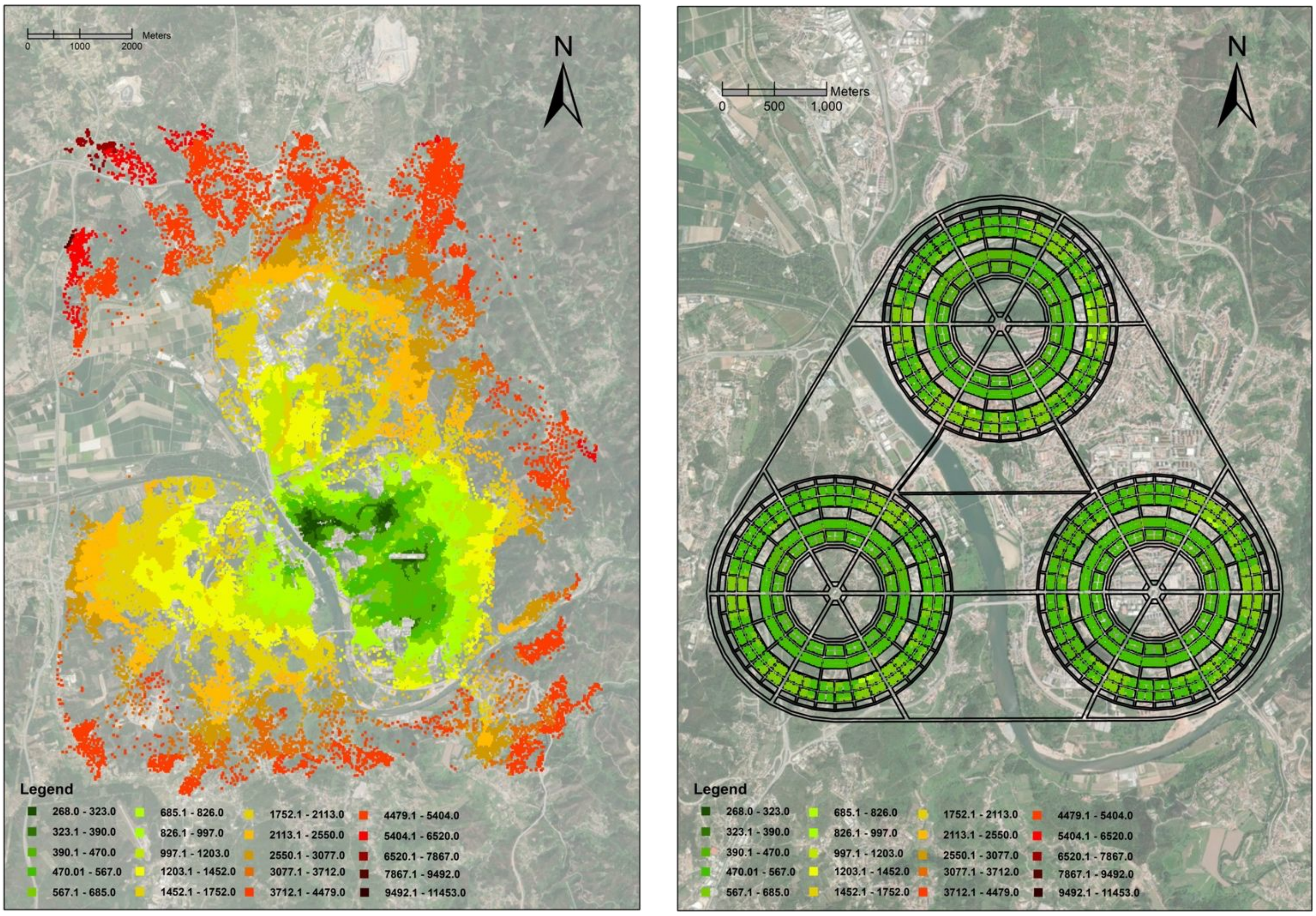
(a) (b)

Figure II.4.2. Comparison in size between the city of Coimbra (**a**), and Coimbra as Garden City (**b**).



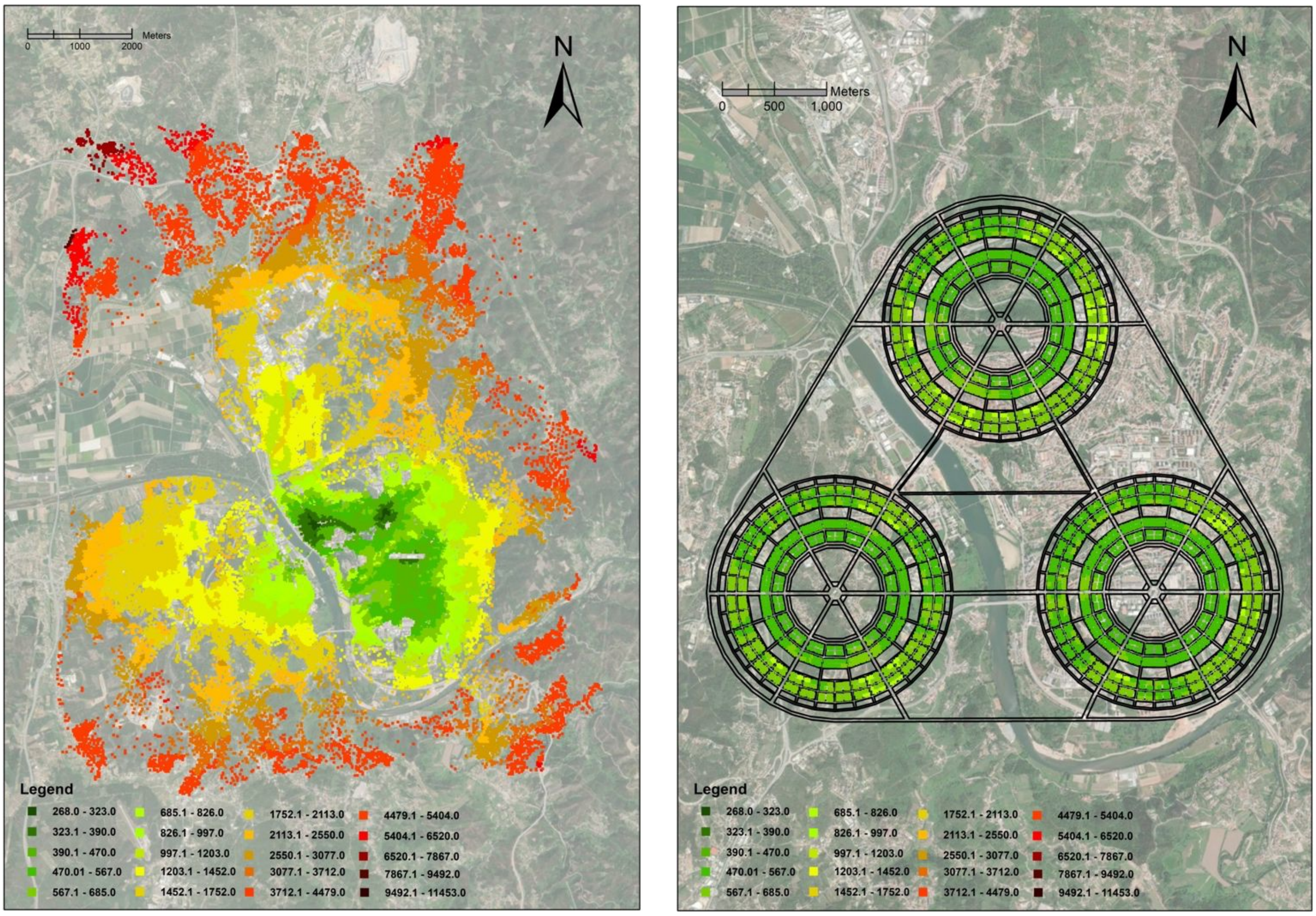
(**a**) (**b**)

Figure II.4.3. Accessibility to urban facilities for $L_k(j_3)$ 100/0/0, Coimbra (**a**), and Coimbra as Garden City (**b**).



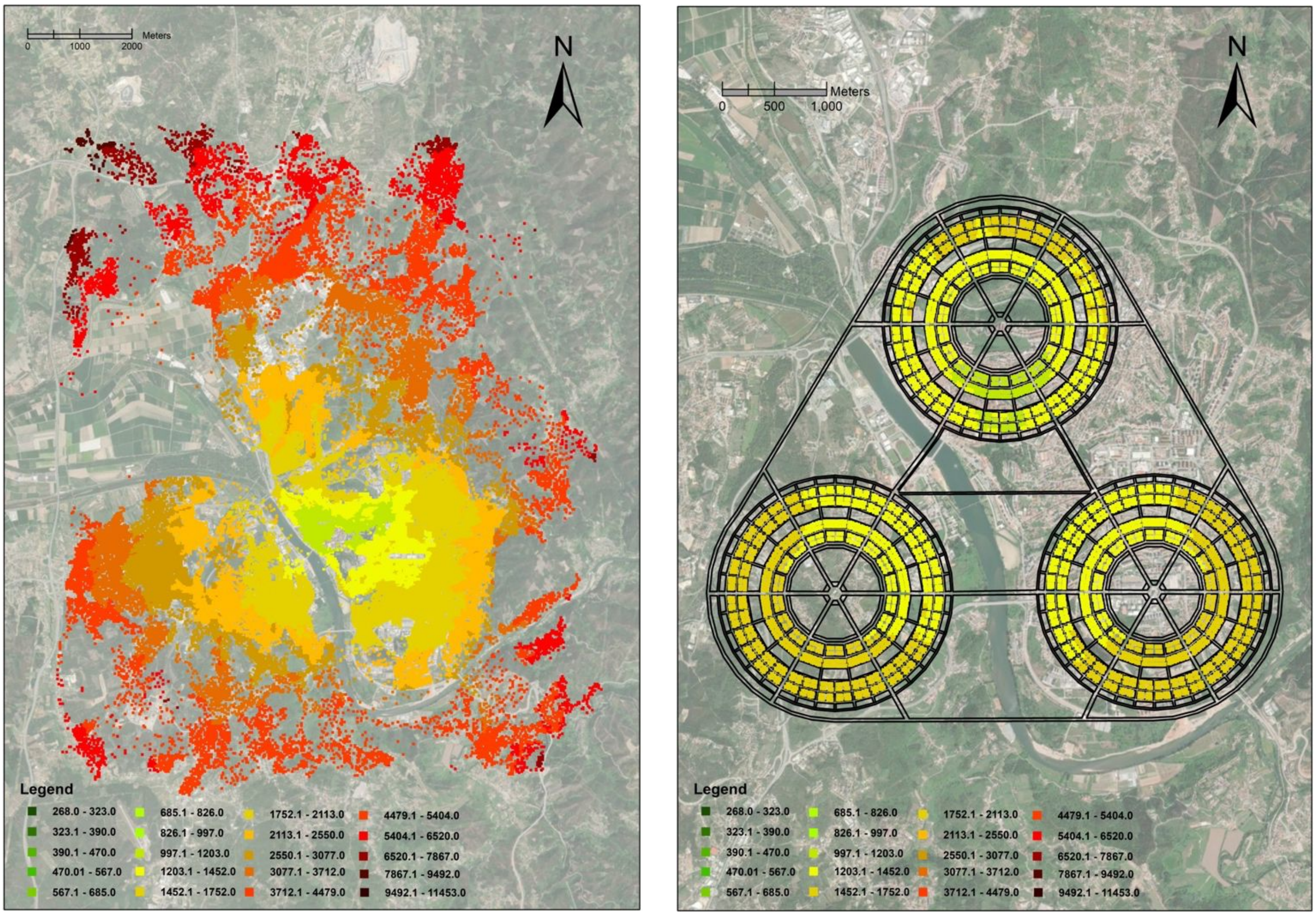
(**a**) (**b**)

Figure II.4.4. Accessibility to urban facilities for $L_k(j_3)$ 70/20/10, Coimbra (**a**), and Coimbra as Garden City (**b**).



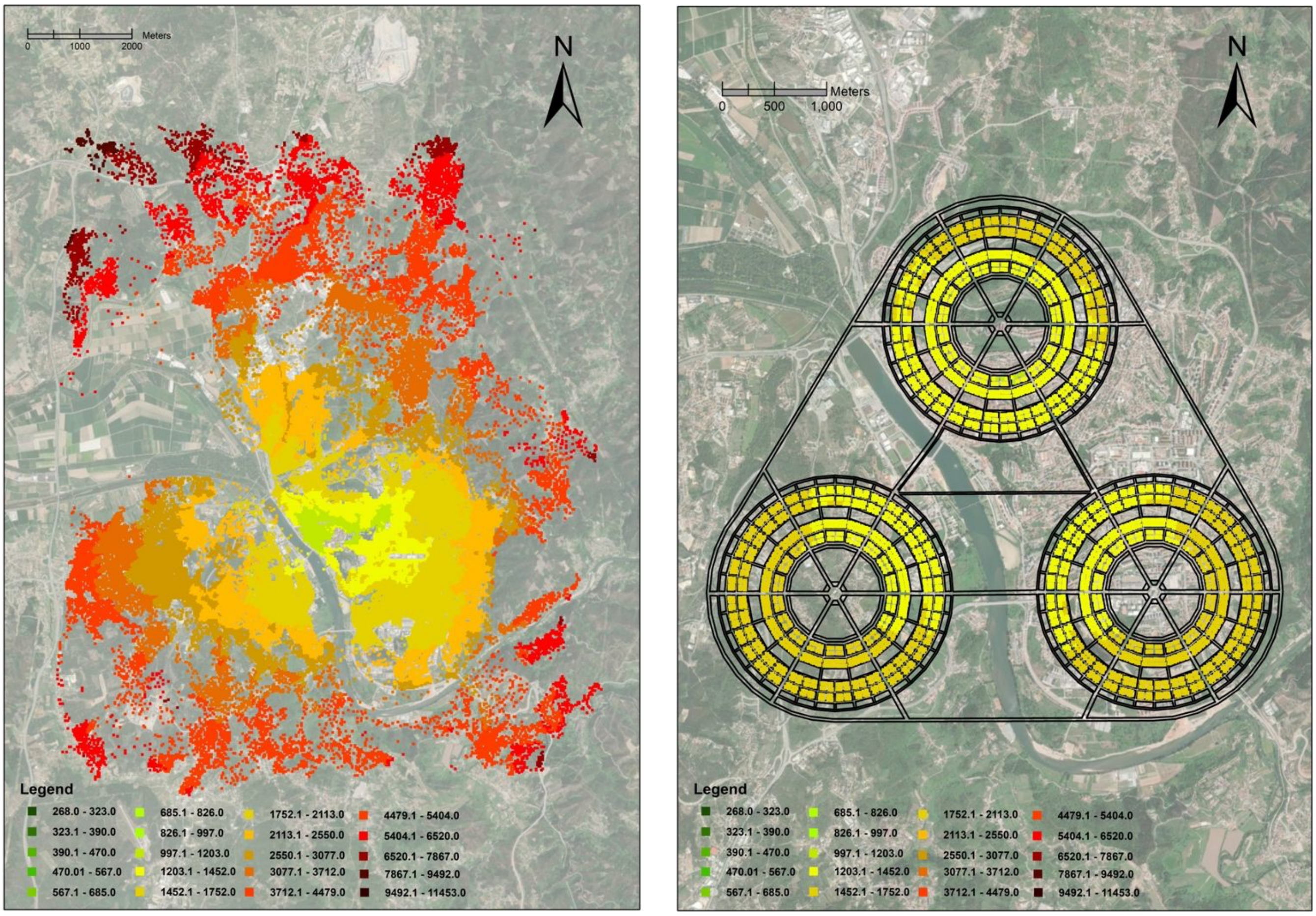
(**a**) (**b**)

Figure II.4.5. Accessibility to urban facilities for $L_k(j_3)$ 50/35/15, Coimbra (**a**), and Coimbra as Garden City (**b**).



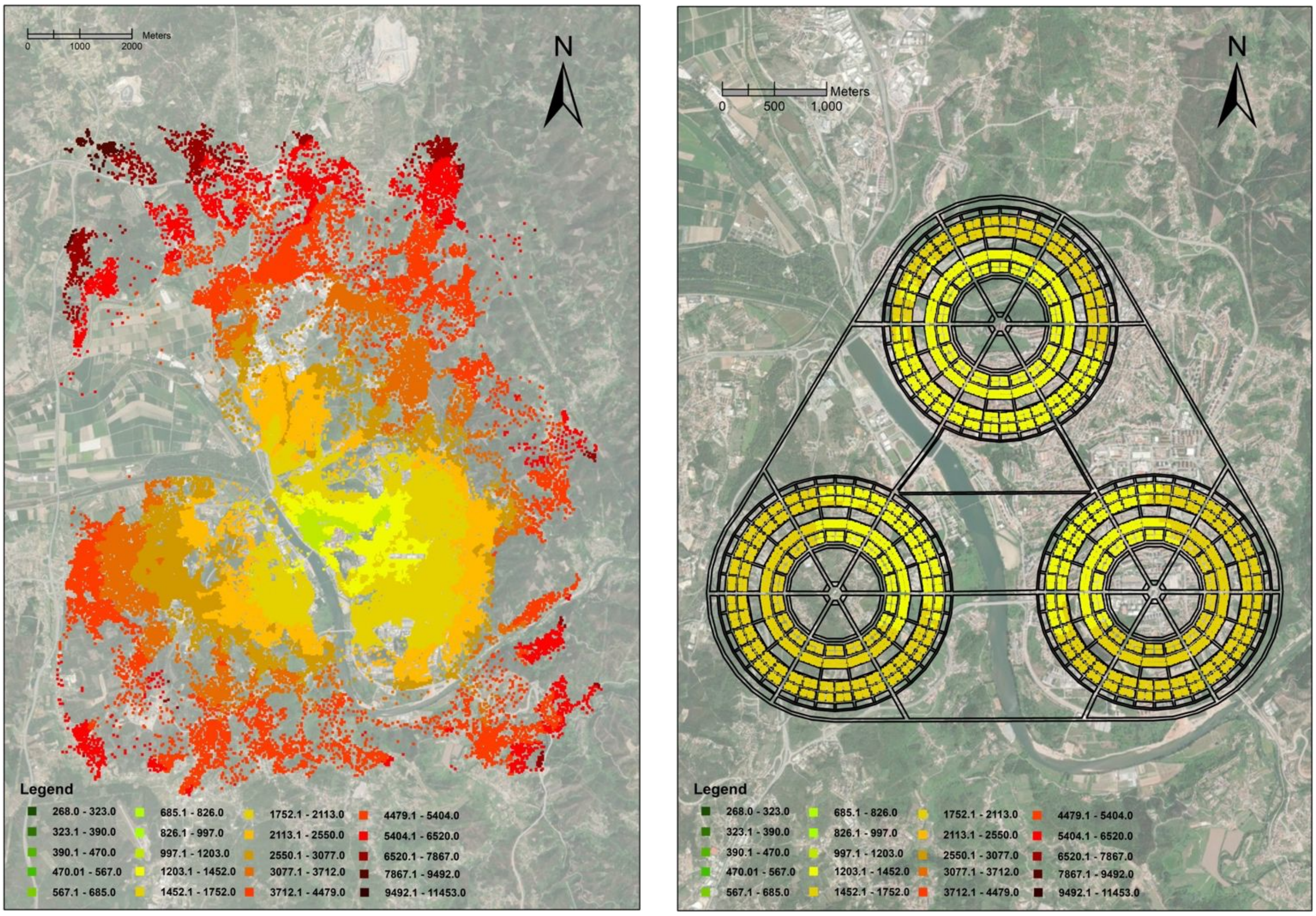
(**a**) (**b**)

Figure II.4.6. Overall accessibility for $L_k(j_3)$ 100/0/0, Coimbra (**a**), and Coimbra as Garden City (**b**).



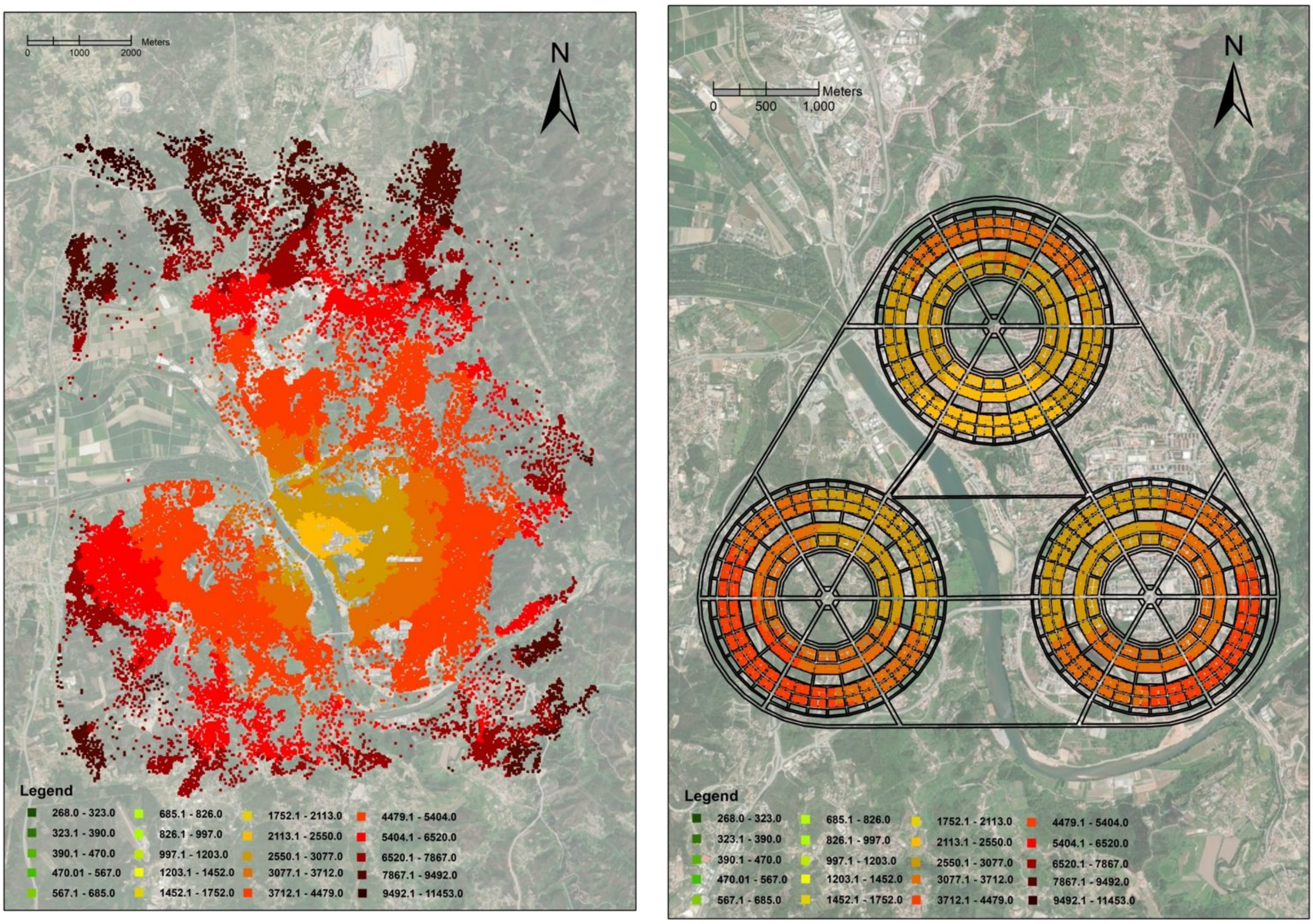
(**a**) (**b**)

Figure II.4.7. Overall accessibility for $L_k(j_3)$ 70/20/10, Coimbra (**a**), and Coimbra as Garden City (**b**).



(**a**) (**b**)

Figure II.4.8. Overall accessibility for $L_k(j_3)$ 50/35/15, Coimbra (**a**), and Coimbra as Garden City (**b**).



(**a**) (**b**)

Figure II.4.9. Job accessibility; Coimbra (**a**), and Coimbra as Garden City (**b**).

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5. THE POTENTIAL IMPACT OF CYCLING ON URBAN TRANSPORT ENERGY AND MODAL SHARE: A GIS-BASED METHODOLOGY

5.1. Sensitive analysis on L_{kj} and job data statistics

Table II.5.1. Active modal share summarizing statistics.

Active modal share per inhabitant (%)		Urban facilities		Urban facilities and jobs	
L_{kj}	Measure	full cycling	no cycling	full cycling	no cycling
70/20/10	Min	3.3	0.5	3.5	0.4
	Max	94.3	71.8	73.7	48.0
	Average	45.8	18.6	35.6	12.7
	Average per inhabitant	55.3	24.7	42.6	16.8
	Standard deviation	24.9	15.9	18.7	10.6
	Coef. of variation	0.54	0.9	0.52	0.87
50/35/15	Min	92.9	69.6	73.2	46.7
	Max	3.2	0.4	3.4	0.4
	Average per inhabitant	53.9	23.5	41.7	16.0
	Average	44.5	17.6	34.8	12.1
	Standard deviation	24.5	15.3	18.5	10.2
	Coefficient of variation	55%	87%	55%	83%

Table II.5.2. Transport fossil energy spending summarizing statistics.

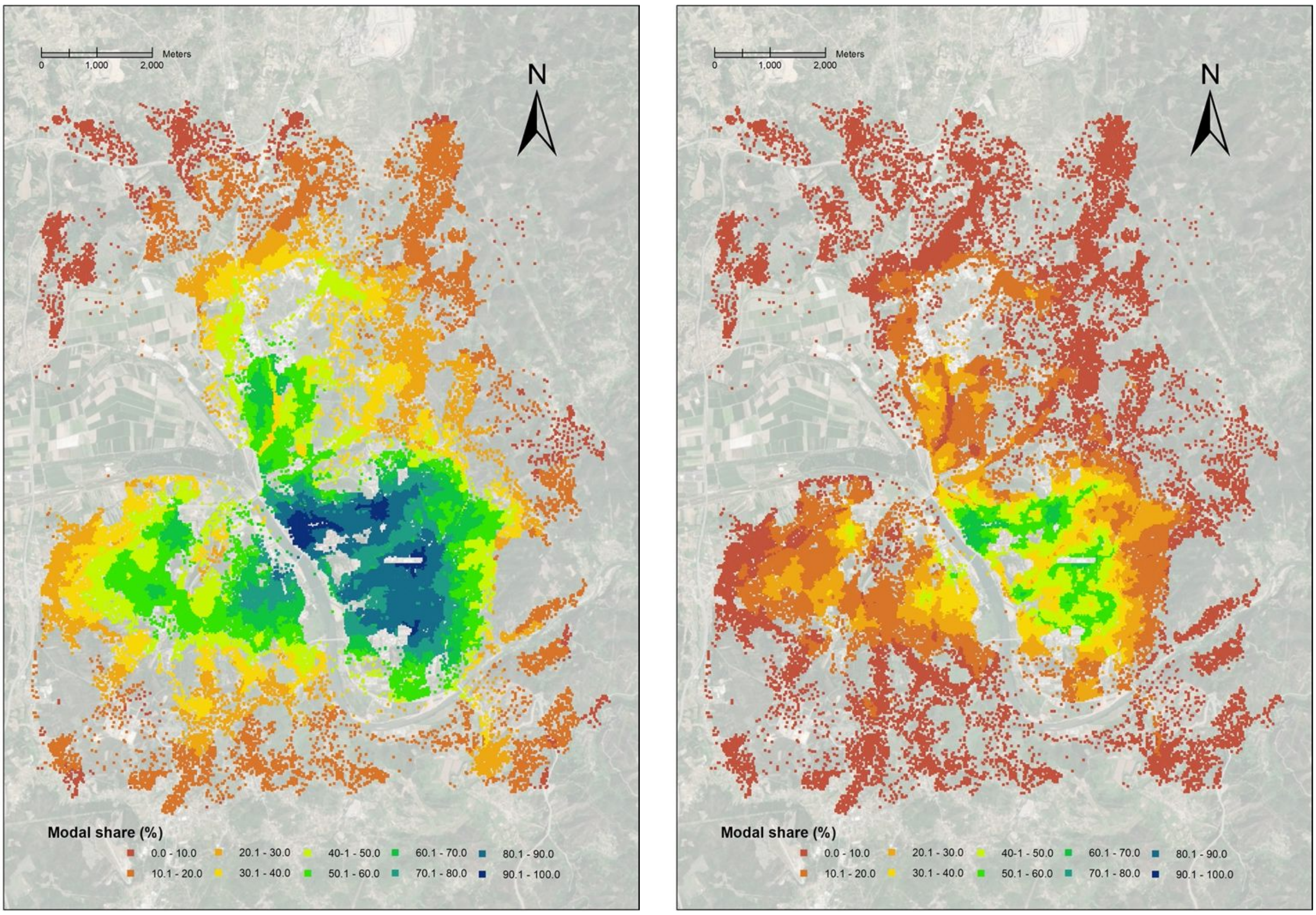
Transport fossil energy spending (MJ/passenger-trip)		Urban facilities		Urban facilities and jobs	
L_{kj}	Measure	full cycling	no cycling	full cycling	no cycling
70/20/10	Min	0.19	0.69	3.29	5.32
	Max	35.37	36.34	46.16	47.59
	Average	6.70	8.18	13.54	15.88
	Average per inhabitant	4.53	5.90	10.69	13.01
	Standard deviation	6.17	6.21	7.97	7.69
	Coef. of variation	0.92	0.76	0.59	0.48
50/35/15	Min	0.24	0.85	3.34	5.38
	Max	35.85	36.89	46.47	47.94
	Average per inhabitant	4.75	6.16	10.82	13.17
	Average	6.97	8.48	13.71	16.08
	Standard deviation	6.27	6.31	7.94	7.75
	Coefficient of variation	90%	74%	58%	48%

Table II.5.3. Accessibility to jobs only summarizing statistics.

Accessibility to jobs only	Active modal share per inhabitant (%)		Transport fossil energy spending (MJ/passenger-trip)	
Measure	**full cycling**	**no cycling**	**full cycling**	**no cycling**
Min	3.8	0.4	8.55	13.21
Max	40.1	7.5	64.81	67.03
Average	18.0	2.7	25.39	29.2
Average per inhabitant	21.2	3.9	23.25	27.47
Standard deviation	8.7	1.6	11.15	10.55
Coef. of variation	48%	59%	44%	36%

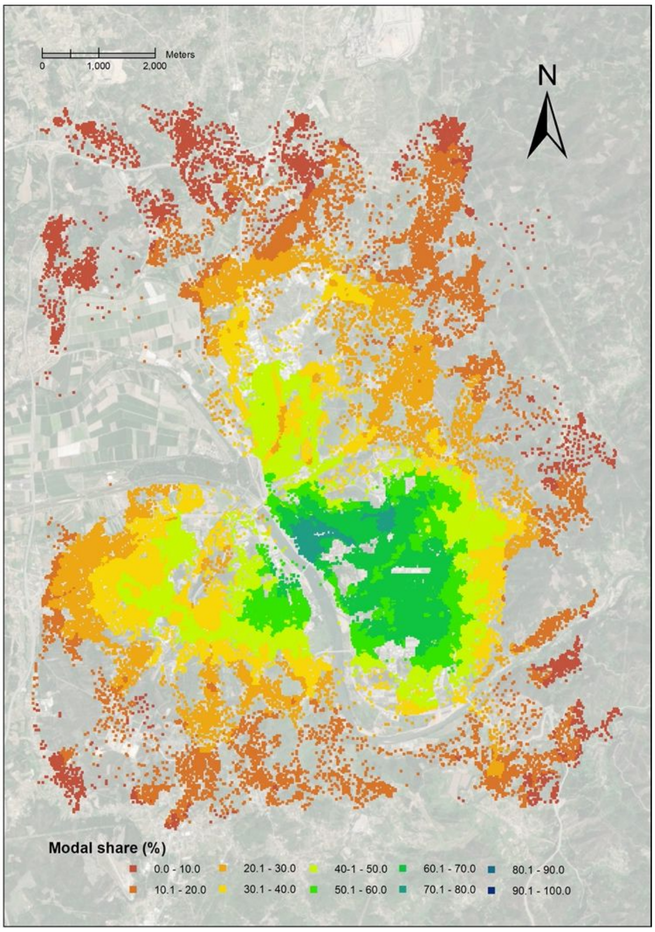
5.2. Full maps for L_{kj} = 70/20/10.

The maps below are full/no-cycling modal share and energy spending maps for three types of accessibility trips: urban facilities, facilities plus jobs, and jobs only. Differential maps between scenarios are also presented for the two indicators.

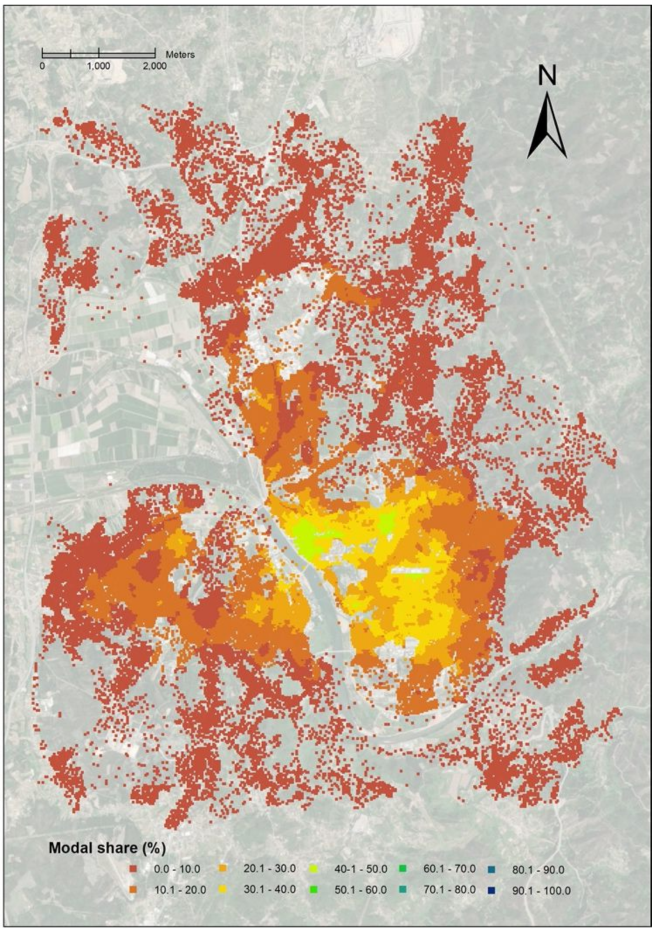


(a) (b)

Figure II.5.1. (a) Full cycling modal share to urban facilities; (b) No cycling modal share to urban facilities.

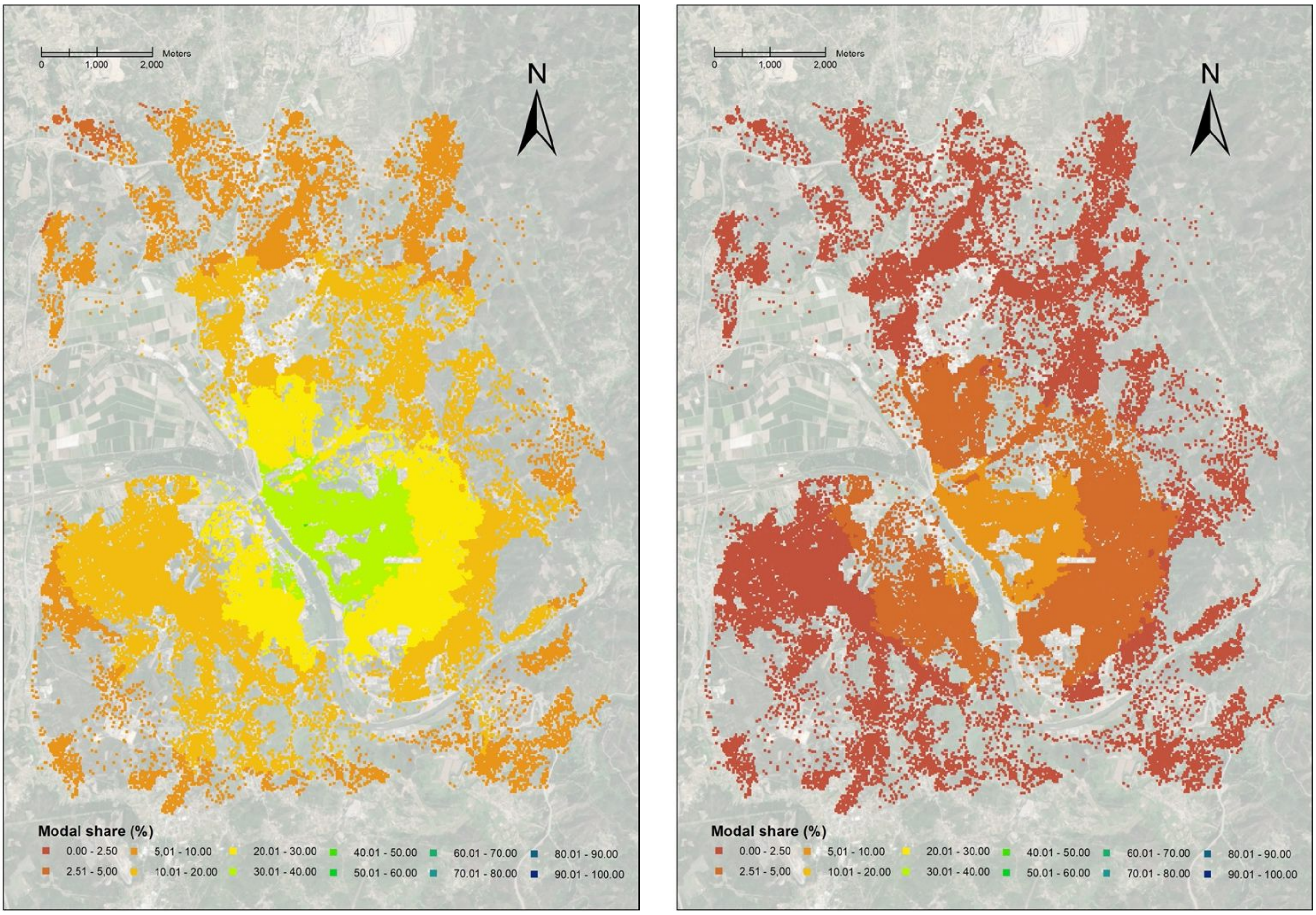


(**a**)



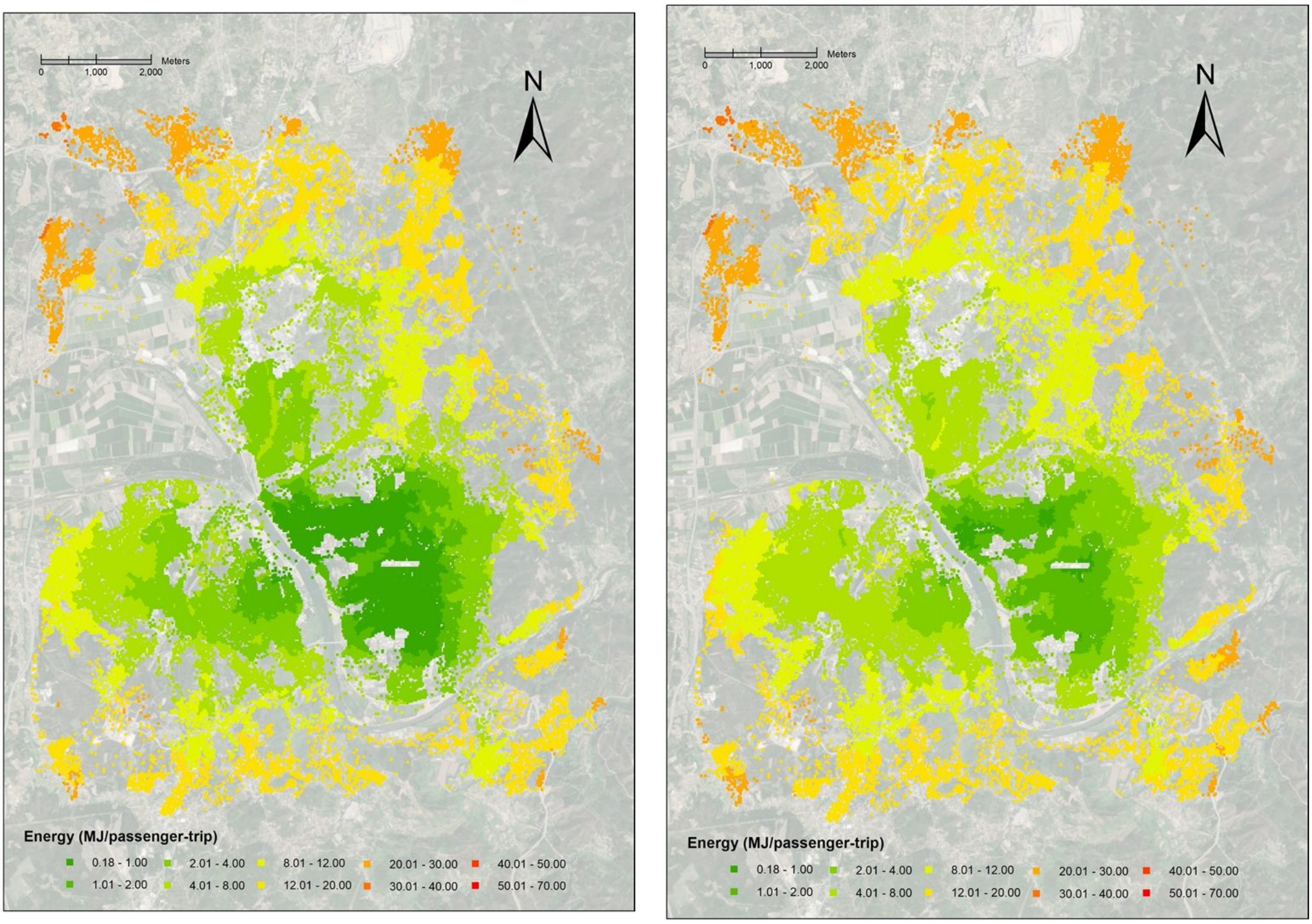
(**b**)

Figure II.5.2. (a) Full cycling modal share to urban facilities plus jobs; (b) No cycling modal share to urban facilities plus jobs.



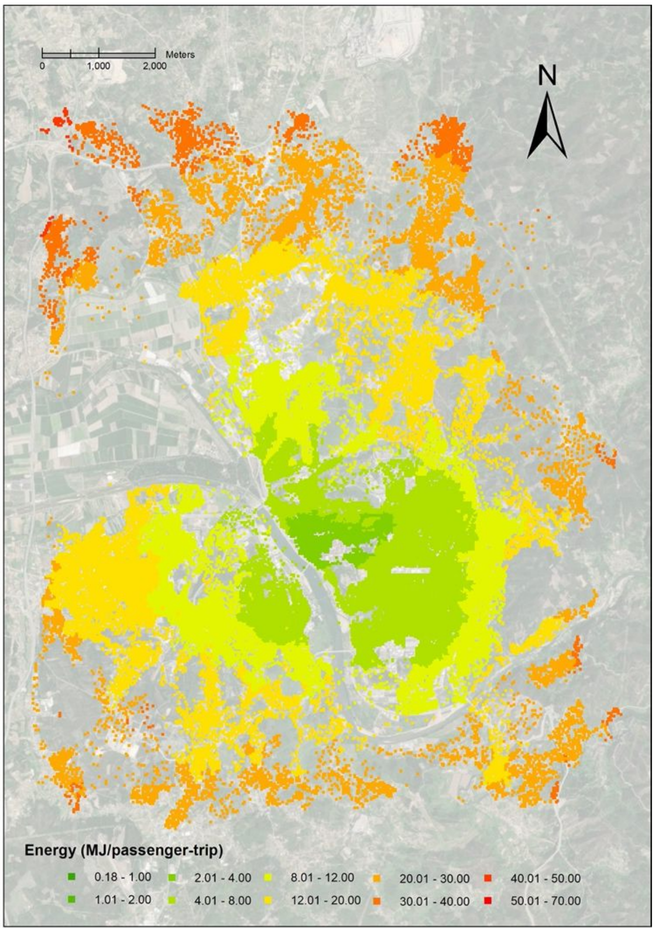
(**a**) (**b**)

Figure II.5.3. (a) Full cycling modal share to jobs; (b) No cycling modal share to jobs.

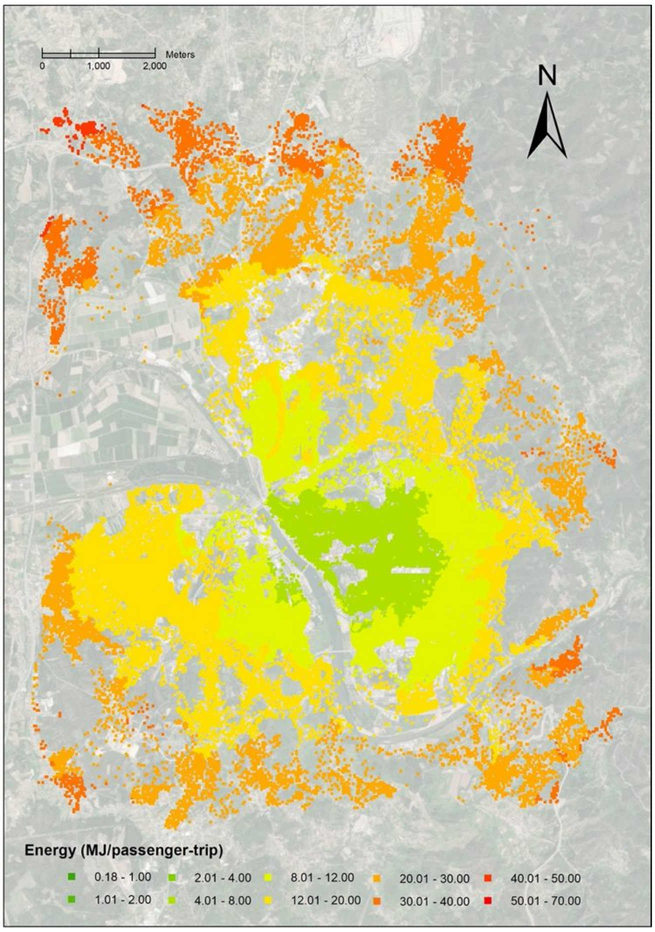


(**a**) (**b**)

Figure II.5.4. (a) Full cycling fossil energy spending to urban facilities; (b) No cycling fossil energy spending to urban facilities.

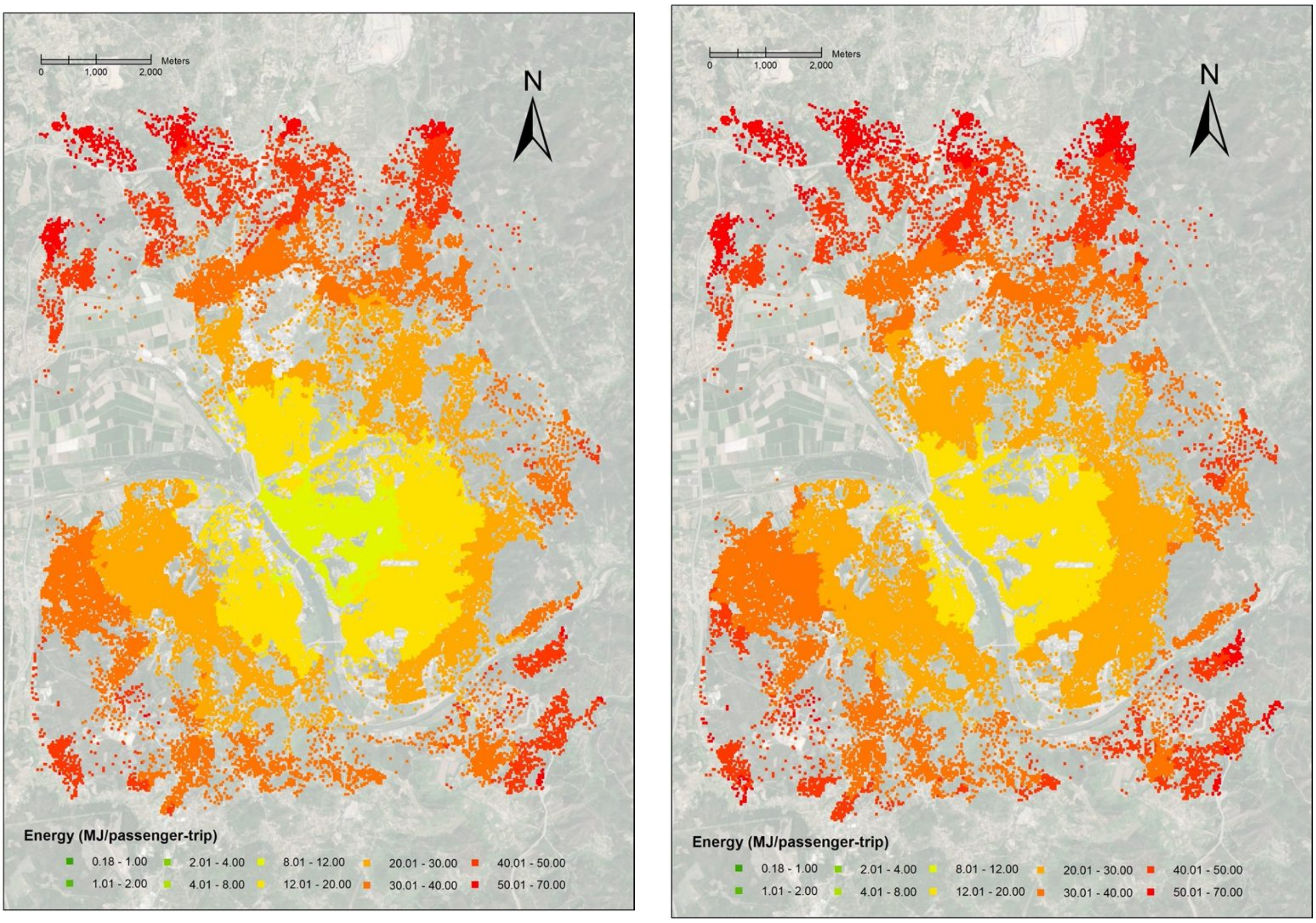


(**a**)



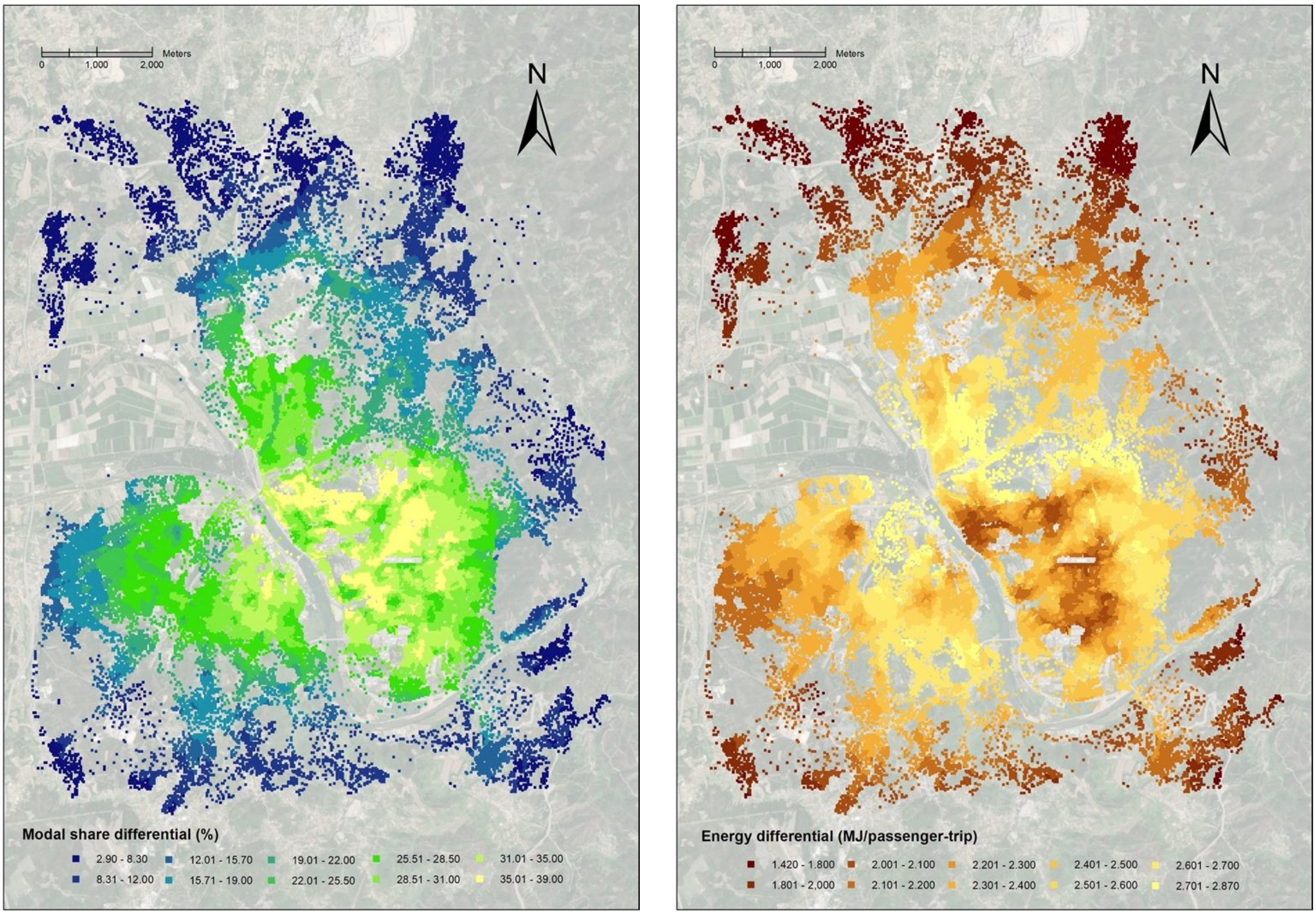
(**b**)

Figure II.5.5. (a) Full cycling fossil energy spending to urban facilities plus jobs; (b) No cycling fossil energy spending to urban facilities plus jobs.



(**a**) (**b**)

Figure II.5.6. (a) Full cycling fossil energy spending to jobs; (b) No cycling fossil energy spending to jobs.



(**a**) (**b**)

Figure II.5.7. (a) Full cycling/no cycling modal share differential to urban facilities plus jobs; (b) Full cycling/no cycling fossil energy spending differential to urban facilities plus jobs.

6. Filling in the spaces: Compactifying cities towards accessibility and active transport

6.1. Evaluation of active travel probability

Evaluation of active travel probability from origin-to-destination (OD) follows the methodology of [2]. The discussion below summarizes the methodology and follows that reference closely. Based on the OD distance, a probability for carrying out the trip in active mode, i.e., either by walking or cycling, is calculated as follows.

First, trip probability for individual walking and cycling modes is modelled via a log-logistic distribution:

$$p(x) = \frac{1}{1 + \exp(a + b \ln x)} \tag{II.6.1}$$

where a, b are parameters and x the network distance for the respective travel mode. Log-logistic parameter values depend on destination type and can be obtained indirectly from the negative exponential law for the walk mode of Yang and Diez-Roux [3] by calculating the distances for which the Yang and Diez-Roux law yields 10% and 90% walk probabilities, inserting these benchmarks in eq. (II.6.1), and solving for a, b for each destination type. This yields the parameters shown in Table II.6.1 below. Trip probabilities for the cycling mode are derived assuming that users typically spend a similar time buffer in cycling trips as in walking trips [4]. However, since the distance ridden by a bicycle is longer due to its higher speed, the effect on (II.6.1) is that, for cycling, the trip probability is given simply by changing the distance by $x \to x \cdot \frac{v_{\text{walk}}}{v_{\text{cycle}}}$. Using the walking speed of Tobler [5] and cycling speed of Parkin and Rotheram [6] yields a ratio of circa $\frac{v_{\text{walk}}}{v_{\text{cycle}}} \approx 0.233$.

The second step in obtaining an active trip probability requires combining walking and cycling probabilities into one single probability. This is done considering three distance regimes: short, long, and medium distances, defined respectively as distances for which walk probability < 50%, < 10%, and in-between [1]. For short distances one has the choice to either walk or use a bicycle and the active trip probability, p_{A}, can be modeled by $p_{\text{A}} = 1 - (1 - p_{\text{W}})(1 - p_{\text{C}})$, with p_{W} and p_{C} obtained applying eq. (II.6.1) for distances x and $0.233x$ respectively, as prescribed above. Extending this reasoning for all distances would lead to an excessively optimistic trip probability for long distances [4,7], so in that the simplifying assumption is made that all active trips are done cycling. Finally, trips in the medium range are modelled by a linear interpolation between the short and long-distance expressions. The mathematical expression for the unified active trip probability is given in eq. (II.6.2) below:

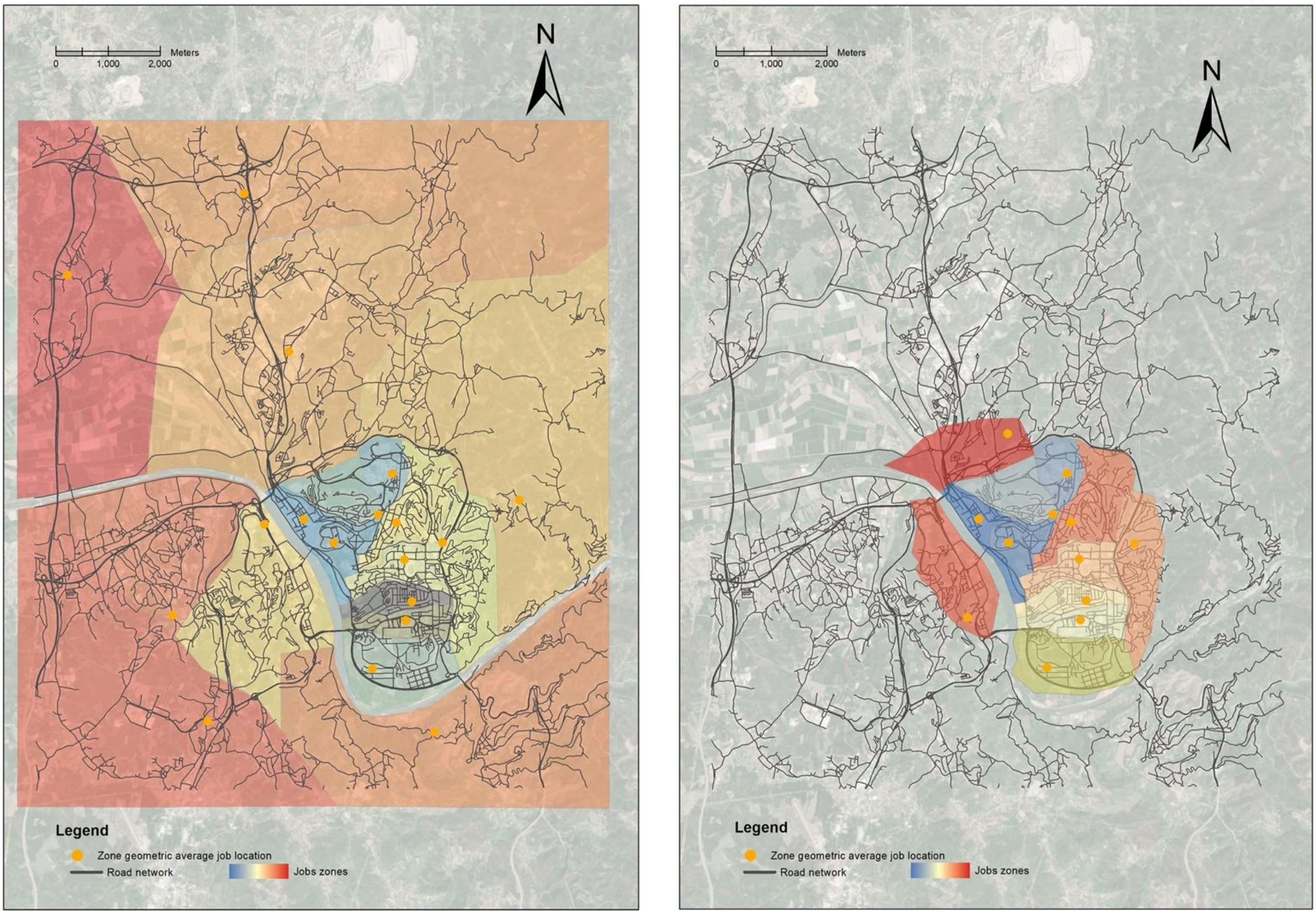
$$p_{\mathrm{A}}(x) = \begin{cases} 1-(1-p_{\mathrm{W}})(1-p_{\mathrm{C}}) & p_{\mathrm{W}} \geq 0.50 \\ p_{\mathrm{C}} + \dfrac{1-(1-p_{\mathrm{W}})(1-p_{\mathrm{C}})-p_{\mathrm{C}}}{0{,}5-0{,}1}(p_{\mathrm{W}}-0{,}1) & 0.10 \leq p_{\mathrm{W}} \leq 0.50 \\ p_{\mathrm{C}} & p_{\mathrm{W}} \leq 0.10 \end{cases} \quad \text{(II.6.2)}$$

Because p_{W} and p_{C} depend on destination type j, the active trip probability in the manuscript reads $p_{\mathrm{A}j}(x)$ to reflect this dependence. For further details and motivation, the reader is referred to [2].

Table II.6.1. Log-logistic parameters for walking.

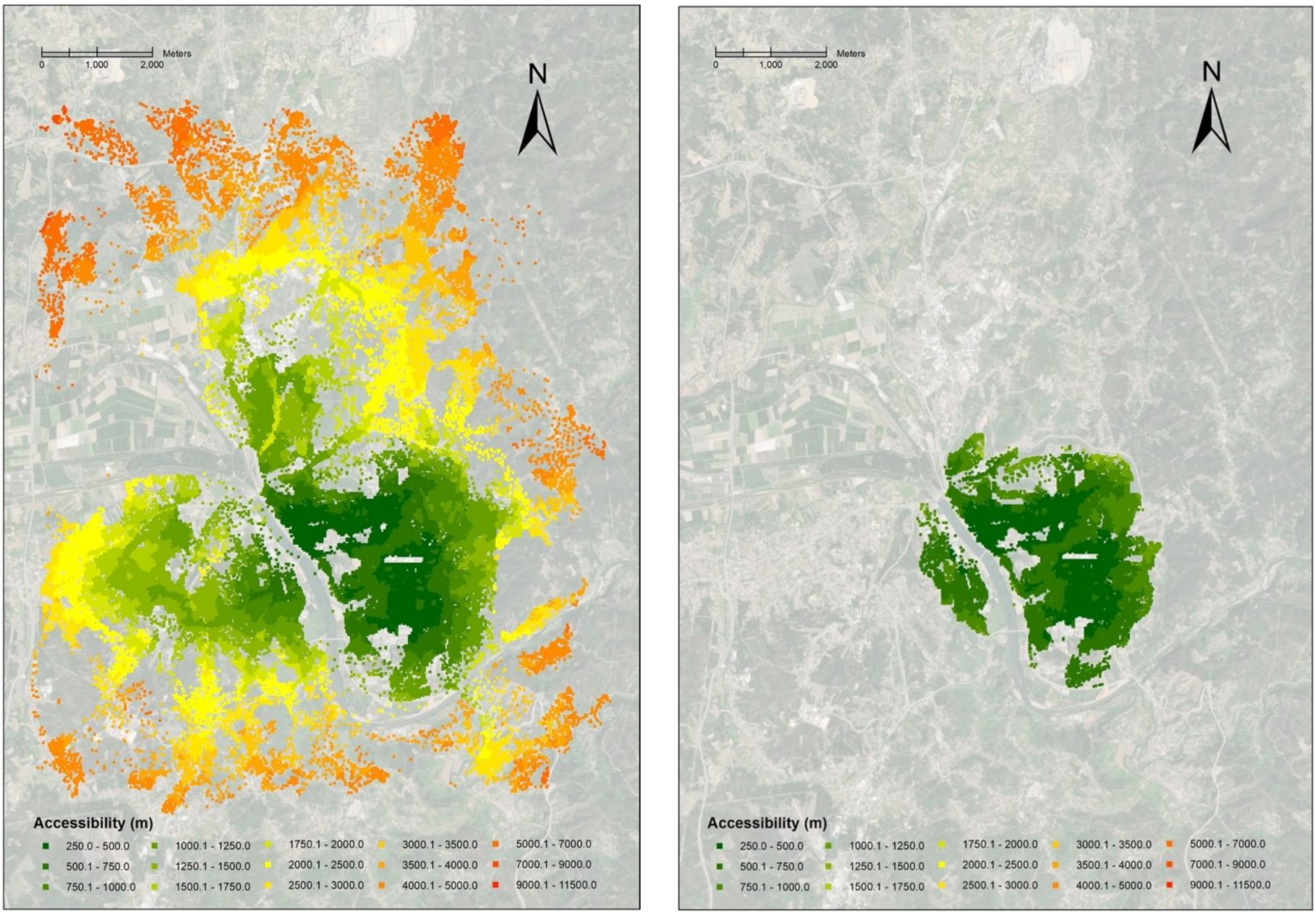
Destination type	***a_j* (distance: km)**	***b_j* (distance: km)**
Post offices	1.19225	1.83021
Sports facilities	0.05574	1.83013
Cultural organizations	1.00344	1.82990
Universities and institutes	1.07775	1.82989
Elderly care centres	1.19225	1.83021
Churches	1.00344	1.82990
High Schools	1.07775	1.82989
Shopping centres	1.19225	1.83021
Entertainment sites	1.00344	1.82990
Primary healthcare services	1.19225	1.83021
Pharmacies	1.19225	1.83021
Restaurants	1.46215	1.83009
Parks and green areas	1.00344	1.82990
Kindergartens	1.46215	1.83009
Primary schools	1.46215	1.83009
Middle Schools	1.46215	1.83009
Grocery stores	1.19225	1.83021
Supermarkets	1.19225	1.83021
Bakeries and pastries	1.46215	1.83009
Jobs	0.89627	1.83017

6.2. Maps



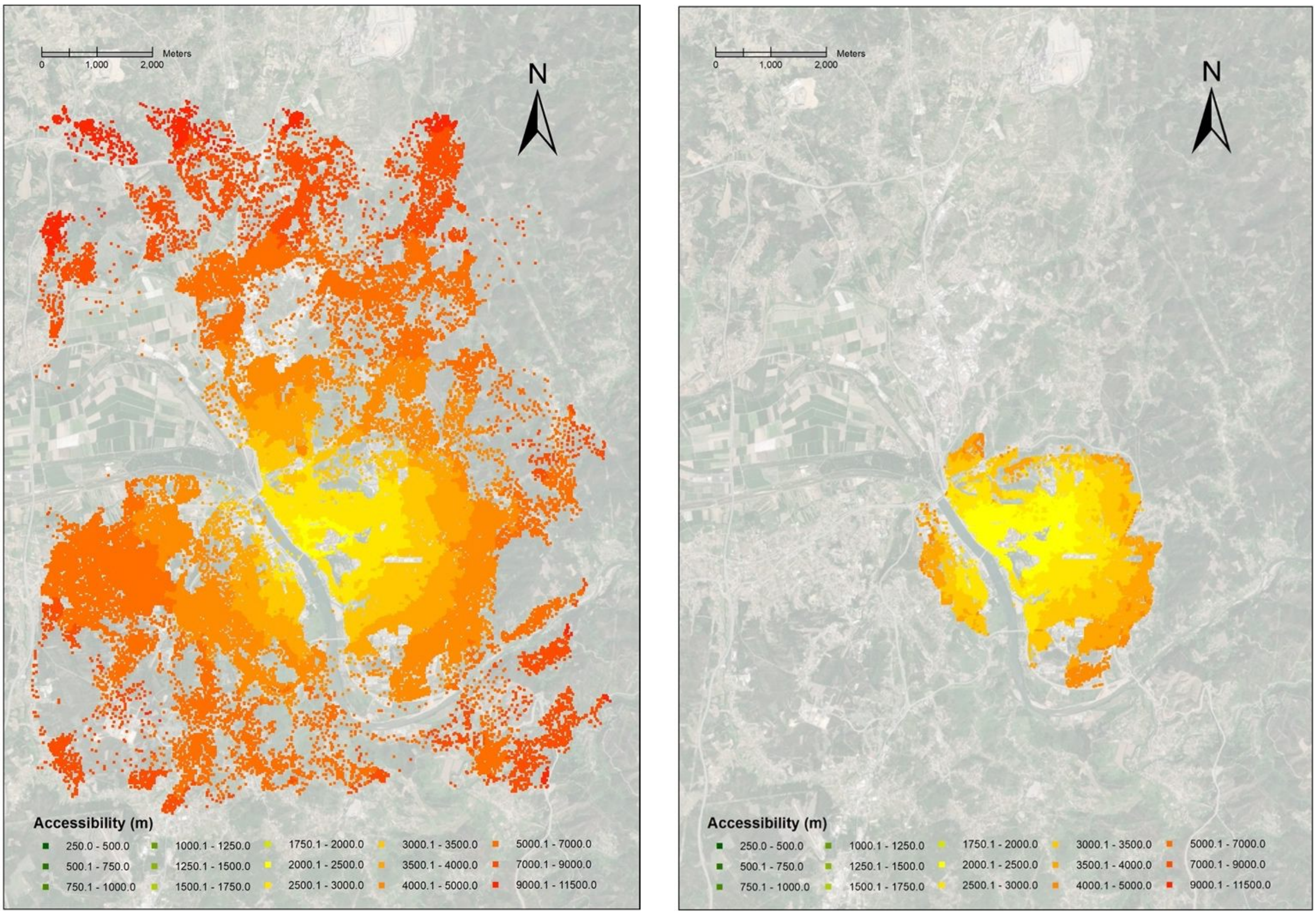
(**a**) (**b**)

Figure II.6.1. Job zones: (a) Coimbra; (b) Infill Coimbra.



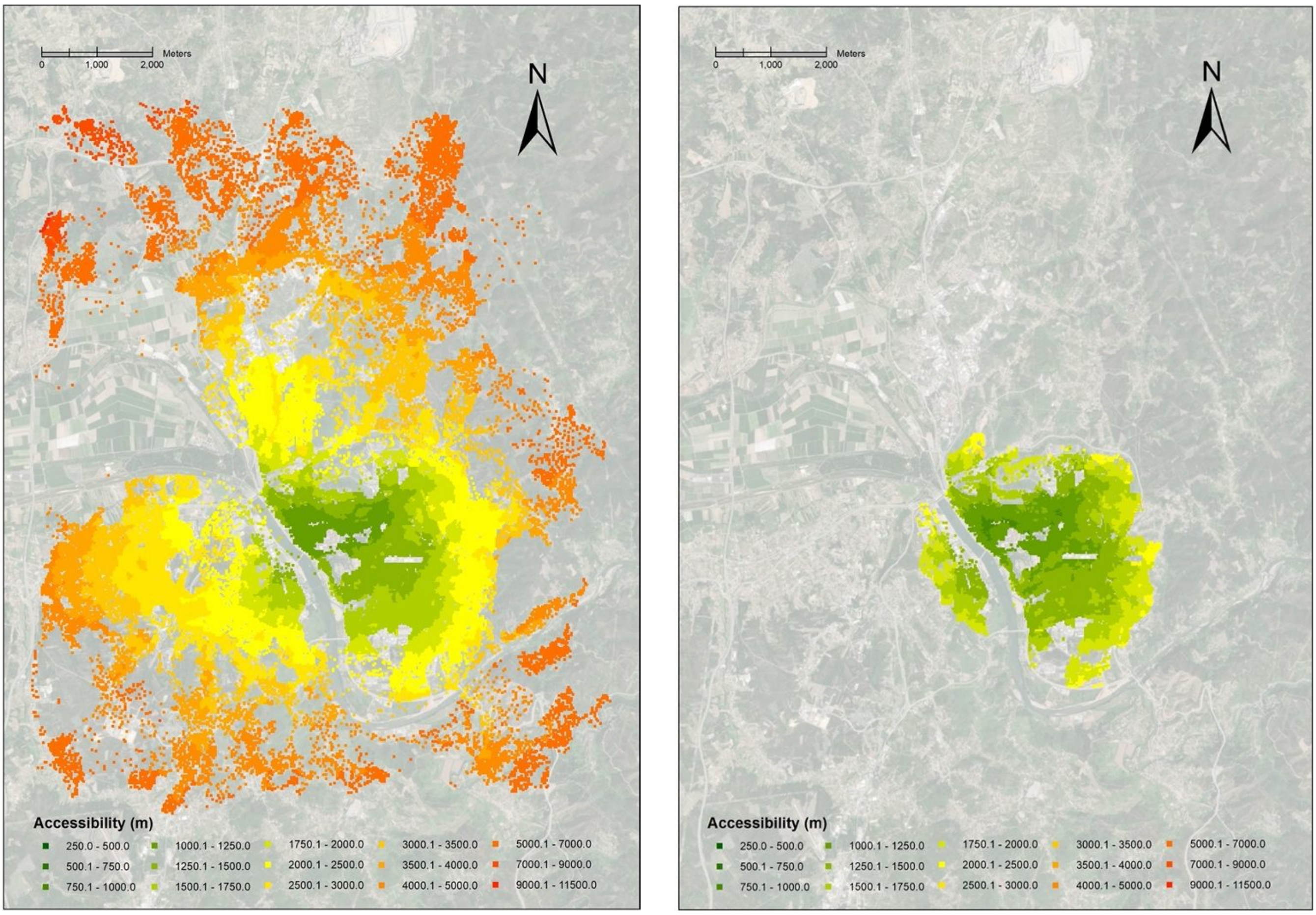
(**a**) (**b**)

Figure II.6.2. Accessibility to urban facilities (m): (a) Coimbra; (b) Infill Coimbra.



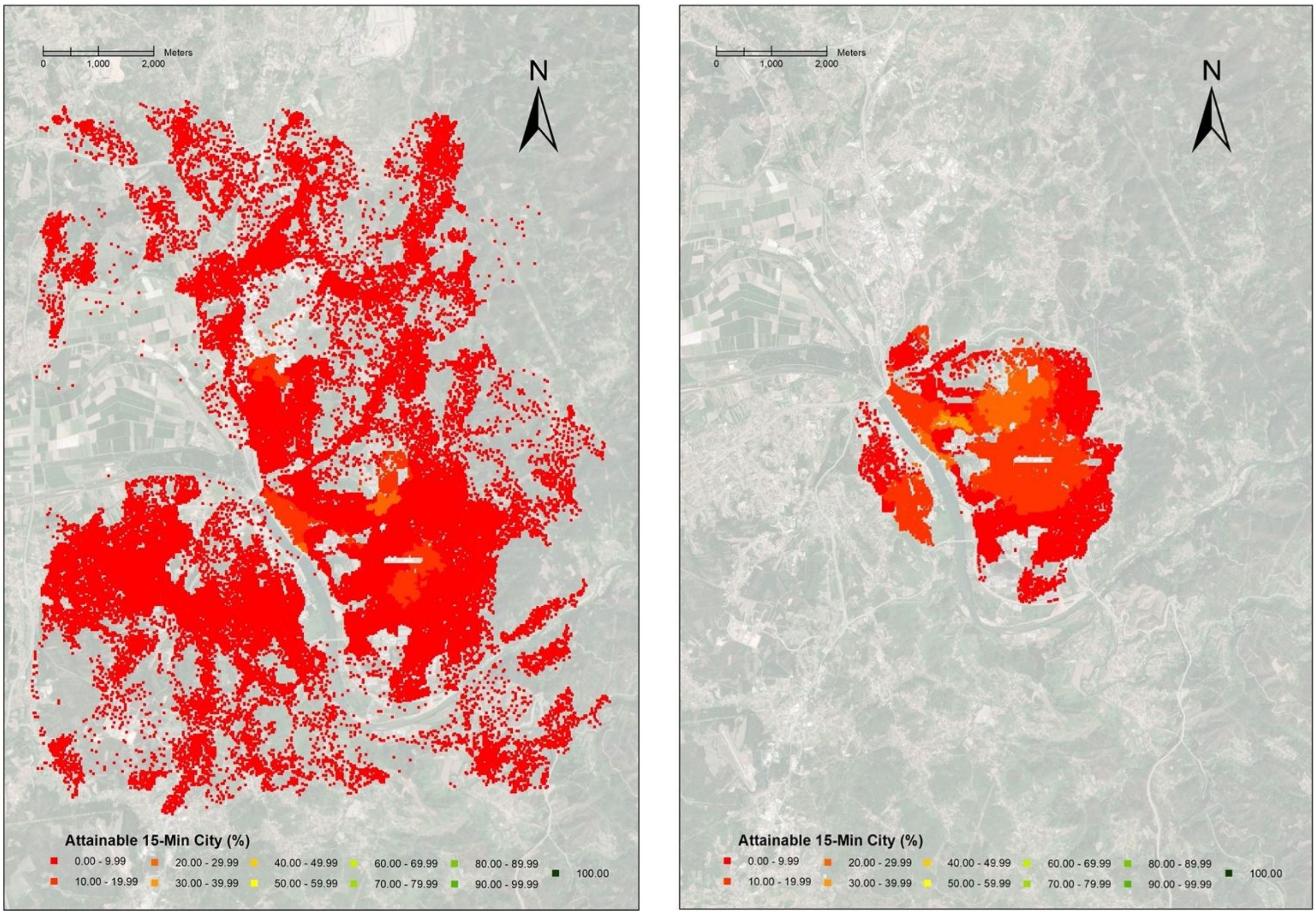
(**a**) (**b**)

Figure II.6.3. Accessibility to jobs (m): (a) Coimbra; (b) Infill Coimbra.



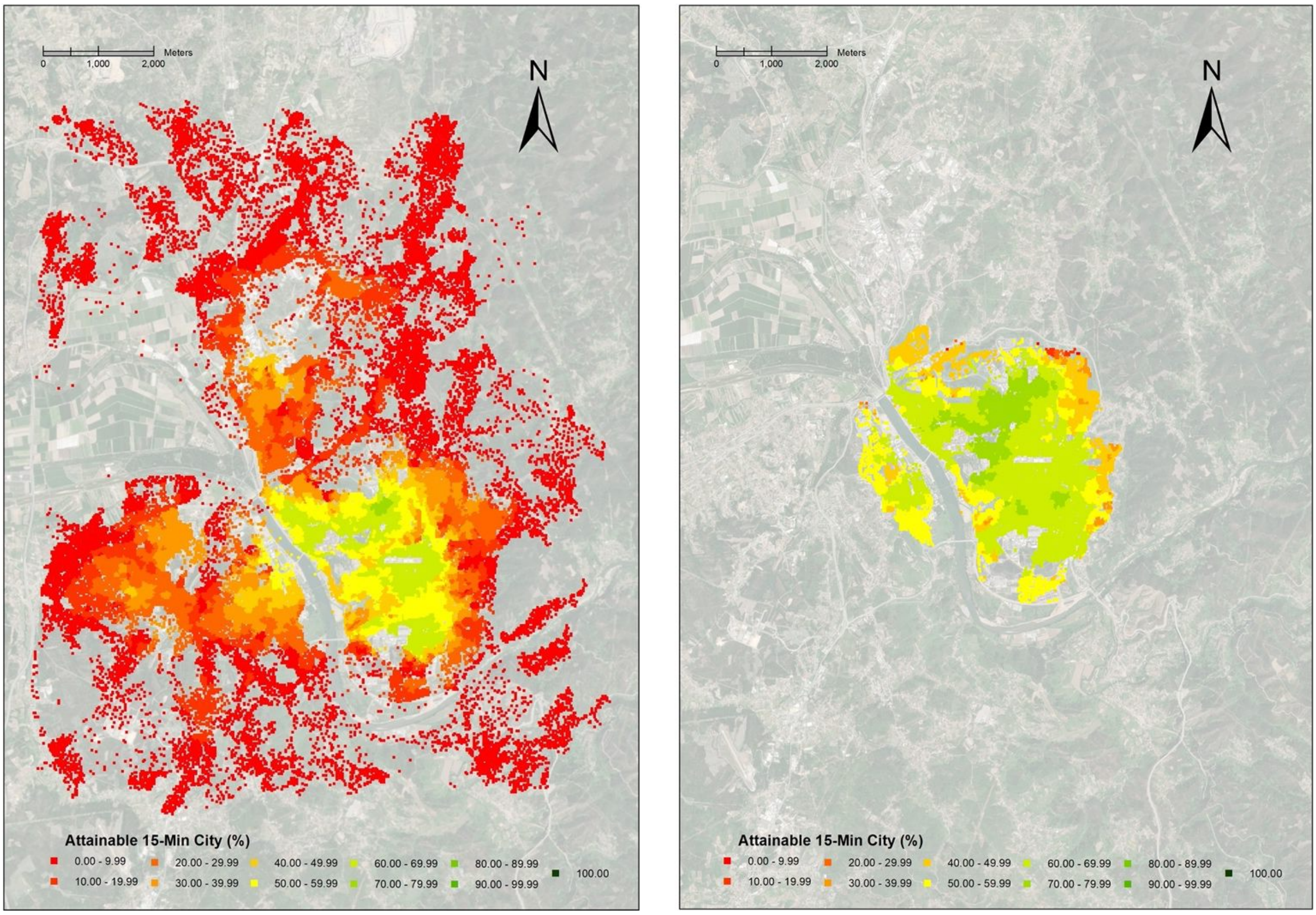
(**a**) (**b**)

Figure II.6.4. Total accessibility [facilities plus jobs] (m): (a) Coimbra; (b) Infill Coimbra.



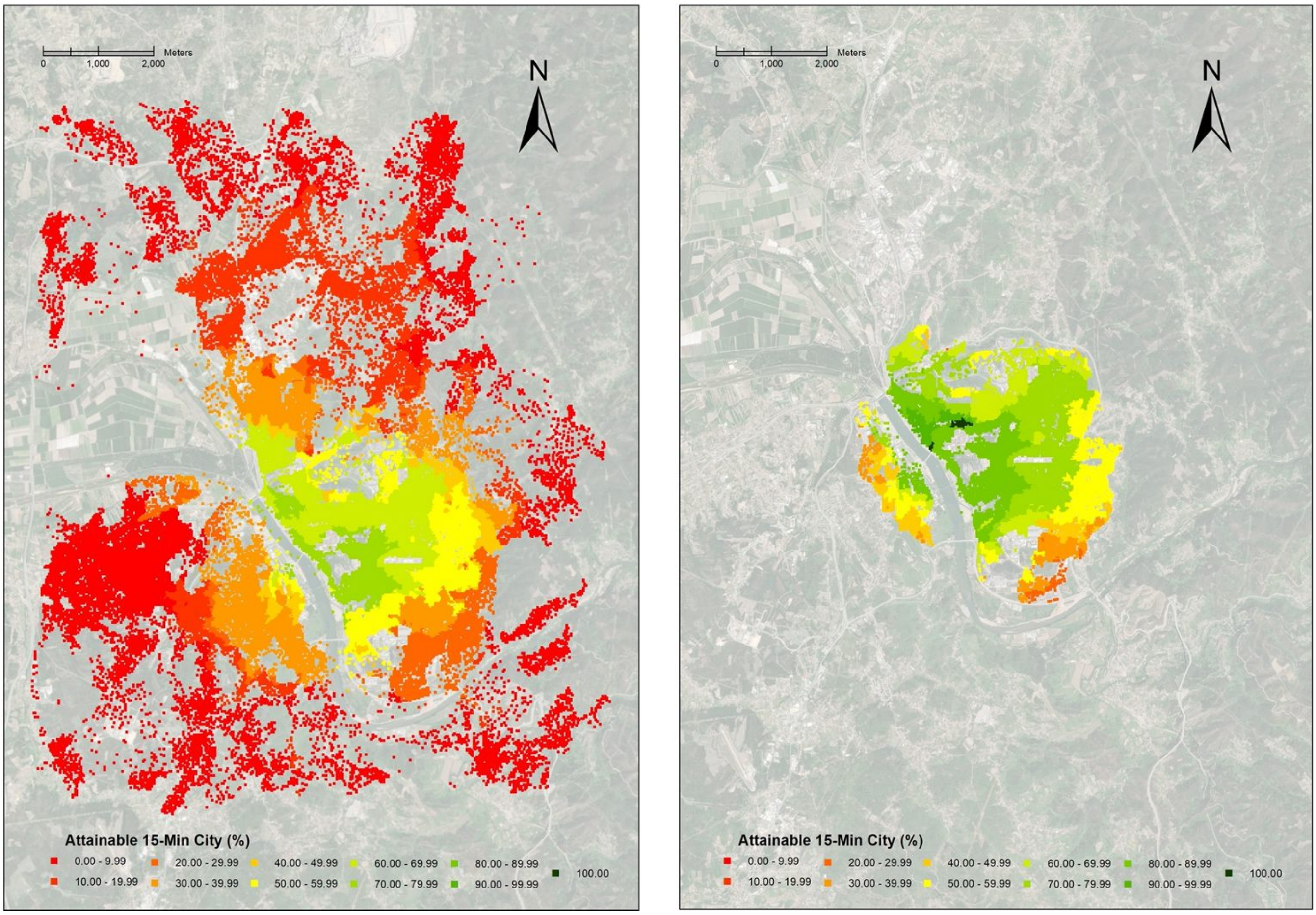
(**a**) (**b**)

Figure II.6.5. 15-Minute City by walking [jobs only] (%): (a) Coimbra; (b) Infill Coimbra.



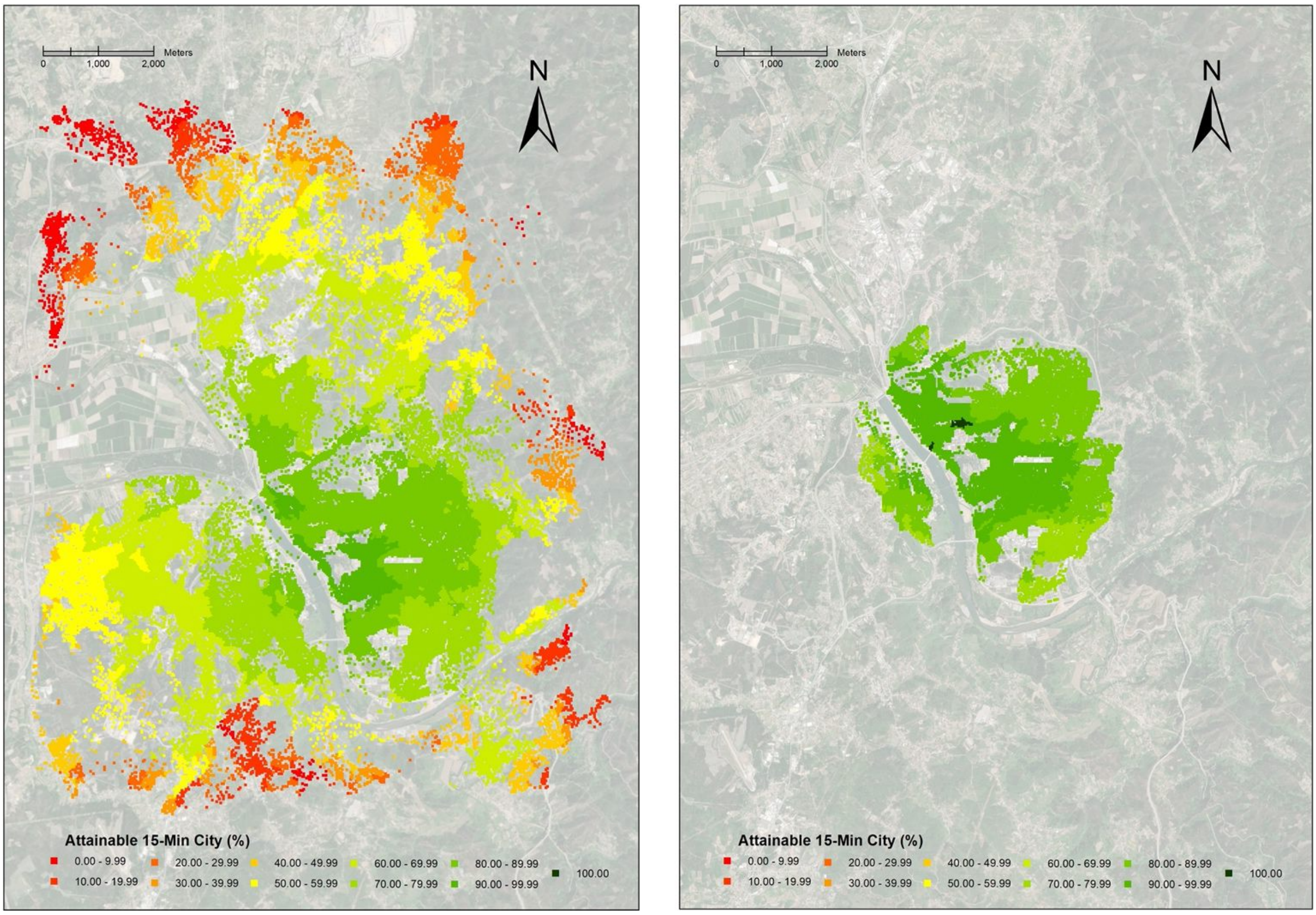
(**a**) (**b**)

Figure II.6.6. 15-Minute City by walking [facilities plus jobs] (%): (a) Coimbra; (b) Infill Coimbra.



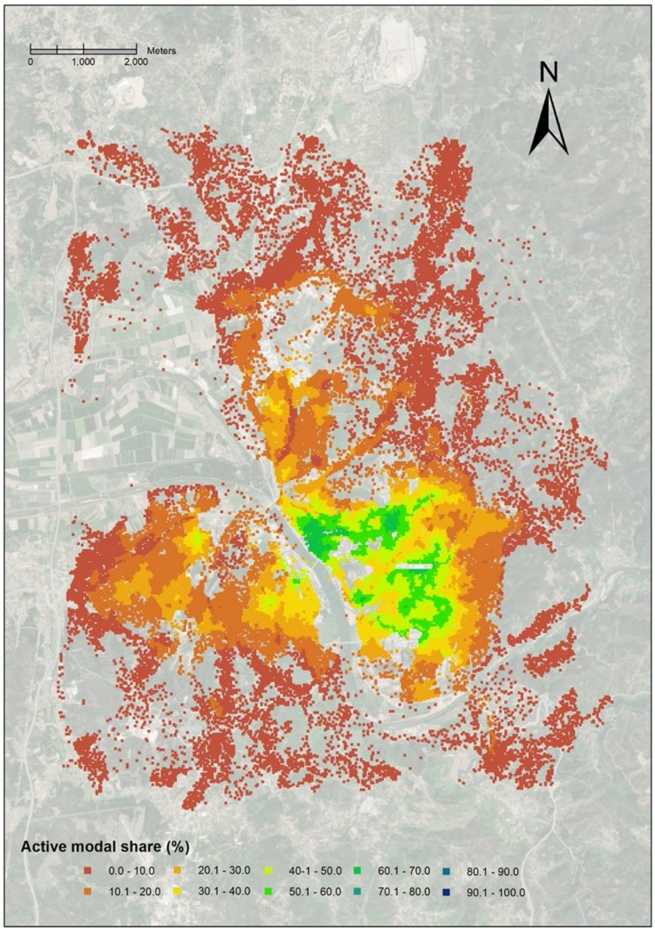
(**a**) (**b**)

Figure II.6.7. 15-Minute City by active modes (walking/cycling) [jobs only] (%): (a) Coimbra; (b) Infill Coimbra.

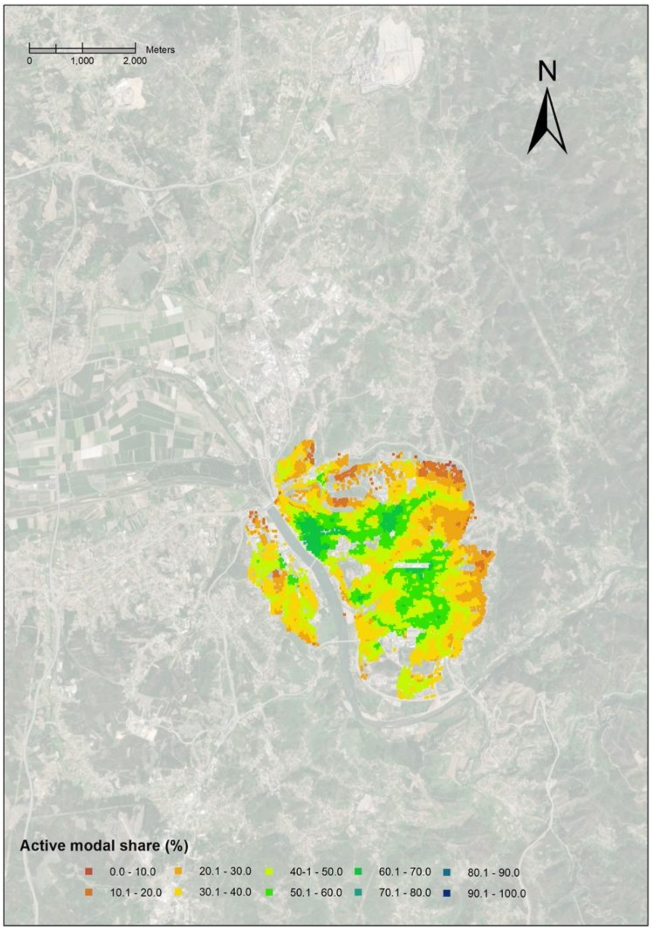


(**a**) (**b**)

Figure II.6.8. 15-Minute City by active modes (walking/cycling) [facilities plus jobs] (%): (a) Coimbra; (b) Infill Coimbra.



(**a**)



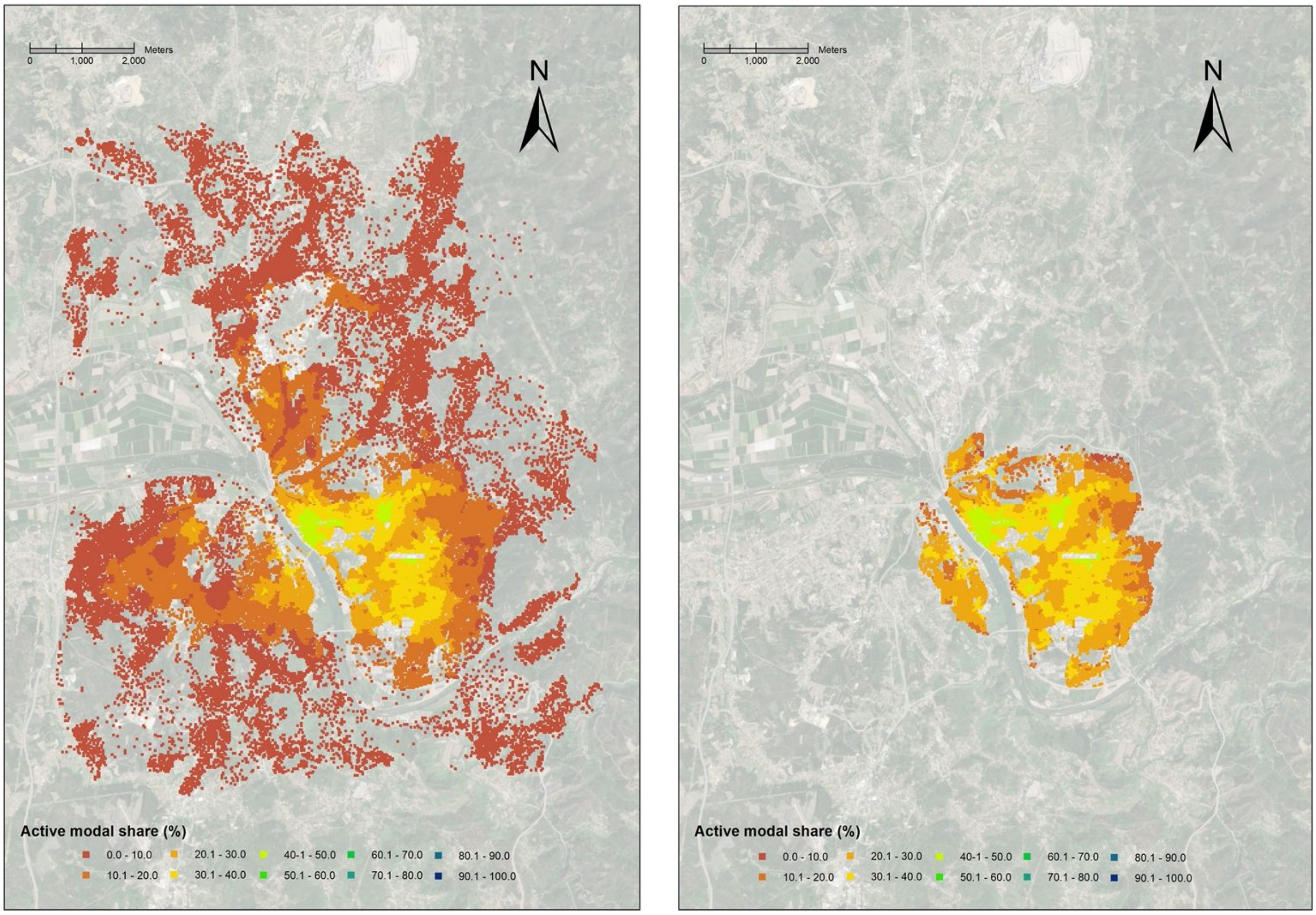
(**b**)

Figure II.6.9. Walk modal share to facilities (%): (a) Coimbra; (b) Infill Coimbra.

(**a**)

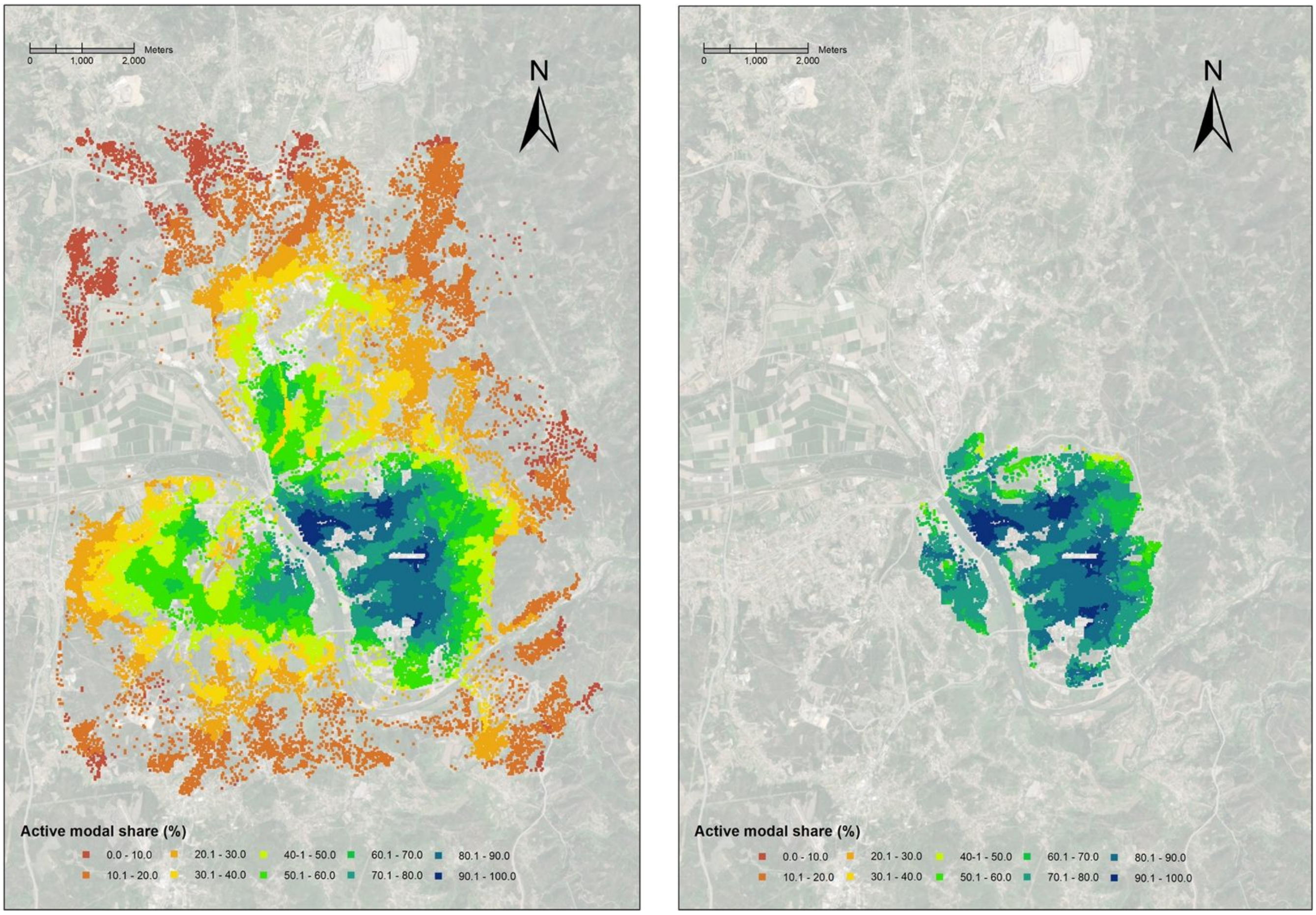
(**b**)

Figure II.6.10. Walk modal share to jobs (%): (a) Coimbra; (b) Infill Coimbra.



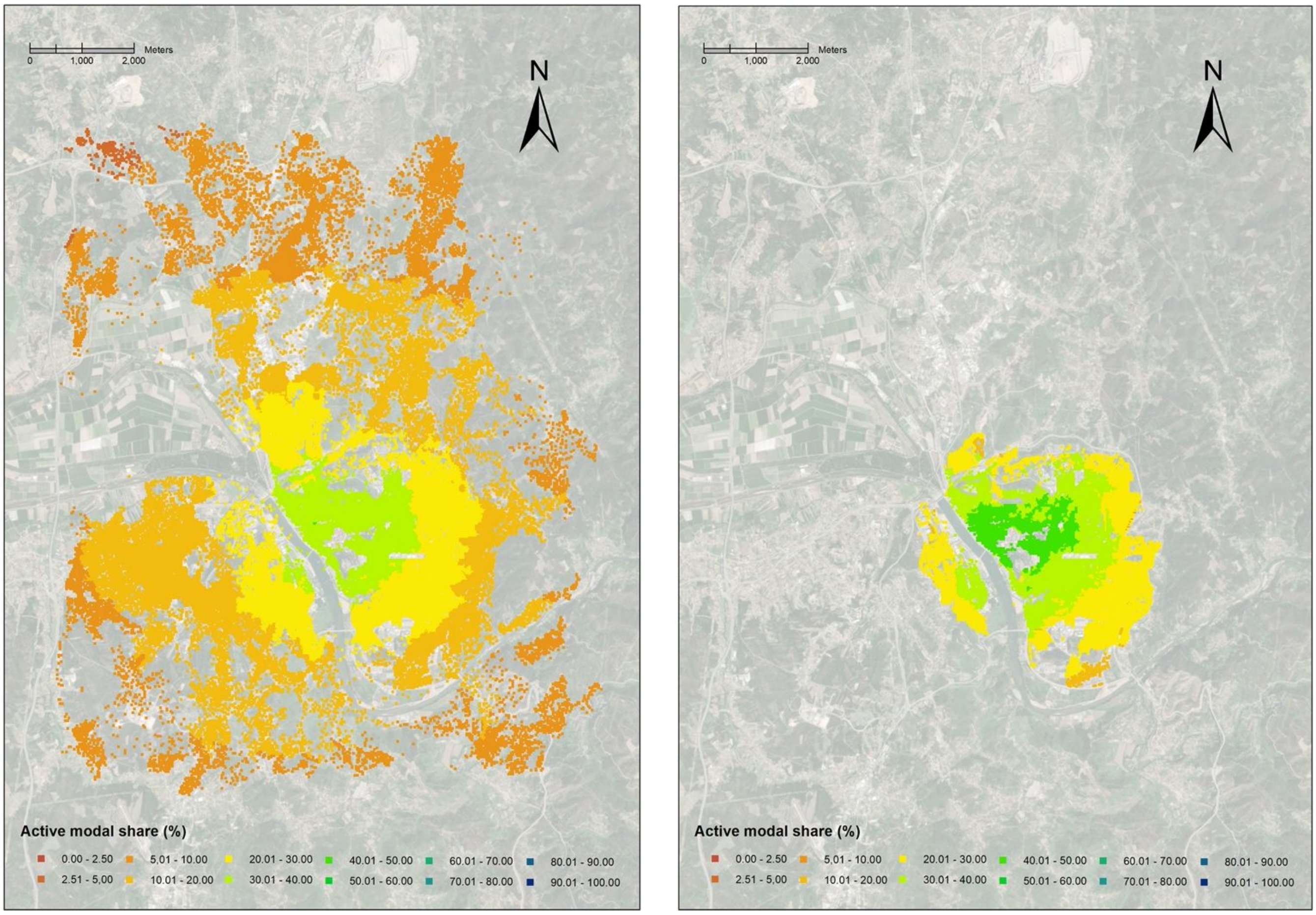
(**a**) (**b**)

Figure II.6.11. Walk modal share to facilities plus jobs (%): (a) Coimbra; (b) Infill Coimbra.



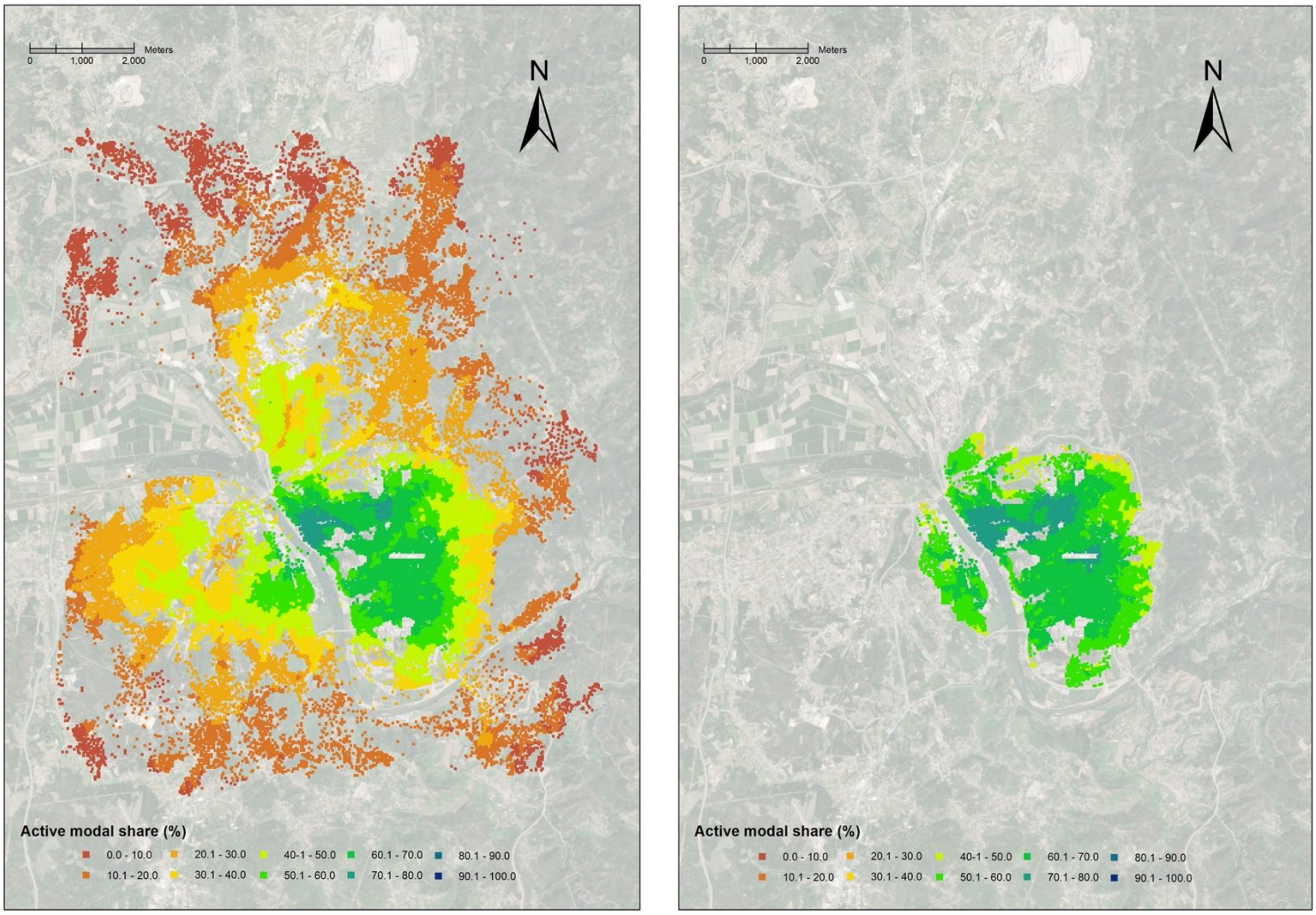
(**a**) (**b**)

Figure II.6.12. Active modal share (walking/cycling) to facilities (%): (a) Coimbra; (b) Infill Coimbra.



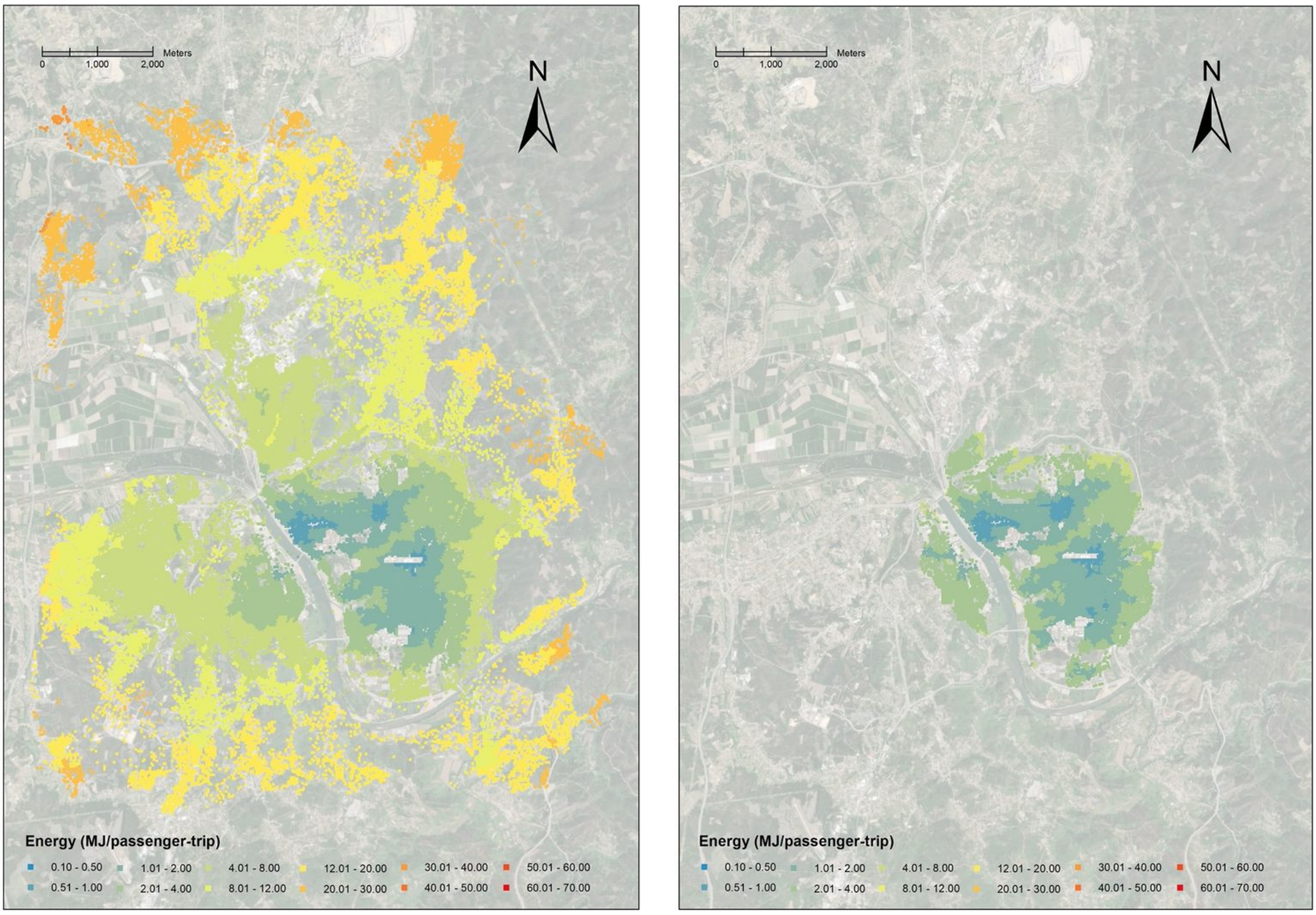
(**a**) (**b**)

Figure II.6.13. Active modal share (walking/cycling) to jobs (%): (a) Coimbra; (b) Infill Coimbra.



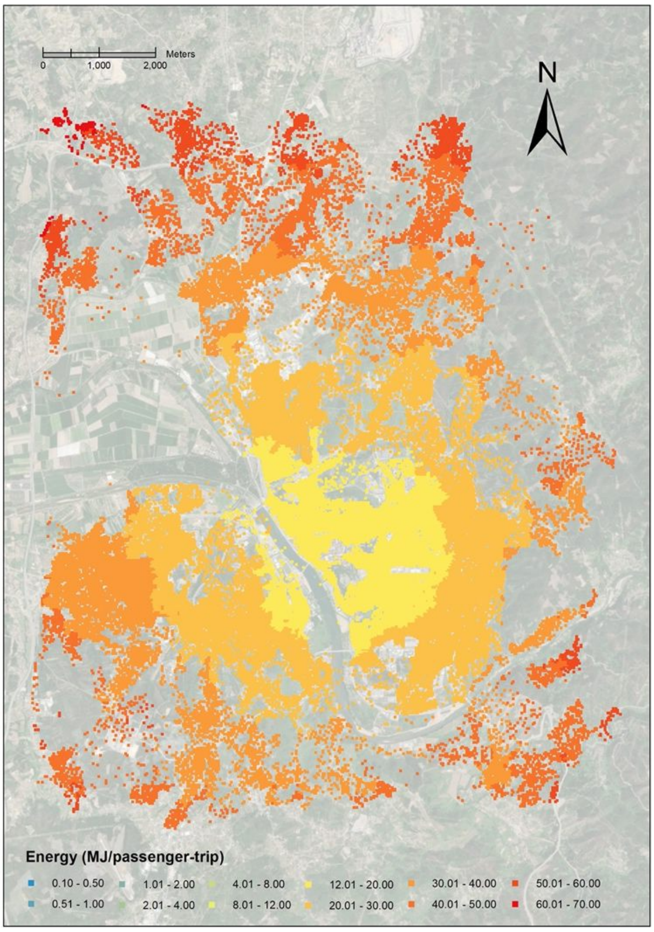
(**a**) (**b**)

Figure II.6.14. Active modal share (walking/cycling) to facilities plus jobs (%): (a) Coimbra; (b) Infill Coimbra.

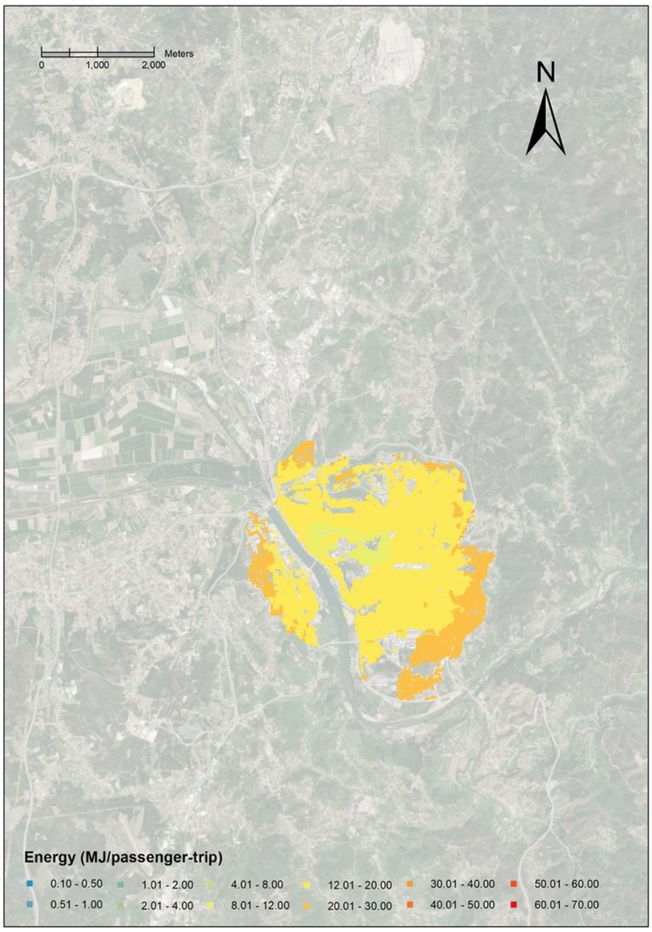


(**a**) (**b**)

Figure II.6.15. Transport energy spending to facilities [active: walk only] (MJ/passenger.trip): (a) Coimbra; (b) Infill Coimbra.

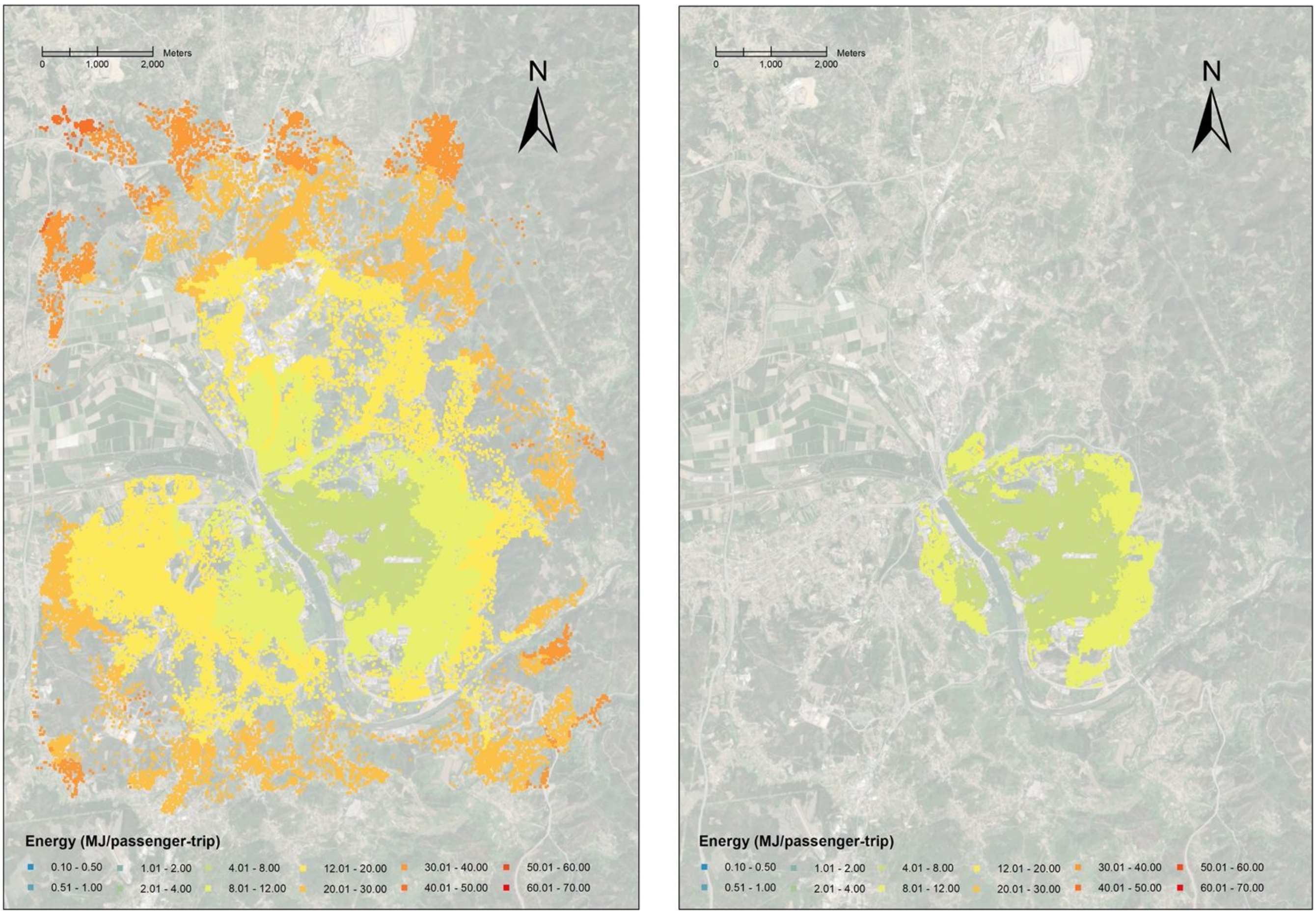


(**a**)



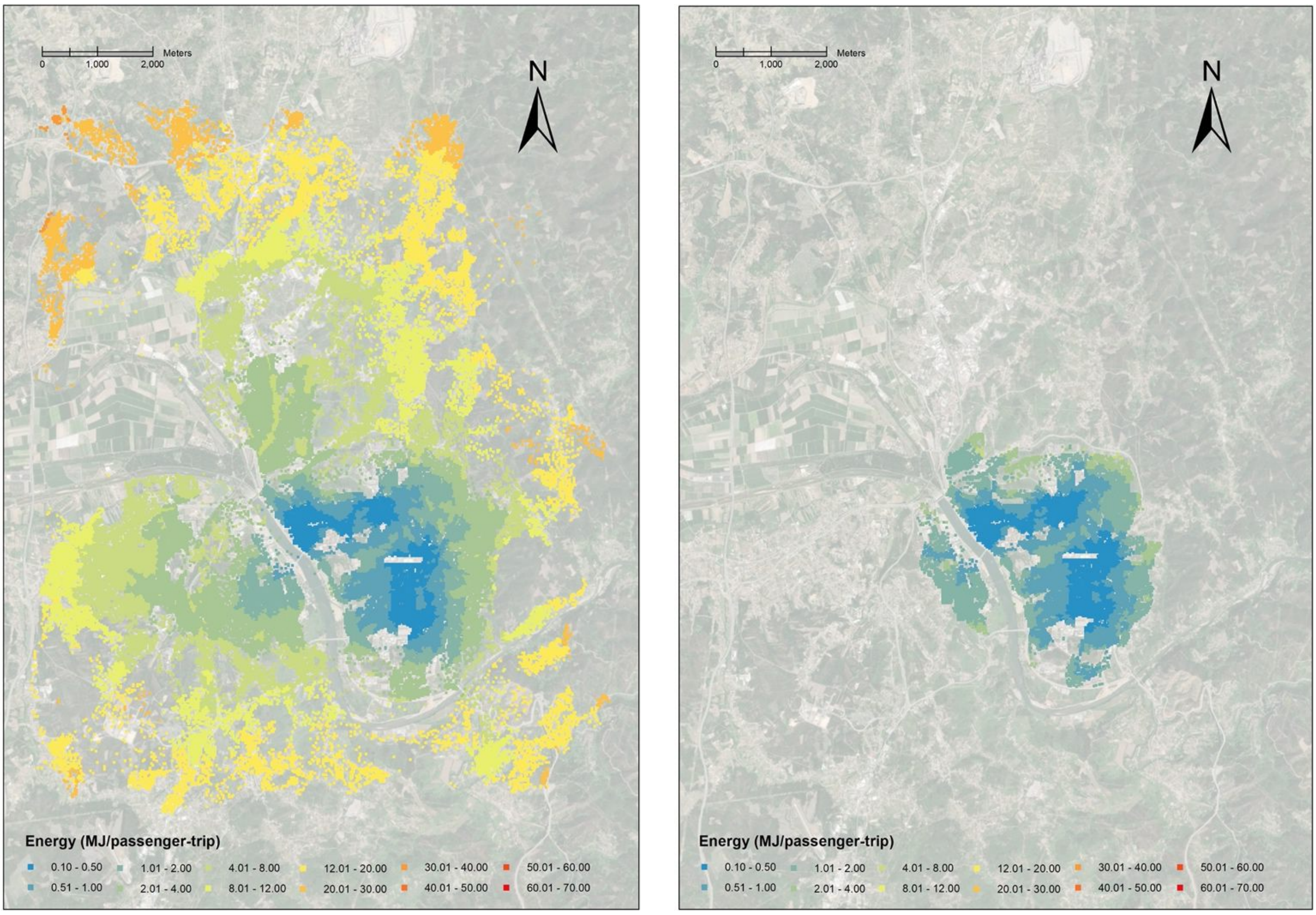
(**b**)

Figure II.6.16. Transport energy spending to jobs [active: walk only] (MJ/passenger.trip): (a) Coimbra; (b) Infill Coimbra.



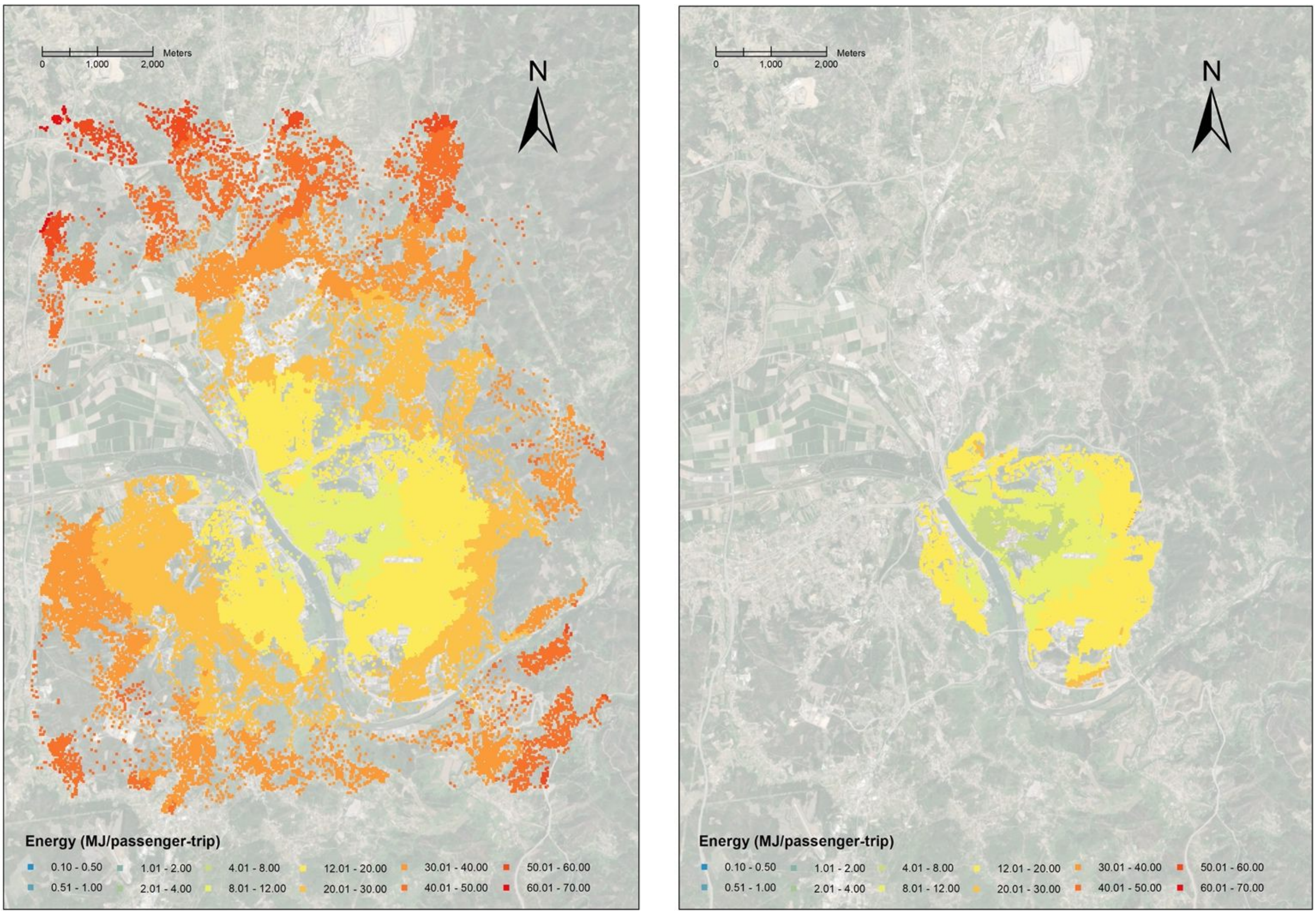
(**a**) (**b**)

Figure II.6.17. Transport energy spending to facilities plus jobs [active: walk only] (MJ/passenger.trip): (a) Coimbra; (b) Infill Coimbra.



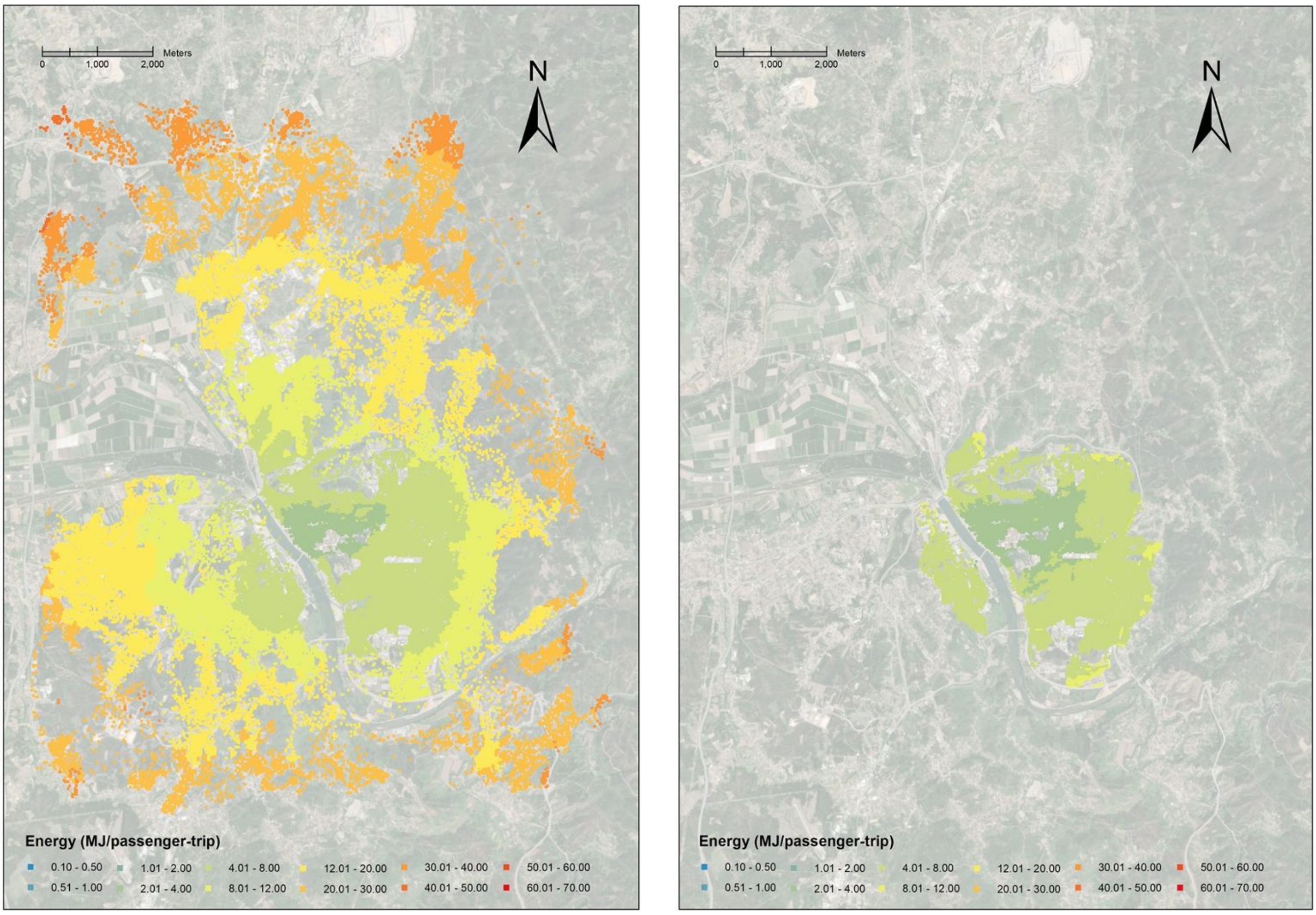
(**a**) (**b**)

Figure II.6.18. Transport energy spending to facilities [active: walking/cycling] (MJ/passenger.trip): (a) Coimbra; (b) Infill Coimbra.



(**a**) (**b**)

Figure II.6.19. Transport energy spending to jobs [active: walking/cycling] (MJ/passenger.trip): (a) Coimbra; (b) Infill Coimbra.



(**a**) (**b**)

Figure II.6.20. Transport energy spending to facilities plus jobs [active: walking/cycling] (MJ/passenger.trip): (a) Coimbra; (b) Infill Coimbra.

7. THE IMPACT OF GEOMETRIC AND LAND USE ELEMENTS ON PERCEIVED PLEASANTNESS OF URBAN LAYOUTS

7.1. Survey images summarizing data

Table II.7.1. Survey images summarizing data.

Image	GreenArea	StreetWidth	NrFloors	BuildingDist	GreenPrivArea
1	small	narrow	med	compact	none
2	med	narrow	tall	sprawl	none
3	small	wide	house	compact	backyard
4	med	narrow	short	compact	backyard
5	high	narrow	house	spaced	backyard
6	med	wide	short	compact	backyard
7	med	wide	short	sprawl	none
8	med	very_wide	tall	sprawl	none
9	high	wide	tall	sprawl	none
10	small	wide	tall	sprawl	none
11	high	wide	skyscraper	sprawl	none
12	none	wide	tall	compact	none
13	med	narrow	house	spaced	backyard
14	none	narrow	house	compact	none
15	high	narrow	med	compact	none
16	none	very_wide	skyscraper	compact	none
17	none	wide	med	compact	none
18	small	wide	short	spaced	none
19	med	very_wide	med	sprawl	none
20	high	narrow	house	spaced	backyard
21	small	very_wide	short	compact	none
22	small	narrow	house	compact	none
23	high	narrow	house	spaced	backyard
24	small	very_wide	skyscraper	sprawl	none
25	small	narrow	house	spaced	backyard

7.2. Survey images (by order of appearance)

Figure II.7.1. Survey image 1.

Figure II.7.2. Survey image 2.

Figure II.7.3. Survey image 3.

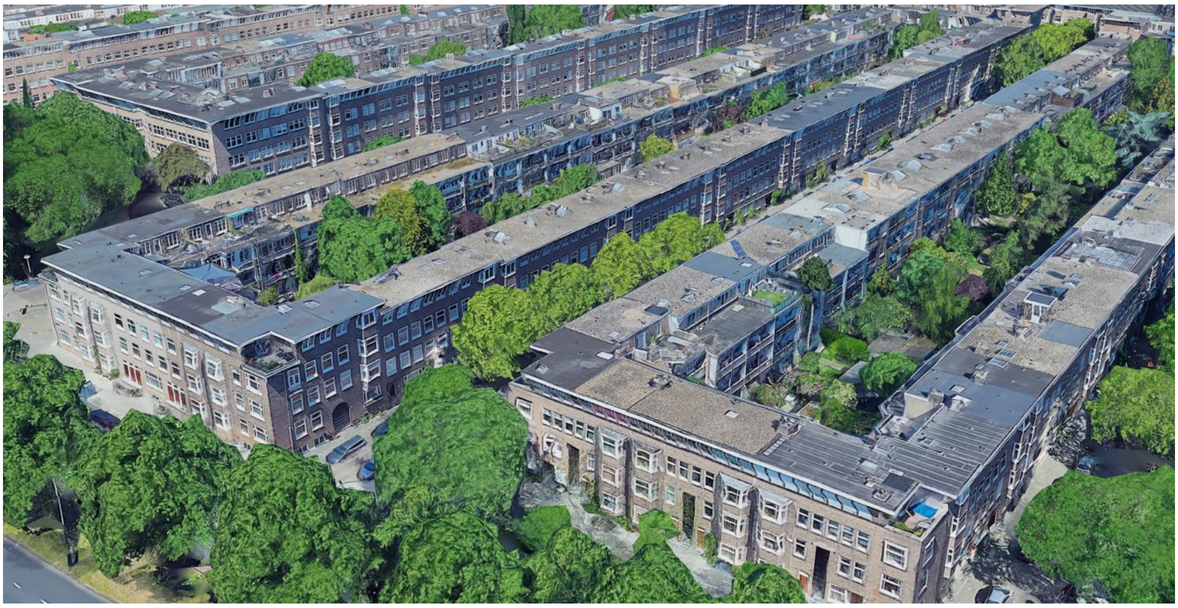


Figure II.7.4. Survey image 4.

Figure II.7.5. Survey image 5.

Figure II.7.6. Survey image 6.

Figure II.7.7. Survey image 7.

Figure II.7.8. Survey image 8.

Figure II.7.9. Survey image 9.

Figure II.7.10. Survey image 10.

Figure II.7.11. Survey image 11.

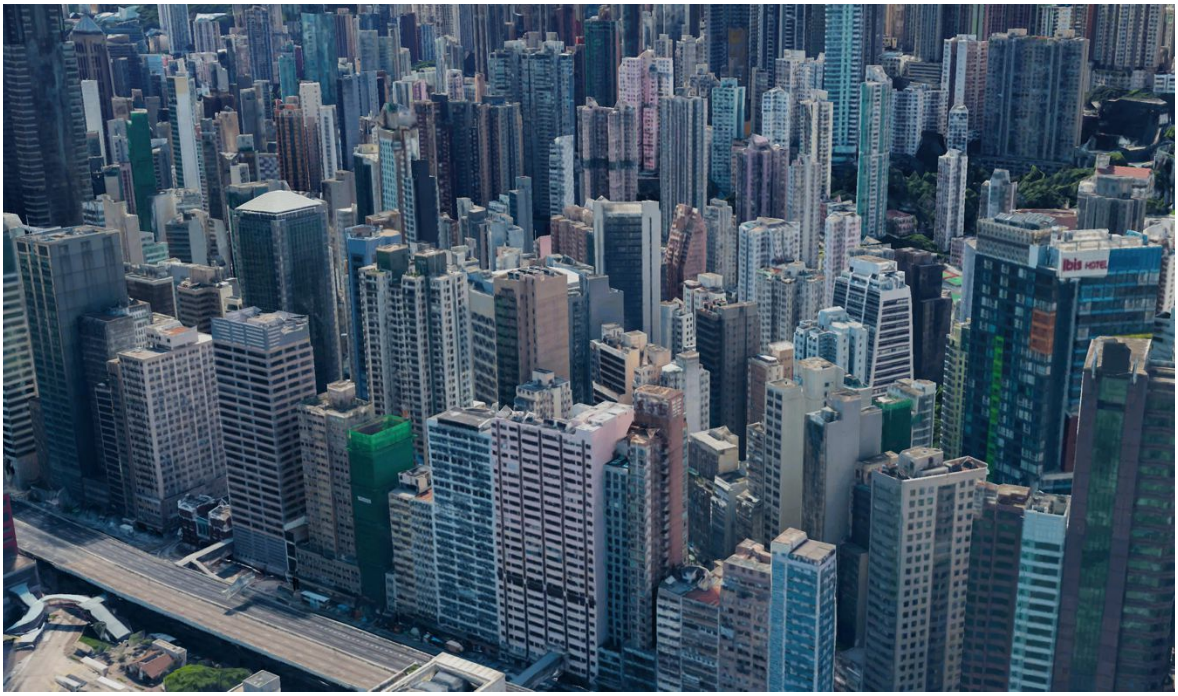


Figure II.7.12. Survey image 12.

Figure II.7.13. Survey image 13.

Figure II.7.14. Survey image 14.

Figure II.7.15. Survey image 15.

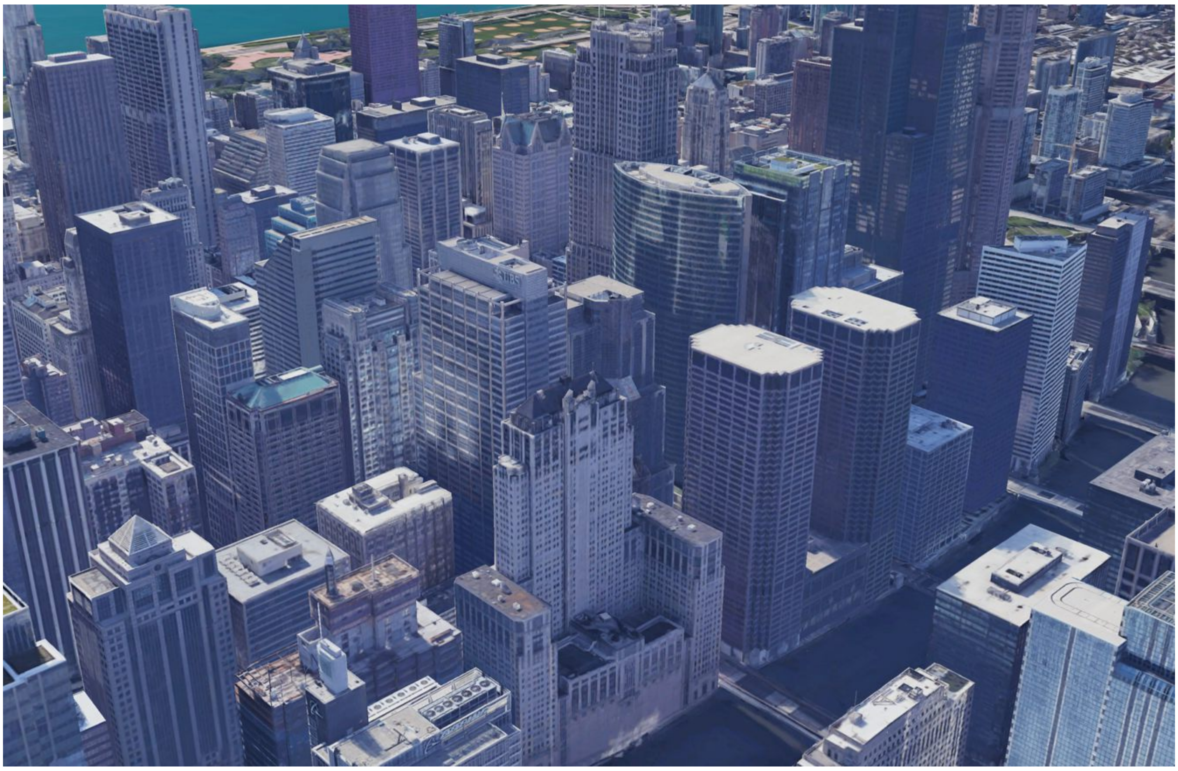


Figure II.7.16. Survey image 16.

Figure II.7.17. Survey image 17.

Figure II.7.18. Survey image 18.

Figure II.7.19. Survey image 19.

Figure II.7.20. Survey image 20.

Figure II.7.21. Survey image 21.

Figure II.7.22. Survey image 22.

Figure II.7.23. Survey image 23.

Figure II.7.24. Survey image 24.

Figure II.7.25. Survey image 25.

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8. Do we live where it is pleasant? Correlates of perceived pleasantness with socioeconomic variables

Figure II.8.1. Favela image 1.

Figure II.8.2. Favela image 2.

Figure II.8.3. Favela image 3.

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