

SSCI 684, Spatial Modeling with GIS

Syllabus

Units: 4

Term Day Time: Spring 2021, Hybrid
Thursdays 2:00-4:50pm PT

Note: Until further notice by USC, Dornsife, and SSI this class will be held entirely online. If/when LA County, City of Los Angeles and USC health and safety protocols allow, the course will resume in a streaming-hybrid format.

Location: USC Zoom Meeting link accessibly via course Blackboard.

Instructor: Laura C Loyola, PhD

Office: AHF B55A

Regular Office Hours: Tues 11 am-12 pm and Wed 2-3 pm PT. Also available most days and times by appointment via email.

Contact Info: loyola@usc.edu, 213-740-5612;
323-457-3504 (remote office)

Library Help: Andy Rutkowski

Office: VKC 36B

Office Hours: Tue 10 am-12 pm and Thu 4:30-5:30 pm PT

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IT Help: Richard Tsung

Office: AHF 145D

Office Hours: By appointment

Contact Info: spatial_support@usc.edu, 213-821-4415

Course Scope and Purpose

This course explores how geographic information systems and related technologies (global positioning systems, remote sensing, etc.) can be used to promote and support the construction and simulation of dynamic models of coupled human-environment systems. The fundamental feature of such systems involves diffusion over time and space, and individual cases may range from diffusion of pollutants and invasive species across landscapes to the diffusion of disease by contact between individuals. The approaches used to model these phenomena may range from the continuous representation of system dynamics to the discrete interactions of individual elements of agent-based models. The measurement and modeling techniques used to describe spatial and temporal processes and patterns affecting human and environmental systems will be introduced with an assortment of weekly readings, discussions, and technical work. The course is aimed at doctoral students and a series of individual and group projects allow class participants to develop and use their own models for more detailed research. Calculus and programming experience may be helpful but are not required. In addition to the textbooks, exercises and readings will be provided from a variety of sources as required.

Learning Outcomes

On completion of this course, students will be able to:

- Describe the fundamental building blocks (data sources, data models, spatial analysis methods, programming tools, etc.) used in geographic information technologies and spatial models.
- Discuss how dynamic spatial models have been implemented to both simulate the functioning of coupled human-environment systems and understand their behavior under altered conditions.
- Explicate the ways in which advances in our knowledge of coupled human-environment systems on the one hand and computer technologies on the other hand have combined to allow more realistic and detailed representations of the spatiotemporal variability of these systems in spatial models.
- Discuss the impact of sampling, resolution, uncertainty, and error on spatial model outcomes and some of the new opportunities afforded by modern instrumentation and measurement techniques.
- Critically evaluate the types of models that will be required in the future to effectively manage land, water, air and biotic resources, assess environmental risks, and promote human health and well-being.

Students may vary in their competency levels on these abilities. You can expect to acquire these abilities only if you honor all course policies, attend classes regularly, complete all assigned work in good faith and on time, and meet all other course expectations of you as a student.

Prerequisite(s): None

Co-Requisite(s): None

Concurrent Enrollment: Students must be enrolled in an existing USC PhD program

Recommended Preparation: Some GIS experience or permission of instructor

Class Conduct

Harassment, sexual misconduct, interpersonal violence, and stalking are not tolerated by the university. All faculty and most staff are considered Responsible Employees by the university and must forward all information they receive about these types of situations to the Title IX Coordinator. The Title IX Coordinator is responsible for assisting students with supportive accommodations, including academic accommodations, as well as investigating these incidents if the reporting student wants an investigation. The Title IX office is also responsible for coordinating supportive measures for transgender and nonbinary students such as faculty notifications, and more. If you need supportive accommodations you may contact the Title IX Coordinator directly (titleix@usc.edu or 213-821-8298) without sharing any personal information with me. If you would like to speak with a confidential counselor, Relationship and Sexual Violence Prevention Services (RSVP) provides 24/7 confidential support for students (213-740-9355 (WELL); press 0 after hours)

Course Structure

The course will be taught as a seminar and class meetings will be split between presentations and discussions of the assigned readings and any questions and related topics that arise from the readings. The learning and teaching strategies are student-centered. They aim to encourage a deep-learning approach by using reflection and self-evaluation. The course readings are designed to provide the essential background and framework for study. Students will be required to reflect on their learning through in-class discussions and a series of carefully crafted assignments.

Technological and Communication Requirements

Students are expected to have a working knowledge of GIS. The modeling software programs and geospatial data required for course assignments will be accessed using computing resources provided by the Spatial Sciences Institute.

SSI Server and Tech Support – At times this course utilizes the SSI Server which is a virtual desktop giving access to many different professional software. If you are unable to connect to the server or experience any type of technical issues, send an email using your USC account to SSI Tech Support at spatial_support@usc.edu, making sure to copy (cc) me on the email.

Required Readings

Students are expected to acquire the textbooks on their own, electronic versions are acceptable when available. Most journal articles are accessible through the USC Libraries system. If a student is unable to access the textbooks, please speak with the instructor at the start of the semester to establish a workaround.

1. Abar, Sameera, Georgios K. Theodoropoulos, Pierre Lemarinier, and Gregory M.P. O'Hare. 2017. "Agent Based Modelling and Simulation Tools: A Review of the State-of-Art Software." *Computer Science Review*. 24: 13-33.
2. Alexandrov, G.A., D. Ames, G. Bellocchi, M. Bruen, N. Crout, M. Erechtkhoukova, A. Hildebrandt, F. Hoffman, C. Jackisch, P. Khaiter, G. Mannina, T. Matsunaga, S.T. Purucker, M. Rivington, L. Samaniego. 2011. "Technical Assessment and Evaluation of Environmental Models and Software: Letter to the Editor." *Environmental Modeling and Software* 26: 328-336.
3. Aung, Tricia, Debora Niyeha, Shagihilu, Rose Mpenbeni, Joyceline Kaganda, Ashley Sheffel, and Rebecca Heidkamp. 2019. "Optimizing Data Visualization for Reproductive, Maternal, Newborn, Child Health, and Nutrition (RMNCH&N) Policymaking: Data Visualization Preferences and Interpretation Capacity Among Decision-Makers in Tanzania." *Global Health Research and Policy*. 4:4.
4. Bhaduri, Budhendra, Edward Bright, Philip Coleman, and Marie L. Urban. 2007. "LandScan USA: A high resolution geospatial and temporal modeling approach for population distribution and dynamics." *GeoJournal* 69, No. 1/2: 103-117.
5. Boulton, Geoffrey, Michael Rawlins, Patrick Vallance, and Mark Walport. 2011. "Science as a Public Enterprise: The Case for Open Data." *The Lancet* 377, no. 9778 (May): 1633-1635.
6. Briggs, David. 2005. "The Role of GIS: Coping with Space (and Time) in Air Pollution Exposure Assessment." *Journal of Toxicology and Environmental Health A* 68: 1243-1261.
7. Brimicombe, Allen. 2010. *GIS, Environmental Modeling, and Engineering* 2nd ed. Boca Raton: CRC Press. (available at VKC and as an e-book form USC Libraries)
8. Brunson, Chris. 2008. "Inference and Spatial Data." In *The Handbook of Geographic Information Science*, edited by Wilson, John P. and A. Stewart Fotheringham, 337-351. Oxford: Blackwell Publishing.
9. Brunson, Chris, A. Stewart Fotheringham, and Martin E. Charlton. 1996. "Geographically Weighted Regression: A Method for Exploring Spatial Non-stationarity." *Geographical Analysis* 28, no. 4 (October): 281-289
10. Buzzelli, M., J. Su, B. Ainslie, D. Steyn, M. Brauer, and T. Larson. 2006. "A GIS Spatiotemporal Model of Ambient Air Pollution Exposure." *Epidemiology* 17: S112-S118.
11. Crooks, Andrew, Nick Melleon, Ed Manley, and Alison Heppenstall. 2019. *Agent-Based Modelling & Geographic Information Systems: A Practical Primer*. Los Angeles, CA: SAGE Publications, Ltd. (available as an e-book from Amazon, NOT available via USC Libraries)
12. de Vos, Martine G., S.J.C. Janssen, L.G.J. van Bussel, J. Kromdijk, J. van Vliet, and J.L. Top. 2011. "Are Environmental Models Transparent and Reproducible Enough?" In *Proceedings of Nineteenth International Congress on Modeling and Simulation*, Perth, Australia: 2954-2961.
13. Daniel, Colin J, Benjamin M. Sleeter, Leonardo Frid, and Marie-Josée Fortin. 2018. "Integrating Continuous Stocks and Flows into State-and-Transition Simulation Models of Landscape Change." *Methods in Ecology and Evolution*. 1-11.

14. Graham, Stephen E. and Thomas McCurdy. 2004. "Developing Meaningful Cohorts for Human Exposure Models." *Journal of Exposure Analysis and Environmental Epidemiology* 14: 23-43.
15. Green, Kass, Russel G. Congalton, and Mark Tukam (2017). *Imagery and GIS: Best Practices for Extracting Information from Imagery*. Redlands, CA: Esri Press. (as needed for remote sensing background) (NOT available via USC Libraries)
16. Hijmans, Robert J. 2012. Cross-validation of Species Distribution Models: Removing Spatial Sorting Bias and Calibration with a Null Model. *Ecology*. 93 (no.3): 679-688.
<https://doi.org/10.1890/11-0826.1>
17. Huang, Yen-Ning, Brian J. Reich, Montserrat Fuentes, and A. Sankarasubramanian. 2019. Complete Spatial Model Calibration. *The Annals of Applied Statistics*. 13 (no.2): 746-766.
18. Jaga, Kushik, and Chandrabhan Dharmani. 2005. "The Epidemiology of Pesticide Exposure and Cancer: A Review." *Reviews on Environmental Health* 20, no. 1 (January): 15-38. (optional)
19. Jakeman, A.J., R.A. Letcher, and J.P. Norton. 2006. "Ten Iterative Steps in Development and Evaluation of Environmental Models." *Environmental Modeling and Software* 21, no. 5 (May): 602-614.
20. Jarvis, Claire H., and Neil Stuart. 2001a. "A Comparison Between Strategies for Interpolating Maximum and Minimum Daily Air Temperatures. Part I: The Selection of "Guiding" Topographic and Land Cover Variables." *Journal of Applied Meteorology* 40, no. 6 (June): 1060-1074.
21. Jarvis, Claire H., and Neil Stuart. 2001b. "A Comparison Between Strategies for Interpolating Maximum and Minimum Daily Air Temperatures. Part II: The Interaction Between Number of Guiding Variables and the Type of Interpolation Method." *Journal of Applied Meteorology* 40, no. 6 (June): 1075-1084.
22. Jerrett, Michael, Altaf Arain, Pavlos Kanaroglou, Bernardo Beckerman, Dimitri Potoglou, Talar Sahsuvaroglu, Jason Morrison, and Chris Giovis. 2005. "A Review and Evaluation of Intraurban Air Pollution Exposure Models." *Journal of Exposure Analysis and Environmental Epidemiology* 15: 185-204. (optional review)
23. Jones, Kelvyn, David Manley, Ron Johnston, and Dewi Owen. 2018. "Modelling Residential Segregation as Unevenness and Clustering: A Multilevel Modelling Approach Incorporating Dependence and Tackling MAUP." *Environment and Planning B: Urban Analytics and City Science*. 45(no.6): 1122-1141.
24. Kanaroglou, Pavlos S., Michael Jerrett, Jason Morrison, Bernardo Beckerman, Altaf Arain, Nicolas L. Gilbert, Jeffery R. Brook. 2005. "Establishing an Air Pollution Monitoring Network for Intra-urban Population Exposure Assessment: A Location-Allocation Approach." *Atmospheric Environment* 39, no. 13 (April): 2399-2409.
25. Kwan, Mei-Po. 2018. "The Neighborhood Effect: Contextual Uncertainties in Geographic, Environmental Health, and Social Science Research." *Annals of the American Association of Geographers*. 108(no.6): 1482-1490.
26. Lilburne, Linda and Stefano Tarantola. 2009. "Sensitivity of Spatial Models." *International Journal of Geographic Information Science*. 23(no.2): 151-168.

27. Longley, Paul A., Michael F. Goodchild, David J. Maguire, and David W. Rhind. 2015. *Geographic Information Systems and Science*. 4th ed. New York, NY: John Wiley and Sons. (Selected chapters) (available from USC Libraries Grand Depository)
28. Maglio, Paul, Martin-J Sepulveda, and Patricia L. Mabry. 2014. "Mainstreaming Modeling and simulation to accelerate Public Health Innovation." *American Journal of Public Health*. 104(no 7): 1181-1186.
29. Mallalo, Abolfazl, Liang Mao, Parisa Rashidi, and Gregory E. Glass. 2019. A GIS-Based artificial neural network model for spatial distribution of Tuberculosis across the Continental United States. *Int. J. Environ. Res. Public Health* 16:157.
30. Manyangadze, Tawanda, Moses John Chimbari, Michael Gebreslasie, Pietro Ceccato, and Samson Mukaratirwa. 2016. "Modelling the spatial and seasonal distribution of suitable habitats of schistosomiasis intermediate host snails using Maxent in Ndumo area, KwaZulu-Natal Province, South Africa." *Parasites & Vectors*. 9:572
doi:10.1186/s13071-016-1834-5.
31. Martin, David J. 2008. "Social Data." In *The Handbook of Geographic Information Science*, edited by Wilson, John P. and A. Stewart Fotheringham, 35-59. Oxford: Blackwell Publishing. (optional) O'Sullivan, David and George Perry. 2013. *Spatial Simulation: Exploring Pattern and Process*. Oxford: Wiley-Blackwell. (available as an e-book from USC Libraries)
32. Mennis, Jeremy. 2006. "Mapping the Results of Geographically Weighted Regression." *Cartographic Journal* 43, no. 2 (July): 171-179.
33. Moore, D.K., Michael Jerrett, W.J. Mack, and N. Künzli. 2007. "A Land Use Regression Model for Predicting Ambient Fine Particulate Matter Across Los Angeles, California." *Journal of Environmental Monitoring* 9: 246-252.
34. Mustapha, Karam, Wuentin Gilli, Jean_marc Frayret, Natia Lahrich, and Elnaz Karimi. 2016. "Agent-Based Simulation Patient Model for Colon and Colorectal Cancer Care Trajectory." *Procedia Computer Science*. 100: 188-197.
35. Neuwirth, Christian, Barbara Hofer, and Angela Peck. 2015. "Spatiotemporal Processes and Their Implementation in Spatial System Dynamics Models." *Journal of Spatial Science*. 60 (no.2): 277-288.
36. O'Sullivan, David and George Perry. 2013. *Spatial Simulation: Exploring Pattern and Process*. Oxford: Wiley-Blackwell. (available as an e-book from USC Libraries)
37. Patterson, Lauren, Marie Urban, Aaron Myers, Budhendra Bhaduri, Eddie Bright, and Phillip Coleman. 2007. "Assessing Spatial and Attribute Errors in Large National Datasets for Population Distribution Models: A Case Study of Philadelphia County Schools." *GeoJournal* 69, no. 1-2 (June): 93-102.
38. Phillips, S.J., R.P Anderson, and R.E. Schapire. 2006. "Maximum entropy modeling of species geographic distributions." *Ecological Modeling* 190 (3-4): 231-259.
39. Romstorfer, G. and G. Schneckenreither. 2012. "Using Open-Source Geo-Data in Agent-Based Models of Health Care Utilization." *IFAC Proceedings*. 45(no.2): 1308-1312.

40. Schmolke, Amelie, Pernille Thorbek, Peter Chapman, and Volker Grimm. 2010a. "Ecological Models and Pesticide Risk Assessment: Current Modeling Practice." *Environmental Toxicology and Chemistry* 29, no. 4 (April): 1006-1012.
41. Schmolke, Amelie, Pernille Thorbek, Donald L. DeAngelis, and Volker Grimm. 2010b. "Ecological Models Supporting Environmental Decision Making: A Strategy for the Future." *Trends in Ecology and Evolution* 25, no 8 (August): 479-486.
42. Skidmore, Andrew, 1st ed. 2002. *Environmental Modeling with GIS and Remote Sensing*. London: Taylor and Francis. (Optional reading for modeling background) (hardcopy available at VKC)
43. Stewart, Kathleen, Junchuan Fan, and Emily White. 2013. "Thinking About Space-Time Connections: Spatiotemporal Scheduling of Individual Activities." *Transactions in GIS* 17, no.6: 791-807.
44. Taboada, Manel, Eduardo Cabrera, Francisco Epelde, Ma Luisa Iglesia, and Emilio Luque. 2013. "Using Agent-Based Simulation for Predicting the Effects of Patients Derivation Policies in Emergency Departments." *Procedia Computer Science*. 18:641-650.
45. Thomson, Dana R, Forrest R. Stevens, Nick W. Ruktanonchai, Andrew Tatum, and Marcia Castro. 2017. "GridSample: an R-package to Generate Household Survey Primary Sampling Units (PSUs) from gridded Population Data." *International Journal of Health Geography*. 16:25.
46. Tracy, Melissa, Magdalena Cerdá, and Katherine M Keye. 2018. "Agent-Based Modeling in Public Health: Current Applications and Future Directions." *Annual Review of Public Health*. 38: 77-94.
47. van der Sluijs, Jeroen P. 2002. "A Way Out of the Credibility Crisis of Models Used in Integrated Environmental Assessment." *Futures* 34, no. 2 (March): 133-146.
48. Weisberg, Michael. 2007. "Who is a Modeler?" *Brit. J. Phil. Sci.* 58: 207-233
49. Wilson, John P. and Peter A. Burrough. 1999. "Dynamic Models, Geostatistics, and Fuzzy Classification: New Sneakers for a New Geography?" *Annals of the Association of American Geographers* 89: 736-46.
50. Zhai, Xinxin, Armistead G. Russell, Poornima Sampath, James A. Mulholland, Byeong-UK Kim, Yunhee Kim, And David D'Onofrio. 2016. Calibrating R-LINE Model Results with Observational Data to Develop Annual Mobile Source Air Pollutant Fields at Fine Spatial Resolution: Application in Atlanta. *Atmospheric Environment*. 147: 446-457.

Description and Assessment of Assignments

Students must participate in class discussion on a regular basis, prepare written assignments in the form of discussion boards and model reports, and complete technical exercises and presentations.

Class Participation (15%): A class participation grade for the semester will be assigned based upon how actively students engage in the course. Students will be required to read all material outlined for each week of the course, and be prepared to lead and participate in group discussions about the readings in class. Failure to attend or to be adequately prepared to discuss the readings will lead to the assignment of a lower grade for that week. Students should

also maintain a written log of insights and observations from the classroom discussions and accompanying homework projects that will assist in completing the final project.

Modeling Exercises (40%): Throughout the semester students will complete four exercises that provide students the opportunity to utilize and reflect upon the technical aspects of various modeling software. Students will implement the model design to health issues/projects of their own. These exercises will require independent background research of the models and/or modeling software and incorporate written reviews of supporting documentation. The modeling exercise may take some time to work through and deliverables will consist of final model outputs plus a write up of 5-6 pages.

In-Class Presentation (15%): Students will conduct a seminar on a topic determined in consultation with the instructor in the second half of the classes scheduled in Weeks 10 and 11. A one-page summary will be distributed in advance of the class itself and the topic may be an evaluation of a model or software (Caline, RePast, etc.), a complex systems subject (fractals, modifiable areal unit problems, neural networks, etc.) or some specific technique or application that is relevant but not otherwise covered in the course.

Final Project (30%): In the second half of the course, students will work on projects determined in consultation with the instructor. Students will construct a spatial model to address some geographically relevant health problem, or problem of their own choosing. The final report and class presentation will summarize insights from each phase of the modeling process as experienced in the problem context.

Grading Breakdown

Assessment	Number	Points Each	% of Grade
Class Participation	15	1	15
Conceptual Model	1	5	5
Modeling Exercises	4	10	40
In-Class Presentation	1	10	10
Final Project	1	30	30
Total	22	-	100

Assignment Submission Policy

Assignments will be submitted for grading via Blackboard using the due dates specified in the Course Schedule below. Students are expected to attend and participate in every class session and to complete and upload all assignments by the deadlines detailed in the Course Schedule. Late work will be assessed a penalty of 10% per day and zero grades will be assigned for work that is more than one week late.

Schedule

	Topic	Readings and Assignments	Deliverables/Due Dates
Module 1: Fundamentals of Spatial Models			
Week 1 1/21* *Monday, 1/18 is university holiday	Introduction to Class Brief introductions coupled with a discussion of class goals, projects, technology, reading assignments, and conceptual models.	Maglio et al (2014); Wilson & Burrough (1999); Crooks et al (2019) Forward, Ch1; Skidmore (2002) Ch 1 (optional, as needed)	No deliverables.
Week 2 1/28	Why Use Models and Differentiating Spatial Models Discuss the importance and value of modeling processes. We discuss what differentiates spatially explicit models and spatial modeling software.	O'Sullivan & Perry (2013) Ch. 1; Aung et al (2019); Stewart et al. (2013); Brimicombe (2010) Ch. 2; Longley et al (2015) Ch. 14, 15 (as needed); Skidmore (2002) Ch. 2 (as needed)	Conceptual Model
Week 3 2/4	The Art of Modeling and Avoiding Bias in Models: Discuss the various features of successful modeling applications, including the need for parsimony, transparency, patience, and the human element of modeling. How these elements can be captured and passed to the users and use cases; how to avoid model bias	Alexandrov et al. (2011); Jakeman et al. (2006); Schmolke et al. (2010a, b); O'Sullivan & Perry (2013) Ch. 3; de Vos et al. (2013); Weisberg (2007);	No deliverables.
Week 4 2/11	Rethinking and Preparing Models in a GIS: A discussion of the importance of and methods used to revise and process a variety of social and environmental datasets, and new data sources for use with a GIS and spatial models.	Boulton et al. (2011); Bhaduri et al. (2007); Thomson et al (2017); Graham et al. (2004); Li et al (2019) Martin (2008) (optional) Green et al (2017) Ch. 3, 4, 7, and 9 (if unfamiliar with Remote Sensing)	Modeling Exercise #1

	Topic	Readings and Assignments	Deliverables/Due Dates
Module 2: Modeling Environmental Systems and Health			
Week 5 2/18* Monday, 2/15 is university holiday	Patterns and Processes: A discussion of some of the ways forces of attraction and segregation, individual mobile entities, and processes of spread are featured in models of social and environmental systems.	O'Sullivan & Perry (2013) Ch. 2; Brimicombe (2010) Ch. 9; Jarvis & Stuart (2001a, b); Jones et al (2018); Briggs (2005); Buzzelli et al. (2006)	No deliverables.
Week 6 2/25	Weighing the Influence of Variables/Uncertainty and Error Propagation in Models: A discussion of spatially explicit variables in distribution models (Maxent) and when spatially heterostatic (GWR); A review of the importance of data quality and discussion of some of the inherent errors in data, and the effects of uncertainty in model inputs	Brunsdon (2008); Mennis (2006); Phillips et al (2006); Manyangadze et al (2016); Kauhl et al (2016) Li (2018) Brimicombe (2010) Ch. 8; Patterson et al. (2007); Kwan (2018) Brunsdon et al. (1996) (if needed)	Modeling Exercise #2
Week 7 3/4	Model Calibration & Validation: An introduction to the special challenges and issues that are confronted when using GIS tools to describe and model place-based exposures and the spatial distributions of phenomena of interest.	Lilburne and Tarantola (2009) O'Sullivan & Perry (2013) Ch. 7; Zhai et al (2016); Hijmas (2012); Huang (2019); Zhai et al (2016)	No deliverables.
Module 3: Modeling Social Systems			
Week 8 3/11	Dynamic System Models: A discussion of the various ways stocks accumulate and flows occur in time and the mathematical modeling protocols used for stocks (integrals) and flows (differentials). Introduction to System Dynamic models.	Hovmand et al (2020) Ch. 15; Neuwirth et al (2015); Daniel et al (2018); Currie et al (2018); Galea et al (2009) Abar et al (2017) (ABM)	No deliverables

	Topic	Readings and Assignments	Deliverables/Due Dates
Week 9 3/18	Agent-Based Models: A discussion of some of the ways which agents have been used to represent mobile individuals in dynamic models of human and environmental systems, and how complex system dynamics may be agent/individual-based or differential equation-based or both.	Crooks et al (2019) (selected chapters); Tracy et al (2018); Romstorfer and Schneckenreither (2012); Taboada et al (2013); Mustapha et al (2012)	Modeling Exercise #3
Week 10 3/25	ABM in GIS: Incorporating ABM into GIS.	Crooks et al (2019) (selected chapters); Li (2020)	Presentation summary
Module 4: Coupled Human-Environment Systems			
Week 11 4/1	Presentations: In-class presentations on model or software evaluation.		Presentation
Week 12 4/8	Modeling the Built and Social Environments: Discussion of the interactions of our dynamic built environment and social environment with health outcomes and various forms of exposure	Moore et al. (2007); Kanaroglou et al. (2005); Marusek et al. (2006); **Additional readings TBD**	
Module 4: Research Trends and the Future of Spatial Modeling			
Week 13 4/15	Spatial and Computational Models: Discuss the distinction between spatial and computational models and an introduction to how spatially explicit models can be transformed.	Mallalo et al. (2019); **Additional readings TBD	Modeling Exercise #4
Week 14 4/22* 4/22 University Wellness Day	No Class Meeting. No deliverables.		No deliverables
Week 15 4/29* Thursday, 4/29 last day of classes	Final Presentations: Students will present their projects, summarizing the insights garnered from each phase of the modeling process as experienced in their specific problem context.		Final project presentations in class. Final report due by 5 p.m. on last day of classes 4/29
Final Exams	Final Assessment Thursday, May 6 2:00-4:00pm PT		

Statement on Academic Conduct and Support Systems

Academic Conduct

Plagiarism – presenting someone else’s ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in *SCampus* in Part B, Section 11, “Behavior Violating University Standards” policy.usc.edu/scampus-part-b. Other forms of academic dishonesty are equally unacceptable. See additional information in *SCampus* and university policies on scientific misconduct, <http://policy.usc.edu/scientific-misconduct>.

Support Systems

Counseling and Mental Health– (213) 740-9355 – 24/7 on call

engemannshc.usc.edu/counseling

Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

National Suicide Prevention Lifeline – 1 (800) 273-8255 – 24/7 on call

www.suicidepreventionlifeline.org

Free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week.

Relationship and Sexual Violence Prevention Services (RSVP) – (213) 740-9355(WELL), press “0” after hours – 24/7 on call

studenthealth.usc.edu/sexual-assault

Free and confidential therapy services, workshops, and training for situations related to gender-based harm.

Office of Equity and Diversity (OED) – (213) 740-5086 | *Title IX Compliance* – (213) 821-8298

equity.usc.edu, titleix.usc.edu

Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants.

Reporting Incidents of Bias or Harassment– (213) 740-5086 or (213) 821-8298

usc-advocate.symplcity.com/care_report

Avenue to report incidents of bias, hate crimes, and microaggressions to the Office of Equity and Diversity | Title IX for appropriate investigation, supportive measures, and response.

The Office of Disability Services and Programs – (213) 740-0776

dsp.usc.edu

Support and accommodations for students with disabilities. Services include assistance in providing readers/notetakers/interpreters, special accommodations for test taking needs, assistance with architectural barriers, assistive technology, and support for individual needs.

USC Campus Support and Intervention – (213) 821-4710

uscsa.usc.edu

Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

Diversity at USC – (213) 740-2101

diversity.usc.edu

Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

USC Emergency - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call

dps.usc.edu, emergency.usc.edu

Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

USC Department of Public Safety – - UPC: (213) 740-6000, HSC: (323) 442-120 – 24/7 on call

dps.usc.edu

Non-emergency assistance or information.

Resources for Online Students

The Course Blackboard page and the GIST Community Blackboard page have many resources available for distance students enrolled in our graduate programs. In addition, all registered students can access electronic library resources through the link <https://libraries.usc.edu/>. Also, the USC Libraries have many important resources available for distance students through the link: <https://libraries.usc.edu/faculty-students/distance-learners>. These include instructional videos, remote access to university resources, and other key contact information for distance students.