

Master of Science in Sustainability Management

Fall 2024 SUMA PS5168: Sustainability Metrics: Data, Construction, and Use

Thursdays 4:10-6:00pm

3 credits

(Subject to Change)

Instructors: Professor Guo Dong, guodong@columbia.edu;
Location: 414 Pupin Laboratories
Office Hours: Friday 2:00-6:00pm, The Interchurch Center, Room 525D (please email me in advance for building access)

Facilitator/Teaching Assistant: Desikan Jayaram, dj2658@columbia.edu
Office Hours: TBA

Course Overview

The urgency to tackle sustainability-related global problems has revealed the growing need to create, maintain and analyze data on environmental and social issues with robust methodologies. The availability of nascent sustainability datasets and advanced data tools such as GIS, machine learning, and blockchain has expanded our capabilities for quick and agile decision-making in the sustainability space. However, compared to real-time economic data, timely and reliable environmental and social data are very much lacking.

Sustainability indicators are able to transform a vast amount of information about our complex environment into concise, policy-applicable and manageable information. There is a very large universe of indicators to measure the sustainability performance of an entity, but the critical question is what to use and how many indicators should be evaluated. Sustainability indicators are either presented in a structured framework that can be used to isolate and report on relevant indicators, or aggregated towards a composite index or score/rating.

The number of indicators used for assessing sustainability have proliferated, with hundreds of sustainability related indices around the world, including the Ecological Footprint, the Human Development Index, green accounting, Sustainable Development Goals, the Environmental Performance Index (EPI) co-developed by Columbia University and Yale University, the Urban Sustainability Ranking System that I helped develop, and various carbon indices.

The course is divided into three sections. The first section will visit different definitions of sustainability to outline the theoretical premises on which current data practices and policies are built, and then outline the most commonly used frameworks and indices that are used to measure sustainability. The second section focuses on the construction of sustainability indices or composite indicators, and outline the methods frequently used in constructing indices, such as standardization, weighting, and aggregation, and analyze how sustainability frameworks can assist in the selection of indicators, which is often the most important yet most inconsistent step in constructing an index. The last section focuses on how composite sustainability indicators are used in practice. This section will discuss the SDGs, urban sustainability indicators, environmental performances indices, the relationship between sustainability and financial performance, the relationship between sustainability and business performance, how to use sustainability data to make investment decisions with a case study on impact investment evaluation.

The course will highlight the strengths and limitations of data that contribute to the selection of proper indicators, the methods for their normalization and aggregation into indices, and their use in the real world. For example, students will learn how to use different datasets and calculation guidelines to assess cities' environmental, and social

footprint. This will help students gain the knowledge of data sources, and process these data through suitable methodologies to identify the sustainability-related risks and opportunities. Students will learn to critically assess existing indicators and indices, focusing on data cleanliness and robustness, and to construct their own index/rating/ranking for a thematic area and a region using the software they are most comfortable using (e.g., Excel, SPSS, Stata, R, Python, etc.).

This course is offered in the Fall Semester, and in person.

Learning Objectives

L1: Identify and distinguish different approaches to sustainability assessment.

L2: Develop a sustainability index encompassing multiple sustainability dimensions.

L3: Evaluate the strengths and limitations of raw sustainability data and explain implications for data and indicator selection.

L4: Apply basic statistical methods for data reduction and extrapolation for the construction of a composite sustainability indicator.

L5: Present the results from their own sustainability index/rating/ranking, defending the choice of raw data, selection of indicators, normalization, weighting, and aggregation methodologies.

Readings

(There is not a comprehensive textbook for this course. Readings for each session will be updated weekly throughout the semester, please check weekly modules for updated readings)

Assignments and Assessments

Data Collection & Extrapolation Exercise (15%) – (L1, L2, L3, L4, L5) – This exercise will be evaluated on a scale of 0-100. Students are required to collect data on 5 sustainability indicators across two cities. Students need to explain why the cities selected are comparable, and data are consistent in terms of their units and collation methodology. Justifications need to be provided. In addition, students will be presented with an indicator dataset across years and cities and are required to fill in the missing values. Evaluation will be based on the methods used for data extrapolation and their justifications.

Midterm Paper (30%) (L1, L2, L3, L4, L5) – The midterm paper will be evaluated on a scale of 0-100. Students are required to work in pairs of two to critically evaluate an existing sustainability index/rating/ranking on a regional or global level. The evaluation needs to be based on students' own reasoning as well as citing from relevant literature.

Final Group Project (45%) (L1, L2, L3, L4, L5) – The final group project is divided into two parts – a group presentation and a final paper, both of which will be graded on a scale of 0-100. Students will engage in a group project to develop a sustainability index on a given theme. Groups will be expected to search for and evaluate data,

process data, clean data, plug in missing values, conceptualize a framework for the selection of indicators, normalize and aggregate these indicators, and conduct sensitivity analysis. Each group will present their results in the final class with an accompanying paper of 20 pages due on the final class. Each paper is required to summarize the result, describes the data sources, and any adjustments that have to be made in scale and unit in order to make the data comparable across cities. Presentations should be no longer than 15 minutes and will be followed by 5 minutes of Q&A.

Class Participation (10%) (L1, L2, L3, L4, L5) - Class participation will be evaluated on a scale of 0-100 and all students are expected to contribute to the classroom discussion. During these discussions, students will be expected to reflect on the pre-class readings and present a critical view based on these readings. Students are welcomed to bring their skills they have learned from other classes, especially those related to data analysis and sustainability. Attendance will count as part of the participation grade and late attendance to classes will impact the grade. Students are expected to inform the instructors via email in advance and within a reasonable timeframe in case of impossibility to attend a class. Failure to attend a class without an excuse will result in deduction of the participation grade. Late submission of assignments will result in a reduction of 10% of the grade.

Grading

The final grade will be calculated as described below, and the grade weight for each assignment is as described in the assignment section.

FINAL GRADING SCALE

Grade	Percentage
A+	98–100 %
A	93–97.9 %
A-	90–92.9 %
B+	87–89.9 %
B	83–86.9 %
B-	80–82.9 %
C+	77–79.9 %
C	73–76.9 %
C-	70–72.9 %
D	60–69.9 %
F	59.9% and below

Assignment/Assessment	% Weight
Data Collection and Extrapolation Exercise	15%
Midterm Paper	30%
Final Project	45%
Class Participation	10%

Course Schedule/Course Calendar

(Subject to change depending on availability of guest speakers)

Date	Topics and Activities	Readings (due on this day)	Assignments (due on this date)
9/5	<p>Week 1</p> <p>Sustainability Definition and Sustainability Data</p>	<ul style="list-style-type: none"> ● Cohen, S. A., Bose, S., Guo, D., DeFrancia, K., Berger, O., Filiatraut, B., ... & Zhang, C. (2014). The Growth of Sustainability Metrics (Sustainability Metrics White Paper Series: 1 of 3). ● Bell, S., & Morse, S. (2008). <i>Sustainability Indicators—Measuring the Immeasurable? 2nd Edition. P3-30</i>. Earthscan. [DG1] ● Solow, R. (1991). Sustainability: An Economist’s perspective. The eighteenth J. Seward Johnson lecture. Woods Hole, MA: Woods Hole Oceanographic Institution. ● Elkington, J. (1998), Cannibals with forks: the triple bottom line of 21st century business, (pp. 1-13, 69-94), New Society Publishers, Gabriola Island, BC; Stony Creek, CT ● Henriques, A., & Richardson, J. Eds. (2004). <i>Triple Bottom Line: Does It All Add Up?</i> Earthscan: Routledge. 	
9/12	<p>Week 2</p> <p>Overview of Sustainability Indicator Frameworks and Indices</p>	<ul style="list-style-type: none"> ● Guo, D., DeFrancia, K., Chen, M., Filiatraut, B., & Zhang, C. (2015). Assessing Sustainability: Frameworks and Indices (Sustainability Metrics White Paper # 3). ● Boulanger, P.-M. (2008). Sustainable development indicators: a scientific challenge, a democratic issue. <i>Surveys and Perspectives Integrating Environment and Society</i>, 1(1). https://journals.openedition.org/sapiens/166 ● The Triple Bottom Line: What Is It and How Does It Work? ● Using The Pressure-State-Response Model To Develop Indicators Of Sustainability: http://documentacion.ideam.gov.co/openbiblio/bvirtual/017931/DocumentosIndicadores/Temasvarios/Docum26.pdf 	

9/19	<p>Week 3</p> <p>Construction of Composite Sustainability Indicators: Indicator Selection and Data Issues</p>	<ul style="list-style-type: none"> • Nardo, M., Saisana, M., Saltelli, A., Tarantola, S., Hoffman, A., & Giovannini, E. 2008. Handbook on constructing composite indicators. Paris: OECD. (pp. 1-43). • Singh, R. K., Murty, H. R., Gupta, S. K., & Dikshit, A. K. (2009). An overview of sustainability assessment methodologies. <i>Ecological indicators</i>, 9(2), 189-212. (Sections 3 and 4 only) • Nardo et al. 2008. OECD Handbook. pp. 44-62. 	
9/26	<p>Week 4</p> <p>Construction of Composite Sustainability Indicators: Imputation and Multivariate Analysis</p> <p>Guest Speaker: Tanja Srebotnjak, Director of the Zilkha Center at Williams College</p>	<ul style="list-style-type: none"> • Nardo et al. 2008. OECD Handbook. pp. 63-88. • A Step-by-Step Explanation of Principal Components Analysis. https://builtin.com/data-science/step-step-explanation-principal-component-analysis 	
10/3	<p>Week 5</p> <p>Construction of Composite Sustainability Indicators: Normalization, Weighting and Aggregation</p>	<ul style="list-style-type: none"> • Guo, D., DeFrancia, K., Chen, M., Filiatraut, B., & Zhang, C. (2015). Assessing Sustainability: Frameworks and Indices (Sustainability Metrics White Paper # 3). • China Sustainable Development Indicator System. (2022). The Earth Institute, Columbia University, China Center on International Economic Exchanges. • Nardo et al. 2008. OECD Handbook. pp. 89-116. • Becker, W., Saisana, M., Paruolo, P., & Vandecasteele, I. 2017. Weights and importance in composite indicators: Closing the gap. <i>Ecological Indicators</i>, 80, 12-22. (read sections 1, 5, and 6) 	Data Collection and Extrapolation Exercise Due
10/10	<p>Week 6</p> <p>Uncertainty and Sensitivity Assessment, Data Visualization</p> <p>Guest Speaker: Alex de Sherbinin, Director and Senior</p>	<ul style="list-style-type: none"> • Nardo et al. 2008: revisit pp. 34-43, read pp. 117-139. • Tate, E. 2012. Social vulnerability indices: a comparative assessment using uncertainty and sensitivity analysis. <i>Natural Hazards</i>, 63 (2), 325-347 • Papadimitriou, E. et al., 2020. JRC Statistical Audit of the 2020 Environmental 	

	Research Scientist, Center for International Earth Science Information Network (CIESIN), Columbia Climate School	Performance Index. Ispra: Joint Research Centre. <ul style="list-style-type: none"> 10 Do's and Don'ts of Infographic Chart Design: https://venngage.com/blog/chart-design/ 	
10/17	Week 7 Sustainability Indicators in Practice: Sustainable Development Goals	<ul style="list-style-type: none"> Bose, S., Guo, D., & Simpson, A. (2019). The Financial Ecosystem: the Role of Finance in Achieving Sustainability. P100-105. Palgrave Macmillan. Sachs, J., G. Lafortune, C. Kroll, G. Fuller and F. Woelm. 2022. <i>SDG Index and Dashboards Report 2022</i>. New York: Bertelsmann Stiftung and Sustainable Development Solutions Network (SDSN) (skim Part 2: The SDG Index and Dashboards at https://dashboards.sdindex.org/chapters/part-2-the-sdg-index-and-dashboards). UN SDGs: https://sdgs.un.org/goals United Nations (2021). The Sustainable Development Goals Report 2021. (P. 4-7 & 62). SDG Good Practices: A compilation of success stories and lessons learned in SDG implementation: https://sdgs.un.org/sites/default/files/2020-11/SDG%20Good%20Practices%20Publication%202020.pdf https://blogs.worldbank.org/opendata/2020-atlas-sustainable-development-goals-stories-and-insights-through-innovative-visuals We the Peoples-Celebrating 7 million voices. My World. The United Nations Global Survey for a Better World. <p><u>Tools:</u></p> <ul style="list-style-type: none"> Measuring Success: Tracking the Progress of the Sustainable Development Goals https://storymaps.arcgis.com/stories/ffa9380903e84bd2bfdd0deef46333 	
10/24	Week 8 Sustainability Indicators in Practice: SDG Index	<ul style="list-style-type: none"> Global SDG Indicators Data Platform The 2020 Atlas of Sustainable Development Goals: Stories and insights through innovative visuals: https://blogs.worldbank.org/opendata/2020-atlas-sustainable-development-goals- 	Midterm Paper Due

		<p>storiesand-insights-through-innovative-visuals</p> <ul style="list-style-type: none"> ● Global indicator framework for the Sustainable Development Goals and targets of the 2030 Agenda for Sustainable Development 	
10/31	<p>Week 9</p> <p>Sustainability Indicators in Practice: Urban Sustainability Indicators I</p>	<ul style="list-style-type: none"> ● Cohen, S., & Guo, D. (2021) <i>The Sustainable City</i>, 2nd Edition. Chapter 1. Columbia University Press. ● Klopp, J. M., & Petretta, D. L. (2017). The urban sustainable development goal: Indicators, complexity and the politics of measuring cities. <i>Cities</i>, 63, 92-97. ● Bell, S., and S. Morse. 2018. “Chapter 12. Participatory approaches for the development and evaluation of sustainability indicators.” In: Bell and Morse (eds), <i>Routledge Handbook of Sustainability Indicators</i>. New York: Routledge. (skim pgs. 188-203) ● China Sustainable Development Indicator System. (2022). The Earth Institute, Columbia University, China Center on International Economic Exchanges. ● Carbon Footprint of World Cities. 	
11/7	<p>Week 10</p> <p>Sustainability Indicators in Practice: Urban Sustainability Indicators II – International City Comparisons</p> <p>Guest Speaker: Anyi Wang, Associate Research Scholar, Research Program on Sustainability Policy and Management, Columbia Climate School</p>	<ul style="list-style-type: none"> ● China Sustainable Development Indicator System. (2023). The Earth Institute, Columbia University, China Center on International Economic Exchanges. ● Case study report to be added by the guest speaker 	
11/14	<p>Week 11</p> <p>Sustainability Indicator in Practice: The Environmental Performance Index (EPI)</p> <p>Guest Speaker: Zach Wendling, Senior Research Associate, Columbia University Center on Global Energy Policy (CGEP)</p>	<ul style="list-style-type: none"> ● Wendling et al. 2020. <i>2020 Environmental Performance Index</i>. New Haven, CT: Yale. (focus on Chapter 1, pages 1-5; skim Chapter 2-3, pages 6-47). ● Hsu, A., L.A. Johnson, and A. Lloyd. 2013. <i>Measuring Progress: A Practical Guide From the Developers of the Environmental Performance Index (EPI)</i>. New Haven: Yale Center for Environmental Law & Policy. (read Chapter 5, pp. 42-53) 	

11/21	Week 12 Sustainability Indicator in Practice: Linking Sustainability Data to Financial Performance	<ul style="list-style-type: none"> ● Bose, S., Guo, D., & Simpson, A. (2019). Chapter 5: Signals of Scarcity and Financial Performance. <i>The Financial Ecosystem: the Role of Finance in Achieving Sustainability</i>. P122-131. Palgrave Macmillan. ● Bose, S., Guo, D., & Simpson, A. (2019). Chapter 4 Accounting for Sustainability: Frameworks for the Aggregation of Financial and Non-financial Metrics. <i>The Financial Ecosystem: the Role of Finance in Achieving Sustainability</i>. P83-100. Palgrave Macmillan. ● Busch, T. and G. Friede (2018). "The Robustness of the Corporate Social and Financial Performance Relation: A Second-Order Meta-Analysis." <i>Corporate Social Responsibility & Environmental Management</i> 25(4): 583-608 ● Utz, S. and M. Wimmer (2014). "Are they any good at all? A financial and ethical analysis of socially responsible mutual funds." <i>Journal of Asset Management</i> 15(1): 72-82 	
12/5	Week 13 Final Presentations		Final Project Due

Course Policies

Participation and Attendance

You are expected to complete all assigned readings, attend all class sessions, and engage with others in class discussions. If you need to miss a class for any reason, please discuss the absence with the instructor in advance.

Late work

There will be no credit granted to any written assignment that is not submitted on the due date noted in the course syllabus without advance notice and permission from the instructor.

Citation & Submission

All written assignments must use standard citation format (e.g., MLA, APA, Chicago), cite sources, and be submitted to the course website or in hardcopies.

School and University Policies and Resources

Copyright Policy

Please note—Due to copyright restrictions, online access to this material is limited to instructors and students currently registered for this course. Please be advised that by clicking the link to the electronic materials in this course, you have read and accept the following:

The copyright law of the United States (Title 17, United States Code) governs the making of photocopies or other reproductions of copyrighted materials. Under certain conditions specified in the law, libraries and archives are authorized to furnish a photocopy or other reproduction. One of these specified conditions is that the photocopy or reproduction is not to be "used for any purpose other than private study, scholarship, or research." If a user makes a request for, or later uses, a photocopy or reproduction for purposes in excess of "fair use," that user may be liable for copyright infringement.

Academic Integrity

Columbia University expects its students to act with honesty and propriety at all times and to respect the rights of others. It is fundamental University policy that academic dishonesty in any guise or personal conduct of any sort that disrupts the life of the University or denigrates or endangers members of the University community is unacceptable and will be dealt with severely. It is essential to the academic integrity and vitality of this community that individuals do their own work and properly acknowledge the circumstances, ideas, sources, and assistance upon which that work is based. Academic honesty in class assignments and exams is expected of all students at all times.

SPS holds each member of its community responsible for understanding and abiding by the SPS Academic Integrity and Community Standards posted at <https://sps.columbia.edu/students/student-support/academic-integrity-community-standards>. You are required to read these standards within the first few days of class. Ignorance of the School's policy concerning academic dishonesty shall not be a defense in any disciplinary proceedings.

Diversity Statement

It is our intent that students from all diverse backgrounds and perspectives be well-served by this course, that students' learning needs be addressed both in and out of class, and that the diversity that the students bring to this class be viewed as a resource, strength and benefit. It is our intent to present materials and activities that are respectful of diversity: gender identity, sexuality, disability, age, socioeconomic status, ethnicity, race, nationality, religion, and culture.

Accessibility

Columbia is committed to providing equal access to qualified students with documented disabilities. A student's disability status and reasonable accommodations are individually determined based upon disability documentation and related information gathered through the intake process. For more information regarding this service, please visit the University's Health Services website: <https://health.columbia.edu/services/ods/support>.

School Policies and Expectations:

Accessibility Statement – I want you to succeed in this course. Contact disability@columbia.edu for learning accommodations.

Names/Pronouns

You deserve to be addressed in a manner that reflects your identity. You are welcome to tell me your pronoun(s) and/or name (if different from University records) at any time, either in person or via email.

Discrimination

We embrace the diversity of gender, gender identity & expression, sex, sexual orientation, race, ethnicity, national origin, age, religion, disability status, family status, socioeconomic background, and other visible and non-visible identities. Columbia University does not tolerate unlawful discrimination, discriminatory harassment, sexual assault,

domestic violence, dating violence, stalking, or sexual exploitation and all such conduct is forbidden by Columbia University Policy.

Duty to Report

You deserve a University community free from discrimination, harassment, and gender-based misconduct including sexual harassment, sexual assault, domestic and dating violence, stalking, and sexual exploitation. It is therefore University policy to require Columbia faculty and staff to report to EOAA any instance or allegation of prohibited conduct involving any undergraduate or any graduate student that is disclosed to, observed by, or otherwise known to that employee. This requirement to report is in place to help ensure that students are provided appropriate resources and to allow the University to mitigate harm to our community.

Confidential Resources

There are confidential resources on campus who do not have a Duty to Report, including:

- * Sexual Violence Response & Rape Crisis/Anti-Violence Support Center (SVR)
- * Ombuds Office
- * Medical Services
- * University Counseling and Psychological Services
- * University Pastoral Counseling
- * Columbia Office of Disability Services

University employees working in a confidential capacity will not report information shared with them.

Inclusion

In the M.S. in Sustainability Management program, faculty and staff are committed to the creation and maintenance of “inclusive learning” spaces – classrooms and other places of learning where you will be treated with respect and dignity, and where all individuals are provided equitable opportunity to participate, contribute, and succeed.

All students are welcome regardless of race/ethnicity, gender identities, gender expressions, sexual orientation, socio-economic status, age, disabilities, religion, regional background, Veteran status, citizenship status, nationality and other diverse identities that we each bring to class.

Class Recordings

All or portions of the class may be recorded at the discretion of the Instructor to support your learning. At any point, the Instructor has the right to discontinue the recording if it is deemed obstructive to the learning process.

If the recording is posted, it is confidential and it is prohibited to share the recording outside of the class.

SPS Academic Resources

The Office of Student Affairs provides students with academic counseling and support services such as online tutoring and career coaching: <https://sps.columbia.edu/students/student-support/student-support-resources>.

Columbia University Information Technology

Columbia University Information Technology (CUIT) provides Columbia University students, faculty and staff with central computing and communications services. Students, faculty and staff may access University-provided and discounted software downloads.

Columbia University Library

Columbia's extensive library system ranks in the top five academic libraries in the nation, with many of its services and resources available online.

The Writing Center

The Writing Center provides writing support to undergraduate and graduate students through one-on-one consultations and workshops. They provide support at every stage of your writing, from brainstorming to final drafts. If you would like writing support, please visit the following site to learn about services offered and steps for scheduling an appointment. This resource is open to Columbia graduate students at no additional charge. Visit <http://www.college.columbia.edu/core/uwp/writing-center>.

Career Design Lab

The Career Design Lab supports current students and alumni with individualized career coaching including career assessment, resume & cover letter writing, agile internship job search strategy, personal branding, interview skills, career transitions, salary negotiations, and much more. Wherever you are in your career journey, the Career Design Lab team is here to support you. Link to <https://careerdesignlab.sps.columbia.edu/>

Netiquette

[Only applies to courses using online platforms]

Online sessions in this course will be offered through Zoom, accessible through Canvas. A reliable Internet connection and functioning webcam and microphone are required. It is your responsibility to resolve any known technical issues prior to class. Your webcam should remain turned on for the duration of each class, and you should expect to be present the entire time. Avoid distractions and maintain professional etiquette.

Please note: Instructors may use Canvas or Zoom analytics in evaluating your online participation.

More guidance can be found at https://jolt.merlot.org/vol6no1/mintu-wimsatt_0310.htm

Netiquette is a way of defining professionalism for collaborations and communication that take place in online environments. Here are some Student Guidelines for this class:

- Avoid using offensive language or language that is not appropriate for a professional setting.
- Do not criticize or mock someone's abilities or skills.
- Communicate in a way that is clear, accurate and easy for others to understand.
- Balance collegiality with academic honesty.
- Keep an open-mind and be willing to express your opinion.
- Reflect on your statements and how they might impact others.
- Do not hesitate to ask for feedback.
- When in doubt, always check with your instructor for clarification.