Sustainable Engineering

School of Civil and Environmental Engineering

CEE 6345 (86066) – 13:30 to 14:45 TR – Ford Environmental Science and Technology – L1125

1. Instructor and Teaching Assistants

John C. Crittenden, Ph.D., P.E.
Civil & Environmental Engineering
Office: 828 W Peachtree Street NW
Suite 320B
john.crittenden@ce.gatech.edu
Office hours: by appointment

Osvaldo A. Broesicke & Junchen Yan
Civil & Environmental Engineering
Office: 828 W Peachtree Street NW
Suite 320
obroesicke3@gatech.edu
junchen.yan@gatech.edu
Office hours: by appointment

2. Course Description

The course is intended to introduce students to the interaction between the human and natural environment, focusing on how the anthropogenic activities have altered the natural environment and provide an overview on the emerging science of sustainability. This course will identify the impacts associated with resource consumption and environmental pollution, and present the quantitative tools that assess environmental impacts and can be used to design for sustainability. At the end of the course, the students are expected to be cognizant about the concept of sustainability, the metrics of sustainability and be able to use the principles of sustainability in their respective field of practice.

The *Course Content* and *Recommended Readings* are outlined below. As we progress through the class, some of these items may change or be rearranged to adjust for our progress or any updated information. Furthermore, some readings will be mandatory. You will be informed of these changes in class and via Canvas.

3. Key Learning Points

The key learning objectives include:

- Sustainability Indicators
- Earth Systems Engineering and Management
- Integration of the Environmental, Social, and Economic Issues
- Lifecycle Analysis
  - Lifecycle Inventory
  - Risk and Impact Assessment
- Material Flow Analysis
  - Urban Metabolism
- Target Plots That Can Be Used to Determine Chemical Safety
- Industrial Ecology
- Urban Sustainability / Infrastructure Ecology
- Dynamics of Sustainability in the Developed and Developing World
- Agent-Based Modeling
- Geoengineering
- Business Models of Sustainability

Engineering Working Definition of Sustainable Development:

Our socioeconomic system is far from sustainable and this may cause us guilt and perhaps frustration and so there may be a tendency to just give up. Consequently, we will use this definition for this class.

Roy F. Weston: "Sustainable Development is a ***process of change*** *in which the direction of investment, the orientation of technology, the allocation of resources, and the development and functioning of institutions transition* ***toward longer-term sustainable activities****. Longer term sustainable development will meet present needs and aspirations without endangering the natural ecosystems and their capacity to absorb the effects of human activities, and without compromising the ability of future generations to meet their own needs and aspirations."*

A simpler working definition of sustainable engineering can be as follows:

Sustainable Engineering is the design of human and industrial systems such that they ensure that humankind's use of the natural resources and cycles do not lead to diminished quality of life due to either losses in future economic opportunities or to adverse impacts on social conditions, human health, and the environment.

These requirements reflect that social conditions, economic opportunity, and environmental quality are essential if we are to reconcile society's development goals with international environmental limitations.

4. Class Operation

This course involves active learning on part of the students. The class will be broken up into groups. Each group will work together on homework and the final project.

Prerequisites:

This course is meant to be taken **by both engineering and non-engineering students**. It requires basic mathematical skills, and the willingness to conduct quantitative analyses. Especially for the group project, students with different backgrounds may be called upon to contribute in different ways.

Attendance:

Students should sign in at the beginning of each class. A sign-in sheet will be provided by the instructor.

Grading:

Homework and Class Participation	25%
Mid-term Exam	25%
Journal Article Critique	10%
Class Project*	40%

**The class project will be a group effort. Therefore, an individual's class-project grade is contingent on a participation "weight" that will reflect their contributions by anonymous evaluation of the individual's peers.*

There will be no final exam in this course. The class project will take the place of the final examinations.

Homework

Homework is to be done individually (unless stated otherwise) but you may certainly seek advice from your group and others.

Format:

- Unless the problems are very short, begin each problem on a new sheet.
- Always restate the problem indicating the given information, desired information, and explain your method. Make liberal use of comments.
- Make liberal use of sketches
- Always use units in your calculations and on graphs. For quantitative problems, please underline, box, or highlight the final answers
- Above all, **BE EXTREMELY NEAT**.

Journal Critique

The journal critique will be worked on individually. In this assignment, you will find a journal article on a sustainability topic, and use what you have learned in the course to discuss and criticize the content. The article you choose to critique must come from a peer-reviewed scientific journal that has been published within the past 5 years. You may use the library search engine to find some articles related to sustainability topics. A few journals are suggested in the syllabus. It's also easier if it's something you find interesting.

A few suggestions and guidelines to follow:

- Write between 500-600 words discussing the good points and bad points of the article.
- A 100-150 word summary on the article can provide a great amount of context. Don't write more than 150 words summarizing the article. This is not meant to be a summary, it's a critique.
- A good way to critique the article is also to compare it to results and methods of similar studies.
- Why did the results differ? How to the results agree?
- How did this article expand or fail to expand on a subject?
- How do the studies complement each other?
- Do NOT regurgitate their caveats.
- Papers submitted, longer than 600 words will not be graded (not including references).
- Submit the original article with your critique
- Try your best to use good english. Go to the student writing center if you need help http://www.communicationcenter.gatech.edu/.
- Format: Double-spaced, 12-point Times New Roman
- Citation Style: Nature (Will be easy if you use Mendeley - Mendeley is a free reference manager)

Class Project

The class project is to be worked on as a group. This project represents a group effort and each group will submit a final report. Sustainable solutions will require coordinated collective efforts with stakeholders who have diverse opinions and objectives. The group projects should be considered an opportunity to explore this approach.

Your class project will be divided into three (3) parts. For each part, your group will make an 8 to 12-minute presentation and submit a short write-up (2-4 pages) that highlights your progress from the previous submittal. In one way, your final report will be a culmination of these three write-ups. A more detailed rubric for your three write-ups and your final report will be provided in the future.

Your final report should not be unnecessarily long (20 pages max, excluding references and appendices), but should contain the following elements:

Abstract. Most technical journals require abstracts which summarize the content of a paper in one paragraph (~200-250 words). The abstracts may be written in the form used in scientific journals. Please include concluding remarks in the abstract. A good format is: (1) background / motivation / problem (optional), (2) objectives, (3) scope (optional), (4) methods, (5) results, and (6) significance of results. Every statement in the conclusion should be capable of undergoing careful scrutiny. Be concise, clear, and direct.

Introduction. The introduction should provide the reader with a concise statement of the theoretical and rational basis. It would be appropriate to follow the form frequently used in scientific journals for the introduction and succeeding sections. The introduction should explain what you have done and what the reader is to expect in the following sections. In other words, tell the reader what you have done and the relationship between what has been done by others and you work.

Materials and Methods. The material and methods that were used to gather, analyze and synthesize a solution to the issue should be discussed in this section. If this section is written correctly, the results and discussion section will be more concise and will focus only on the presentation of the results and interpretation the results. Additionally, this section should contain the goal and scope definition and the Life Cycle Inventory (LCI) phase of the lifecycle assessment (LCA). The LCI data should be provided in the appendix, and not in the main body of the paper. Finally, you must include your LCA rationale – what particular method did you use, and why?

Results and Discussion. Results should be summarized, tabulated, or plotted neatly. Particular attention should be paid to the units employed. S.I. units are preferred. **Sample calculations should be shown in the appendix**. Also reference the 12 Principles of Green Engineering. This section of the report gives greatest insight into the integrity of the writers. It is very easy to over interpret results. Caution should be observed in interpreting the results and alternatives should be considered.

Conclusion, Future Research and/or Investigation. Most good investigations raise additional questions that can not be addressed without additional time, talent and resources. The section should help focus the reader on what should be undertaken next. Your conclusion should be short paragraph about your recommendations and rationale without repeating what you stated in the results/discussion section.

References Cited. Please refer to the American Chemical Society guideline for the format that should be used and the manner in which references are cited (http://pubs.acs.org/userimages/ContentEditor/1246030496632/chapter14.pdf).

General Formatting. To keep the report easier to read, keep a 1.5 line spacing. The report must be a maximum of 20 pages, excluding references and appendices. **Reports longer than 20 pages**

(excluding references and appendices) will be returned without grading. If a revised report is not resubmitted prior to the submission deadline, the report will be graded up to the 20th page, meaning that all sections that follow (e.g., results and conclusion) will not contribute toward your final score. Additionally, you will receive **10 marks off your final project** grade.

Figure Formatting. Embed all tables and figures within the text. Do not provide them at the end of the main body of the paper. Make sure that the text in the figures, if any, is legible. The smallest font for embedded figures is size 9. REDRAW FIGURES IF NECESSARY. All figures and tables must be referred to in the main text body. We will discuss figures more in the class, but some examples are below.

Example of a Bad Figure. The following figure (Figure 3: Comparison of Midpoint Impacts) was submitted in a previous class report. Can you read any of the values? Can you read any of the categories? All fonts should be legible and easy to read, otherwise, your figure is useless. As you plot your figures, ask yourself, is this the best way to represent the data: do I need all this ink, can I read it, do the colors add to the representation of the data. Finally, the caption does nothing to tell me what is being shown on the figure. Captions should be descriptive and explain the figure, explain trends, and anything else that would make the understanding the figure easy.

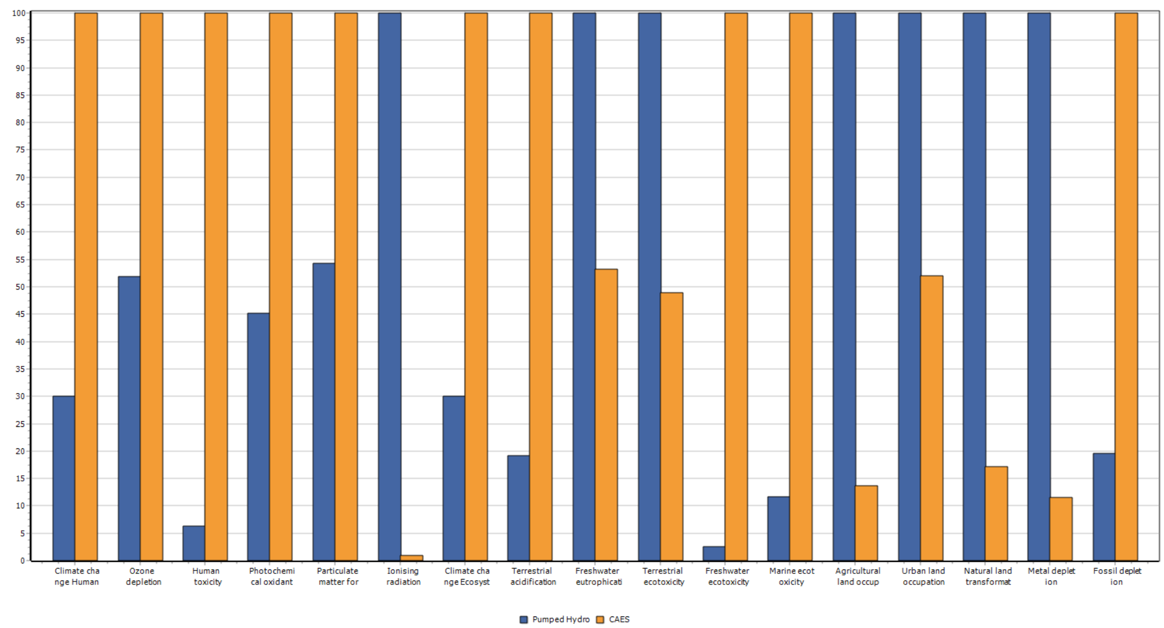

Figure 3: Comparison of Midpoint Impacts

Example of a Good Figure. Below is an example of a figure in one of our publications: James, J.-A.; Sung, S.; Jeong, H.; Broesicke, O. A.; French, S. P.; Li, D.; Crittenden, J. C. Impacts of Combined Cooling, Heating and Power Systems, and Rainwater Harvesting on Water Demand, Carbon Dioxide, and NO x Emissions for Atlanta. *Environ. Sci.Technol.* **2018**, *52* (1), 3–10.

Notice that the caption is descriptive. The caption describes what each of the different layers signify in this plot (i.e., the dashed line, the solid bars, and the crosshatched pattern). Even though the figure was reduced in size for the publication, it is still legible. The figure also makes use of patterns to add an extra layer onto the figure to show the additional change to emissions levels when existing buildings are also considered in the analysis. Finally, it makes use of different plot types (i.e., a line) to provide the reader with the baseline emissions for the study.

Criticisms. In retrospect, we should have chosen a sans-serif font, especially since it scales better (easier to read when resized to a smaller size). Moreover, some of the abbreviations used in the figure are described in the paper; however, should a person simply look at the figure, there is no explanation of what terms like MCG mean – this should have been reiterated in the caption. Finally, when printed in black and white, the dark purple and dark orange may be difficult to distinguish, making the use of color pointless for mass distribution.

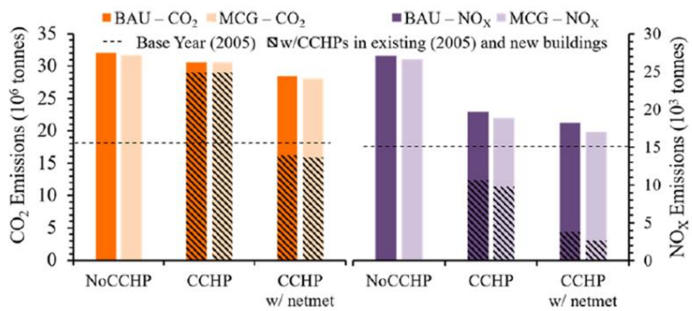

Figure 5. Total annual CO_2 and NO_x emissions of the 13-county Atlanta Metropolitan region, from energy consumption commercial and residential buildings for two growth scenarios. The dashed line represents the CO_2 and NO_x emission levels in the base year (2005). The solid bars represent the total emissions for existing and new buildings when only new buildings have CCHP systems. The crosshatched pattern indicates the CO_2 and NO_x emission levels if all buildings, existing and new, have CCHP systems.

Etiquette during classes, honor code, disabilities, and special arrangements

When you are in class you need to be focused: cellphones must be silenced and not used. Laptops and tables are allowed to take notes, but it is strictly forbidden to use them for other purposes. **Each time a student is caught browsing the internet, emailing or following social media, her/his participation grade will be reduced by 5 percent.**

All assignments and exams are strictly individual. Compliance with the Georgia Tech Academic Honesty Policy and Honor Code will be strictly enforced in the class. The text of the honor code can be found at: http://www.deanofstudents.gatech.edu/integrity/page.php?acadcode.htm.

Plagiarism, fundamentally, is representing someone else's work as one's own. Reproducing (even a small piece) of someone else's text exactly or restating someone's original ideas without attribution is strictly prohibited. It is always appropriate to cite the source or to use a quotation with proper attribution. It is also appropriate to credit any charts, graphs or other graphics (pictures, etc.) if they are not original, including when they have been slightly modified from the original.

There is a zero-tolerance policy for any violations of these rules. All violations are reported to the Georgia Tech Office for Academic Misconduct. If you have a documented disability and wish to discuss academic accommodations, please contact me as soon as possible. Please also let me know if you are an athlete with special requirements.

5. Course Content

Week	Day	Date	Module	Lecture Title	Deliverables
1	T	8/20/2019	1	Introduction to Sustainability and Sustainable Engineering	**HW1 Assigned**
	Th	8/22/2019	1, 2	Intro (Continued) / Energy and Climate Change	
2	T	8/27/2019	2	Energy and Climate Change (Cont.)	**HW1 Due** **HW2 Assigned**
	Th	8/29/2019	3	Geoengineering: Carbon Cycle	
3	T	9/3/2019	3	Geoengineering: Other Natural Cycles	**HW2 Due** **HW3 Assigned**
	Th	9/5/2019	4	Material Flow Analysis	
4	T	9/10/2019	5	Lifecycle Assessment	**HW3 Due** **HW4 Assigned**
	Th	9/12/2019	5	LCA (Cont.)	
5	T	9/17/2019	5	LCA Example	
	Th	9/19/2019	**Preliminary Group Project Presentation**		**Phase 1 Write-up**
6	T	9/24/2029	Tentative: SimaPro Workshop at BBISS		**HW4 Due** **HW5 Assigned**
	Th	9/26/2019	6	Grand Challenges for Sustainability	
7	T	10/1/2019	6	Grand Challenges: Tech Solutions	
	Th	10/3/2019	7	Risk Assessment	
8	T	10/8/2019	7	Risk Assessment	
	Th	10/10/2019		**Mid-term Examination**	
9	T	10/15/2019	**Fall Recess**		
	Th	10/17/2019	8	12 Principles of Sustainable/Green Eng.	
10	T	10/22/2019	9	Urban Sustainability	
	Th	10/24/2019		Interim Group Project Presentation	**Phase 2 Write-up**
	F	10/25/2019		**Withdrawal and Grade mode Deadline**	
11	T	10/29/2019	9	Urban Sustainability	
	Th	10/31/2019	9	Complexity Management	
12	T	11/5/2019	10	Introduction to Industrial Ecology	
	Th	11/7/2019	10	Metrics of Industrial Ecology	
13	T	11/12/2019	10	Sustainability Metrics	
	Th	11/14/2019	11	Economics and Social Sustainability	
14	T	11/19/2019	11	Economics of the Environment	
	Th	11/21/2019		**Flexible Days (Previous items may be moved down)**	
15	T	11/26/2019		**Flexible Days (Previous items may be moved down)**	
	Th	11/28/2019		**Thankgiving Break**	
16	T	12/3/2019		**Final Presentation**	**Phase 3 Write-up**
	Th	12/5/2019		**No Class**	
	F	12/6/2019		No Class	Journal Critique Due
17	Th	12/12/2019		**Final Reports Due / Group Member Evaluations Due**	
18	M	12/16/2019		**Grade submission deadline**	

6. Recommended Readings

Week	Module	Lecture Title	Recommended Readings
1	1	Introduction to Sustainability and Sustainable Engineering	McIsaac, G.F., Morey, N.C. Engineers' role in sustainable development: Considering cultural dynamics, *Journal of Professional Issues in Engineering Education and Practice* **1998**, *124* (4), 110-119 Crittenden. J.C. Engineering the quality of life. *Clean Techn. Environ. Policy* **2002**, 4, 6-7. Mihelcic, J.R., et al. Sustainability science and engineering: The emergence of a new metadiscipline. *Environ. Sci. Technol.* **2003**, *37* (23), 5314-5324. Sustainability and Engineering in New Zealand: Practical Guidelines for Engineers. Xu, M; Crittenden, C; et al. Gigaton Problems Need Gigaton Solutions, *Environ. Sci. Technol.* **2010**, *44* (11), 4037-4041.
1, 2	2	Energy and Climate Change	Chow, J., Kopp, R.J., Portney, P.R. Energy resources and global development. *Science* **2003**, *302*, 1528-1531. Pacala, S., Socolow, R. Stabilization wedges: Solving the climate problem for the next 50 years with current technologies. *Science* **2004**, *305*, 968-972. Washington, W.M., et al. How much climate change can be avoided by mitigation? *Geophys. Res. Lett.* **2009**, *36*, L08703. Fargione, et al., Land Clearing and the Biofuel Carbon Debt, *Science* **2008,** *319*, 1235-1238. Myhrvold, N.P., Caldeira, K., **2012**. Greenhouse gases, climate change and the transition from coal to low-carbon electricity. Environ. Res. Let, 7, 014019
2,3	3	Geoengineering: Carbon Cycle	Wigley, T. M. L., A Combined Mitigation/Geoengineering Approach to Climate Stabilization. *Science* **2006,** 314, 452-454 Victor, D. G., et al., The Geoengineering Option. *Foreign Affairs*, **2009**, *88*(2), 64-76 Stavins, R. N; The Costs of Carbon Sequestration: A Revealed-Preference Approach. *The American Economic Review,* **1999**, *89* (4), 994-1009 Kauppi, P; Sedjo, R; Technological and Economic Potential of Options to Enhance, Maintain, and Manage Biological Carbon Reservoirs and Geo-engineering, Chapter 4, *Climate Change 2001: Mitigation, IPCC Third Assessment Report*, **2001**, 301-344 Rockström, J., et al., **2009**. A safe operating space for humanity. Nature 461, 472–475 Barnosky, A.D., et al., **2012**. Approaching a state shift in Earth's biosphere. Nature 486, 52–58
3	4	Material Flow Analysis	Matthews, E., et al. *The Weight of Nations: Material Outflows from Industrial Economies*; World Resource Institute: Washington DC, 2000. Bringezu, S., et al. International comparison of resource use and its relation to economic growth: The development of total material requirement, direct material inputs and hidden flows and the structure of TMR. *Ecol. Econ.* **2004**, *51*, 97-124. Gerst, M. D; Graedel, T. E; In-Use Stocks of Metals: Status and Implications. *Environ. Sci. Technol.* **2008**, *42* (19), 7038-7045.

Week	Module	Lecture Title	Recommended Readings
4,5	5	Lifecycle Assessment	ISO. *Environmental Management: Life Cycle Assessment, Principles and Framework*; ANSI/ISO 14040, **1997**. Hendrickson, C., Horvath, A. Economic input-output models for environmental life-cycle assessment. *Environ. Sci. Technol.* **1998**, *32* (7), 184A-191A. Williams, E.D., Ayers, R.U., Heller, M. The 1.7 kilogram microchip: Energy and material use in the production of semiconductor devices. *Environ. Sci. Technol.* **2002**, *36* (24), 5504-5510. Hauschild, M.Z. Assessing environmental impacts in a life-cycle perspective. *Environ. Sci. Technol.* **2005**, *39* (4), 81A-88A. Scientific Applications International Corporation (SAIC). *Life Cycle Assessment: Principles and Practice*; US EPA: Cincinnati, Ohio, **2006**. Carnegie Mellon University Green Design Institute. Economic Input-Output Life Cycle Assessment (EIO-LCA) Model; http://www.eiolca.net/. National Renewable Energy Laboratory (NREL). U.S. Life-Cycle Inventory Database; http://www.nrel.gov/lci/. Duchin, F. Industrial input-output analysis: Implications for industrial ecology. *PNAS* **1992**, *89*, 851-855. Lave, L.B., et al. Using input-output analysis to estimate economy-wide discharges. *Environ. Sci. Technol.* **1995**, *29* (9), 420A-426A. Hendrickson, C.T.; Lave, L.B.; Matthews, H.S. *Environmental Life Cycle Assessment for Goods and Services, Chapter 2: Hybrid LCA Analysis*; Resources for the Future Press: Washington DC, **2006**.
6,7	6	Grand Challenges for Sustainability	Steffen, W., et al. *Global Change and the Earth System: A Planet under Pressure, Executive Summary*; Springer: Heidelberg, 2004. Costanza, R., et al. Sustainability or collapse: What can we learn from integrating the history of humans and the rest of nature? *Ambio* **2007**, *36* (7), 522-527. Liu, J., et al. Complexity of coupled human and natural systems. *Science* **2007**, *317*, 1513-1516. Kolpin, D. W., et al. Pharmaceuticals, hormones, and other organic wastewater contaminants in U.S. streams, 1999-2000: A national reconnaissance. *Environ. Sci. Technol.* **2002**, *36* (6): 1201-1211. Allenby, B. The industrial ecology of emerging technologies. *J. Ind. Ecol.* **2009**, *13* (2), 168-183.
7,8	7	Risk Assessment	US EPA. *Pollution Prevention (P2) Framework*; 2005 Cash, G.G. Prediction of chemical toxicity to aquatic organisms: ECOSAR vs. Microtox® Assay. *Environ. Toxicol. Water Qual.* **1998**, 13 (3), 211-216.
9	8	12 Principles of Sustainable/Green Eng.	Anastas, P.T., Zimmerman, J.B. Design through the 12 principles of green engineering. *Environ. Sci. Technol.* **2003**, *37* (5), 94A-101A. McDonough, W., et al., Applying the principles of green engineering to cradle-to-cradle design. *Environ. Sci. Technol.* **2003**, *37* (23), 434A-441A. The President's Council on Sustainable Development. *Towards a Sustainable America;* 1999.

Week	Module	Lecture Title	Recommended Readings
10,11	9	Urban Sustainability	Grimm, N.B., et al. Global change and the ecology of cities. *Science* **2008**, *319*, 756-760. Batty, M. The size, scale, and shape of cities. *Science* **2008**, *319*, 769-771. Li, K., et al. Development of a framework for quantifying the environmental impacts of urban development and construction practices. *Environ. Sci. Technol.* **2007**, *41* (14), 5130-5136.
11	9	Complexity Management	Bonabeau, E., Agent-based modeling: Methods and techniques for simulating human systems. *PNAS*. **2002**. 9, 7280-7287 Macy, M. W; Willer, R; From Factors to Actors: Computational Sociology and Agent-Based Modeling. *Annual Review of Sociology*. **2002**, *28,* 143-166 UN, The Millennium Development Goals Report, New York, **2005** Rees, W. E; The built environment and the ecosphere: a global perspective, *Building Research & Information*, **1999**, *27*(4/5), 206–220
12	10	Industrial Ecology	Jelinski, L.W., et al. Industrial ecology: Concepts and approaches. *PNAS* **1992**, *89*, 793-797. Frosch, R.A. Industrial ecology: A philosophical introduction. *PNAS* **1992**, *89*, 800-803. von Hauff, M., Wilderer, P.A. Industrial ecology: Engineered representation of sustainability. *Sustain. Sci*. **2008**, *3*, 103-115.
13	10	Sustainability Metrics	Rees, W., Ecological footprints and appropriated carrying capacity: What urban economics leaves out. *Environment and Urbanization.* **1992**, ***4*(**2), 121–130. Anielski, M; Rowe, J., *The Genuine Progress Indicator – 1998 Update.* **1999**. Redefining Progress Esty, Daniel C., Levy, M; Srebotnjak, T; de Sherbinin, A., *2005 Environmental Sustainability Index: Benchmarking National Environmental Stewardship*. **2005** New Haven: Yale Center for Environmental Law & Policy.
13,14	11	Economics and Social Sustainability	Costanza, R; Daly, H. E., Toward an ecological economics. *Ecological Modelling*. **1987**, 38 (1-2), 1-7. Costanza, R; et al; The value of the world's ecosystem services and natural capital, *Nature* **1997**, 387, 253-260 Costanza, R; et al., Managing Our Environmental Portfolio. *BioScience*. **2000**, 50(2), 149-155.
14	11	Economics of the Environment	Viljoen, J; Defining a business model for sustainability – does one size fit all? **2008.** *World Export Development Forum* Nidumolu, R; Prahalad, C. K., Rangaswami, M. R; Why Sustainability Is Now the Key Driver of Innovation, *Harvard Business Review*, **2009.** Papadakis, K; Socially sustainable development and participatory governance: legal and political aspects, **2006,** International Institute for Labour Studies Geneva Magretta, J; Growth through global sustainability. **1997**, *Harvard Business Review*, 79-88 Hart, S. L; Milstein, M. B; Global Sustainability and the Creative Destruction of Industries, *Sloan Management Review*, **1999** (Fall), 23-33

7. Useful Links

UN website:

http://www.un.org/esa/sustdev/index.html (UN Division of Sustainable Development)
http://www.unep.org/ (UN Environment Programme)

Indicators:

http://www.epa.gov/indicate/ (US EPA)
http://www.iisd.org/measure/ (International Institute for Sustainable Development)
http://themes.eea.eu.int/all_indicators_box (European Union)
http://themes.eea.eu.int/index_html#Sectors_and_activities (European Union)
www.sustainable-development.gov.uk/indicators/index.htm (United Kingdom)
http://www.epa.gov/iwi/ (Watersheds)
http://www.epa.gov/ost/biocriteria/index.html (Biocriteria)
http://www.worldbank.org/data/wdi2001/ (World Development Indicators)
http://www.met-office.gov.uk/research/hadleycentre/ (Climate Prediction & Research)

Construction:

http://www.rethinkingconstruction.org/ (Constructing Excellence)
http://www.cbpp.org.uk/ (Best Practices)
http:www.m4i.org.uk (Movement for Innovation)
http://www.ciria.org.uk/ (Indicators)

Waste:

http://www.epa.gov/osw/ (US EPA)
http://ewasteguide.info/ (Electronic Wastes)

Energy:

http://www.esource.com/public/default.asp (Energy Business Intelligence)
http://www.eren.doe.gov/ (Renewable Energy)
http://www.cee1.org/home.html (Consortium of Energy
Efficiency)

LCA:

http://iac.rutgers.edu/database/ (14,000+ Assessment)
http://hpb-1a.nrel.gov/lci/ (US LCI database)
http://www.epa.gov/nrmrl/lcaccess/ (US EPA)
http://www.life-cycle.org/ (LCA Links)
http://www.eiolca.net/ (CMU EIOLCA)

Listing of World Wide Environmental Agencies / NGO's:

http://www.worldbank.org/nipr/epas/index.htm (Listing of Agencies)
http://gemi.org/ (Global Environnemental Management Initiative)
http://www.sustainablebusiness.com/ (Sustainable Business)
http://www.wbcsd.org/ (World Business Council on Sustainable Development)
http://www.ceres.org/ (Coalition for Environmentally Responsible Economies)
http://www.globalreporting.org/ (Global Reporting Initiative)

http://www.ulsf.org/	(University Leaders for a Sustainable Future)
http://www.sdcn.org/	(Sustainable Development Communications Network)
http://www.environmentalsustainability.info/	(Environment Portal & Search Engine)
http://www.secondnature.org/	(Second Nature – Sustainable Education)
http://www.sustainableliving.org/	(Sustainable Living Network)
http://www.ucsusa.org/	(Union of Concerned Scientists)
http://www.epa.gov/oppt/greenengineering/	(The Green Engineering Program)
http://www.epa.gov/dfe/	(Designing for Environment Program)
http://www.epa.gov/cpg/	(Comprehensive Procurement Guidelines Program)
http://www.epa.gov/sectors/	(The Industry Partners Program)
http://www.epa.gov/epaoswer/hazwaste/minimize/	
http://www.epa.gov/p2/	
http://www.epa.gov/oppt/p2framework/	(The P2 Program)
http://www.epa.gov/epaoswer/non-hw/reduce/epr/	(The Product Stewardship Program)

Sustainability-related Journals:

http://www3.interscience.wiley.com/journal/118902538/home	(Journal of Industrial Ecology)
http://pubs.acs.org/journal/esthag	(Environmental Science & Technology)
http://www.elsevier.com/locate/jclepro	(Journal of Cleaner Production)
http://www.elsevier.com/locate/ecolecon	(Ecological Economics)
http://www.elsevier.com/locate/energy	(Energy)
http://www.elsevier.com/locate/enpol	(Energy Policy)
http://www.elsevier.com/locate/jenvman	(Journal of Environmental Management)
http://www.springerlink.com/content/100370	(Environmental Management)
http://www.springerlink.com/content/120154	(Sustainability Science)
http://www.elsevier.com/locate/resconrec	(Resources, Conservation and Recycling)
http://www.scientificjournals.com/sj/lca/	(International Journal of Life Cycle Assessment)