USF UNIVERSITY OF SOUTH FLORIDA

Educating the Engineer of 2020 : Environmental and Societal Impact of Engineering Practice

Purdue University
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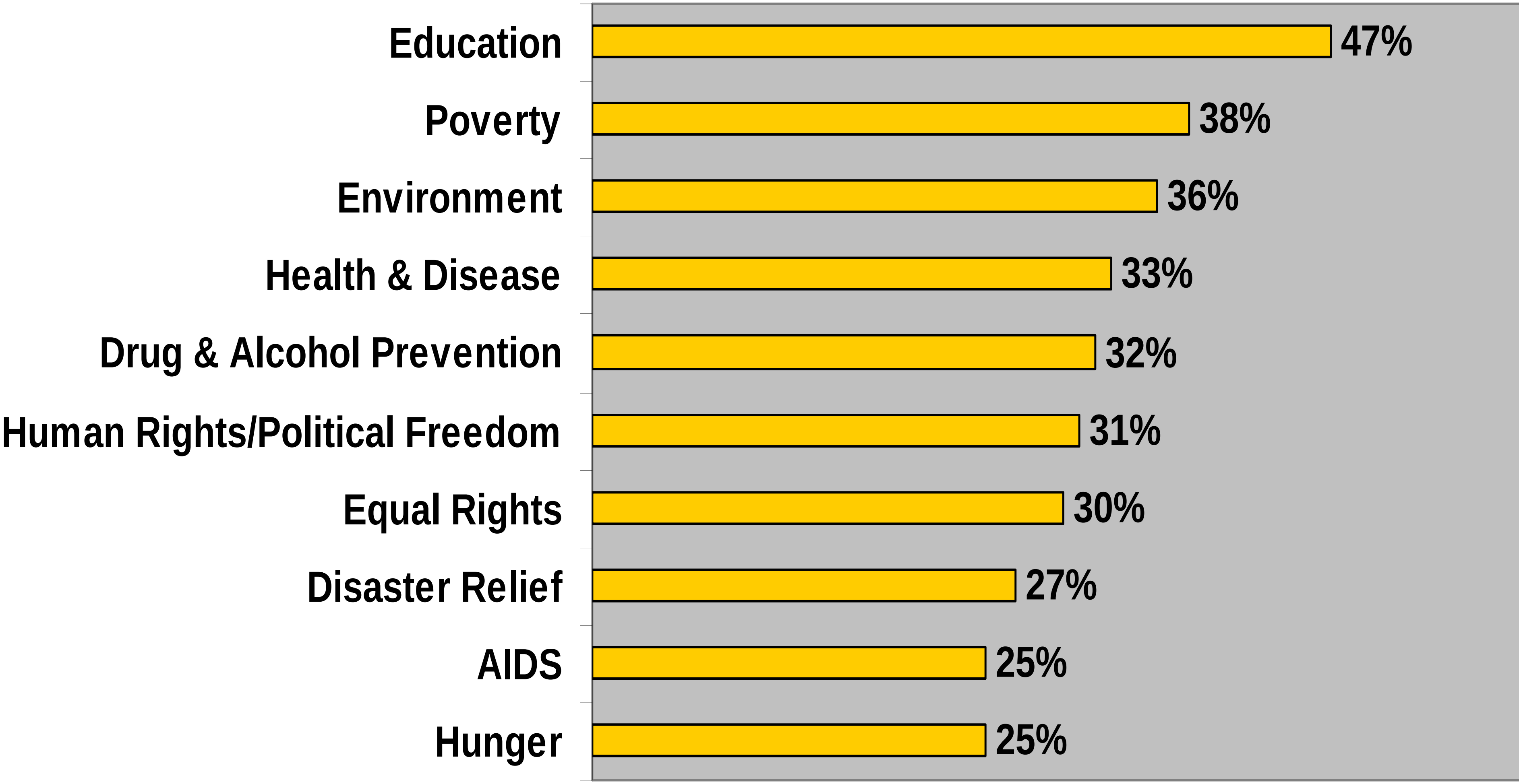
In response to a question about what they learned from their education and research experience, a graduate engineering student answered that

"along with gaining valuable engineering skills, they also learned what it was like to put engineering into practice while taking into consideration the social, economic, and environmental limitations of the developing world."

- perspectives on the importance of including environmental and societal impacts of engineering in the overall agenda of engineering education

Top 10 Causes on Millennials' Minds



2006 Cone, AMP Insights

Engineering Challenges per US National Academy of Engineering

- Achievements of 20^{th} Century

Grandest Engineering Challenges for 21st Century

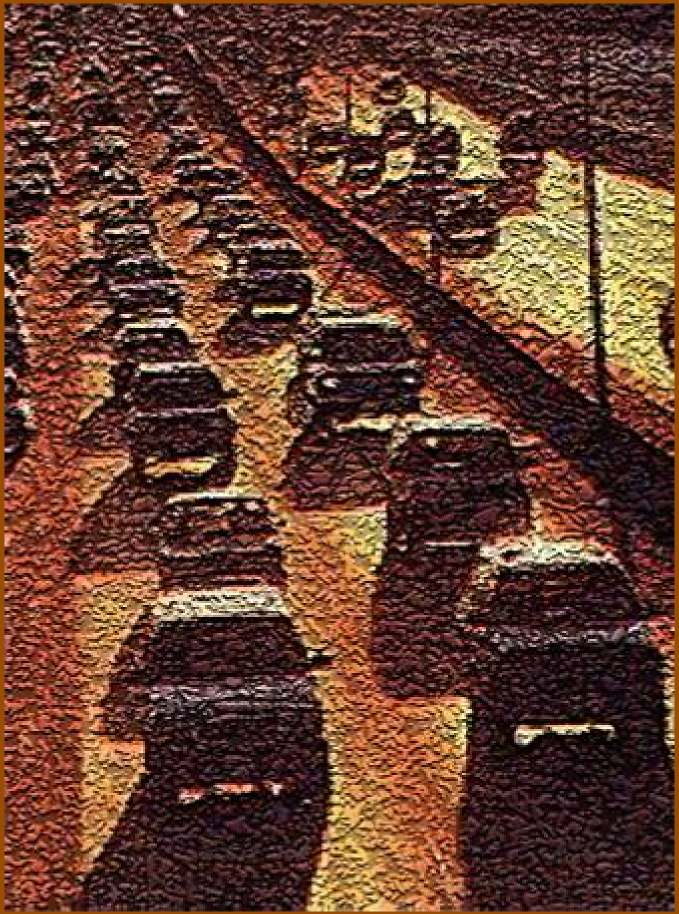
GLOBAL SOCIAL CHALLENGES

- Technology that addresses Social Issues
- Cannot be solved by Technology alone

Tom Katsouleas, PRISM Magazine May 2009

One Example

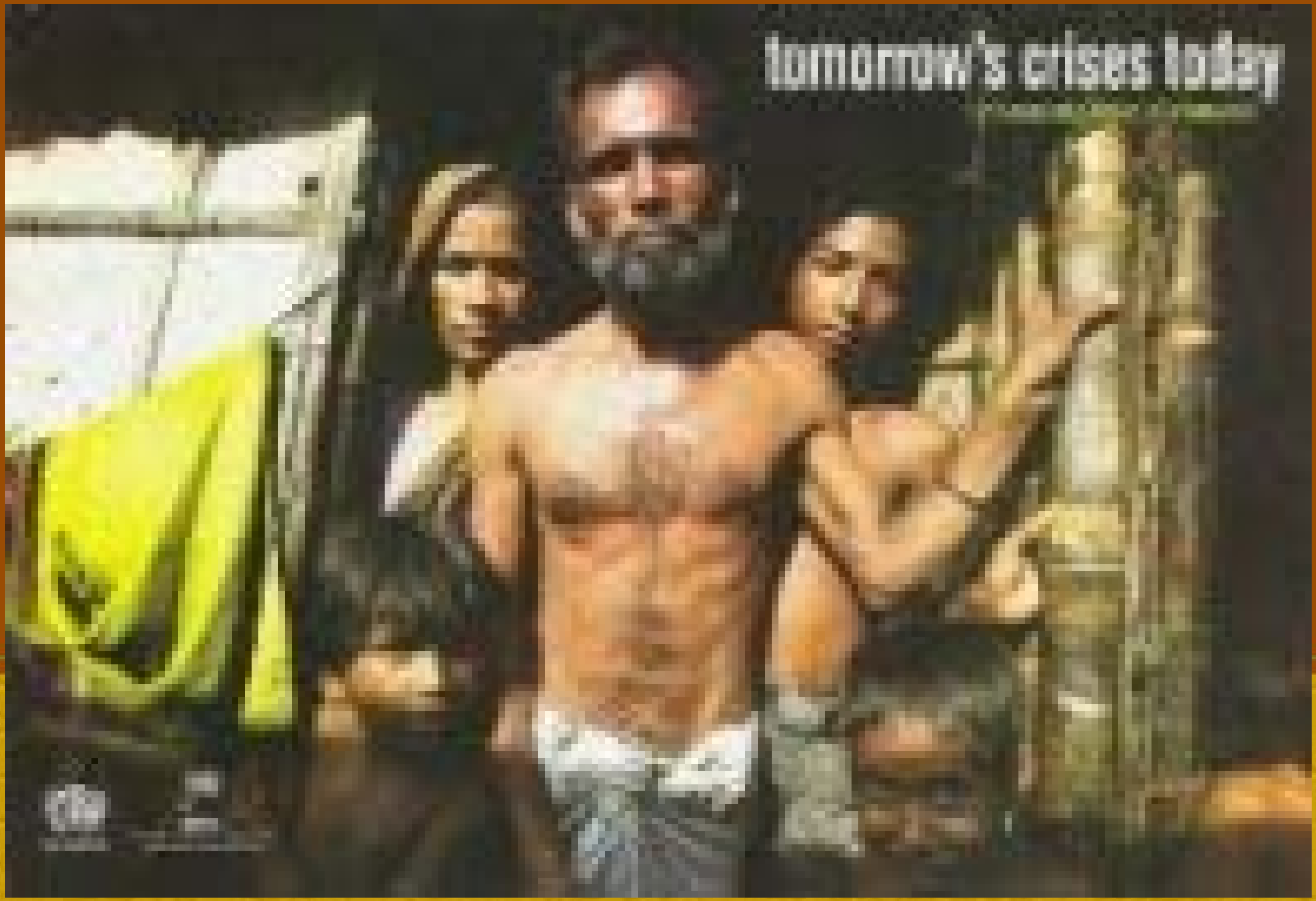
- In the 1990s, the number of U.S. cars increased six times faster than the population did from 1969 to 1995 (Alvord, 2000).
- The Copenhagen-based European Environment Agency (EEA) stated that more efficient engines may not be enough to offset shifts towards larger cars, increases in car and air travel, and increases in distance driven per person (Burke, 2000).



In simple terms

$$\begin{bmatrix}\text{Too Many} \\ \text{Widgets}\end{bmatrix} \times \begin{bmatrix}\dfrac{\text{Less Pollution}}{\text{Widget}}\end{bmatrix} = \begin{bmatrix}\text{More} \\ \text{Pollution}\end{bmatrix}$$

Humans are a feature of the built environment (photo from UN Habitat)



Urban features also include CHILDREN, the first casualties of slums.

Source: Zerofootprint,2008

The Millennium Development Goals can define innovation in engineering practice for decades

At the 2002 World Summit on Sustainable Development (Johannesburg), world leaders reaffirmed the principles of sustainable development adopted at the Earth Summit ten years earlier. One outcome was the development of the Millennium Development Goals (MDGs). The eight MDGs provide a global vision of development in which health and education are equal pillars of importance. They represent commitments to reduce poverty, hunger, ill health, gender inequality, lack of access to clean water, and environmental degradation

Source: Mihelcic et al., 2009

Conventional way to Evaluate Sustainability

Three Pillars of Sustainability

Environmental Social Economic

Evaluating Sustainability in a Different Context

Five Pillars of Sustainability

Environmental | Social-Cultural Respect | Political Cohesion | Community Participation | Economic

McConville, J.R., and J.R. Mihelcic, "Adapting Life Cycle Thinking Tools to Evaluate Project Sustainability in International Water and Sanitation Development Work," *Environmental Engineering Science*, 24(7):937-948, 2007

- Environmental Sustainability implies that non-renewable and other natural resources are not depleted nor destroyed for short-term improvements.
- Economic Sustainability implies that sufficient local resources and capacity exists to continue the project in the absence of outside resources.
- Socio-Cultural Respect implies that the project is socially acceptable because it was built on an understanding of local traditions and core values.
- Community Participation implies a process which fosters empowerment and ownership within members of the community through direct participation in decision-making about development that will affect the community.
- Political Cohesion involves increasing the alignment of development projects with host country priorities and coordinating aid efforts at all levels (local, national, and international) to increase ownership and efficient delivery of services.

McConville, J.R., and J.R. Mihelcic, "Adapting Life Cycle Thinking Tools to Evaluate Project Sustainability in International Water and Sanitation Development Work," *Environmental Engineering Science*, 24(7):937-948, 2007

- **Discussion of initiatives at the University of South Florida that help develop teaching ideas, approaches, methods, that help students appreciate the importance of E+S impacts of engineering (and recommendations for what Purdue can do)**

Thanks to Linda Phillips, Qiong Zhang, Maya Trotz, Daniel Yeh, Amy Stuart, Sarina Ergas, Jeff Cunningham, Peter Stroot, Delcie Durham, Linda Whiteford, Rebecca Zarger, Bob Brinkman, Yogi Goswami, Norma Alcantar……………

- I will move from undergraduate classroom to doctoral education and research to larger programs

Teaching risk, ethics, justice……….

Educate engineers how their decisions may burden disadvantaged segments of society and ecological systems with a greater (and unfair) amount of environmental risk.

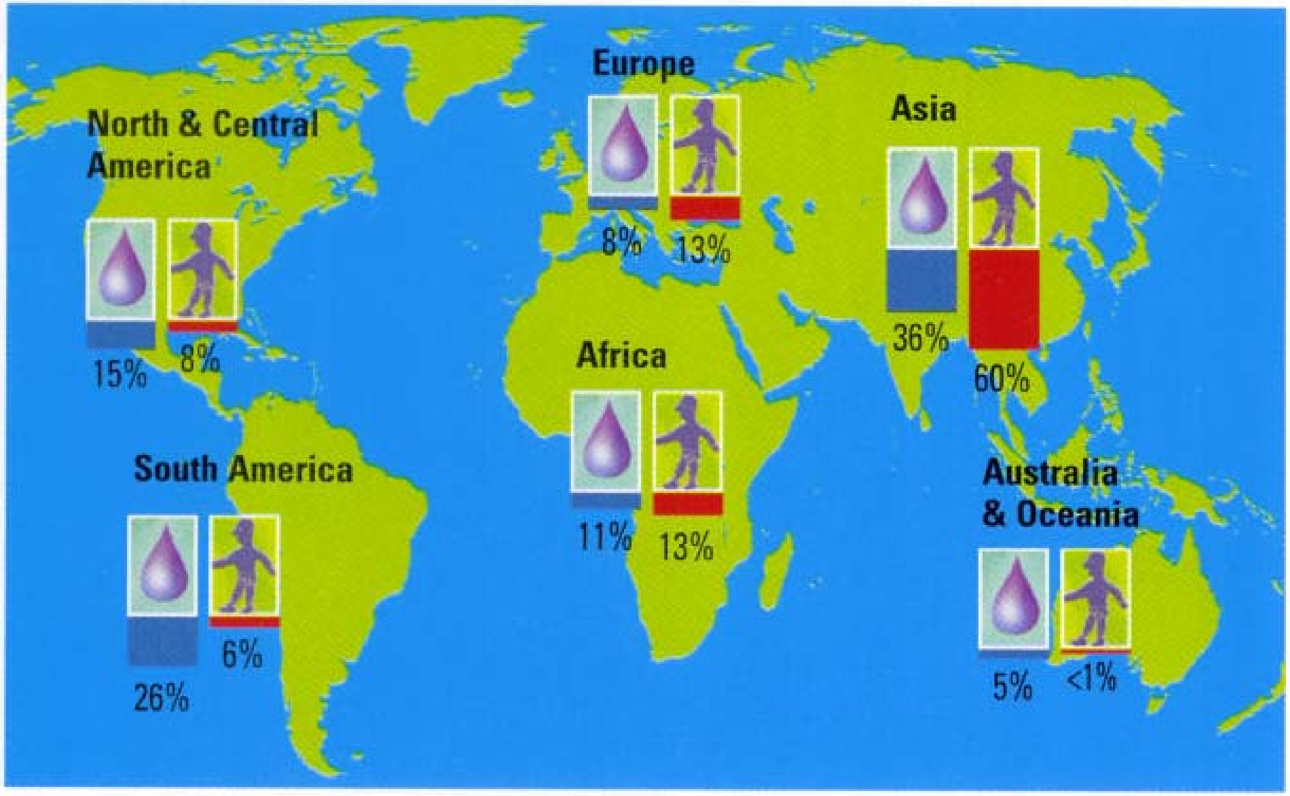
Carrying capacity, equity, regional and global disparities, service learning, etc. are all ways to integrate discussion of these important topics into our classrooms.

"All people, whatever their stage of development and their social and economic conditions, have the right to have access to an adequate supply of safe drinking water."

–World Health Organization

Water availability versus population

(from UNESCO-WWAP, 2003)



Typical Learning Objectives based on:

FOUNDATIONAL KNOWLEDGE; the understanding and remembering information and ideas,

APPLICATION; skills, creative and practical thinking, and managing projects.

Fink's Taxonomy of Significant Learning being applied to integrating sustainability into engineering curriculum

Category of Significant Learning	Description	Special Values
Foundational Knowledge	Understanding and remembering information and ideas	Provides the basic understanding that is necessary for other kinds of learning.
Applications	Skills, thinking (critical, creative, and practical thinking), managing projects	Allows other kinds of learning to become useful.
Integration	Connecting ideas, people, realms of life	The act of making new connections gives learners a new form of power, especially intellectual power.
Human Dimension	Learning about oneself and others	Informs engineers about the human significance of what they are learning.
Caring	Developing new feelings, interests, values	When engineers care about something, they then have the energy they need for learning more about it and making it a part of their lives. Without the energy for learning, nothing significant happens.
Learning how to Learn	Becoming a better student, inquiring about a subject, self-directing learners	Enables engineers to continue learning in the future and to do so with greater effectiveness.

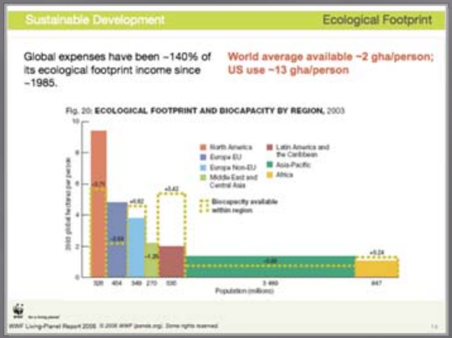
Tools

Learning Objectives

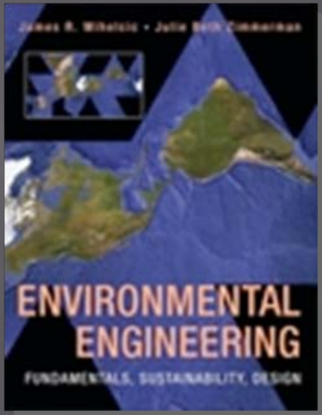
Learning Activities

Learning Assessments

Learning Suites



Teaching Slides with notes



This work was made possible by the National Science Foundation's DUE#0717428 | © Jane Qiong Zhang and Linda Vanasupa

Environmental Engineering: Fundamentals, Sustainability, Design

(Mihelcic and Zimmerman, John Wiley, 2009)

Expanded content for 21st century issues

Topics Integrated	Sustainability, energy, climate, social justice, people, risk integrated throughout
Global Outlook	Provides window to global environmental problems and solutions
Justice and Design	Illustrates link between social and environmental justice, design and practice.

We use many nontraditional education and research partners that get our classroom and research into a community (communities, municipalities, nongovernment organizations)

6 credit International Capstone Design Integrates Practice with Communities http://cee.eng.usf.edu/ICD




Master's International Peace Corps http://cee.eng.usf.edu/peacecorps

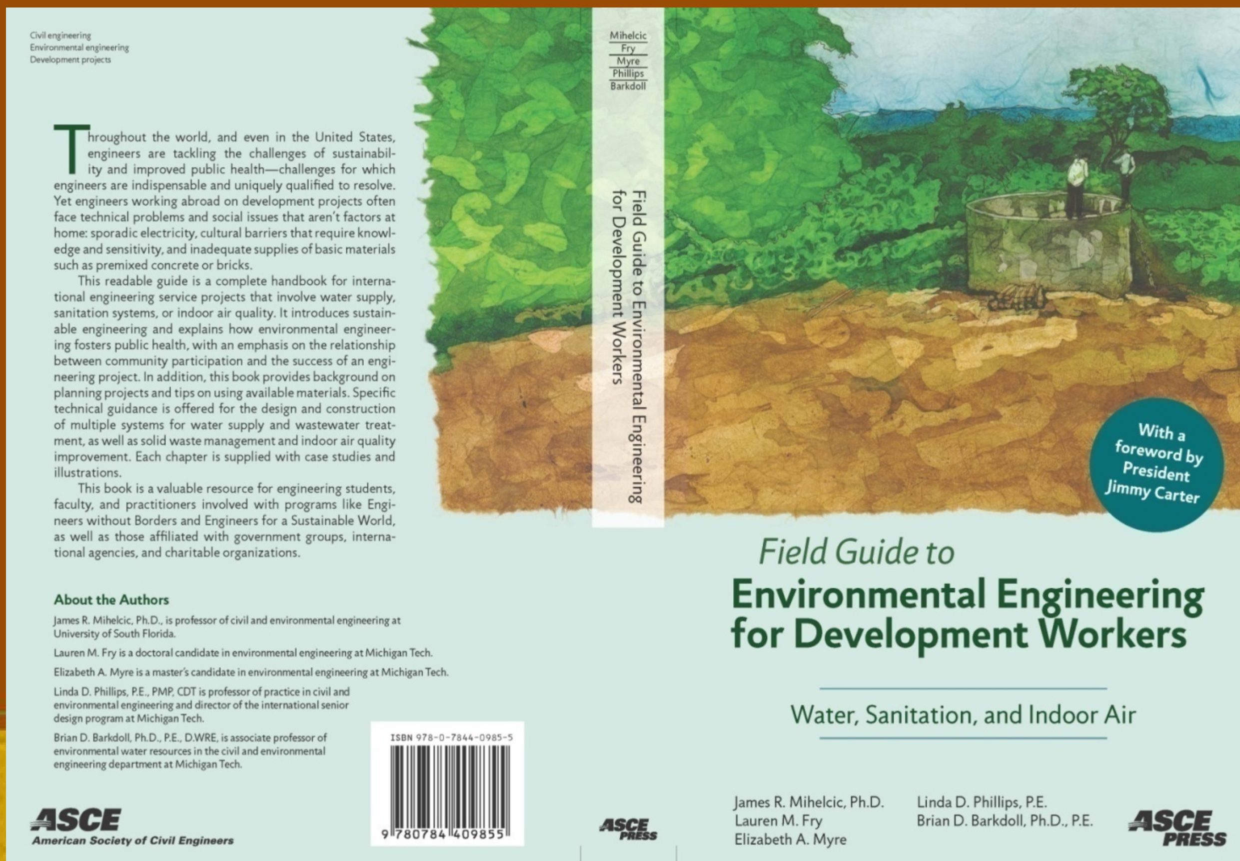
- Sustainable Development Engineering
- Global Health Assessment Strategies
- Research Methods in Applied Anthropology

Language and Graduate Certificate in "Water, Health, Sustainability"




Our Classrooms and Laboratories

Mihelcic, J.R., et al.,
Field Guide in Environmental Engineering for Development Workers: Water, Sanitation, Indoor Air
American Society of Civil Engineers (ASCE) Press, 2009.



Chapters on health, community participation, project management

Provide Opportunities for doctoral students to integrate social and environmental issues in the classroom and with their dissertation research and scholarship

NSF programs 1) Bolivia, and 2) with UNESCO-IHE focused on technology to meet the Millennium Development Goals

Education: Evolution of Courses and Strategic use of Certificates

Sustainability Concepts: Interdisciplinary Graduate Course that uses a case study approach and field experiences in Tampa and overseas. Courses are taught through the departments of Civil and Environmental Engineering, Geography, and College of Public Health

Green Engineering for Sustainability:

Graduate & Undergraduate Certificates: For example, at USF we have a new graduate certificate in Water, Health, Sustainability that has coursework in engineering, science & policy, health, and anthropology

Multi-Disciplinary Doctoral Graduate Fellowship Program at the Water-Energy-Materials-Human-Nexus

(supported by U.S. Department of Education)

The nation has an unprecedented need for engineers who can understand sustainability and solve problems around the water-energy-materials-HUMAN interface.

These engineers must be trained to develop and use integrative assessment methods to evaluate impacts and trade-offs for these interdependent infrastructures and their relationship to societal needs.

Lastly, an example from Practice

Water Environment Federation Technical Exposition & Conference (Oct, 2009)

Workshop 212: Managing Wastewater as a Renewable Resource: A Socio-Technological Framework and Assessment Technique