

On May 8, 2007 in the UWMC theatre, Jon Foley presented the final public lecture of the 2006-2007 UWMC Shared Reading program. Dr. Foley is the Director of the Center for Sustainability and the Global Environment (SAGE) at the University of Wisconsin-Madison. His research group studies the interactions between complex global environmental systems and human societies, using state-of-the-art computer models and satellite measurements to analyze changes in land use, ecosystems, climate and freshwater resources across local, regional and global scales. His talk was entitled: "Living on a Shrinking Planet: Challenges & Opportunities for a Sustainable Future"

Dr. Foley began by describing how we are living in, perhaps, the most interesting time in human history. This conclusion is based on two observations. First, we are the first generation that can take a truly planetary perspective. Over the last century, human societies and economies have become increasingly interconnected over vast distances. We have also been able to send people and machines into space. The pictures sent back reveal an isolated and finite Earth: the only home we will ever know. Second, history is accelerating. Not only have there been dramatic changes in culture and technology, the rate of change is accelerating. From an *Affluenza* perspective, the increasing rate of consumption is the most significant. Ever increasing consumption results in depletion of non-renewable resources and greater production of waste products, such as CO<sub>2</sub>, that are overwhelming natural waste assimilation processes. According to Dr. Foley, there is no historical parallel to these realities.

But why does this matter? According to Dr. Foley, it matters because the planet is starting to respond to our actions. One way is through the effects of CO<sub>2</sub> on the oceans and atmosphere. As atmospheric CO<sub>2</sub> concentrations increase, some CO<sub>2</sub> dissolves in the ocean, producing carbonic acid, thus making the oceans more acidic. If this continues, the chemistry of coral reef production will be inhibited, resulting in further declines in some of the most productive ocean ecosystems. Also, CO<sub>2</sub> is a greenhouse gas. Therefore, as the atmospheric CO<sub>2</sub> concentration increases, more heat is trapped on the planet, leading to increased temperatures and climate change. Dr. Foley pointed out that this is basic chemistry and physics. But, what evidence is there that any of this is happening?

To answer this question, Dr. Foley presented some of the evidence. First, a 2000 year climate record of the northern hemisphere indicates a temperature spike beginning around 1900. Since then, the global average temperature has increased 1° C. The significance of this seemingly small change was made clear when Dr. Foley explained that during the last ice age, the global average temperature was only 3° C cooler than today. On a planetary scale, small temperature changes can have large effects. Further evidence includes the fact that ten of the hottest years on record have occurred in the last fifteen years. Most glaciers and ice fields are losing mass, and where the mass of ice is increasing, the increase is consistent with climate change models. Arctic sea ice is also declining. In addition, biological systems are responding in ways consistent with climate change predictions. Evidence is lacking for one thing however: the idea that global climate change is *not* happening. In fact, Dr. Foley discussed a recent study of the peer-reviewed scientific literature on climate change. Of 928 papers published between 1993 and 2003 that

listed the keywords "climate change", *every single one* agreed with the consensus that greenhouse gas emissions are a major driver of climate change.

The bad news is, of course, that things are even worse. According to Dr. Foley, climate change is only one symptom of a much larger problem. He then discussed an issue also addressed by Bill Rees in a previous talk: ecological overshoot. Human activity has pushed the planet beyond its limits. As examples, Dr. Foley described how 40% of land has been converted to human use, 80% has experienced disturbance by humans, and that 40% of the products of photosynthesis are appropriated by humans. In addition, 50% of fresh water is used in some way by humans, and nutrient pollution, especially nitrogen and phosphorus, has increased since the advent of industrial agriculture.

Dr. Foley put all of this in other words: it's all hitting the fan at the same time. The most important environmental issues are no longer local; the entire biosphere is threatened. The list of global problems he provided is daunting: 1) shrinking arctic sea ice, 2) plant ranges expanding northward, 3) increased fires in tundra biomes, 4) potential positive feedbacks that may accelerate climate change, 4) bleaching coral reefs, 5) ocean acidification, 6) declining or collapsed fisheries, 7) tropical deforestation, 8) increased fire risk in the tropics, and 9) threats to unique cultures. The last point he explicitly called genocide.

*Genocide.* Dr. Foley's use of the word emphasized an important theme in his presentation: this is not just a scientific issue; it is a moral issue as well. Climate change, loss of ecosystem services, and ecological overshoot all conspire to have potentially devastating impacts on human well-being. Foley and his colleagues recently completed a study that conservatively estimates that 150,000 people die each year due to the direct effects of increased temperatures. This estimate does not include mortality and morbidity due to climate-induced changes in food security, natural disasters, infectious disease dynamics, water shortages, or economic disruptions. Perhaps more importantly, these impacts will disproportionately affect the poor. Another way that Dr. Foley explained the moral dilemma is that the people who will suffer the most from CO<sub>2</sub> emissions are the people who release the least CO<sub>2</sub>.

Many environmentalists claim that not only must we act, but we must act right now. Dr. Foley asked an intriguing question: why must we act *right now*? His answer: because we are running out of time. He then explained why this is the case. There is tremendous inertia in the climate system. When you burn a gallon of gasoline, about 20 pounds of CO<sub>2</sub> are emitted into the atmosphere, where it will stay for about 110 years. Also, the CO<sub>2</sub> being emitted will take about 30-50 years to effect the climate due to the heat capacity of the planet. This means that, even if we stopped all greenhouse gas emissions today, we are still committed to significant climate change. Therefore, decisions we make now will steer the climate for the next 300-500 years or more. Current estimates indicate that in order to avoid the worst case scenario, humanity must decrease its greenhouse gas emissions by 80% by 2050. Some estimates indicate that this means that the United States will need to cut emissions by 95%. Since this cannot be done overnight, we must start now. Dr. Foley and others think we have a 10-20 year window of opportunity to get this process underway. If we are lucky, that is.

Can this be done? Do we have the technology? The answer is: yes. Dr. Foley then presented the results of a study done by Stephen Pacala and Robert Socolow of Princeton University showing that the application of conservation and proven, available technologies could stabilize atmospheric carbon dioxide at levels that would avoid the worst case scenarios. Dr. Foley pointed out that this study illustrates a common theme: there will have to be multiple solutions; there is no magic bullet. What's more, Dr. Foley identified yet another theme: a lot of money can be made in the process. Getting to a sustainable world will require people to do things. Wind turbines and solar panels need to be built, assembled and maintained. Biofuels need to be grown, processed and distributed. Energy efficient buildings need to be built, purchased, and used by families and businesses. All of these things will create jobs and contribute to the economy. In addition, increased efficiency will decrease the energy costs to individuals and businesses alike.

As he ended his talk, Dr. Foley indicated that we are at a defining moment in human history. Because of our knowledge base, we have more opportunity now than ever before to improve human well-being. This will require that we learn how to plan on time scales of decades to centuries. He also agreed with Bill Rees in that knowledge leads to a moral imperative to act. Therefore, we must also maintain a moral compass as we try to determine who we are and who we could be.

### **Further reading:**

If you are interested in exploring in more detail the ideas presented by Dr. Foley, the following sources will get you started.

1. Completed in 2005, the Millennium Assessment (MA) describes the state of the world's ecosystem services and the effects of changes in ecosystem services on human well-being. The site provides a wealth of free resources, including pdfs of all MA reports and PowerPoint presentations. <http://www.millenniumassessment.org/en/index.aspx>
2. The Global Footprint Network analyzes the ecological footprint of the world and individual nations. It also has a calculator for determining your own ecological footprint. <http://www.footprintnetwork.org/>. In addition, it has published the Living Planet Report in cooperation with the World Wildlife Fund, which can be downloaded at: [http://www.panda.org/news\\_facts/publications/living\\_planet\\_report/lp\\_2006/index](http://www.panda.org/news_facts/publications/living_planet_report/lp_2006/index)
3. The Intergovernmental Panel on Climate Changes has available their most recent reports that can be downloaded as pdfs. <http://www.ipcc.ch/>
4. RealClimate is a web-site run by climate scientists. It contains multiple links to other websites, including those of climate change skeptics. <http://www.realclimate.org/>
5. The Union of Concerned Scientists provides information on multiple environmental issues, and provides personal actions that may help. <http://www.ucsusa.org/>

6. The September 2006 issue of *Scientific American* is devoted to renewable energy and decreasing greenhouse gas emissions, and includes an article by Stephen Pacala and Robert Socolow, whose work was described by Dr. Foley.

7. Jonathan A. Patz, Diarmid Campbell-Lendrum, Tracey Holloway, Jonathan A. Foley (2005) Impact of regional climate change on human health. *Nature* 438, 310 - 317.

8. Donella H. Meadows, Jorgen Randers, Dennis L. Meadows (2004) *Limits to Growth: The 30-Year Update* Chelsea Green, publishers.

9. Naomi Oreskes (2004) BEYOND THE IVORY TOWER: The Scientific Consensus on Climate Change. *Science* 306: 5702, p. 1686. See also: *LETTERS: Consensus About Climate Change?* Roger A. Pielke, Jr.; and Naomi Oreskes (2005) *Science* 308:5724, p. 952.