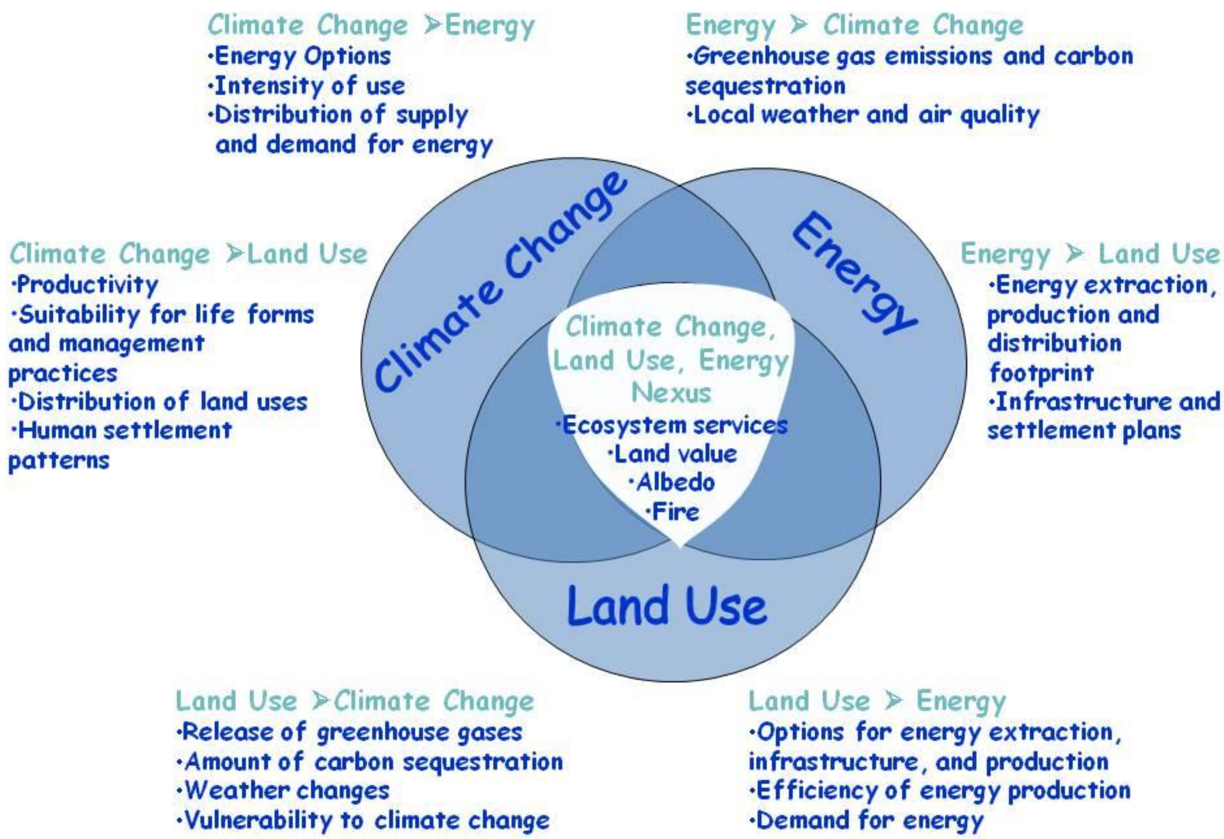
Summary of the July 2009 Forum
Center for BioEnergy Sustainability (CEBS)
"BioEnergy – Climate Coupling"

Virginia Dale, Director of CBES, opened the July forum by introducing the key interactions that are part of "The Energy-Climate Change-Land Use Nexus." The complexity of the relationships between energy, climate change, and land use are currently being explored by Virginia, Keith Kline, Rebecca Efroymson, and Arielle Notte. They have identified many of the interrelationships between these facets of the nexus:



Virginia illustrated the vast opportunities for modeling and data collection by examining the impact of fire on climate change, energy, and land use. Fires occur for many reasons ranging from natural causes to the use for fuel and agriculture. The data availability is low and the uncertainty is high making the study fire a strong candidate for research possibilities.

The "BioEnergy – Climate Coupling" is a Laboratory Directed Research and Development (LDRD) project of Oak Ridge National Laboratory (ORNL). John Drake, the principal investigator of the LDRD, presented his team's work on ORNL capability for projecting future potential and impact. He emphasized the importance of team building and a multidisciplinary approach in being able to address hard questions in understanding and predicting the effects of bioenergy development on the earths climate. Some of the fundamental processes were illustrated through the processes that govern of the land's surface energy balance.

Land-Surface – Climate Interactions between the incoming short wave solar energy and the outgoing long wave heat energy are affected by surface moisture levels as well as the moisture and chemicals content of the clouds. The earth's energy balance is a complex, nonlinear system that is reflected in shifting weather patterns and climate change. Modeling the interaction of the physical climate system with the terrestrial ecosystems and land use practices is partly limited by measurements. Alan Betts has remarked that "the large scale evaporation-precipitation feedback is difficult to characterize because there are no routine measurements for the central links in the chain."[1]

The Carbon-Climate change coupling is affected by food production, fuel demand, and the human pressures based on the population. One of the considerations in replacing fossil fuels with biofuel is the carbon payback time of converted land, which is the number of years it takes to for the carbon emissions saved to offset the carbon generated to convert existing land-cover to biofuel feedstock. It is estimated that the carbon payback time for tropical forest is 300-1500 years where it is less than 100 years for grasslands. The question of carbon payback time for other land-use was raised to illustrate that the full life cycle of carbon in the climate system.

The A1FI high-emission scenario from the IPCC is based on a global economy with equalizing standard of living (thus eventual population decline) in the developing world with an energy supply dominated by fossil fuels. The LDRD's scenario development does reflect changes in land use associated with an optimal deployment agricultural and bioenergy crops. The scenerio developed was based on a "story" or set of assumptions about how bioenergy would be deployed and was not based on economic modeling.

Forrest Hoffman and Bill Hargrove have developed a clustering technique that takes account of many ecological and climate variables in the "placement" of crops to produce land use projections into the future for 4 staple foods (maize, rice, soybean, and wheat) and 4 biofuels (cassava, oil palm, sugarbeet, and sugarcane). These projections take into account the changing ecoregions associated with temperature and precipitation shifts of a changing climate. The "global current, and two models, Hadley and PCM, and two scenarios each, A1 and B1, and two dates for each, 2050 and 2100. So this is 2 x 2 x 2 +1 = 9 copies of all the land on the planet at 4 sq km resolution, broken into 30 thousand common clusters." The LDRD is developing datasets at 1km resolution to determine optimal crop deployment and plans to make these available for reference to the broader community.

Dr. Drake reviewed the flaws in the BioEnergy – Climate Coupling "story" developed under the LDRD. These flaws will be addressed in the next phase of the project. The next iteration will incorporate land-use change and population projections as well as the lack of economic modeling. Jae Edmonds or Pacific Northwest National Laboratory (PNNL), Bill Collins of (Lawrence Berkeley National Laboratory (LBNL), and John Drake of ORNL are the proposal team for Integrated Earth System Model (iESM) project. The project goals are to:

- Create first generation iESM (human and physical components)

- Develop components to improve understanding of coupling/feedbacks: prognostic land use change, carbon budgets, bioenergy, ecosystems and agriculture
- Realistic, managed hydrology with economic coupling
- Advanced concepts for adaptation and water management

1) A. Betts, JAMES Vol. 1,No.4 (2009)

Presentation Slides