

Climate Change Effects on Forests: An Introduction to Issues

Environmental and Energy Study
Institute

Anthony C. Janetos

Joint Global Change Research Institute

11 February 2008

Battelle



**Pacific Northwest
National Laboratory**
Operated by Battelle for the
U.S. Department of Energy

2007 IPCC Conclusions

- The observed change in the climate system over roughly the past century is virtually certain to be due in part to human influences.
- The observed changes in climate are very likely to continue, and even accelerate during the current century.
- There are now many observed, well-documented impacts of changes in natural resources, animal and plant species, and ecosystems in many regions of the world.
- Impacts in the future are very likely to grow in both number and magnitude.
- Climate change and its impacts present challenges for adaptation in both the developing world, and as well among developed countries.

Overview of Possible Forest Effects

- ▶ Phenology and Productivity
- ▶ Ecosystem Processes
 - Carbon Storage
 - Water Flow
- ▶ Fire Frequency and Intensity
- ▶ Pests
- ▶ Shifting Species on the Landscape

Phenology and Productivity

- ▶ Good satellite-based evidence of broadening of growing season in northern temperate latitudes in North America
- ▶ Some evidence, but not broad, that productivity has increased
 - Many interacting factors on this last point (e.g. N deposition)
- ▶ Some forests already responding very dramatically to drought stress - large mortality events

Ecosystem Processes

- ▶ Results from CO₂ enhancement experiments on forest stands show range of results
 - Higher productivity, but extra C goes into short-lived pools (fine roots, twigs), not trunk growth or long-lived soil pools
 - Strong interaction with ozone concentrations
- ▶ Effects on other processes and services, e.g. water balances, not as well understood

Fire Frequency and Intensity

- ▶ Models have suggested for many years that increased fire risk and frequency was an important issue
- ▶ Now have examples of changes in fire frequency and intensity clearly driven by climate variability
- ▶ This, too, a story of multiple causative factors - interaction with fire suppression and pests

Pests

- ▶ Classical response of environmentally stressed forests - greater pest infestations on weakened trees
- ▶ Seeing this clearly in several places in the US (Rockies, Southwest, Southeast)
- ▶ But also seeing pest infestations that are a direct response to changes in climate variability, especially in winter temperatures



Shifting Species on the Landscape

- ▶ For the past 20 years, modeling studies have suggested that a major impact in the long term would be movement of species to new “climate space”
- ▶ How rapidly this would happen is not clear - models vary as to how well they simulate time-frames, and don't have really good regional climate simulations
- ▶ But do have examples now of tree-line changes and shifts in alpine vegetation
- ▶ Likely that the general conclusions from models are robust in this regards

Adaptation and Research

- ▶ Seeing impacts now
- ▶ Not a lot of guidance for the agencies to follow in terms of adapting to or coping with current or future change from climate (GAO report)
- ▶ Clearly need to devote effort to understanding what management actions make sense

Main Conclusions

- ▶ Climate is indeed driving many ecosystems across thresholds that are important for managers to consider;
- ▶ The consequences of known thresholds challenge our current capacity to manage those ecosystems sustainably; and
- ▶ We require both better management techniques and a much better predictive capability to use our knowledge of thresholds more effectively in building adaptive management capacity.

Adaptation and Coping

- ▶ Because changes occurring now, have both coping to current circumstances and questions about planning for future circumstances to consider
- ▶ Requires some knowledge of regional climate changes and environmental consequences
- ▶ Requires information on current practices for coping and understanding of factors that control vulnerability
- ▶ Requires ability to model effectiveness of adaptation strategies as part of integrated response portfolio

Research Agenda

- ▶ Suggests that most important knowledge to get as quickly as possible is information about potential end-points and lag-times.
 - Importance of ecological modeling and monitoring
 - Importance of better regional climate change information
 - Importance of understanding potential costs and effectiveness of adaptation and management strategies
- ▶ What are potential magnitudes of important end-points?
- ▶ Are there thresholds we must worry about?
- ▶ To what degree is there sufficient ecological “buffering” to guard against cascading effects?
- ▶ What are the implications for atmospheric greenhouse gas concentrations and therefore emissions and mitigation costs?
 - Need integrated way of understanding potential portfolio of actions and their consequences
 - Collaborations of Ecosystem modelers, Integrated Assessment modelers and Earth System modelers have a lot of promise here