



# Climate Change, Uncertainty and Forecasts of Global to Landscape Ecosystem Dynamics

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## Overview:

- **Multi-Scale Assessment**
  - Global to Local Scales
  - Near to Long Term Scales
    - Natural Climate Variability – Near term Variability vs. Long term trends
    - Historical Management Legacy – e.g., Fire Suppression
- **Natural Resources and Issues of Concern**
  - Biodiversity – Vegetation Type and Species Distribution
  - Global Carbon Balance – Sources and Sinks, Forest Productivity
  - Catastrophic Disturbance, e.g. Fire and Infestation
- **Management Of Change, per se**
  - Perpetual Uncertainty
  - Toolbox for Managers

**Scenario Development** by the Intergovernmental Panel on Climate Change (IPCC) of the U.N. Framework Convention on Climate Change (UNFCCC), documented in the "Special Report on Emissions Scenarios" (SRES).

- 1) Socio-economic scenarios are developed first, e.g.
  - a. Business as usual (similar to A2 SRES scenario)
  - b. Relatively 'green' stabilization scenario at 750 ppm CO<sub>2</sub>, e.g. SRES A1B
  - c. Much greener stabilization at 550 ppm, e.g. SRES B1
- 2) From 1, above, greenhouse gas emissions scenarios are developed
- 3) From 2, above, greenhouse gas atmospheric concentration timeseries are developed.

**Uncertainty arises between different SRES scenarios and General Circulation Models** with respect to the amplitude of temperature changes and the regional patterns and amounts of precipitation changes.

## Global Impacts – In Progress Now

- **"Early greening – later browndown"** (LPJ and MC1 Dynamic General Vegetation Models (DGVMs) running under numerous future climate scenarios)
  - Initially, **carbon gains from mild warming** outweigh carbon losses
  - **ET and decomposition increase exponentially with temperature** and eventually overcome productivity increases, producing net carbon losses, with **potential for large-scale, catastrophic forest dieback. Positive Feedback to warming.**
  - Boreal and Temperate forests could show **regional increases in biomass consumed by fire of 20% to 60% or greater over large areas of the globe.**
  - **High risk of water shortages in temperate and subtropical regions**
  - Plant migrations will not be able to keep up with climate change
    - Rapid migrators (pests, weeds) will invade communities that house T&E species, which tend to be very slow migrators
    - **Potential for mass extinctions**

## Regional Impacts – In Progress Now

- **Regional Legacy of management activities**, e.g.
  - Fire Suppression and Exclusion
  - Grazing, Harvest, Agricultural Abandonment
- **Interdecadal climate variability** is manifest as persistent regional droughts, floods, cold spells and hot spells and could be enhanced by GHG-induced climate change, creating **significant uncertainty at the regional scale in the near term**.
- **Possibly wetter in the West, Drier in the Eastern U.S.**
- Large potential for **increased woody expansion (carbon sequestration) in the West**, but accompanied by increased fire
- Initial growth increases possibly followed by **widespread drought, infestation and fire in the Eastern U.S. temperate and subtropical forests**. Possible conversion of forests to savannas, woodlands and grasslands.
- **Widespread, catastrophic ecosystem dieback potential** in both eastern and western woody ecosystems.
- **Large migration potential** of subtropical (frost-intolerant) vegetation and wildlife into temperate ecosystems (Infestations, Weeds, increased competition for T&E species)

## Local Impacts – In Progress Now

- Several **statewide assessments have been published for California**
  - Considerable vegetation composition change
  - Increased fire risk in coastal and inland mountains
- **Very few process-based landscape-scale simulations of climate change** impacts have been done. Glacier National Park is a good example.
- **Landscapes will be significantly transformed by:**
  - Phenology shifts
  - Physiognomic change
  - Considerable migration
  - Potential dieback in specific landscape locations
  - Shifting elevational ecotones, both up (higher temperatures) and down (enhanced moisture)
- **Interdecadal climate variability significantly increases the uncertainty** at the landscape scale in the near term. This is the scale at which management puts ‘boots on the ground’.

## Management Toolbox

- Almost all current, commonly used, quantitative tools for forest planning, such as FVS, TELSAs and VDDT, do not explicitly take climate variability and change as inputs.
- These tools must be re-built to take climate variability and change directly as inputs, yet to retain the ‘look and feel’ of the commonly used tools
- Workshops between scientists and managers will help to design and refine these tools
- Socio-economic factors must be built into the models
- **Managers’ ‘worldview’ must change from managing for the *status quo* to managing for *change*, per se.**
- **Use scenario and risk analysis, since the future will ‘forever’ remain uncertain, but within definable bounds.**