Impacts of Climate, Drought, and Storms on Trees and Forests

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Weather vs. Climate

• Climate:
  • The average weather of a location or region over a long time scale (years, decades, centuries).

• Weather:
  • The current and anticipated condition of the atmosphere at a given point in space and time.
Weather vs. Climate: to put it another way

• Climate:
• Weather
Climate

• Climate is based on four prevailing factors:
  • Latitude
  • Altitude
  • Continentality
  • Proximity to regional and global circulations
    • Gulf stream, California High, trade winds, etc.
Climate

• How climate shapes the forest:
  • The driver of species range.
  • Each climate factor can affect a species range, even on a small scale.

• Assisted migration:
  • Anthropogenic shifts in species range in anticipation of climate change
  • What about the WEATHER?
Climate

- Prehistoric climate fluctuation
Climate
Oregon has a wide range of climates due to three primary climatic factors:

- Altitude, continentality, and proximity to the Pacific Ocean
- Less impact from a change in latitude due to the limited difference border to border
Climate

- Elevational gradient of climate and the affects on tree species
Climatic shifts

- Current shifting climates move an ecosystem to a higher stress state, resulting in increasing mortality.
Drought

• Types of drought:
  • Meteorological
  • Agricultural
  • Hydrological
  • Socioeconomic

• Climatic drivers of drought
  • Global circulations
    • ENSO, PDO, MJO, etc.

• The longer a drought persists the higher the impact.
  • Starts as weather, becomes climate
Drought: Small scale

• Cellular responses to drought:
  • Depends on the species physiology
  • Isohydric
  • Isohydrodynamic
  • Anisohyric

• The whole tree is involved, from the tip of the leaf to the smallest root.

From P. J. Franks et al.
Drought: Risk vs. Reward

**Isohydric:**
- **Risk:**
  - Carbon starvation
  - Reduced growth
  - Reduced competition effectiveness
- **Reward:**
  - Less risk of cavitation
  - Ready to go when conditions improve

**Anisohyric:**
- **Risk:**
  - Cell cavitation
  - Continued soil water depletion
- **Reward:**
  - Higher growth
  - Increased competition ability
  - Function in droughtier climates
Drought: Response to biotic agents

- Tree response changes based on the insect or disease attacking the tree and what is being attacked along with the degree of moisture stress.

**Table 4** Conceptual Table showing that the risk of damage due to drought depends on three components: (i) insect or fungus trophic behaviour (primary vs. secondary agents), (ii) type of affected tree part (foliar vs. woody organs) and (iii) water stress severity (relative to P50, the species specific index of drought tolerance)

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<thead>
<tr>
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<th>Mild water stress</th>
<th>Severe water stress</th>
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<tbody>
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<td><strong>Primary agents</strong></td>
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<td>Foliar organs</td>
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<td>Woody organs</td>
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<td><strong>Secondary agents</strong></td>
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<td>Woody organs</td>
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↓ Reduced damage in water-stressed trees.
↑ Increased damage in water-stressed trees.
→ Unchanged damage in water-stressed trees.

Drought: Response to biotic agents

• Drought predisposes trees to attack by primary and secondary damage agents, especially bark beetles and wood boring insects.
  
  • We see this in drought stressed trees,
  
  • fire damaged and stressed trees, and
  
  • in urban settings with the many stresses placed on urban trees
Recent droughts have had a visible impact on forests around the Willamette Valley:
  - Secondary insects and diseases caused significant branch flagging, top die back, and tree mortality.
Drought: Response to biotic agents
Drought: Large scale
Drought

• Management implications:

  • How to manage damaged stands?

    • Not all trees are damaged or killed

    • Difficult age class, too young to be commercial, too young to restart
Storm Damage

• Storm damage can be in many forms:
  • Chronic
  • Acute
  • Freezing
  • Wind events
  • Landslides
  • Lightning
  • Etc.
Storm Damage

• Oregon is no stranger to storm damage:
  • The Columbus day storm: 138 mph gust in Newport, 127 mph gust in Corvallis,
  • The 1996 floods,
  • 1950 snow storm:
    • January totals: 52 in. at Corvallis, 128 in. on Santiam summit, 74 in. on Sexton summit.
Storm Damage: Columbus Day 1962
Storm Damage

- November 2014 saw a freezing rain event that broke many tree tops
  - Aerially surveyed damage showed 6,600 acres of damage
  - Ground surveys showed much more.

- Increases stand risk to Douglas-fir bark beetle, secondary beetles
  - May start to see damage this spring
Storm Damage

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