Visualizing Regional Modeling Outputs within PINEMAP’s Decision Support System

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Pine Integrated Network: Education, Mitigation, and Adaptation Project

PINEMAP:

Six disciplinary Aims
- Monitoring
- Genetics
- Modeling
- Economics
- Education
- Extension

- 51 Co-PI’s at
- 12 Institutions and
- 8 Forest Research Cooperatives
- 5-year (now 6) project
- More than 100 current and legacy data sites
Pine Management Decision Support System

A set of tools that use climate data and regional productivity models to explore relationships of pine plantation management & climate and provide forest management guidance.

Pine trees grow for 15-35 years. So, how do we plan for the future?

How did we put it together?

The DSS combines future climate projections for the next 100 years (in 20 year slices) with the latest forestry research.
**DSS Tool Development - iterative process**

- Seedling deployment & environment tools: beta testing and refinements (~2 mth process each)

Let’s start with the climate data

**University of Idaho’s MACA**

- Multivariate
- Adaptive
- Constructed
- Analogs

- Statistical downscaling method – daily data
- ~6km resolution
- 20 different General Circulation Models from IPCC’s 5th Assessment
Two Future Climate Projections

Baseline
- 1950-2005
- Model has its own physics
- Simulated over this period/ compared to actual data- validates model!

1. Moderate level of Emissions
   (CO\textsubscript{2} Concentration)
- Reduced levels of emissions/CO\textsubscript{2} concentration
- Representative Concentration Pathway (RCP) 4.5 Watts/m\textsuperscript{2}
- 2006-2099

2. High Level of Emissions
   (CO\textsubscript{2} Concentration)
- Based on current trajectory
  - 2006-2099
  - RCP 8.5 Watts/m\textsuperscript{2}

Climate Data Projected out to 2099
- 20 year time slices: historical and future projections
Tools structured into Four Groups

1. Environment
   - Temperature
     - Extreme Minimum Temperature
     - Summer Temperature
   - Precipitation
     - Summer Precipitation
   - Drought
     - Summer Dryness Index

2. Establishment
   - Dynamic Hardiness Zones
     - Cold-Tolerant Markets for Nurseries
     - Source Ranges for Greater Productivity

3. Management
   - Tools coming soon!

4. Production
   - Tools coming soon!

Tools coming soon:
- extreme max temperature risk
- growing season length
- flood risk
- forest productivity model outputs
  - gross and net primary productivity
  - net ecosystem productivity
  - merchantable volume
  - carbon above ground
  - water stress, e.g. water yield

How does the DSS work?

- Select your tool

DSS Introduction

- Background
  1. About DSS Tools
  2. Data and Regional Product
  3. Climate Data
  4. Thematic Layer
  5. Title Series
- Pine Integrated Network: Education, Mitigation, and Adaptation Project

The image shows a decision support system for forestry management, offering tools to assess various environmental factors and their impacts on forest productivity.
How does the DSS work?

Location-based:
- Select a point on the map, or lat/long
- Change threshold

For future maps...
- Select your Emissions Scenario
- Select your time slice

<= historical avg number of days below freezing per year

Environment tools:
Extreme minimum temperature

1.5 – 9.2 fewer days with temperatures below freezing in 2020-2039 under high emissions

3-map layout!
Environment tools: Summer Precipitation

Up to 2.7 inches wetter or 1.1 inch drier

HUC 2-12 overlays & rivers/lakes layer

Historical average: 13.6 inches

Future Spread: 12.5 – 16.4 inches
Environment Tools: Summer Precipitation

- Spread of different 20 year time slices at that location
- Two different emissions scenarios
  - Left = moderate, right = high

Coming Soon: Water Yield (in mm)

Output from Water Supply Stress Index Model (WaSSI)
RCP4.5 2020-2039
PINEMAP DSS Tools

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New Tools Spring 2016

Pine Management Decision Support System

- http://climate.ncsu.edu/pinemap/

Note: screenshots were taken from our development version of the DSS so all features may not have been pushed to production (above link) yet
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PINEMAP DSS
Eye-Tracking Study Preliminary Results
(Slides courtesy of Lindsay Maudlin & Karen McNeal)
What is eye tracking?!

Reading - Free Exploration

Out of the total 5 minutes of free exploration time, the average amount of time spent reading is 127 seconds with a standard deviation of 63 seconds.

<table>
<thead>
<tr>
<th></th>
<th>Background</th>
<th>DSS Tools</th>
<th>Climate Data</th>
<th>Layout</th>
<th>Time Series</th>
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<tbody>
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<td>30</td>
<td>29</td>
<td>28</td>
<td>28</td>
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<td>1</td>
<td>2</td>
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Group A: Reading
Max number of counts (46.96)

Group B: Reading
Max number of counts (30.72)
Location Selection

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<th>Central NC</th>
<th>Raleigh</th>
<th>Columbia</th>
<th>Little Rock</th>
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<tr>
<td>Other</td>
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</table>

Determining a Value/Paths to Answering

**Extreme Minimum Temperature Tool:**
Question 1: Map legends were used heavily here but not much after (n=18).
Question 2: The three panel maps were not used often (n=6). The question was also answered with the time series plots (n=7). There was not an overwhelming majority.

**Summer Precipitation Tool:**
Question 1: Map text combined with the title were used by more than half (n=16).
Question 2: More than half (n=16) used just the bars to answer the time series question, and several more (n=7) used the bars and the legends.

**Seedling Market Tool:** This is where most of the confusion occurred.
Question 1: All of those with data (n=28) used the maps to answer.
Question 2: All of those with data (n=27) used the maps to answer.
Time Series

Most (n=28) found the time series. The majority just looked at the bars (n=18) where they either did mental math, hovered over the bars for more information and did mental math, or compared the sizes of the bars. The others (n=8) went back and forth between the bars and the legend. The average amount of time spent on this particular question was 58 seconds with a standard deviation of 33 seconds.
### Show Layer Options/FAQ/Tooltips Buttons

<table>
<thead>
<tr>
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<th>Show Layer Options (SMT Q2)</th>
<th>FAQ (Free Exploration)</th>
<th>FAQ (Any Task or Question)</th>
<th>Tooltips</th>
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<td>7</td>
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<td>26</td>
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</table>
Seedling Market Tool

Of those who found the 5 degree range button (n=19):
  The average time it took to find the button was 31 seconds with a standard deviation of 26 seconds.
  The average time it took to answer the question was 87 seconds with a standard deviation of 36 seconds.
Of those who did not find the 5 degree range button (n=12):
  The average time spent on the question was 89 seconds with a standard deviation of 58 seconds.

Group A:
5 degree range

Left: Max number of counts (21.87)
Right: Adjusted for the number of participants (17)
Group B:
5 degree range

Left: Max number of counts (16.30)

Right: Adjusted for the number of participants (14)