Southern Pines at Risk? Mapping the Future

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Introduction

Climate change poses a direct threat to the well-being of millions of landowners and others employed by the industry. Erratic weather and warming temperatures will force landowners to revisit their current management strategies, prompting a new "climate-smart" or risk avoidance approach. We modeled temperature changes and presented them using plant hardiness zones. The northward shift of plant hardiness zones offers an opportunity to plant more southern families/cultivars to capture growth and improve health and profits. However, that same northward "opportunity" also yields invasive plant and insect outbreaks. Additionally, if business as usual continues, rainfall and storm events will occur less often but will be more intense when they do occur. Specifically, summers may see decreased rainfall while winters see increased rainfall. These patterns may exacerbate drought conditions leading to degraded soils, limited water availability/consumption, and elevated risk of wildfire.

Continuing good silvicultural management practices can increase forest resilience and mitigate climate-related problems. By introducing new management techniques such as encouraging rainwater and nutrients to stay on site and proactive thinning, we can further combat climate change, while keeping costs manageable to landowners. Because climate-related risks are likely to be site-specific, this poster aims to address the need for realistic solutions to help landowners adapt. Through improved management practices such as site preparation, thinning, prescribed fire regimes, rotations, and collecting rainfall more efficiently, we may foster species sustainability in a changing climate.

Soils Under Climate Change

Temperature and rainfall changes in the future are expected to make soils prone to runoff and nutrient loss. Summers in the southeast are expected to receive less rainfall, causing longer droughts. These droughts will then be followed by heavy rainfall events in some areas, further stressing soils to compact, runoff, and degrade[3]. Winters in the southeast are expected to see more intense storm events. This may increase runoff because in the winter months it is more difficult for trees to use rain water and the ground is less permeable[4]. This process becomes an issue in a changing climate as poorest loblolly pine performance is on shallow soils, eroded soils, and very wet sites.

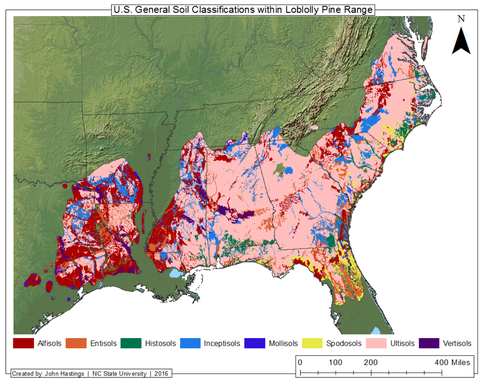

Figure 1

While soils on most loblolly pine plantations throughout the region are Ultisols *(Figure 1)*, loblolly pine growth is possible on many soil types[1]. Unfortunately, many of the soils in the region are beginning to show wear and loss of fertility from decades of overuse. As temperature increases, water content may decrease, limiting microbial activity. Soil microbial populations are important for nutrient storage that help to prevent nutrients from being washed off site[11].

How Will Climate Change In The Future?

Erratic weather and warming temperatures may require landowners to revisit your current management strategies or utilize a new approach. We forecasted changes through a sample of models and presented them in simple maps using the gardener-friendly plant hardiness zone colors to show change over time. The results show a northward shift of each plant hardiness zones *(Figure 2)*. A positive effect of shifting plant hardiness zones is loblolly pine range expansion. In the future you may have an opportunity to plant more southern families/cultivars to capture growth and improve health and profits.

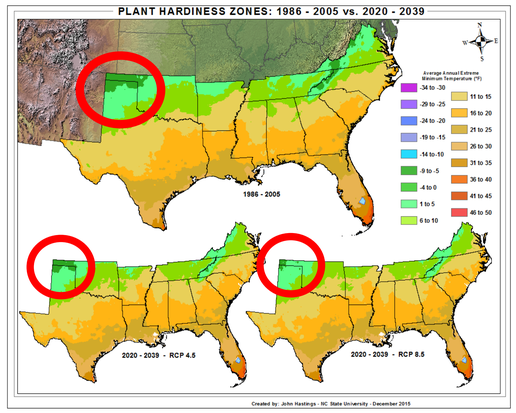

Figure 2

Families in the southern part of the range could become more adapted to the central part of the range, while central range families become more adapted to the northern part of the range. However, the northward trend of plant hardiness zones could also introduce other problems that may require expensive solutions to capture growth and improve health and profits. Some landowners may see their plantations become more adaptable in a changing climate.

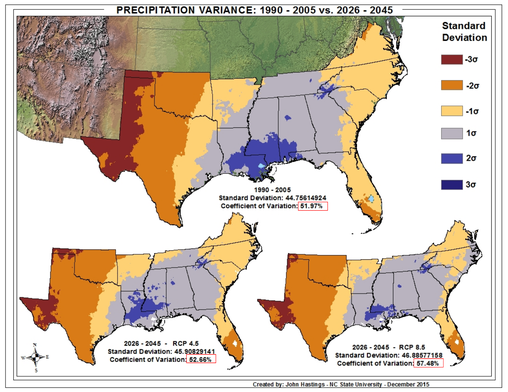

Figure 3

Future patterns of rainfall and the risk of drought are another critical factor to your forest resources well-being. Under drought conditions, trees are at a higher risk of internal damage making them prone to wildfire. Drought stressed trees may also shift carbon usage to defense and reduce their carbon uptake to nearly zero. To understand how future rainfall patterns may change, rainfall was projected for two greenhouse gas trends. The first trend represents a steady decline in greenhouse gas emissions. The second represents continued emissions at their current level. Our results show if business as usual continues in the future, rainfall and storm events will occur less often but will be more intense when they do occur *(Figure 3)*. This means that you may have very wet years and very dry years. It also means that your trees and soil may be more stressed and perform poorly in dry years.

Invasive Outbreaks Under Climate Change

Increased temperature in the future could impact the spread of forest pests. Invasive plant and insect outbreaks in the past have shown that as temperature rises, more areas become suitable habitat *(Figure 4)*. When this happens, newly infested forest are at a higher risk, as tree are unlikely to adapt to or migrate away from the pests. In short, increased temperature would make the range of loblolly pine larger, however, it would also increase the likelihood of pest outbreaks, as a result. Increased temperature and drought could also lead to invasive plant and insect population growth and aid in their ability to survive throughout the winter.

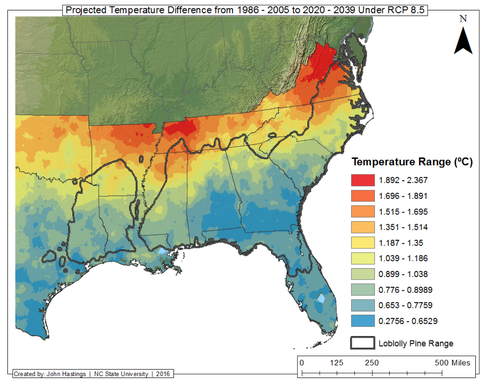

Figure 4

The southern pine beetle (*Dendroctonus frontalis*) is the most destructive insect in southern pine forests. From 1970 to 1996 alone, southern pine beetle (SPB) caused over $1.5 billion in damages. Of the factors that influence SPB outbreaks, climate is the most concerning and is expected to make the spread of SPB much more likely. Temperature changes will have the greatest impact on forest stressors such as SPB; however, differences in rainfall patterns would influence SPB outbreaks by changing the physical growth of both the insect and loblolly pines.

Management Tips for Resilient Forests

Plantations and modified natural forests will face greater risks of large-scale losses due to climate change. Similar to current management strategies, risk of climate change is likely to be site-specific. For example, fertilization may worsen drought stress in some areas, while having no negative effects in others. Risks such as these can be partially offset by following adaptive forest management tips *(Figure 5)*.

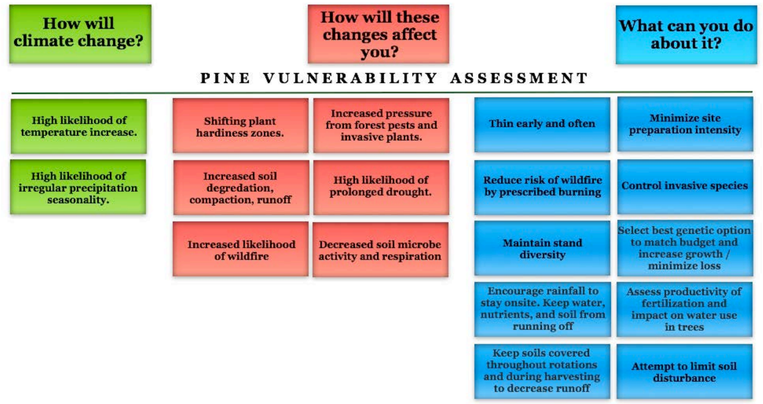

Figure 5

Multivariate Adaptive Constructed Analogs(MACA) Statistical Downscaling Method
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