Enhancing Tools and Geospatial Data to Support Operational Forest Management and Regional Forest Planning in the Face of Climate Change

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Project Overview

Introduction

A detailed understanding of how forest composition, structure, and function will be impacted by projected climate change and related adaptive forest management activities are particularly lacking at local scales, where on-the-ground management activities are implemented.

Climate sensitive forest dynamics models may prove to be effective tools for developing a more detailed understanding. However, to be applicable to both regional forest planning and operational forest management, modeling approaches must be capable of simulating forest dynamics across large spatial extents (required for regional planning) while maintaining a high-level of spatial detail (required for operational management). These data are difficult to generate with traditional remote sensing techniques.

Our primary objective is to develop a system to spatially parameterize and supply critical initial conditions for two separate climate-sensitive forest dynamics models across unique ecoregions (in terms of forest structure and composition) via an integration of sub-orbital climate-sensitive forest dynamics models to assess the potential impacts of changing climate, disturbance regimes, and adaptive forest management practices on future forest conditions at spatial scales relevant to forest management and planning.

Since it is forest managers who will ultimately implement climate considerations into their management strategies, there is a clear need to bridge the spatial disconnect between traditional, regional-level remote sensing science and the scales at which forest managers operate.

Approach

1. Employ remote sensing data (airborne LiDAR and NASA satellite data and derived products) to generate detailed (tree-level), spatially-explicit forest inventory data across large spatial extents.

2. Demonstrate how this data can be used in conjunction with climate-sensitive forest dynamics models to assess the potential impacts of changing climate, disturbance regimes, and adaptive forest management practices on future forest conditions at spatial scales relevant to forest management and planning.

3. Inform our science with management needs, share our results and decision-support tool with forest managers, and educate students at a variety of levels (pre-college, college, community college, undergraduate, and graduate students) about the impacts of climate on forest condition and function.

1. Geospatial Forest Inventory

Objective

We will employ k-NN imputation to generate tree-level forest inventory data (tree-list imputation) in a form that can be used to parameterize two separate forest dynamics models: Climate-FVS (Stand-level) and Landis-II or Landis-pro (Landscape-level).

Approach - Tree-list Imputation

The methodology leverages statistical similarity between remote sensing variables to predict field measured tree-lists to unsampled areas. This example leverages LiDAR data; however any spatial data related to forest structure could be employed as predictor variables.

Preliminary Results - Tree-list Imputation

Initial results demonstrate strong linear relationships between forest inventory metrics derived from the imputed tree-lists and independent validation data. Results are from the Malheur N.F. study landscape in Oregon.

The imputed tree-lists can be applied spatially to provide inputs to climate sensitive forest dynamics models. Each pixel in this dataset contains a tree-list (i.e., individual tree records).

2. Modelling Forest Response

Objective

Assess the potential impacts of changing climate, disturbance regimes, and forest management practices on future forest composition, structure, and function, with a specific focus on assessing resilience to climate change.

Approach

Climate-FVS and Landis-II will be parameterized via the imputed tree-lists which in turn will be used to assess the efficacy of potential adaptive management strategies for enhancing forest resilience to climate change. Specifically we will run a separate simulation for various GCM and emission scenarios across a range of adaptive management strategies.

2. Modelling Forest Response (Cont.)

Potential Adaptive Management Strategies

Forest managers have many potential adaptive management strategies at their disposal including:

Promoting resistance to change - Improve the ability of a forest to resist external stressors (e.g., fire fuels reduction, installation of fire breaks, removal of invasive species, among others).

Enhancing resilience to change - Improve the ability of a forest to return to a prior condition following disturbance (e.g., intensive planting, enhancing complexity such species diversity and structural diversity).

Accommodating change - Assist transition to future conditions (e.g., assisted species migration, alter ecological or successional trajectories, among others).

Example Application and Results

Effects of climate change on forest type in an example landscape in northeastern Minnesota using the LANDIS-II Biomass Reclassification extension. Results could be used to inform management decision such as species assisted migration.

3. Education

Objective

The educational plan is designed to meet the needs of multiple audiences including forestry professionals (existing workforce training) and students at a variety of levels (pre-college, undergraduate, and graduate education).

Approach - Educational Plan

The education plan is comprised of several linked research and education activities including: (i) meeting with land managers to discuss practical silvicultural strategies for adapting to climate change (this will inform research tasks), and (ii) developing and delivering education modules to diverse audiences including forest management professionals, pre-college youth, community college students, as well as undergraduate and graduate students.

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