Challenges and innovations in applying a new forest dynamics model to Eastern Canada

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INTRODUCTION

Advances in landscape modeling have enhanced our understanding of ecological processes. Landscape models can bridge the gap between observation and prediction, offering valuable insights for environmental decision-makers.

Forest Landscape Models (FLMs), such as LANDIS-II, distinguish themselves by simulating complex vegetation-based processes and interactions in a spatial-explicit manner.

The major challenge in applying such models to new areas lies in parameter estimation. LandR is a reimplementation of the LANDIS-II Biomass model in SpaDES. LandR addresses the parameterization challenge by incorporating novel methods for estimating model parameters from sample plot data and remote-sensed products such as SCANFI.

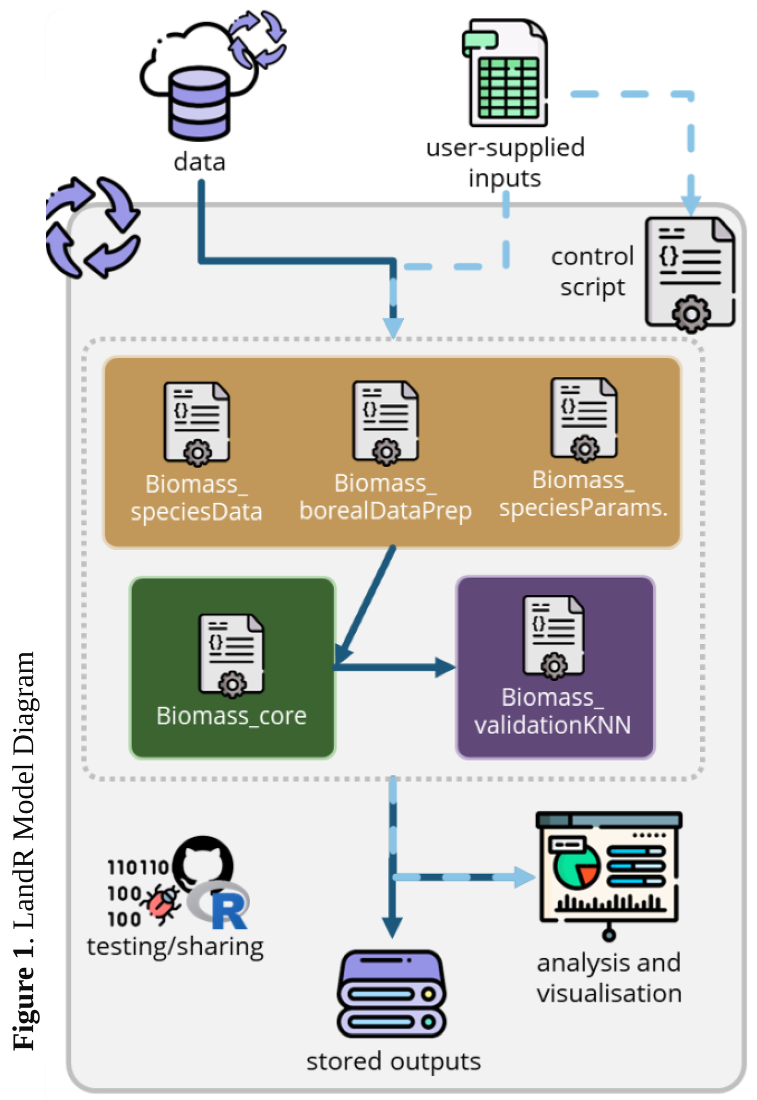

Figure 1. LandR Model Diagram

SCOPES

LandR was first prototyped Western Canada's boreal forests (Micheletti et al, 2021) , and has been extended to parts of Ontario. It is a versatile framework extendable to each geographical setting where parameterization exists, which includes all of Canada's managed forest lands. Here we report our efforts to parameterizing the LandR tree-species specific growth and mortality model for the boreal and hemi-boreal regions of Eastern Canada. We used plot data sourced from two main channels: the National Forest Inventory (NFI) and Provincial Permanent Sample Plots.

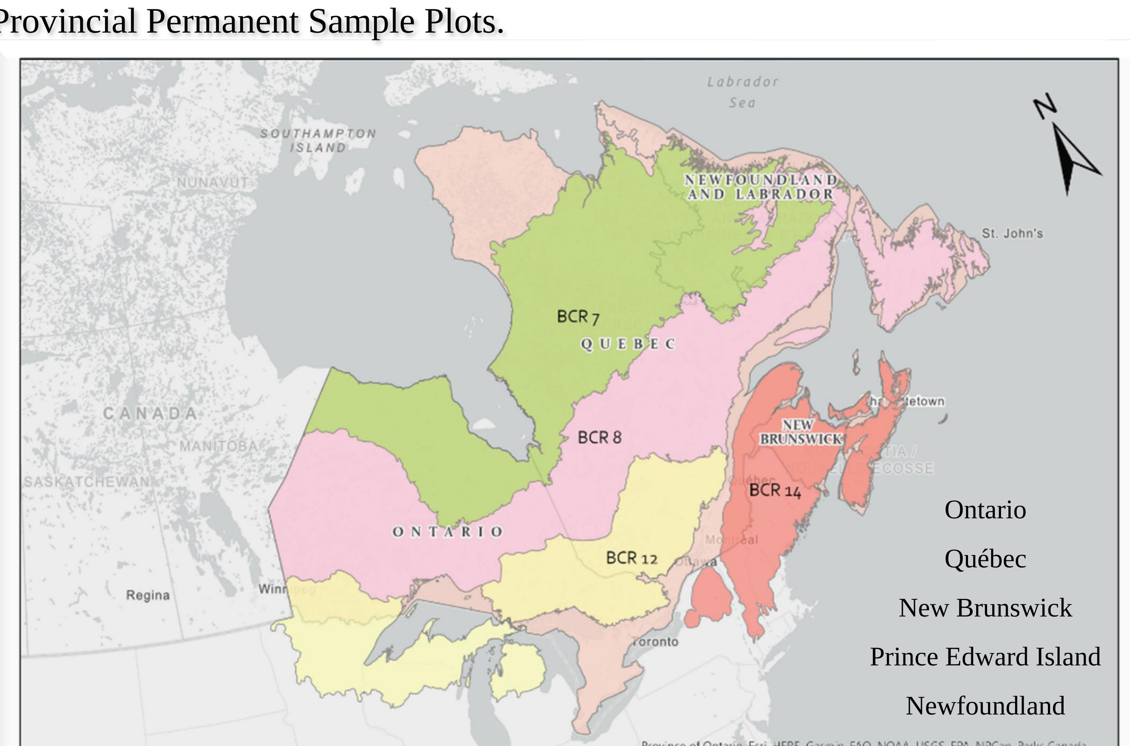

Figure 2. Study Area

LandR PARAMETRIZATION

LandR comprises a core simulation module and three supporting modules dedicated to data preparation and parameterization. Tree species-level traits (growth curve, mortality shape which initially come from publicly available LANDIS-II tables.) are parameterized using data from sample plots .they Use ~41,000,000 hypothetical species growth curves (generated with LandR Biomass core), to find which hypothetical species growth curve most closely matches the growth curve observed in the PSP data – on a species-by-species base.

As an example, here Picea Mariana tree species selected.

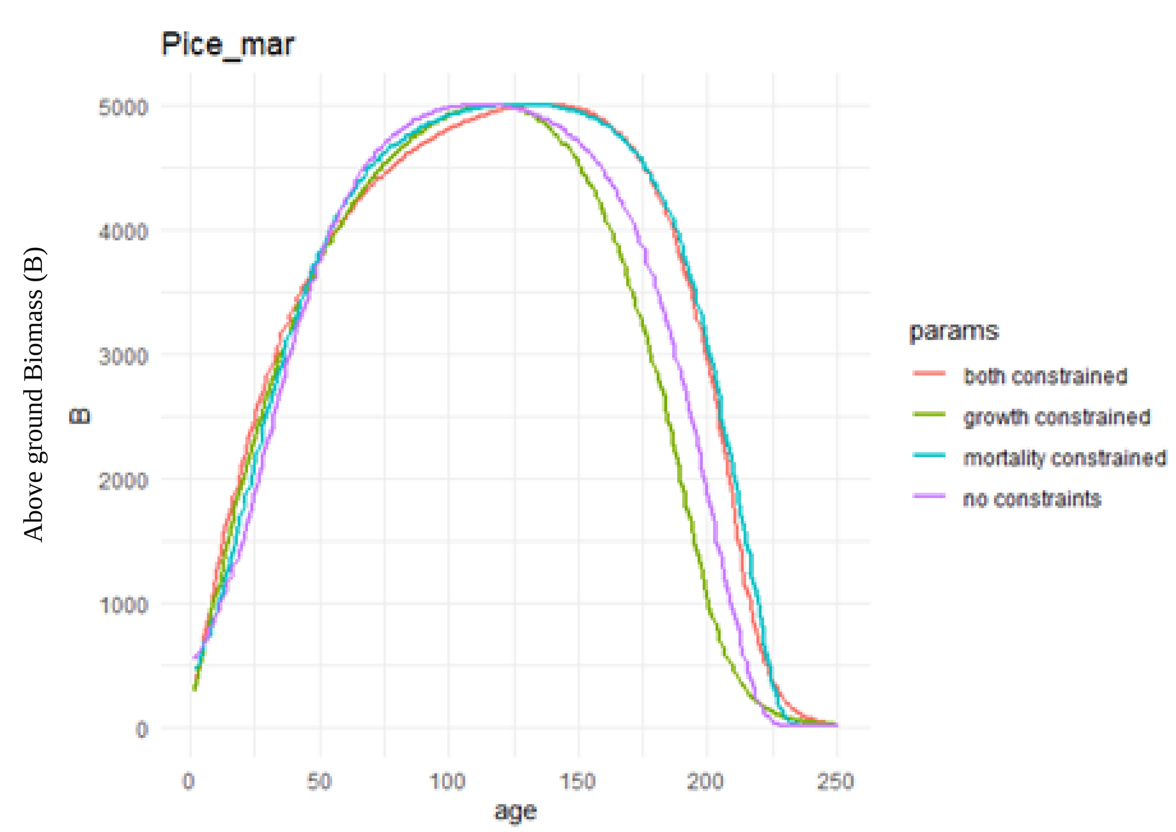

Figure 3. Growth curve for Picea Mariana tree species generated by LandR

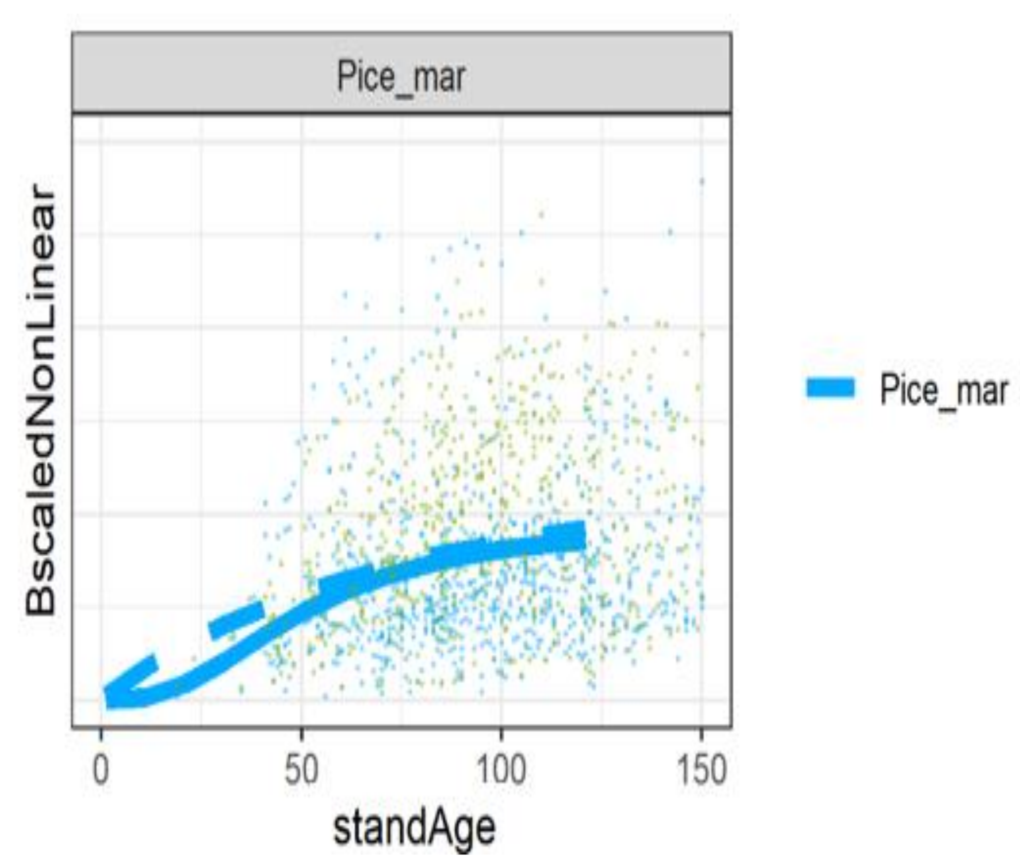

Figure 4. Curve matching-Comparing the best landR curve

- ✓ As an Example:
- Here, we use New Brunswick and a small part of Ontario

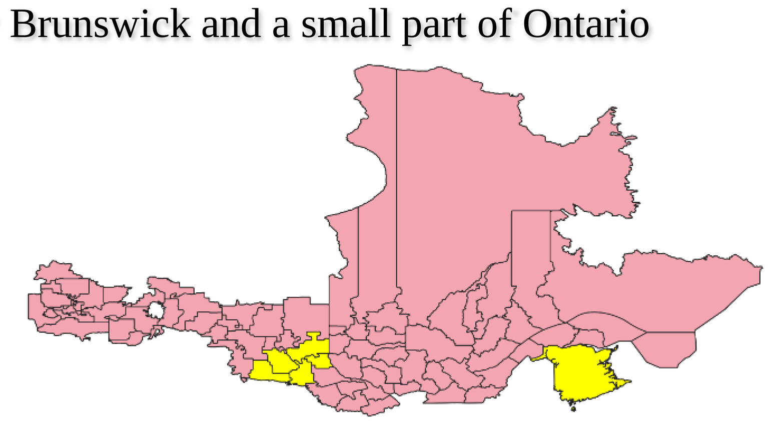

Figure 5. NB And small part of Ontario study areas

- Define species list
- Set module-specific parameters
- Set simulation parameters (e.g. start and end year)

SIMULATION RESULTS

Here are some of The main Visual Outputs of simulation by LandR. They are species level biomass, age and dominance across the landscape and the simulation length, and several maps of stand biomass, species Percent Cover and reproductive success (i.e, new biomass) on a yearly basis.

ONTARIO

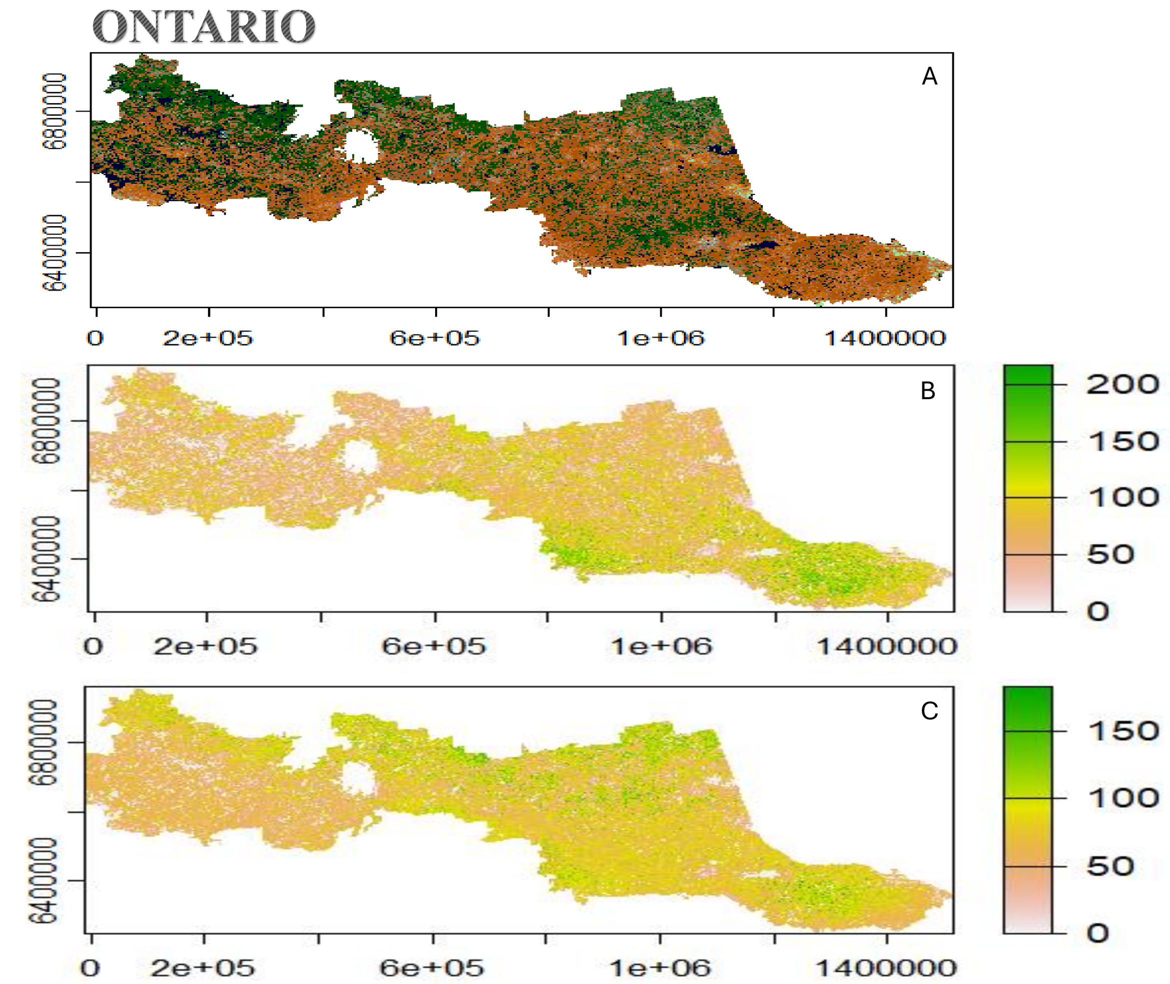

Figure 6. . Simulation outputs: A. Template study area, B. Raw Biomass map and C. Stand age respectively

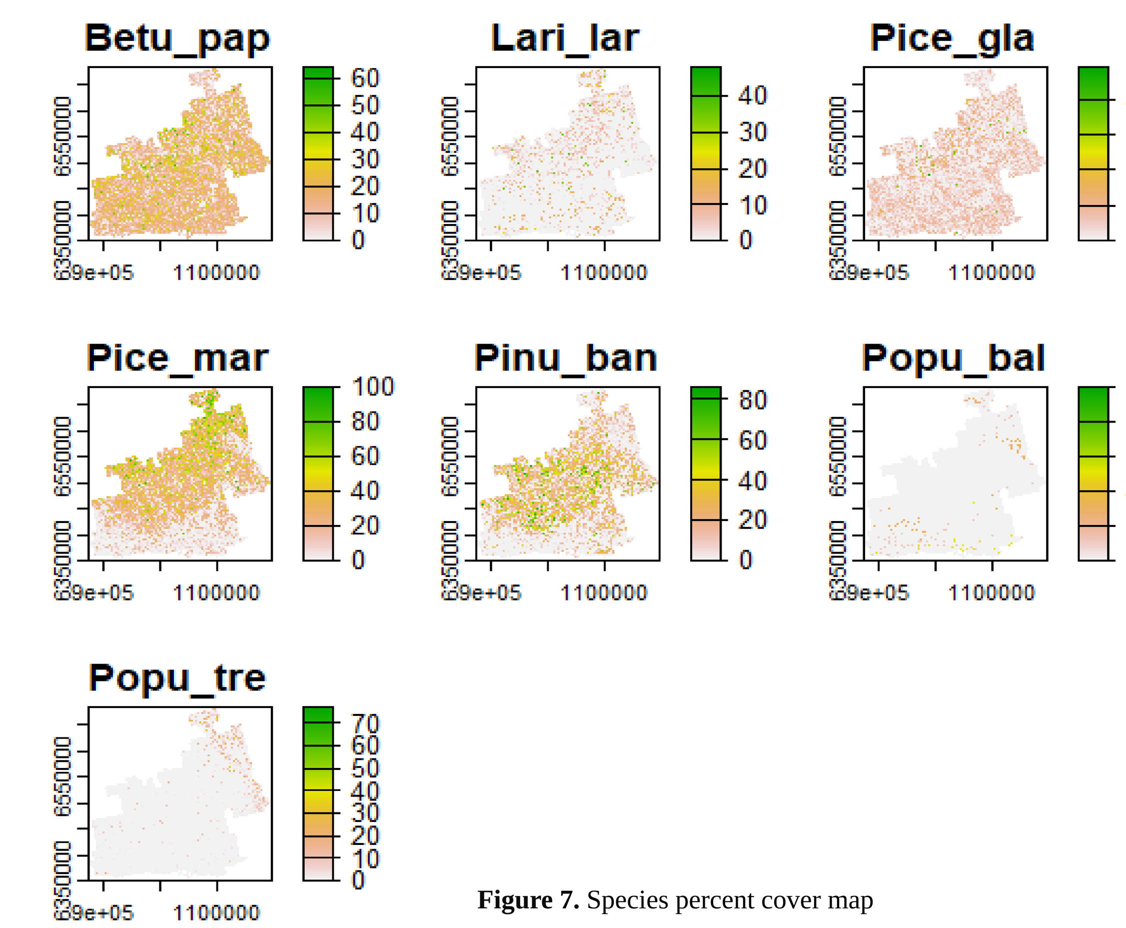

Figure 7. Species percent cover map

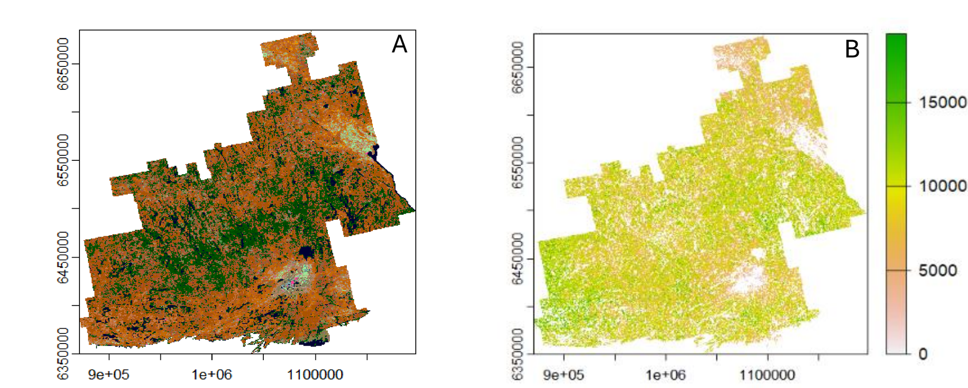

Figure 8. .Simulation outputs: ,A. study area and B. Biomass map

Figure 9. Observed Changes in dominant tree species in a 110-years period

New Brunswick

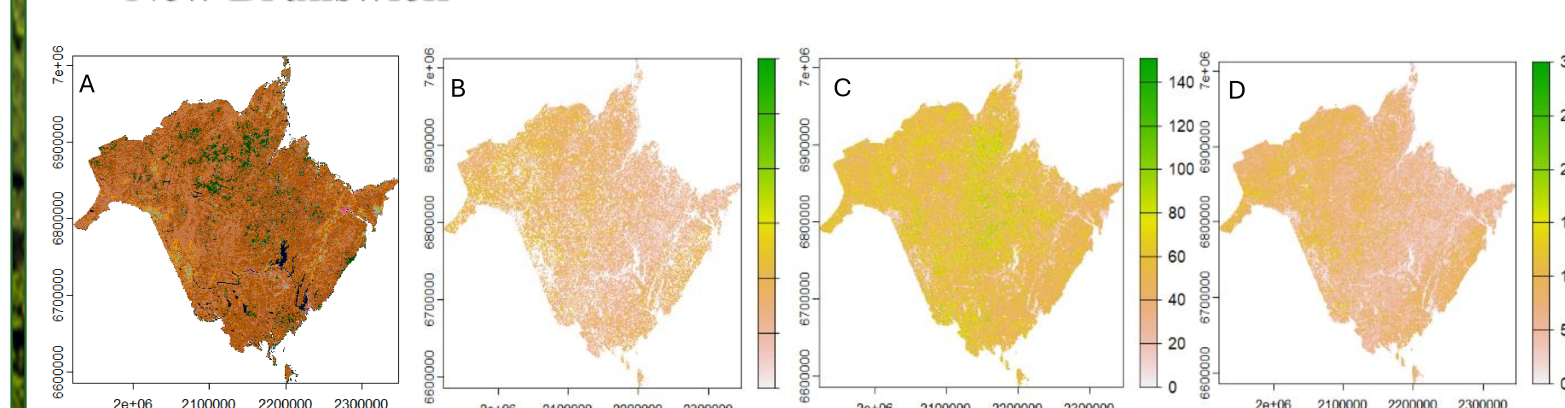

Figure 10. simulation outputs: A. Template study area, B. Raw Biomass map and C. Stand age and D. Biomass map respectively

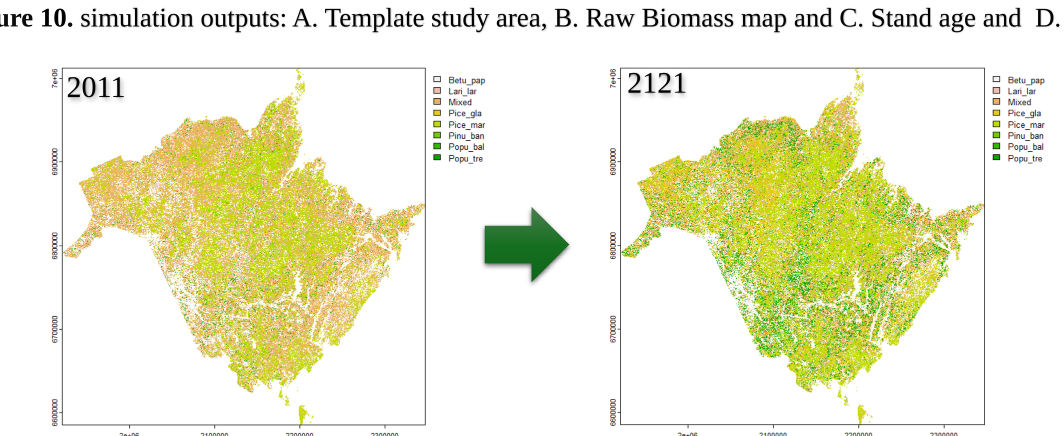

Figure 11. Observed Changes in dominant tree species in a 110-years period

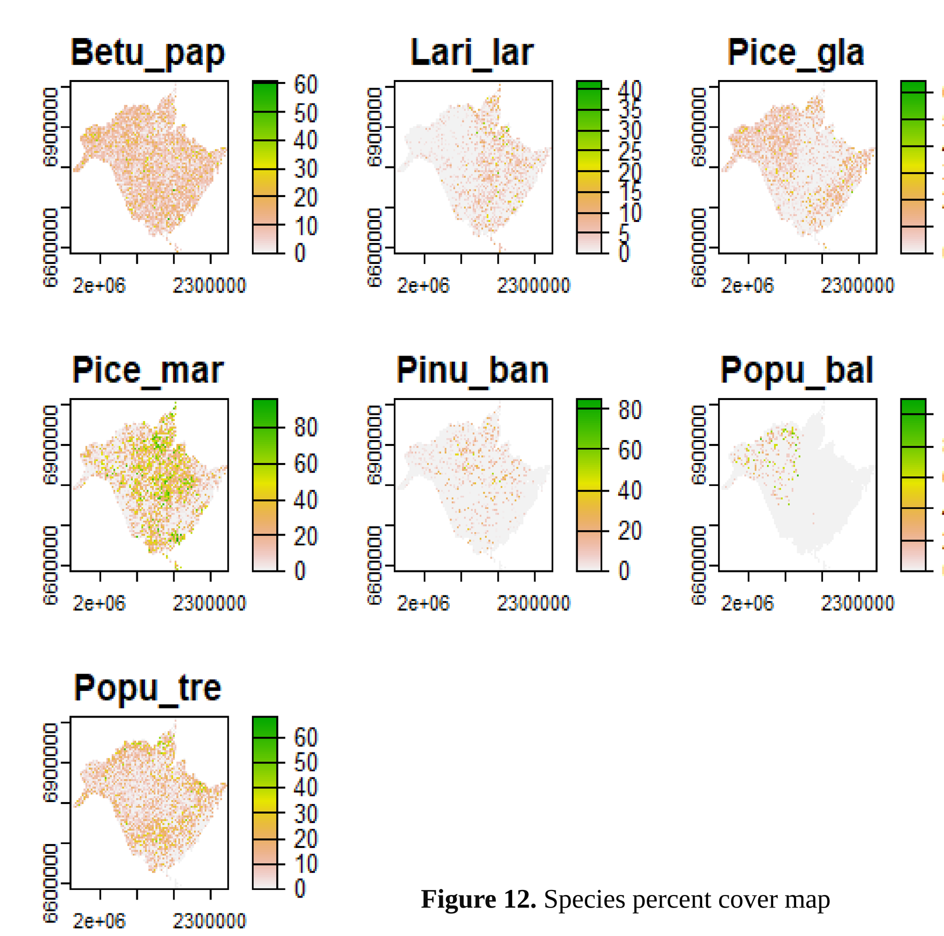

Figure 12. Species percent cover map

NEXT STEPS

1. Complete parameterization for all 6 provinces and 3 states
2. Develop parameterizations for climate sensitive growth and mortality (again from plot data)
3. Integrate Firesense, our climate and vegetation sensitive landscape fire model (Marchal et al,2016)
4. Develop and integrate forest management modules.
5. Integrate predictive bird species abundance models.

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