RPA Forest Dynamics
Projection Methods

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The RPA Assessment:

• The Forest and Rangeland Renewable Resources Planning Act of 1974 mandates a national report (RPA Assessment) on the conditions and trends of renewable resources on all forest and rangelands every ten years.

• The RPA Assessment provides a snapshot of current U.S. forest and rangeland conditions and trends; identifies drivers of change; and projects 50 years into the future (2020-2070 for the 2020 RPA).
Criteria for 2020 RPA scenarios

• Link to structure of other national and international assessments.

• Address a reasonable range of plausible futures.

• Sufficient to address connections among drivers of change and natural resources.

• Consistent from a climate and socio-economic perspective.

• Anticipate challenges and support resource management and policy deliberations of interest to multiple audiences in public and private spheres.
Scenarios in the 2020 RPA

• 2010 RPA and Update
  • Linked to IPCC 4th Assessment and associated data

• 2020 RPA
  • Climate scenarios linked to IPCC 5th Assessment
    • Representative Concentration Pathways (RCPs) that represent a range of potential global warming
  • Socioeconomic scenarios linked to global scenarios developed in parallel effort to IPCC
    • Shared Socioeconomic Pathways (SSPs) that examine various development trajectories based on different assumptions of socioeconomic and governance trends.
Forest Inventory (FI) sub-model:
- Starting conditions:
  - Forest Inventory (FI)$_t$
  - Land Use (LU)$_t$
  - Climate Conditions (CC)$_t$
  - Forest Products Outputs and Prices (FPOP)$_t$
  - Population, demographics, and economics (PDE)$_t$

Primary scenario projections (50 yr):
- Forest conditions (FIA plots; 90m raster)
- Land uses (counties; 90m raster)
- Forest products outputs and prices (countries; US regions)
- Timber harvest/management (plots)
- Forest carbon (plots) and wood products carbon (nation)

Scenario Data:
- CMIP5 (RCP)
- RPA Scenario (RCP, SSP)

RPA Timber Supply Model:
- Timber supply (TS)$_{t+n}$

RPA Forest Dynamics Model:
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RPA Forest Products Trade Model:
- Forest Inventory (FI)$_{t+n}$
- Land Use (LU)$_{t+n}$
- Climate Conditions (CC)$_{t+n}$
- Forest Products Outputs and Prices (FPOP)$_{t+n}$

RPA Land Use Change Models:
- Harvested wood product carbon inventory (HWPC)$_{t+n}$

2020-USFAS
Improvements for 2020 RPA

• New models of county-level population and income tied to SSPs: drives land use change and supply/demand for products.

• Developing a new RPA Forest Products trade model to replace USFPM (developed for 2010 RPA): drives future harvest needs

• WoodCarb rebuilt and ported to R: Interacts with global trade model

• New RPA Land Use Model—addressing climate change as well as land rent drivers

• RPA Forest Dynamics
  • Empirical species assemblage transitions tied to future climates.
  • Improved harvest probability models
  • Methods developed to incorporate fire and other disturbance projections/scenarios
  • Methods to handle atmospheric enrichment incorporated
  • Driven by a fully implemented annual design.
  • Remeasurements available for east and PNW. Leads to increased capacity for model validation
Model: Plot State Dynamics
- Age
- Harvest
- Fire
- Other Disturbance
- Planting
- Forest Type/assemblages

Output: Plot States

Model: Plot Imputation

Output: Plot Lists**

Model: County Land Use Change

Output: expansion factors

Output: County transition matrices

Model: Spatial Land Use Imputation

Output: Fine Scale land use Maps

Output: Fine Scale land use and forest conditions maps

Output: Future Forest Inventories
- Plot lists
  - GRM
  - Expansion Factors

Output: Future land use conditions

Model: Change Description
- Statistics
- Graphs
- Maps

Output: Fine Scale land use and forest conditions maps

Interpretation and Analysis
- Scenarios
- Issues
- Data server
- Web products
- Consultations

Notes:
- * timber price inputs are developed with market models
- **imputation yields multiple realizations
- ***change in expansion factors may also come directly from the spatial imputations

DB: Scenario Data (RCP+SSP)
- Climate
- Population
- Income
- Timber prices*

DB: Initial Forest Condition (FIA)

DB: Historical Plot Records (FIA)

DB: Initial land Use Condition (NRI)

DB: Geospatial Data

RPA-2020
Forest Dynamics and Land Use
Forest inventory

• Define and inventory as a collection of n plots with X measured attributes and Z exogenous attributes:
  \[ i(t) = (X_1, X_2, X_3, ... Z_1, Z_2, Z_3, ...) \]

• For example, X includes
  • Age
  • Forest type
  • Harvest condition
  • Disturbance
  • Location
  • Biomass density
  • ....

• For example, Z includes
  • Average temperature over previous ten years
  • Average annual precipitation
  • Potential Evapotranspiration
  • ....
Inventory projection mechanism: State Transition + Imputation

**Transition**

- $I_{i,t}(X_1, X_2, X_3, ... Z_1, Z_2, Z_3, ...)$
- $I_{i,t+1}(X_1, X_2, X_3, ... Z_1, Z_2, Z_3, ...)$
- For key “state” variables, we model change in values between $t$ and $t+1$
  - Here: $X_1, Z_1, Z_3$

**Imputation**

- Sample with replacement from the historical library of forest plots with projected state variable values $(X_1, Z_1, Z_3)$
- Output defines a set of plots that represents the inventory at $t+1$
- Repeat $n$ times to generate distributions around key variables and maintain covariance structure
- Note: values of non-state variables are inferred from imputation
Stochastic approach

- 200 realizations at each time step (black dots)
- Distribution of outcomes
- Ensemble projector (red line)
Policy relevance example

- Under previous administration RPA projections used to develop a mid-century strategy (2050) for GHG emission reductions.

- Scenario components
  - **Reduced deforestation**: shift from the reference case to the low development intensity case as described in the USDA BE report projections. This yields a no net loss of forest area.
  - **Afforestation/Restoration**: tree planting on marginal ag land in the East (low option: 10 mil acres; high option 30 mil acres). Restore persistently nonstocked forest land in the West (low option: 9 mil acres; high option 14 mil acres)
  - **Fire mitigation**: reduce the areal extent of fire by 10%
  - **Expanded wood production**: Increase solid wood product use by 10% in construction. Also includes changes in wood products carbon pools.
Land use scenarios: developed from the USDA projections (USDA OCE 2015)

Afforestation + restoration policy:

- High option - 30 million acres afforested in the east + 14 million acres restored in the west.
- Low option - 10 million acres afforested in the east + 9 million acres restored in the west.

Fire mitigation: reduce areal extent of wildfire by 10%

Expanded wood products use: increase solid wood product by 10% in construction.
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Thanks for listening

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