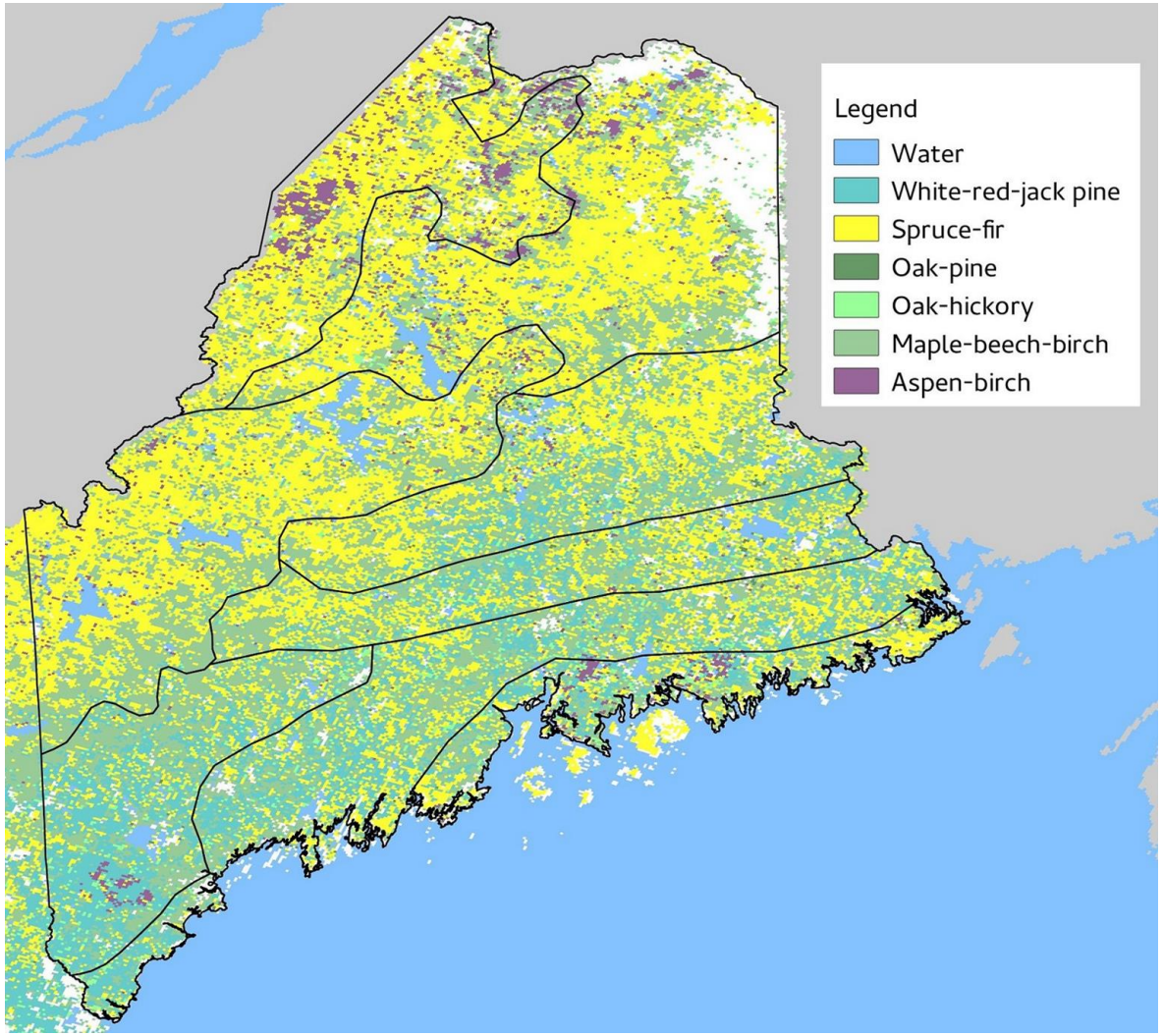
Potential Economic and Environmental Impacts of Emerging Forest Product Markets

Dr. Adam Daigneault,
Assistant Professor of Forest Policy and Economics
University of Maine

Maine's New Forest Economy
October 23, 2019

Maine's Forest Sector

- Most forested state in the US (89%)
- Most dependent state on its forest sector (4-6% of GDP)
- Transitional forest that covers a variety of ecosystems and climate zones
- Diverse private ownership
- Leader in conservation easements and early adopter of forest certification



7 distinct climate zones and >20 commercial tree species

Industry in Transition

An 'economic crisis' in Maine's paper industry, mapped

March 15, 2016 Economy Maine paper, paper manufacturing, papermaking
By Darren Fishell

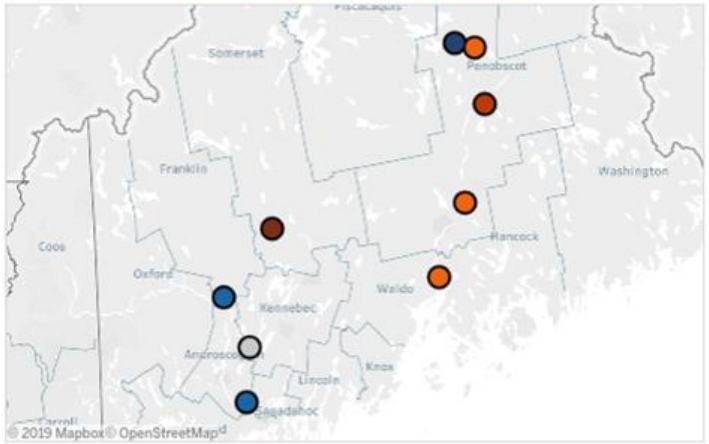
Like 172 Tweet Save Share 3

Madison Paper Industries announced it will shut its doors in May.

And then there will be eight.

The latest paper mill shutdown announcement will make for five major closures in the past three years, after East Millinocket, Lincoln, Old Town and Bucksport.

Mill closures over the last decade



SOURCE: RESTORE The North Woods, news reports.
bangordailynews.com

Closure year
2008 2016

+ableau

The accounting has varied in the wake of the Madison closure, but without it the

Timeline: The often-dashed hopes for redevelopment of the Millinocket paper mill

MOST POPULAR


A 164-year-old Bangor church w hold its last service on June 30


Award is offered — and rescinde — for 'American Pie' singer


Orono track and field star write her own ticket to University of Alabama


Janet Mills still hasn't paid the t tab for her inaugural celebratio


Houlton man accused of driving wrong way down I-95

RELATED ARTICLES


Tax lien on former

Indirect costs of more potential paper mill closures hit loggers hardest

Ashley L. Conti | BDN

Tom Pelkey of Orland climbs on top of his load of logs to secure them in Blue Hill, Oct. 9, 2014.

MOST POPULAR


A 164-year-old Bangor church will hold its last service on June 30

POLL QUESTION

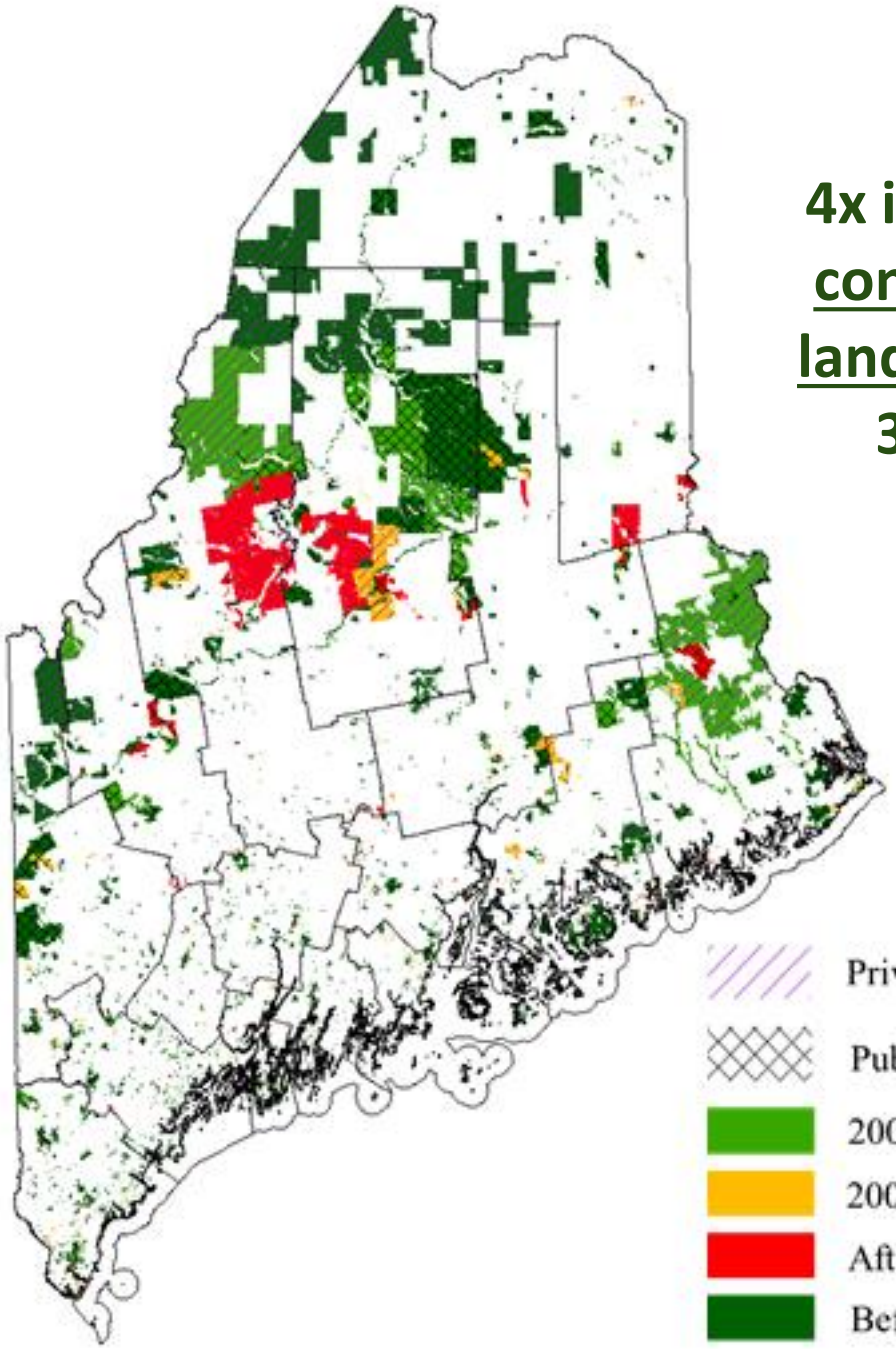

Maine House votes to end ban on use of state money for abortion services


Rockland police arrest familiar suspect for school medication burglary


Houlton man accused of driving wrong way down I-95

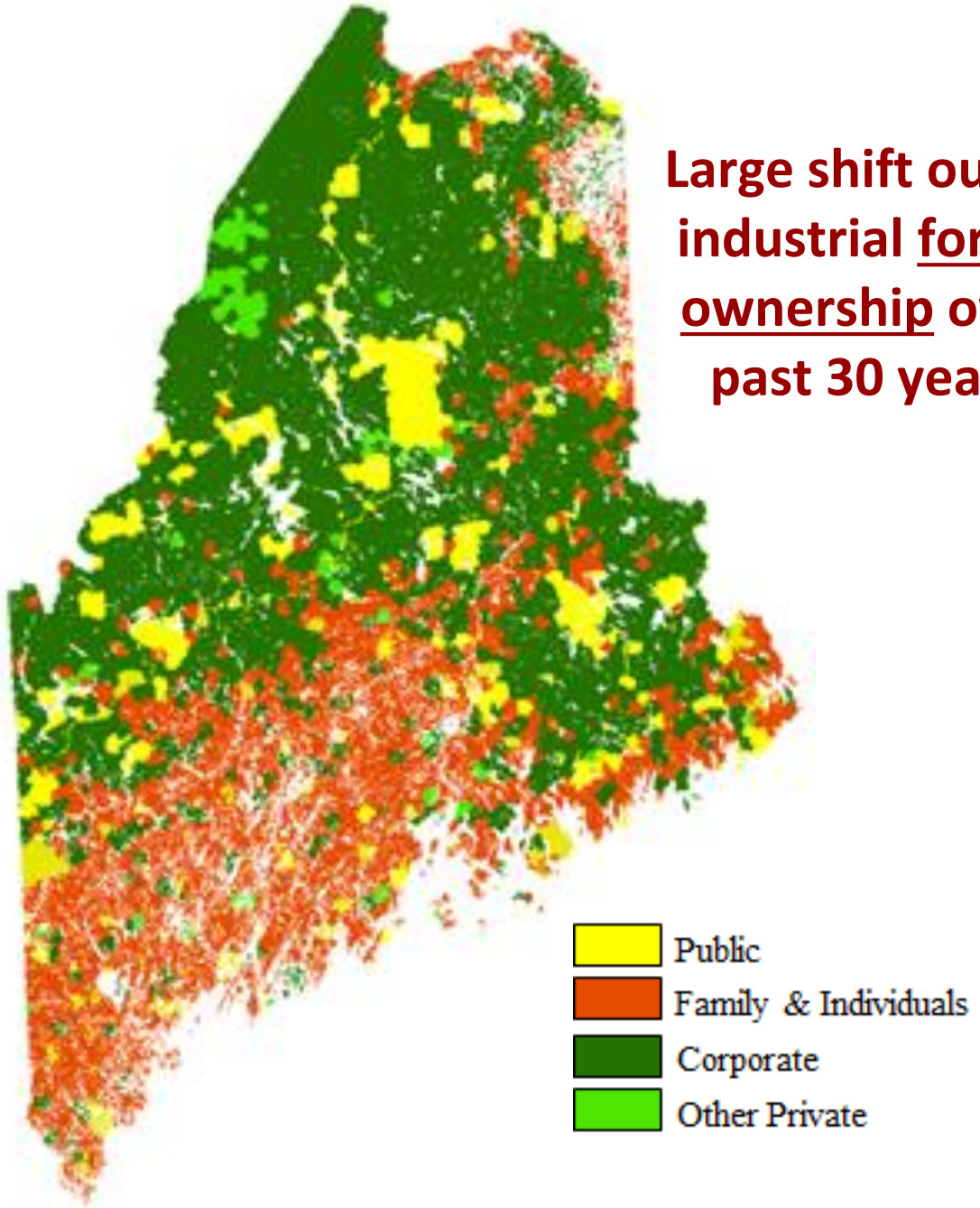

Maine Senate endorses modified paid leave mandate

9 paper mills have closed in the last decade

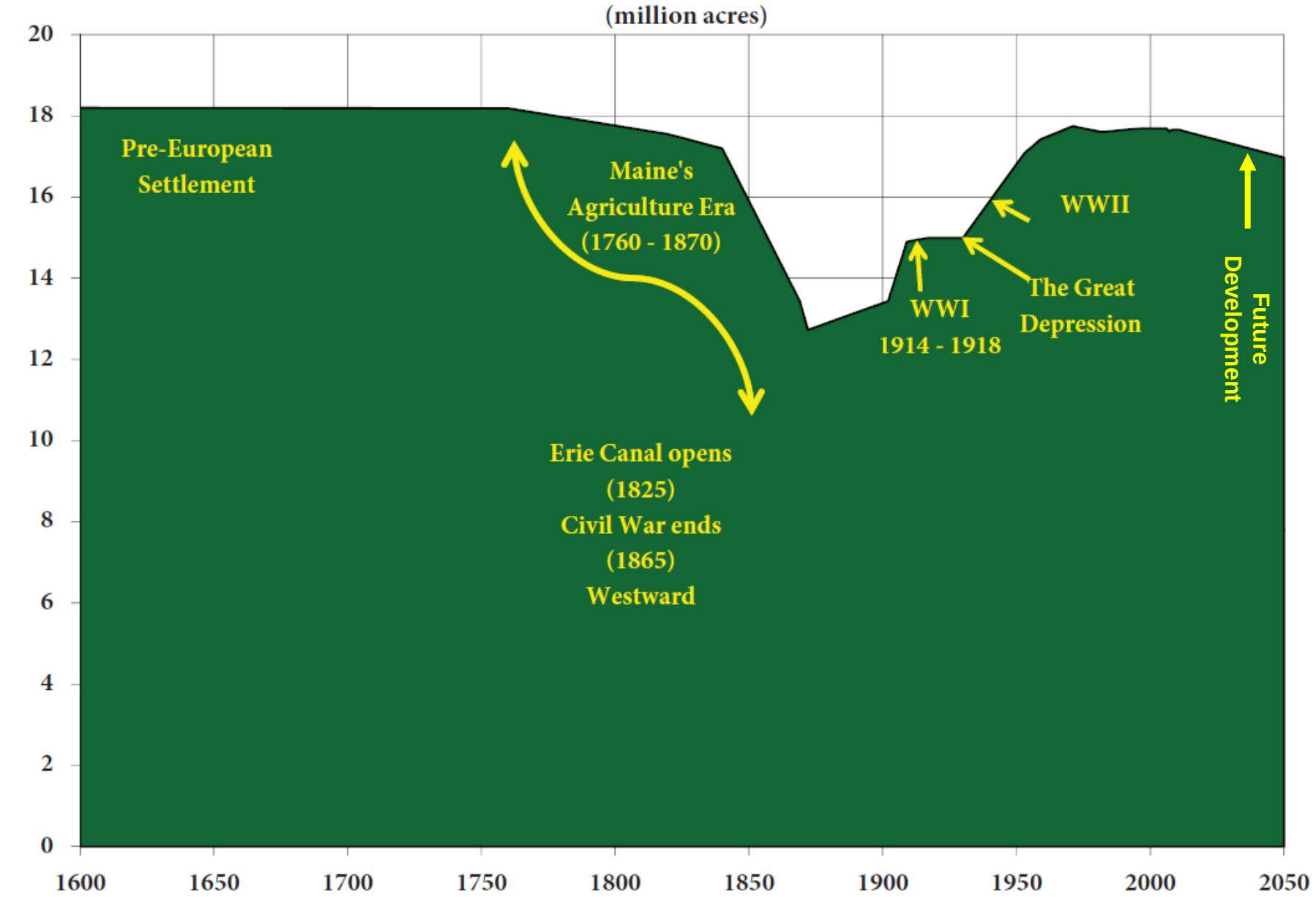


4x increase in conservation land over past 30 years

Large shift out of industrial forest ownership over past 30 years



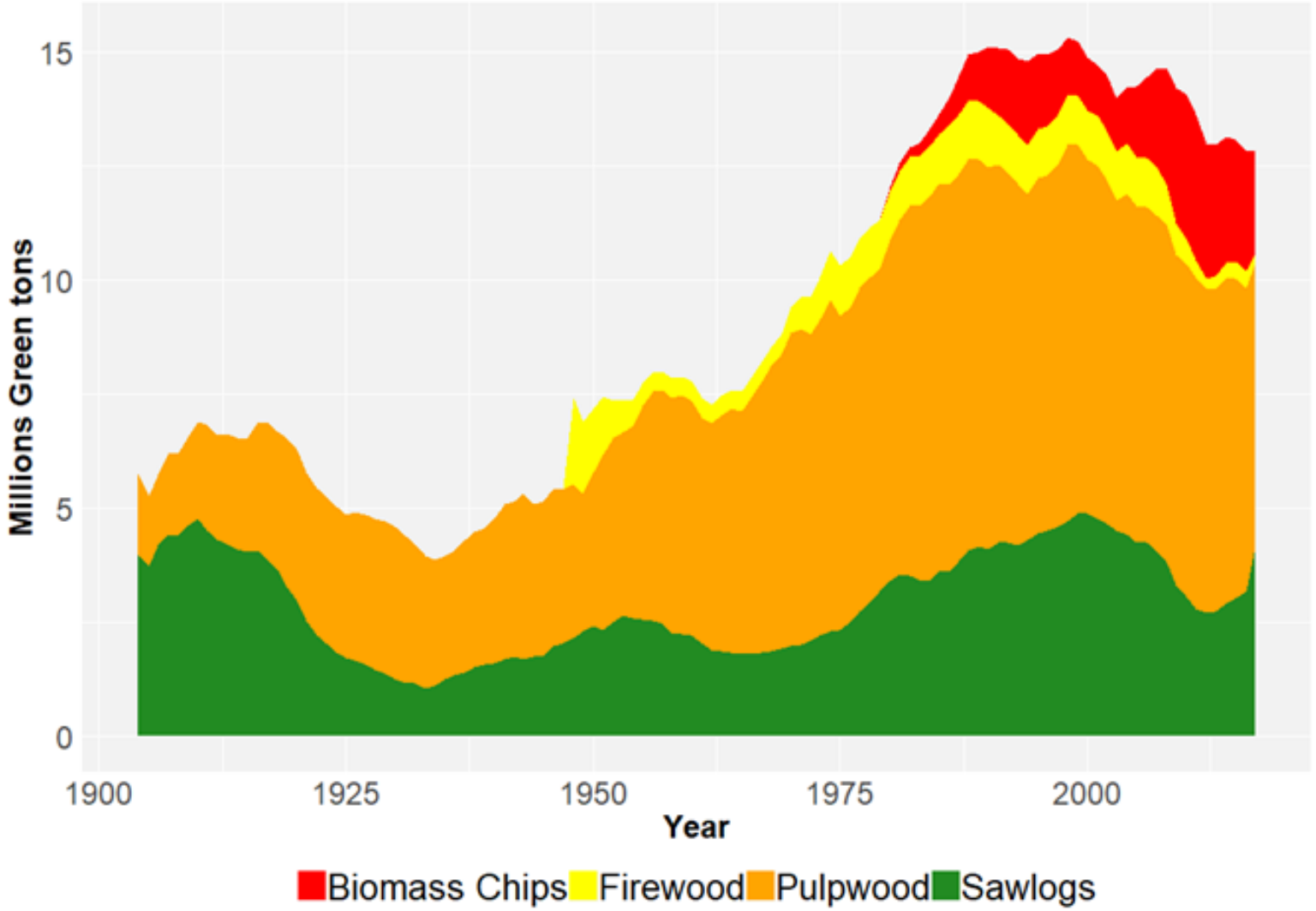
Estimates of Maine's forestland (past, current, and projected)



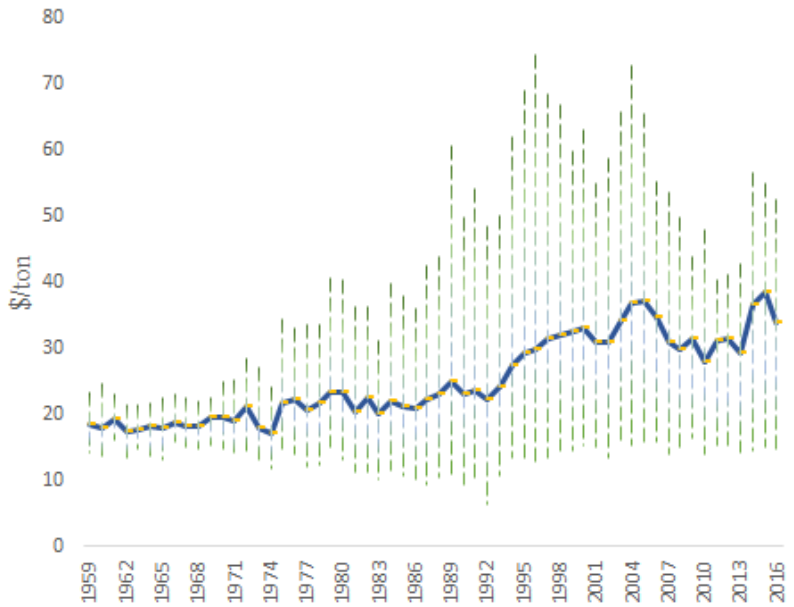
Source: Ken Laustsen, Maine Forest Service

Harvests and Stumpage Price History

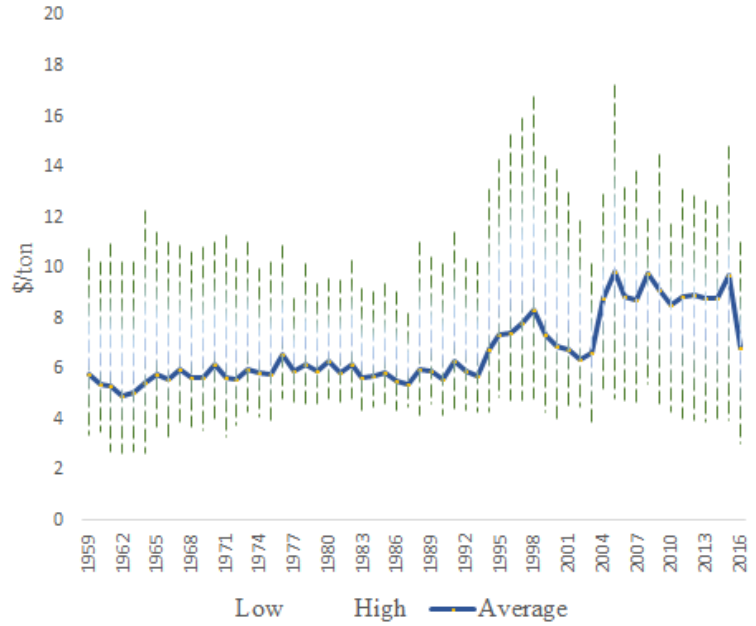
Maine Total Annual Harvest by Product



Sawlogs Price



Pulpwood Price



What ‘new products’ could Maine have to offer?

- Mass timber (e.g., CLT)
- Liquid biofuels
- Bioplastics
- Cellulose Nanofiber (CNF)
- Forest carbon sequestration
- Other forest ecosystem services

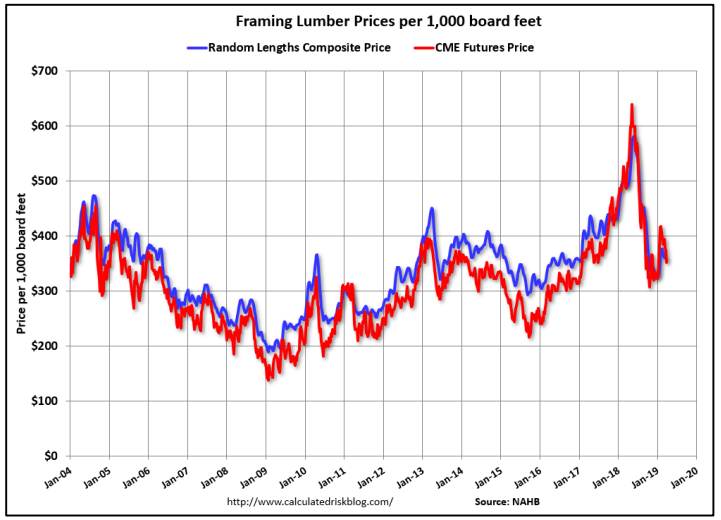
Photo courtesy Kaiser Group and Path Architecture

Completed in 2018, Carbon12 was engineered using an innovative steel brace frame core surrounded by a timber and CLT structure

Sourced from Breneman et al. (2019)

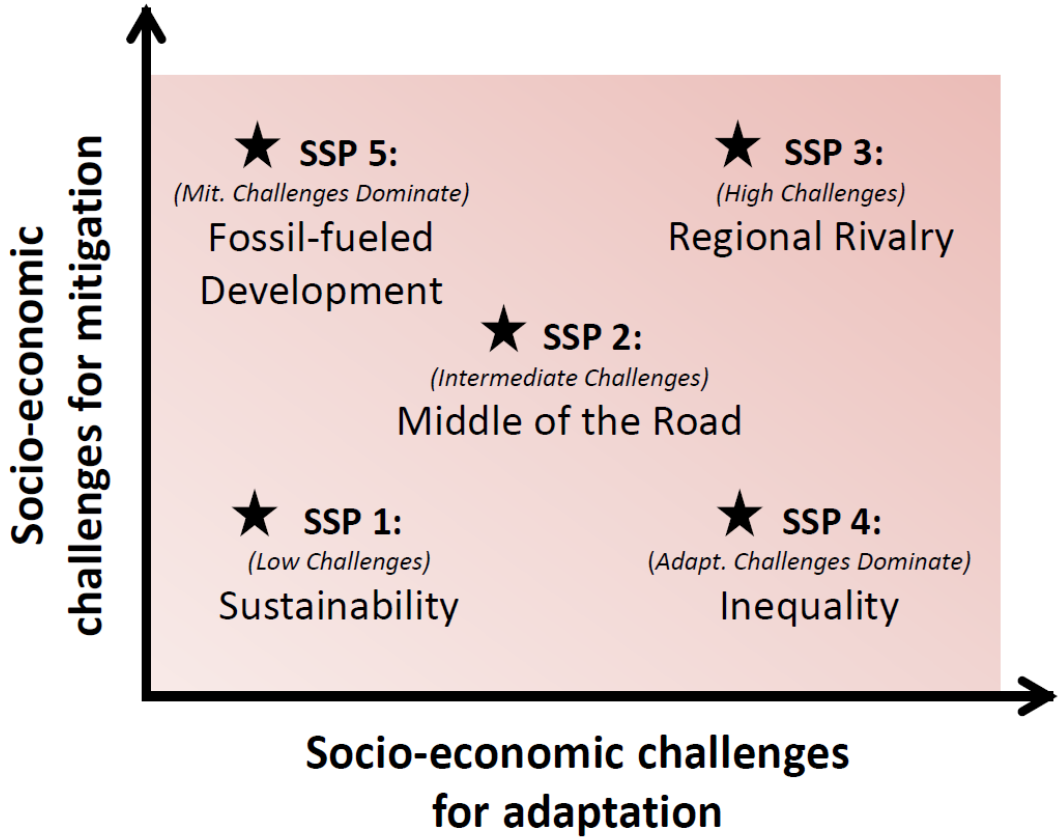
What are we concerned about?

- Market conditions
- Consumer preferences
- Feedstock availability
- Environmental impacts
- Pests, disease, climate change
- Land use change
- Policy



What will the forest sector look like in the future?

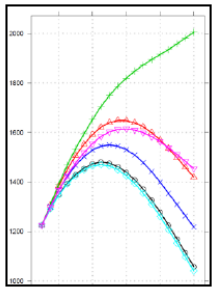
- Don't have a crystal ball → rely on scenario analysis
- Use IPCC Shared Socioeconomic Pathway (SSP) approach to develop 5 'alternative future' pathways



Narrative

Qualitative description of broad patterns of development

Logic relating elements of narrative to each other

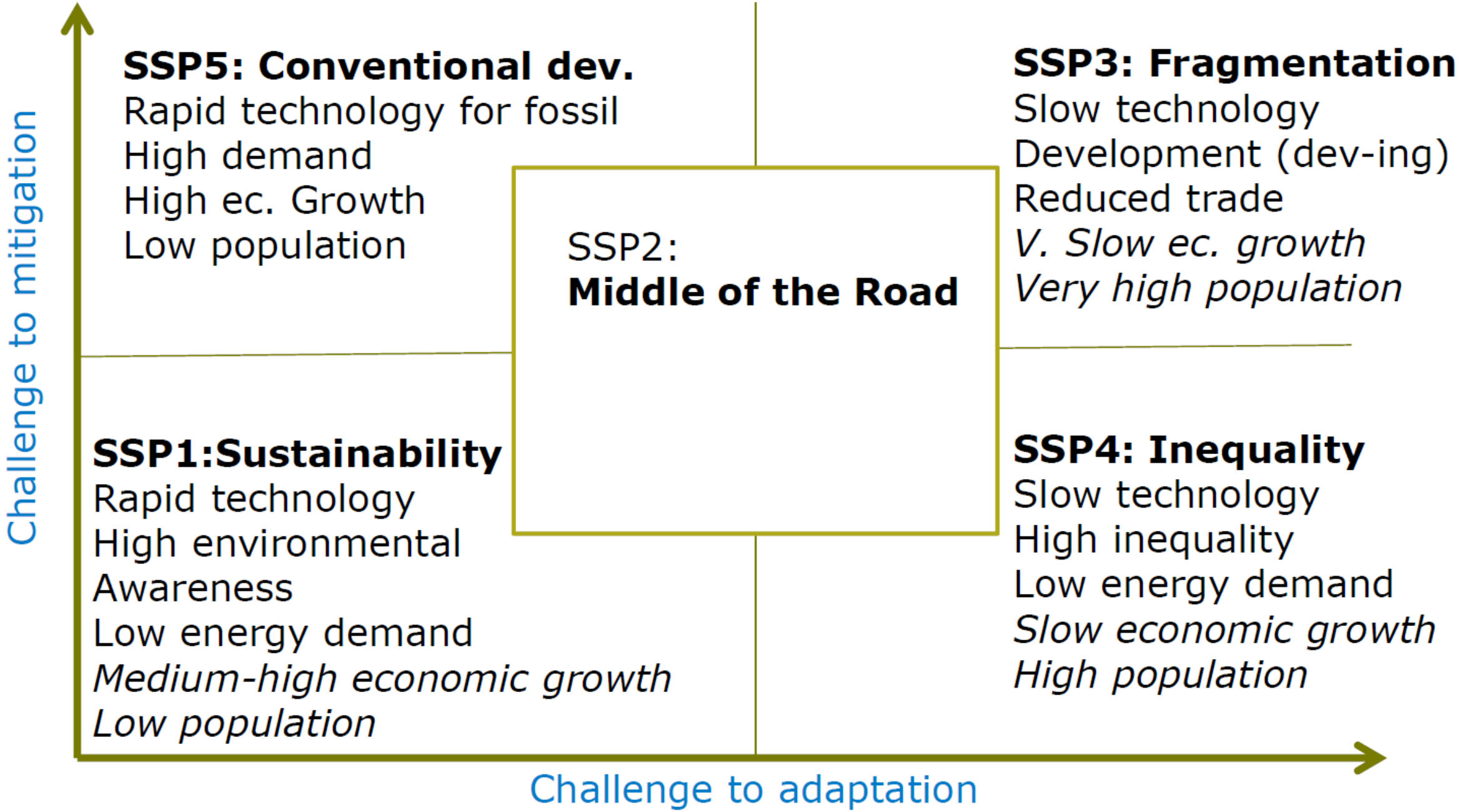


Quantitative elements

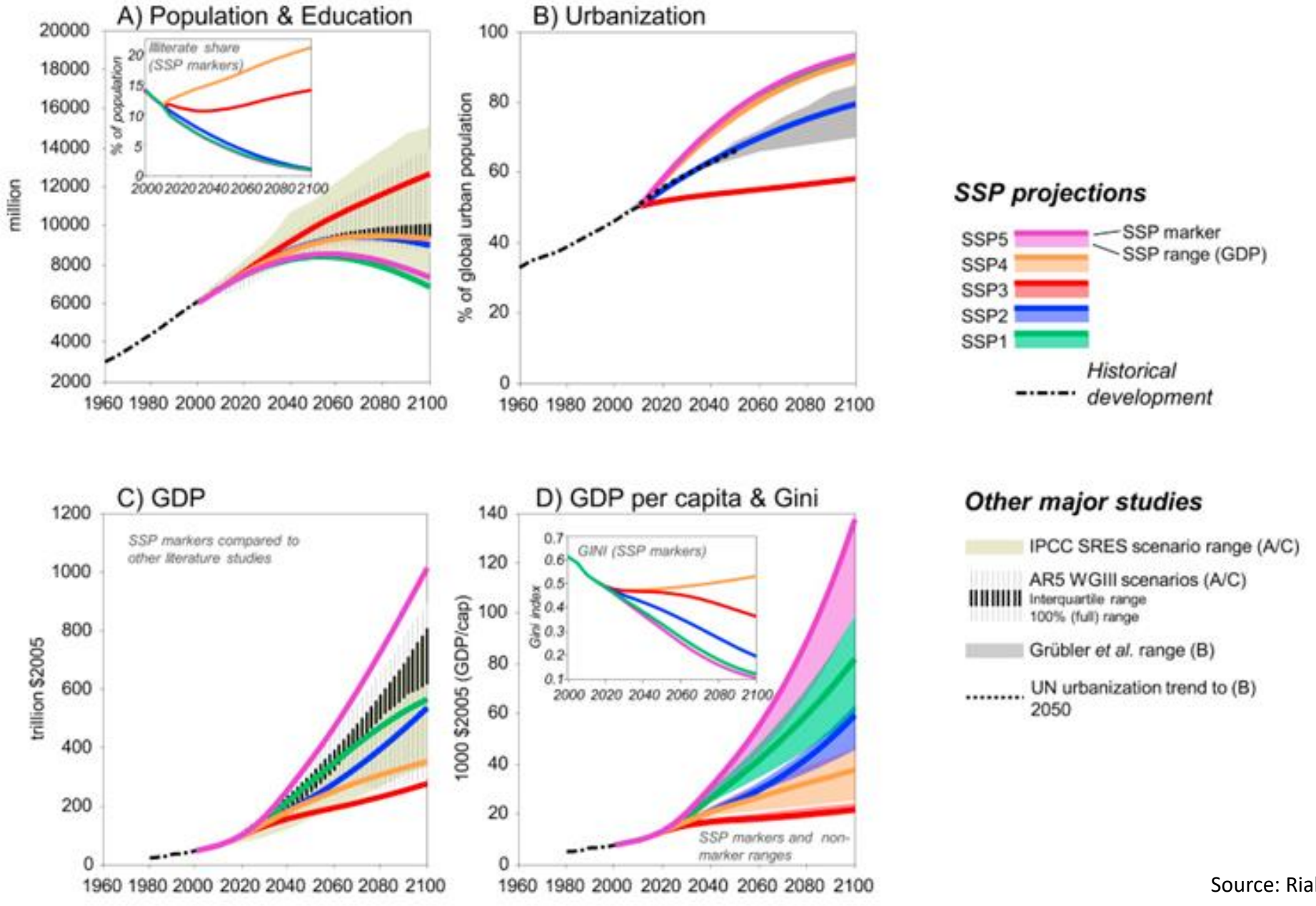
National:

- Population
- Education
- Urbanization
- GDP

SSP narratives, quantitative elements: **2017 special issue of *Global Environmental Change***.

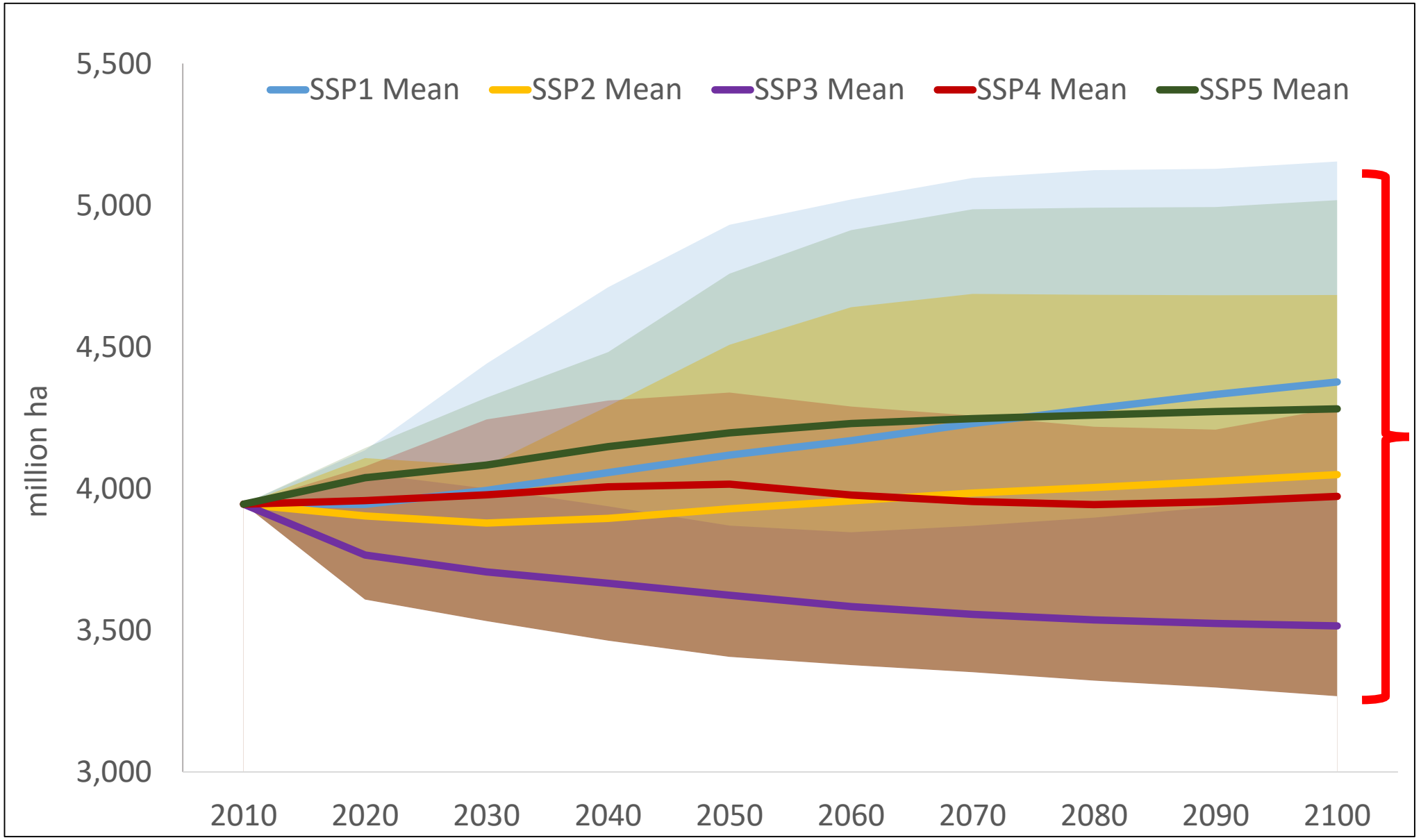

Challenge to mitigation
SSP5: Conventional dev.
Rapid technology for fossil
High demand
High ec. Growth
Low population
SSP3: Fragmentation
Slow technology
Development (dev-ing)
Reduced trade
V. Slow ec. growth
Very high population
SSP2:
Middle of the Road
SSP1:Sustainability
Rapid technology
High environmental
Awareness
Low energy demand
Medium-high economic growth
Low population
SSP4: Inequality
Slow technology
High inequality
Low energy demand
Slow economic growth
High population
Challenge to adaptation

Each pathway can include a range of socio-economic indicators



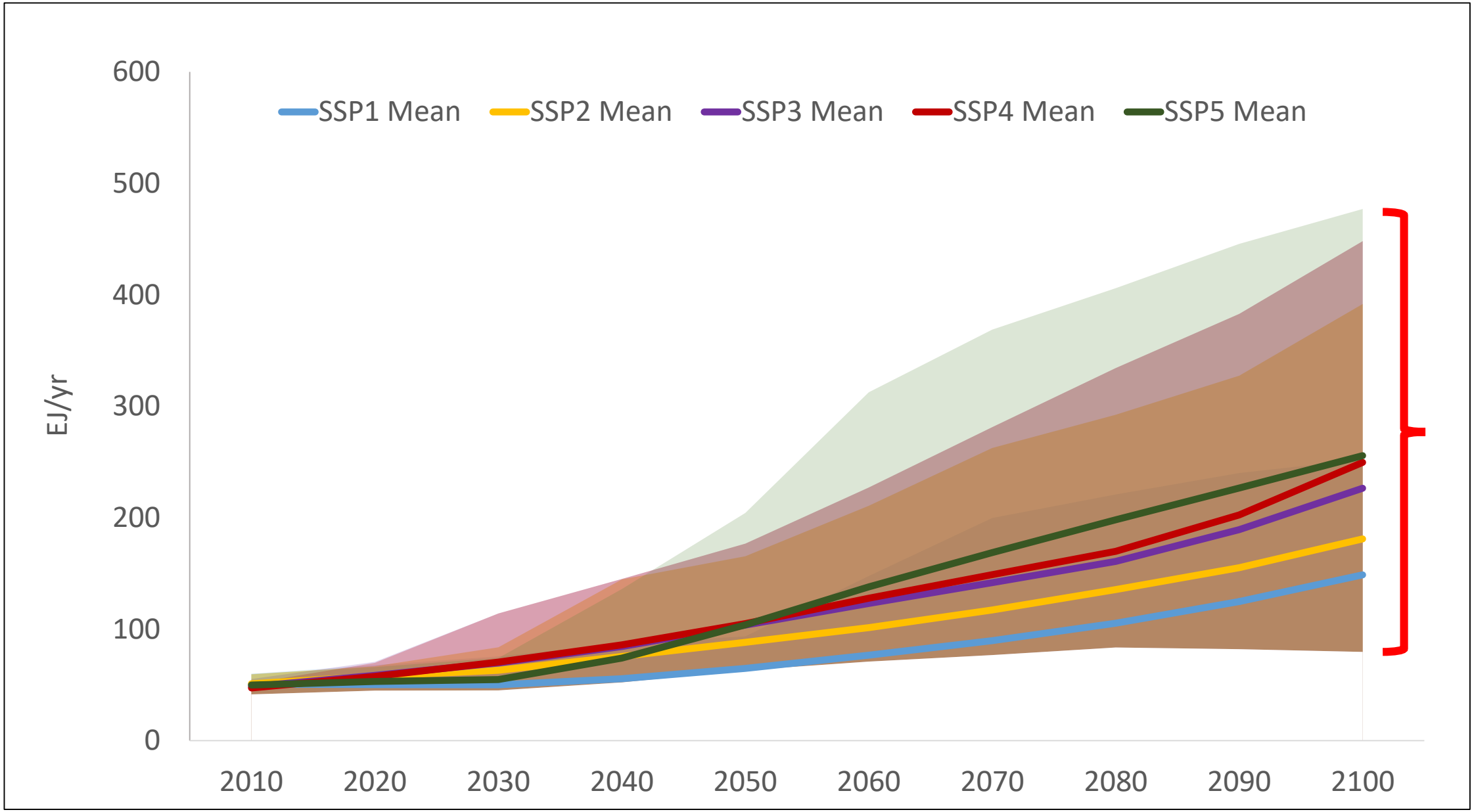
Source: Riahi et al (GEC, 2017)

Recent studies have indicated that the impact on forests could be all over the map…



Popp et al. (2017) range of projected global forest land cover for 5 SSPs, 2020-2100.

…as well as bioenergy demands (Riahi et al., 2019)



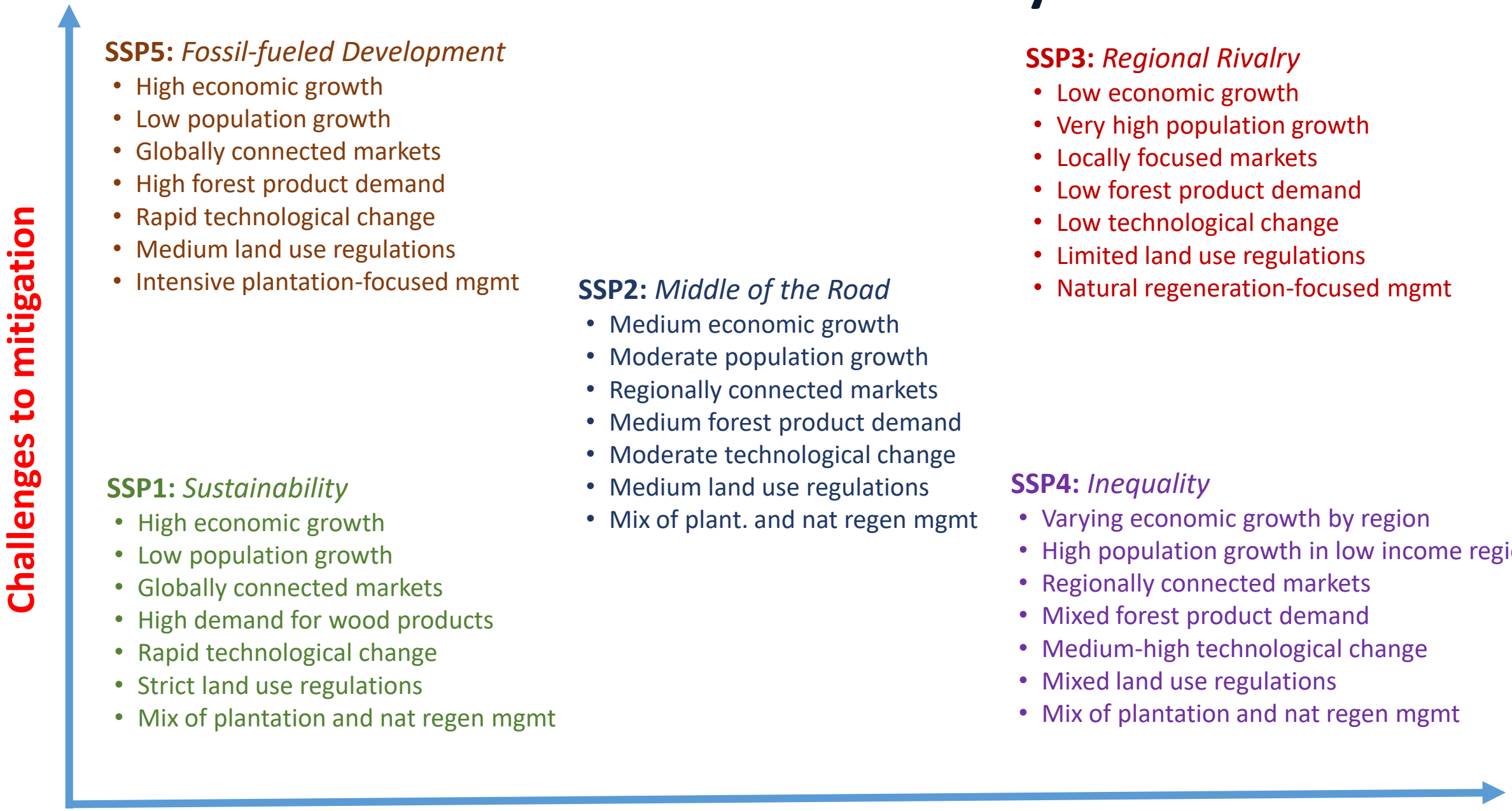
Riahi et al (2017) range of projected global biomass energy consumption for 5 SSPs, 2020-2100.

Role of Global Forests

- In future, there is the potential for additional deforestation and/or enhanced sequestration
- Changes in forest area, harvests, and carbon stock depend on:
  - Demand for timber and wood products
  - Demand for other land-based commodities
  - Institutional factors
  - Technological change
  - Geography
  - Climate impacts
- Options/practices for forest-based mitigation and adaptation:
  - Afforestation/Avoided deforestation
  - Forest Management (change rotations, silviculture, species)
  - Wood-based bioenergy

Positive effect
Negative effect
Varying effect

Forest Sector Pathways



SSP5: *Fossil-fueled Development*

- High economic growth
- Low population growth
- Globally connected markets
- High forest product demand
- Rapid technological change
- Medium land use regulations
- Intensive plantation-focused mgmt

SSP3: *Regional Rivalry*

- Low economic growth
- Very high population growth
- Locally focused markets
- Low forest product demand
- Low technological change
- Limited land use regulations
- Natural regeneration-focused mgmt

SSP2: *Middle of the Road*

- Medium economic growth
- Moderate population growth
- Regionally connected markets
- Medium forest product demand
- Moderate technological change
- Medium land use regulations
- Mix of plant. and nat regen mgmt

SSP1: *Sustainability*

- High economic growth
- Low population growth
- Globally connected markets
- High demand for wood products
- Rapid technological change
- Strict land use regulations
- Mix of plantation and nat regen mgmt

SSP4: *Inequality*

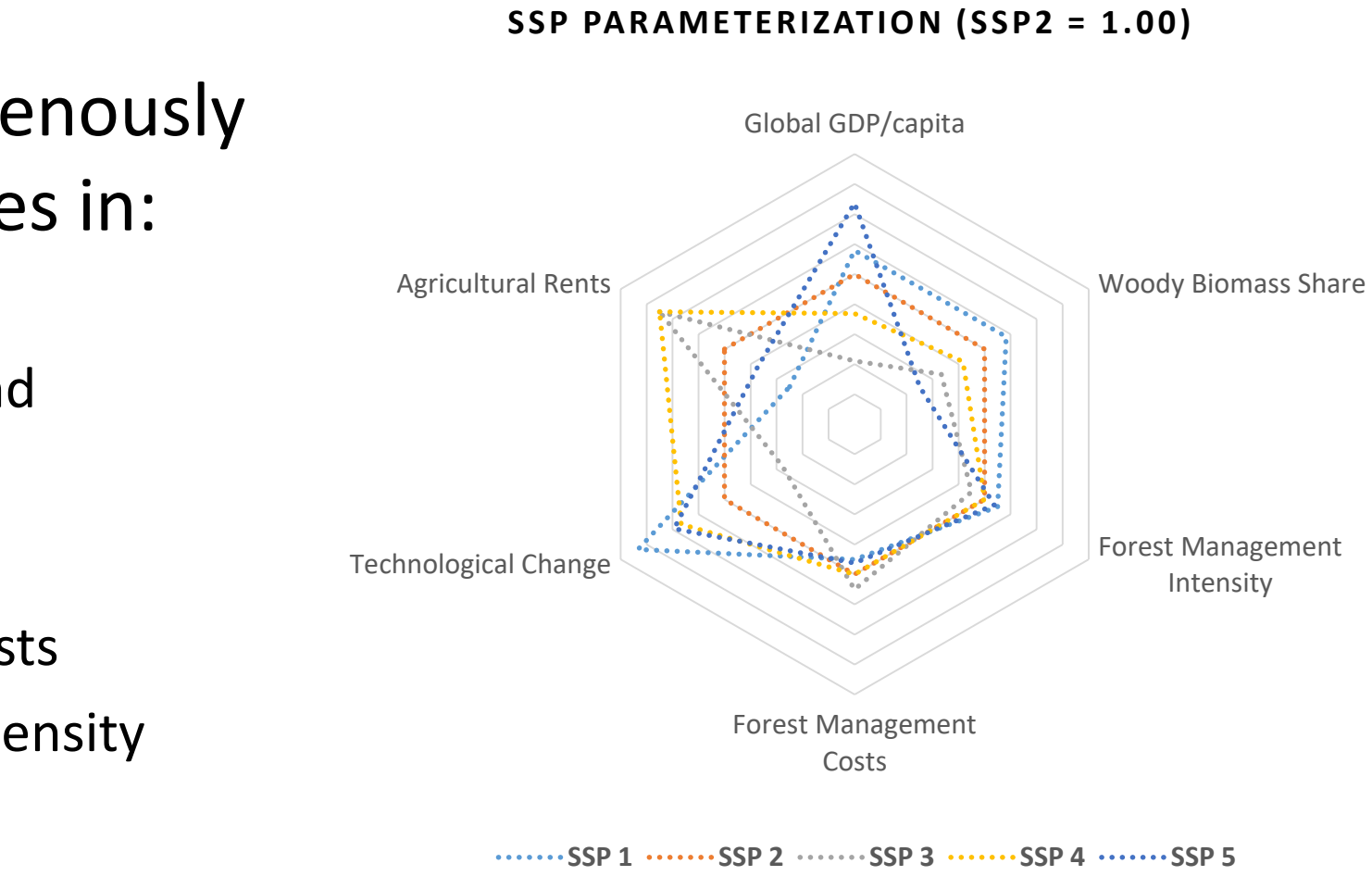
- Varying economic growth by region
- High population growth in low income regions
- Regionally connected markets
- Mixed forest product demand
- Medium-high technological change
- Mixed land use regulations
- Mix of plantation and nat regen mgmt

Dynamic Global Optimization Forestry Model

- Based on Sohngen et al., 1999; Daigneault et al., 2012.
- Forward-looking dynamic model solved in decadal increments beyond 2200
- Global timber demand is exogenous and driven by population, income and technology change.
- Dynamic forests: Timber production in 300+ forest ecosystems determined by optimization over forest age classes, area of accessible and inaccessible land, planting, and management intensity.
  - Keep track of age classes.
  - Keep track of investments.
  - Keep track of where forests are located.
- Prices endogenously determined.
- Land demand driven by agricultural markets via rents, but exogenous to model

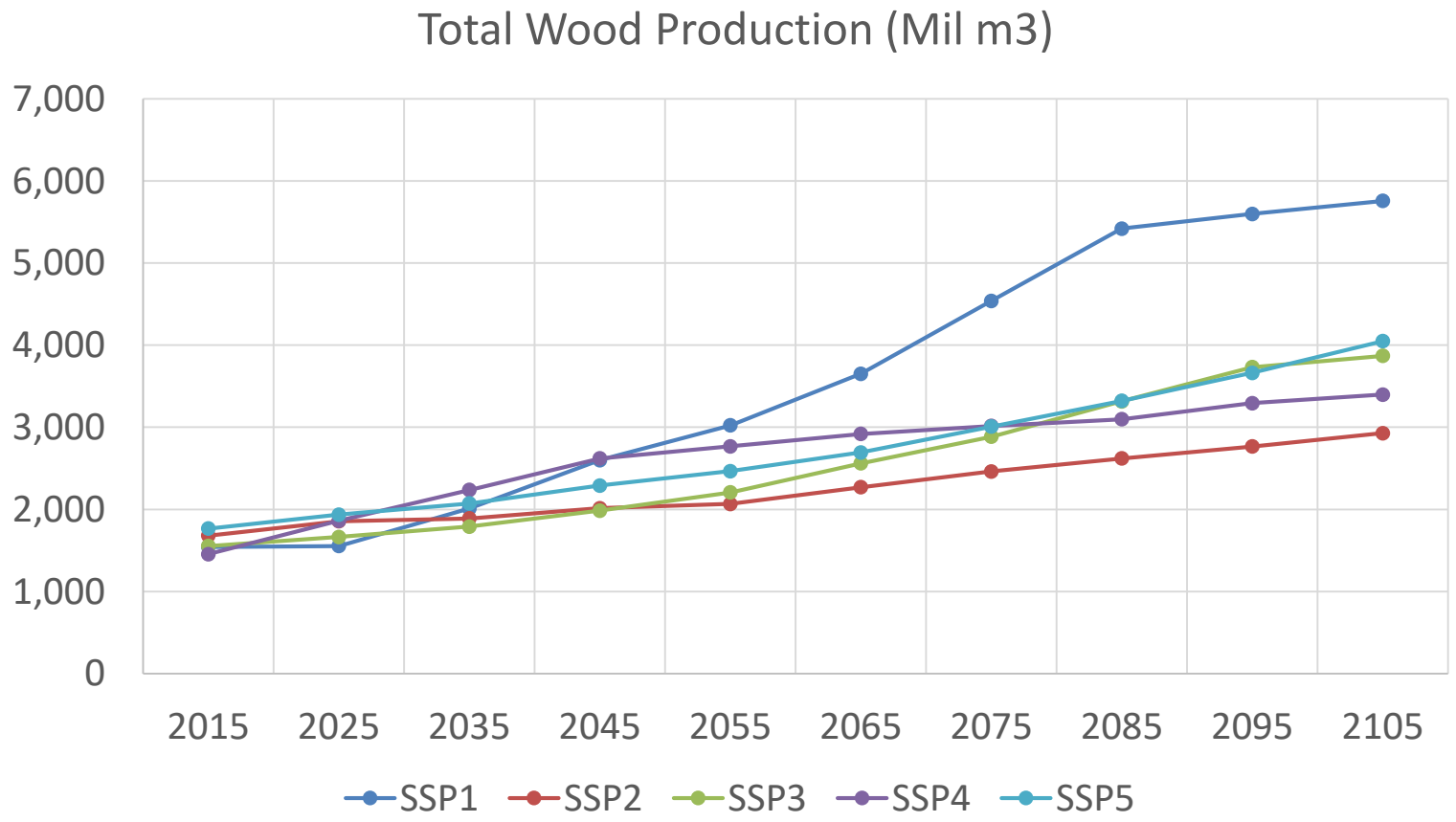
Model SSPs by exogenously specifying differences in:

- GDP/Capita
- Woody biomass demand
- Agricultural rent shifts
- Technological change
- Forest management costs
- Forest management intensity
- Consumer preferences



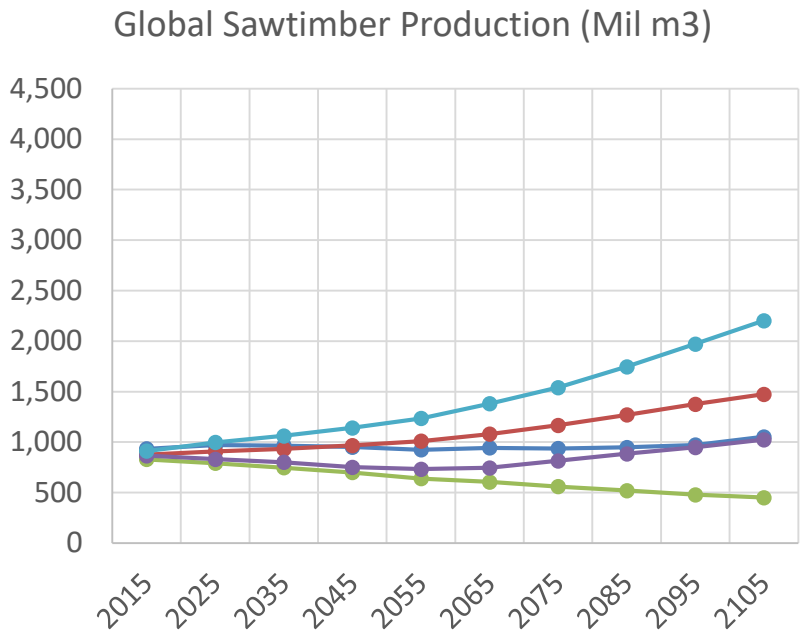
Global Forest Sector Estimates

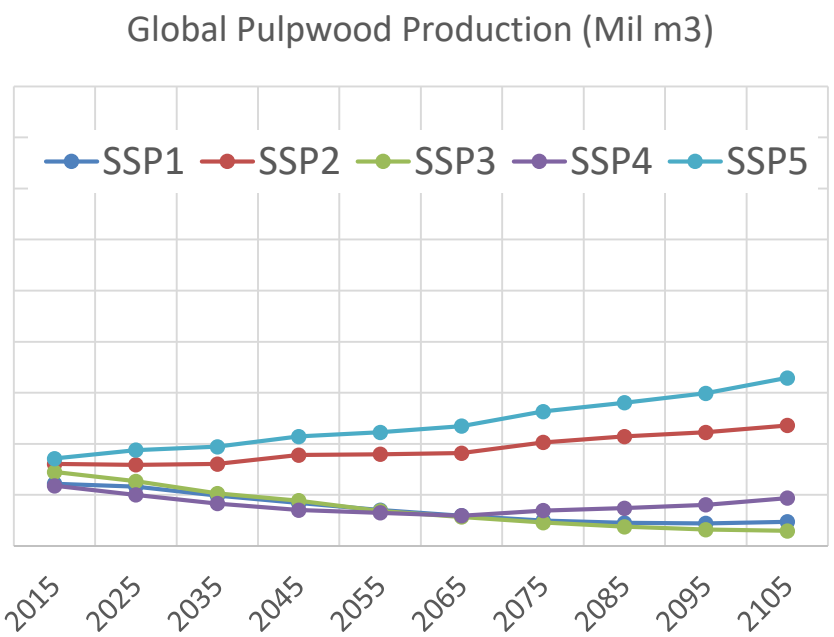
Total global timber harvests projected to increase across all scenarios/pathways…

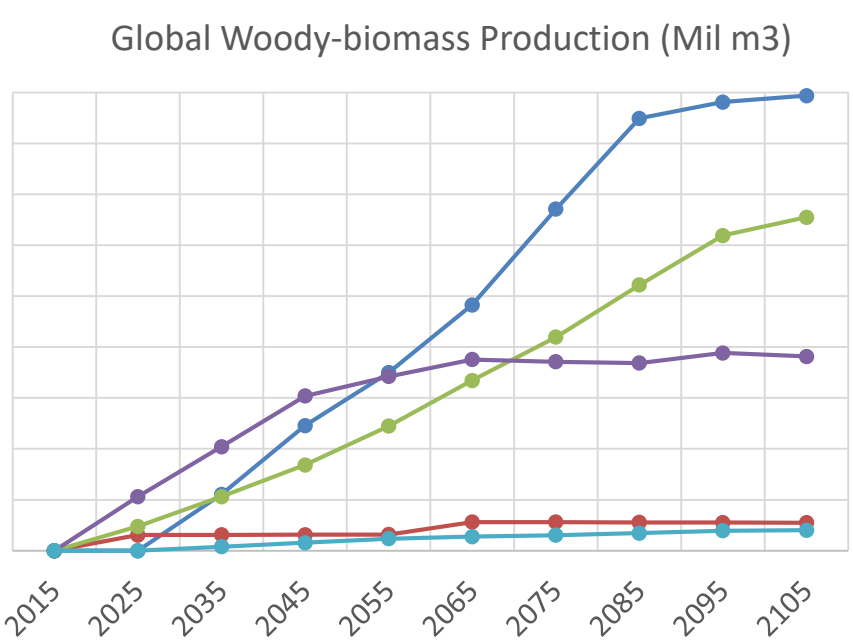


- Larger increases for scenarios with high per capita income (SSP 1 and 5)
- Product-level demand varies widely (next slide)

…but harvests by more specific timber grade varies…

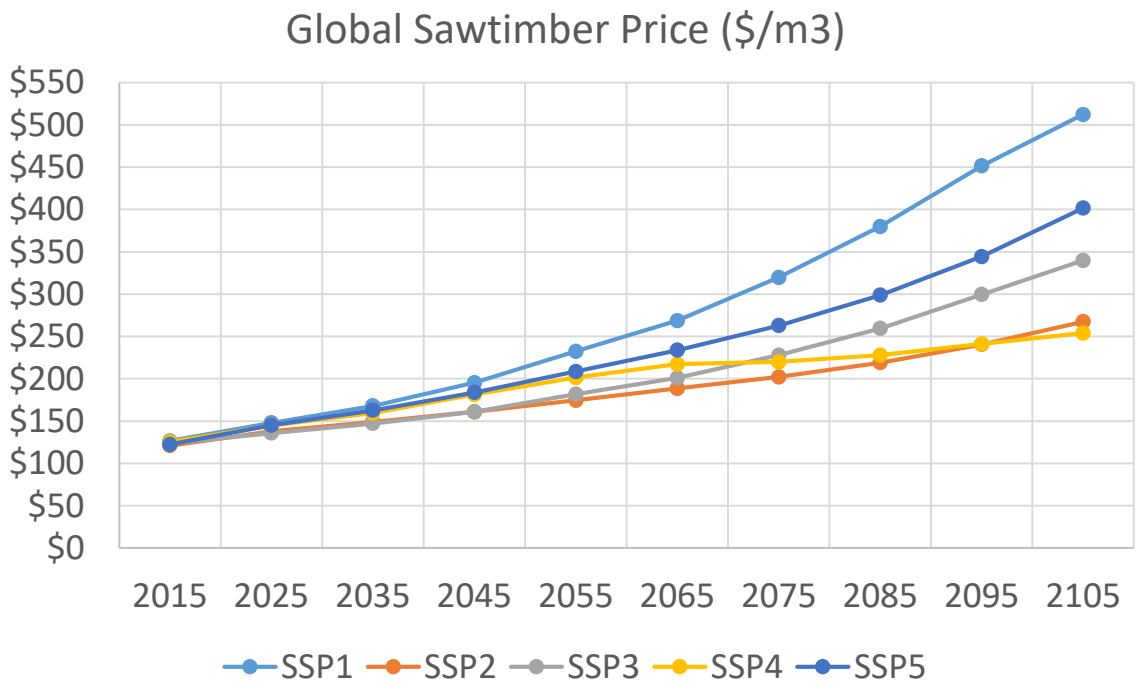


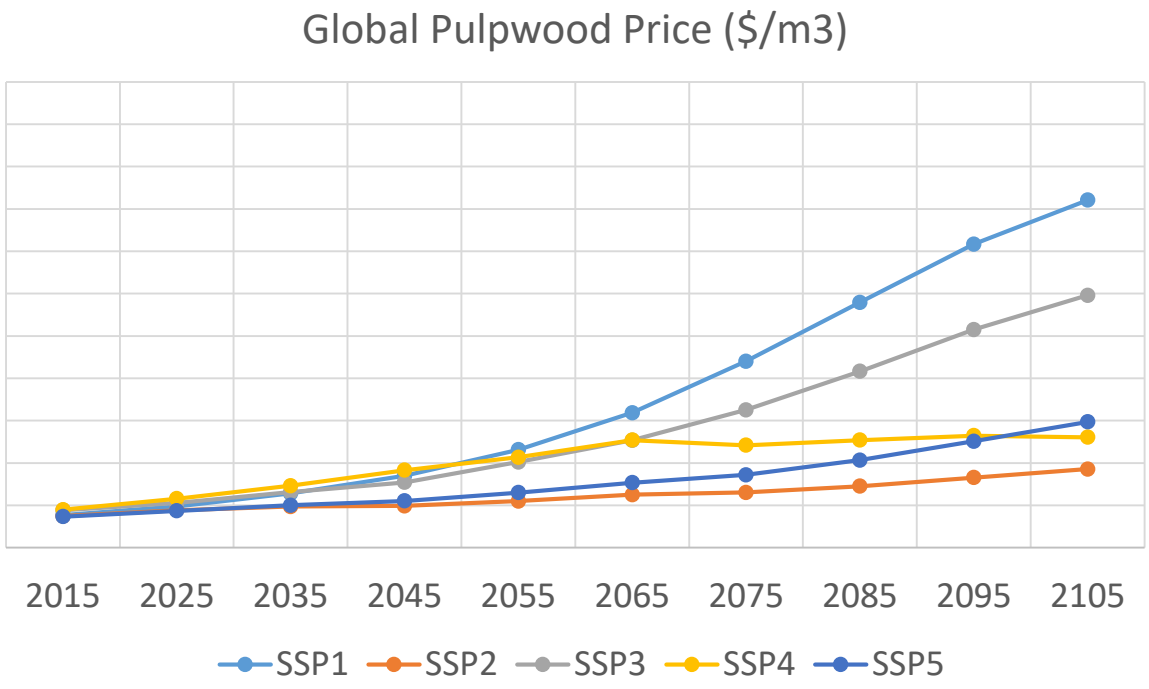




- *Income effect:* GDP per capita: SSP 5 dominates sawtimber and pulpwood demand vs. SSP 3 low economic growth, low timber demand, high biomass demand
- *Substitution effect:* Product preferences: SSP 1 shifts to more sustainable timber products (sawtimber) and bio-energy (woody-biomass)
- *Land competition*: High agricultural land rents, SSP 3

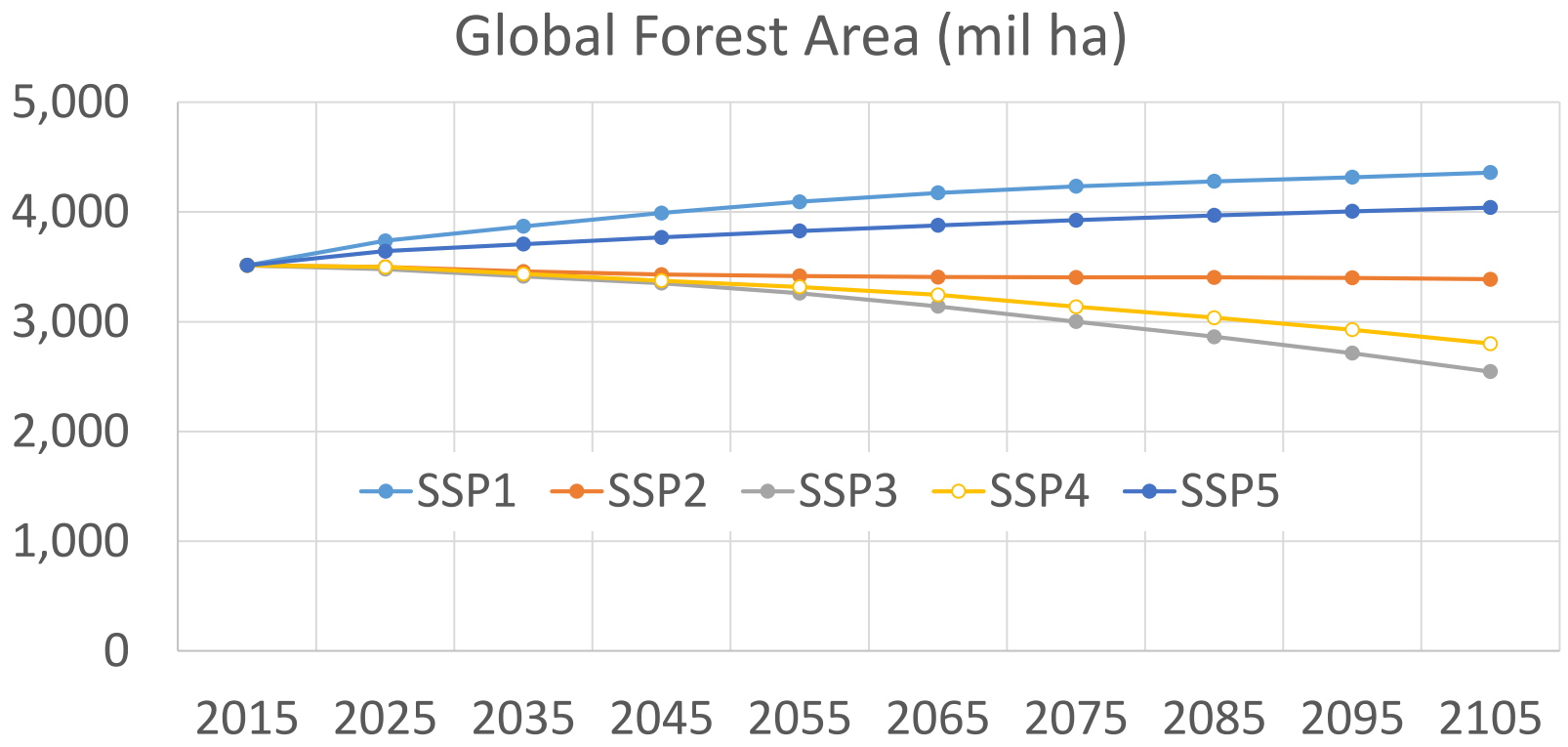
…timber prices are estimated to increase across all pathways, too…





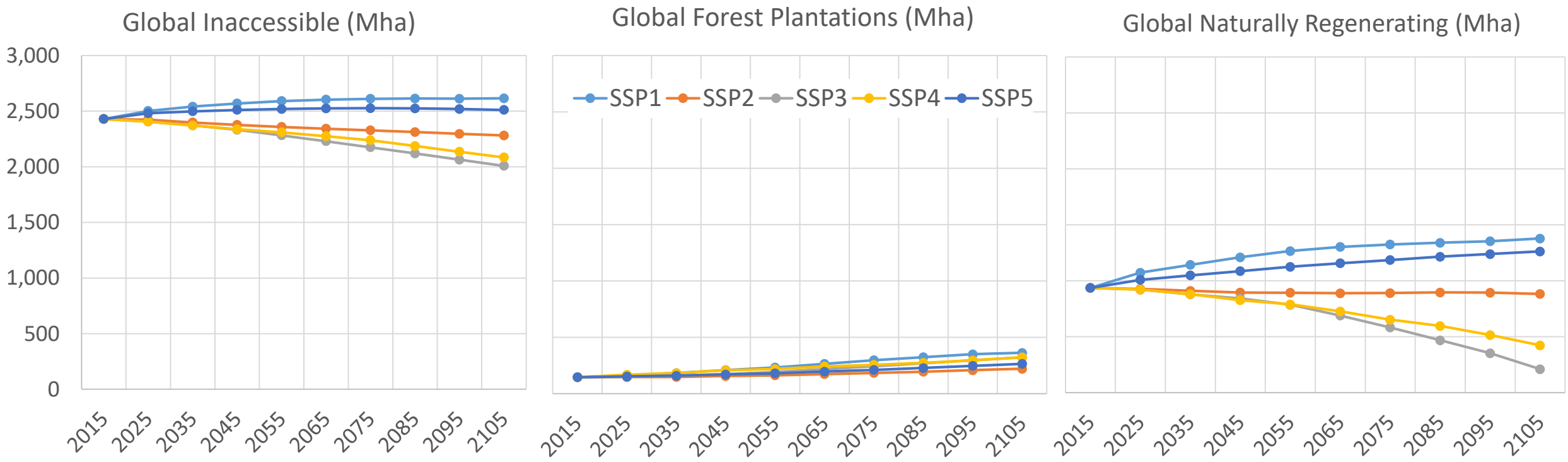
- Drivers: Biomass demand; Management intensity; Technological change; Land values
  - Pulpwood price increases more rapidly because of increasing supply of woody-biomass for energy (primary substitute)
  - SSP1: High demand → large price increases despite low mgmt. cost and high tech change

…but the total area of forest could vary by nearly +/- 1 billion hectares…



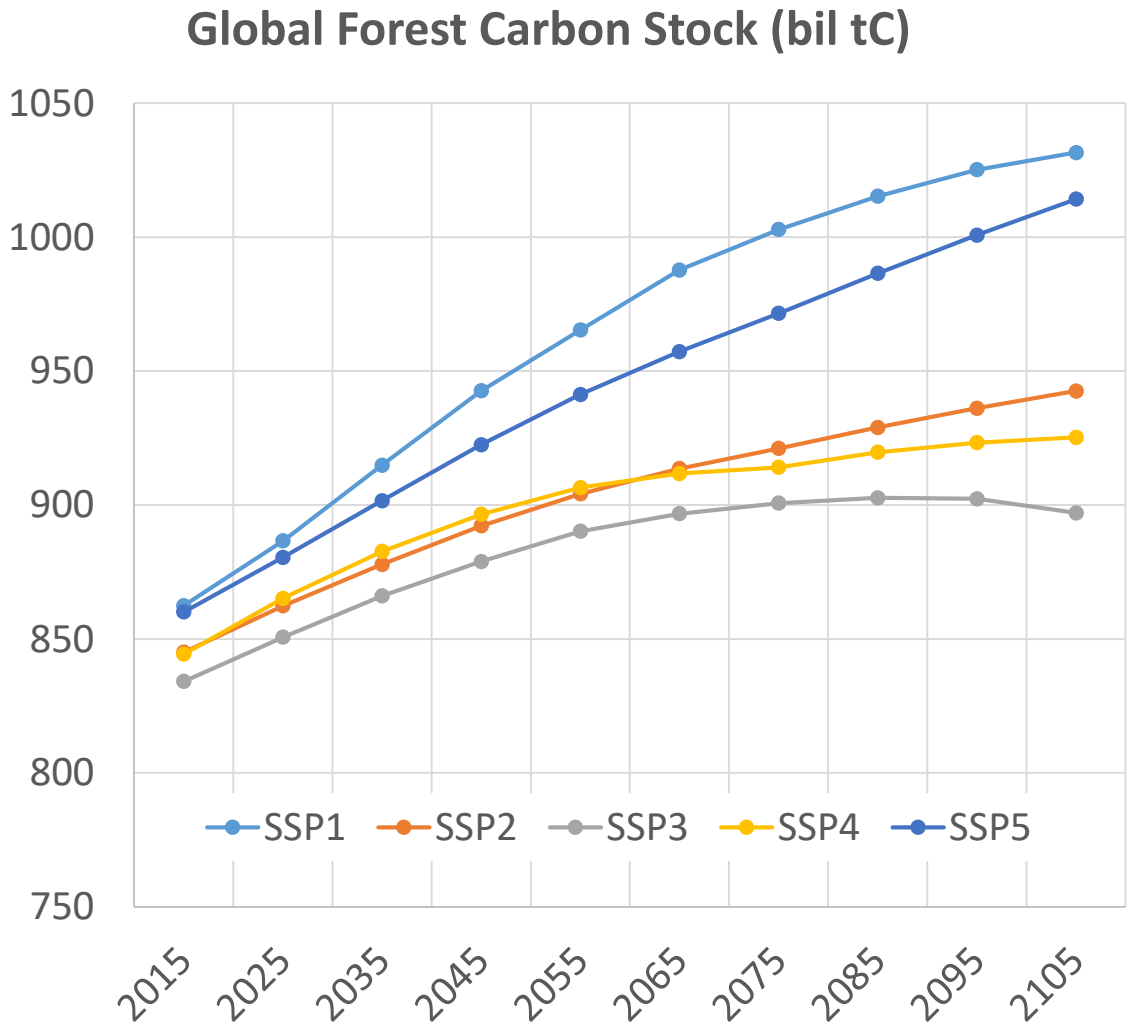
- Global forest area is estimated to change from about 3,500 Mha today to anywhere between a 967 Mha decline (SSP3) to a 841 Mha increase (SSP1) by 2100
- Estimates are the equivalent to an annual change of -0.24% to 0.32%.

…and the area of specific types of forests are affected differently, too…



- SSPs with strong growth in wood product demand (SSP1) or low productivity (SSP 4) are likely to develop more **high yield forest plantations**.
- SSP1 has the largest growth in non-plantation forests due to **limited pressure for other land uses**, low consumption preferences and high technological change.
- In SSP 3 and 4, the **loss in inaccessible forests** is not offset by increases in plantations.

…but overall, increased total timber demand and prices mean more carbon is stored in forest growing stock and harvested wood products…



- Growing demand for forest products (industrial and/or energy) increases global forest carbon sequestration
- Expansion in plantations and intensive management increases carbon intensity (tC/ha)
- SSP1 has largest increase over next century (21%)
- SSP3 C stocks peak in 2085 as bioenergy demand plateaus

Global SSP Scenario Summary

1. Growing income is primary driver for increased forest product demand

2. Wood for bioenergy demand highly substitutable with pulpwood regardless of consumer preferences (e.g., SSP1)

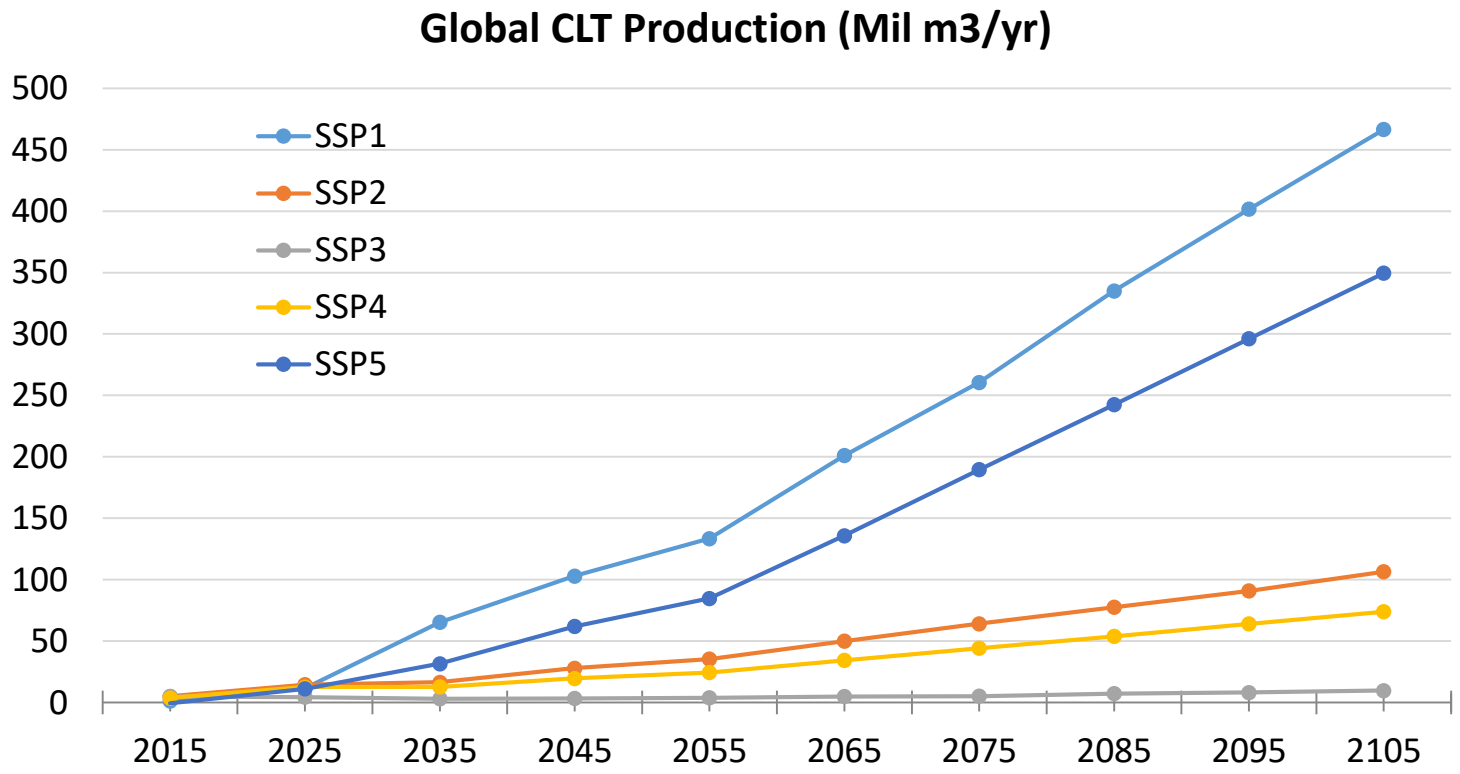
3. Agricultural land values have strong influence on how different forests expand/contract

4. Carbon stocks estimated to increase regardless of SSP. Driven by strong market for at least one major forest product in each pathway

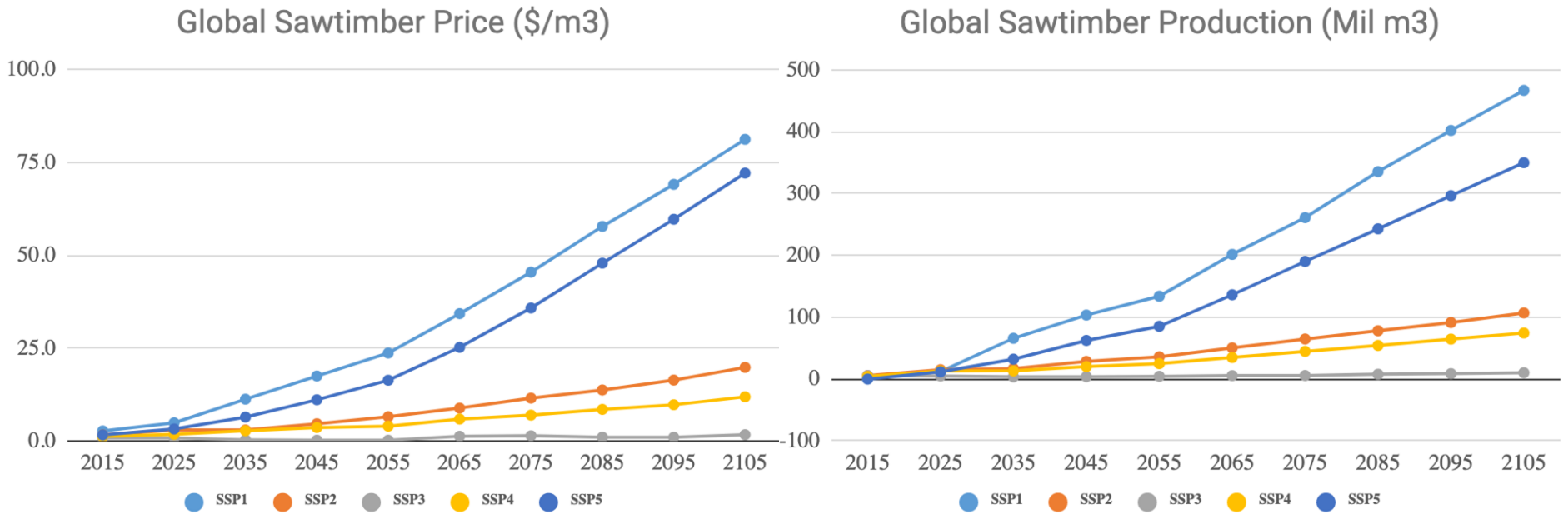
A Closer Look at Global Impacts of CLT

Methodology

- Same as previous approach/model, but isolate effects of varying CLT demand
- CLT projections based on trends in urbanization, wood-based construction, consumer preferences technological change, etc.
- Production by 2100 ranges from 10 to 460 million m3/yr

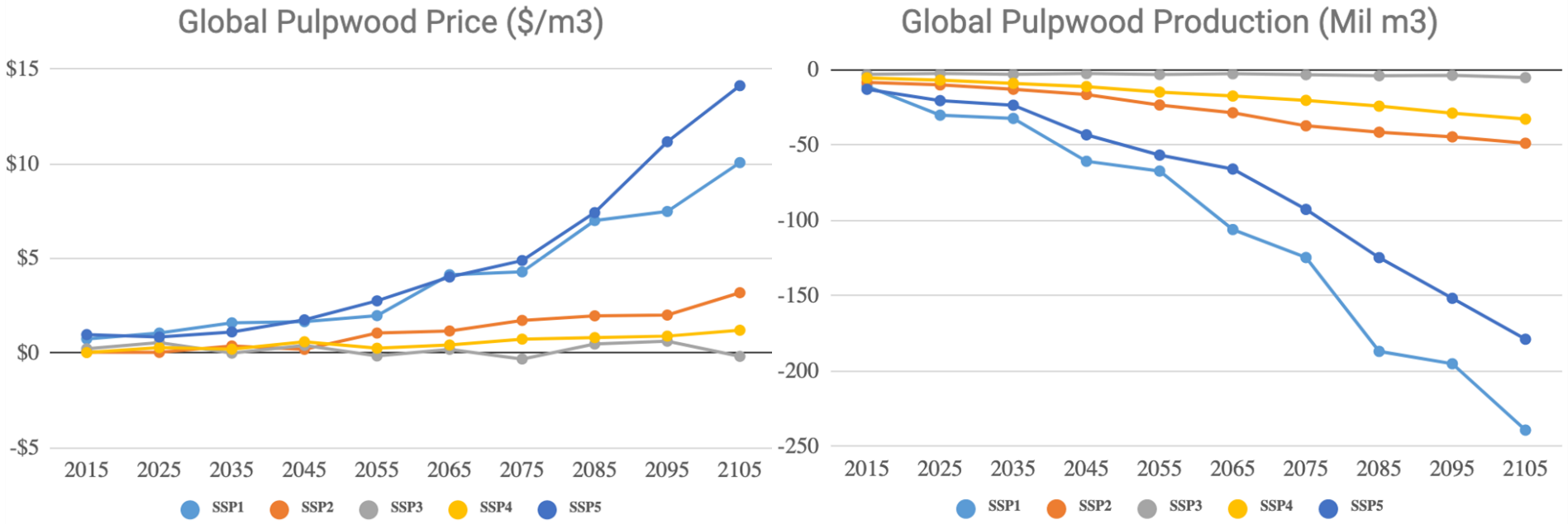


Global Sawtimber Prices & Production



More CLT → greater increases in sawtimber prices and production

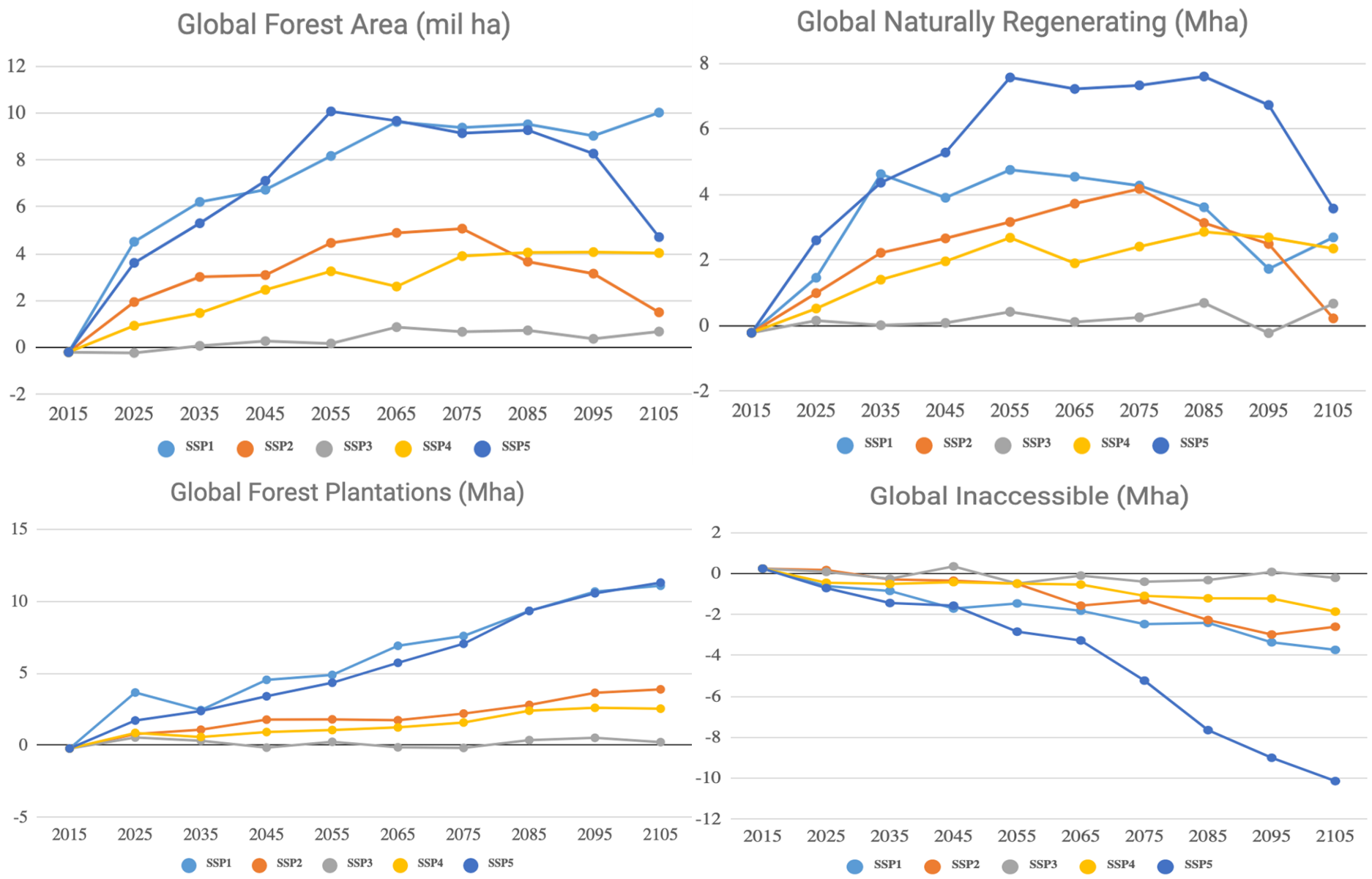
Global Pulpwood Price and Production

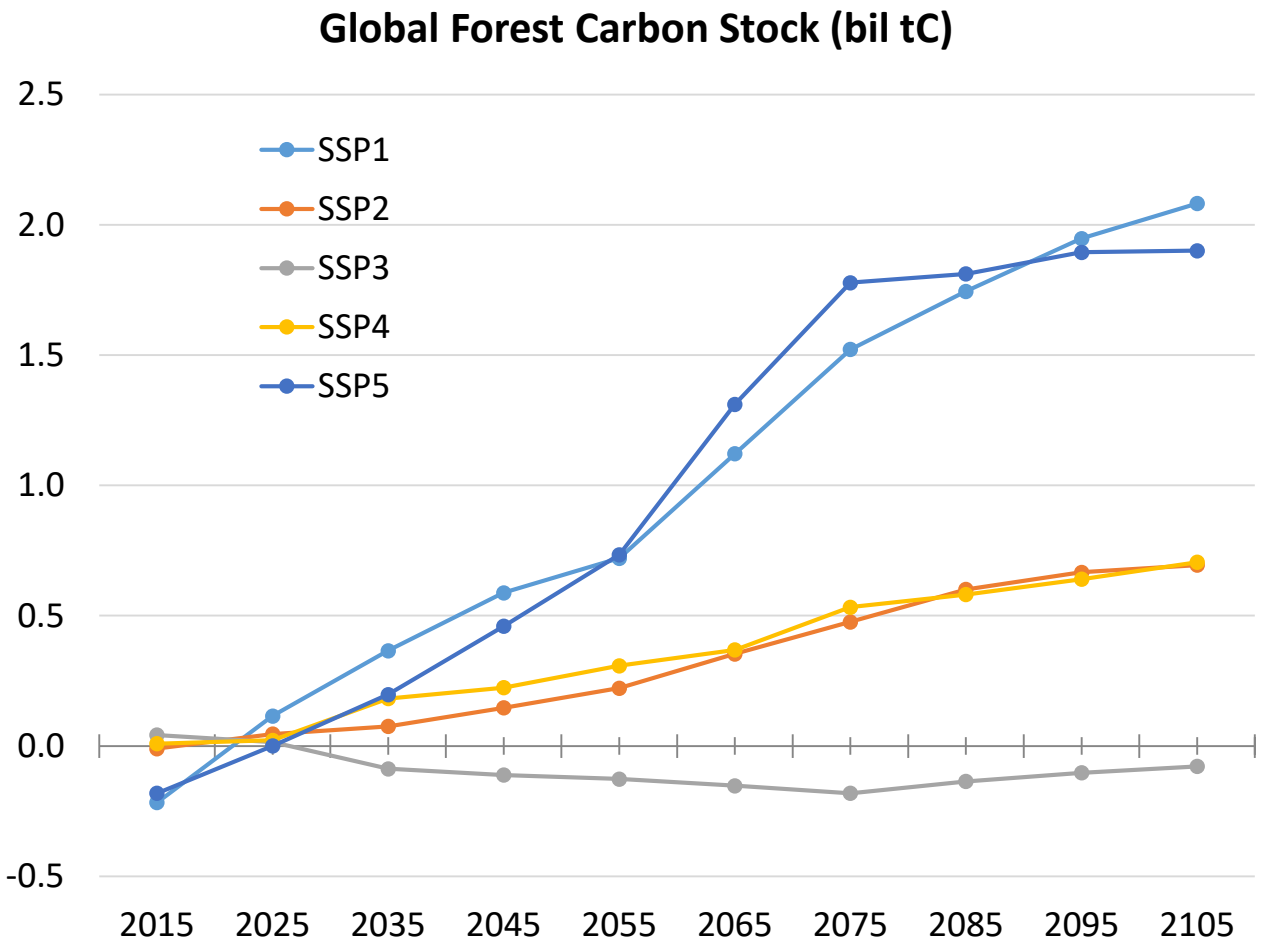


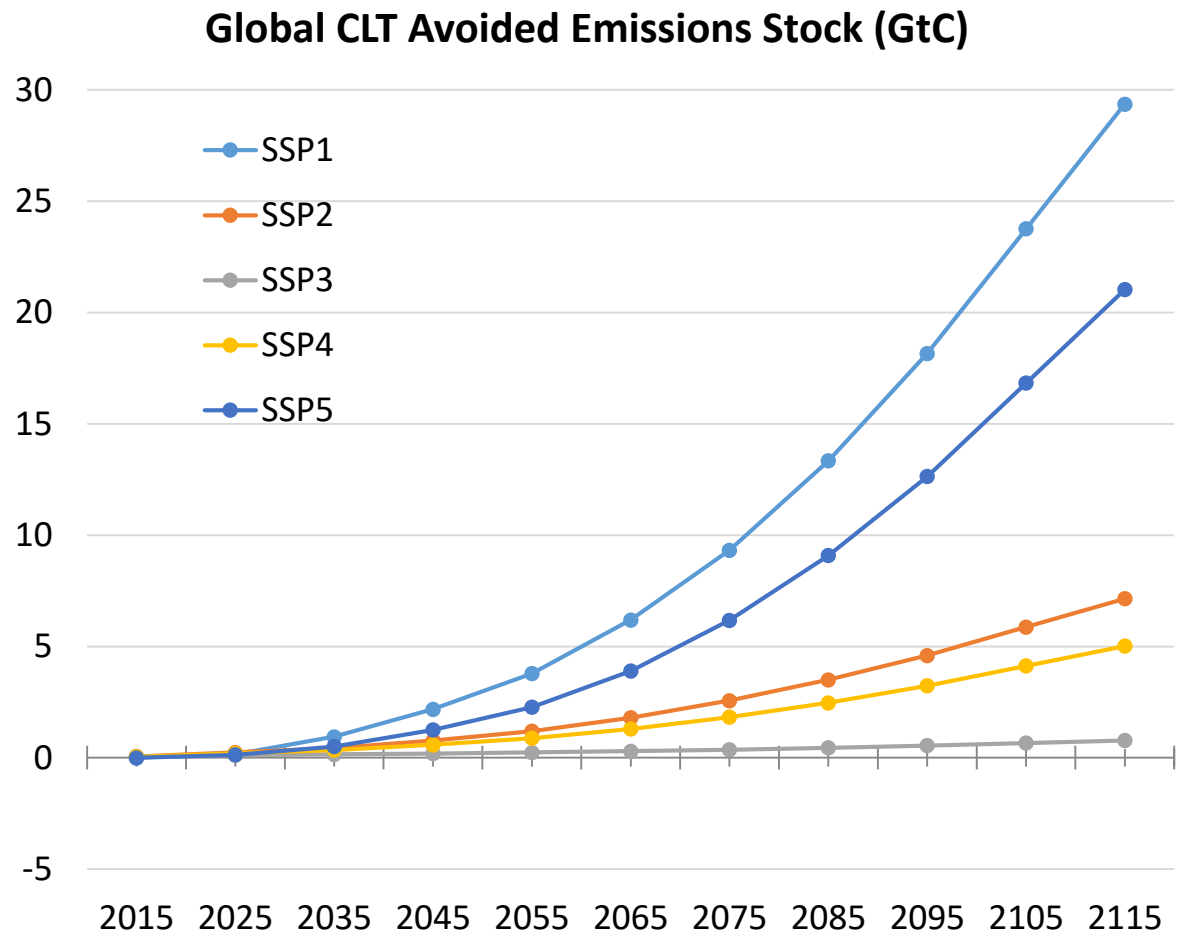
More CLT → greater decreases in pulpwood production, but increases in pulpwood prices (substitution effect)

More CLT → increase in total forest area → primarily high yield plantations at the expense of inaccessible forests (substitution effect)

Change in Global Forest Area







More CLT → larger increases in aboveground and harvested wood product carbon stocks (price incentive)

More CLT → greater levels of avoided emissions from other building materials (substitution effect)

Global CLT Scenario Summary

1. Increase **demand for CLT** results in **higher prices** across timber product class
2. Demand met by a mix of **increased forest area** and extended **rotation ages**
3. Global **forest carbon stocks** increase for all but the most pessimistic (SSP3) scenario due to **improved management & expanded area**
4. **Avoided emissions** from **substituting wood** for other building products has **larger effect** than forest carbon

Maine's Forest Sector Future?

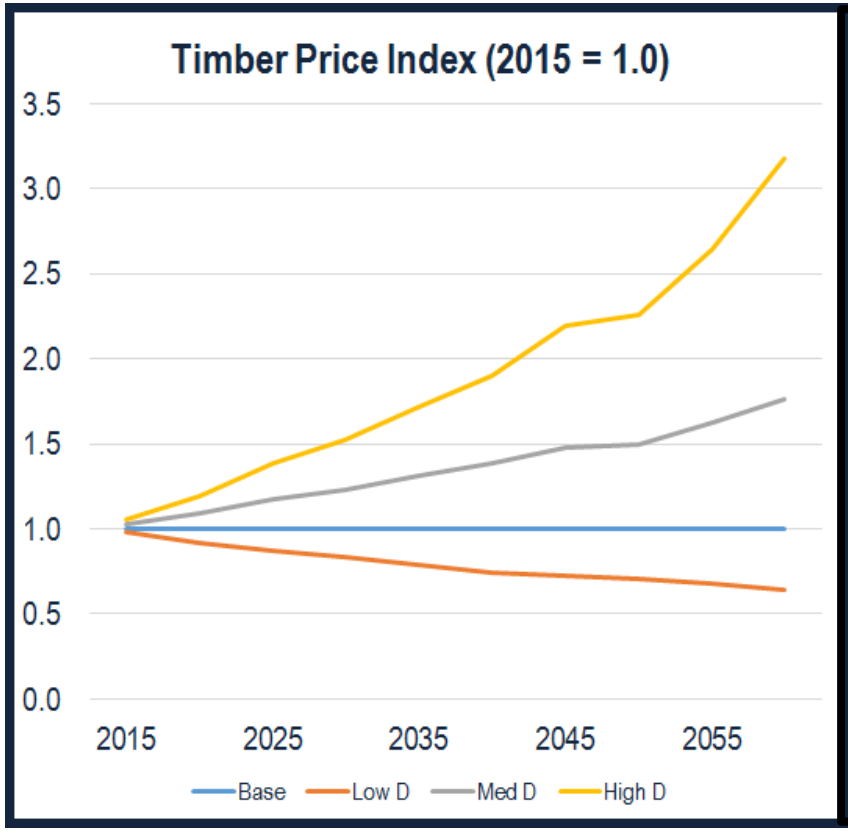
Looking Forward

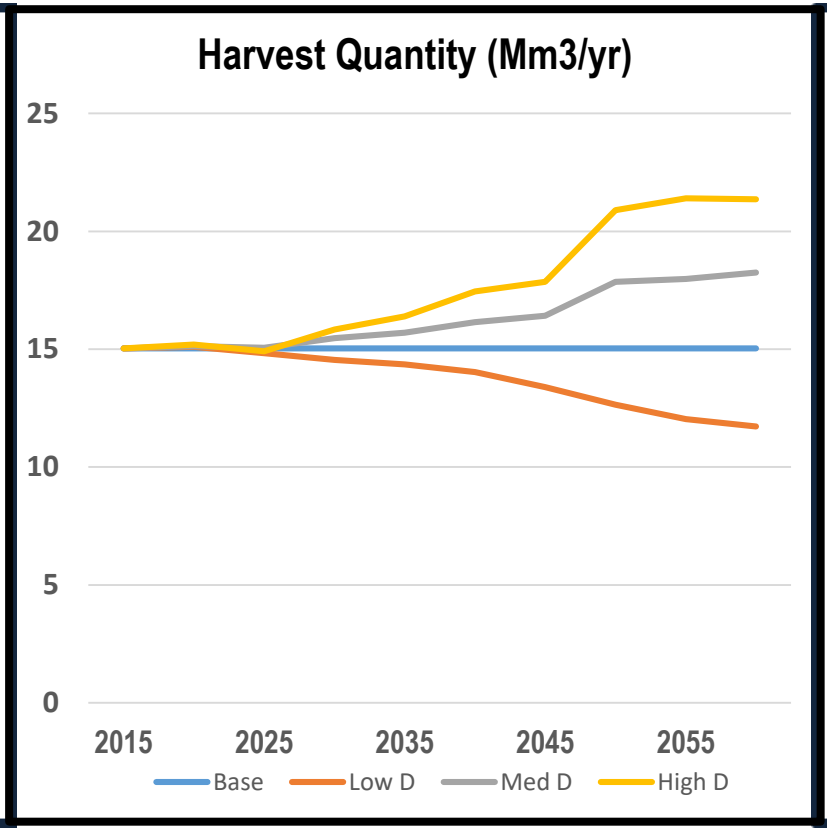
- A lot of transition in the forest economy
- Are there more constraints or opportunities?
  - Markets: New vs. traditional
  - Land ownership : more conservation, multi-use
  - Consumer preferences: bio-based products
  - Climate, environmental and land use policy
- Lots of talk and focus on emerging markets
  - Mass timber/CLT
  - Nanocellulose-based products
  - Liquid biorefineries
  - Others?

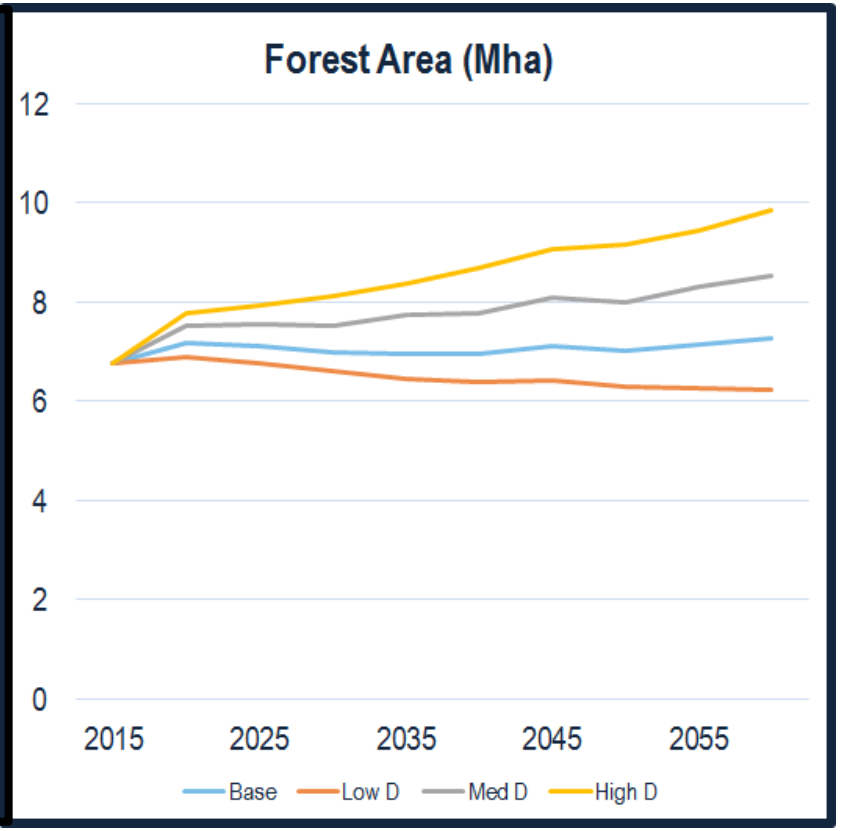
- Take an integrated modeling approach to explore alternative futures

DRAFT RESULTS – DO NOT CITE

Approach: Alternative Maine Timber Demand Scenarios (L, M, H)

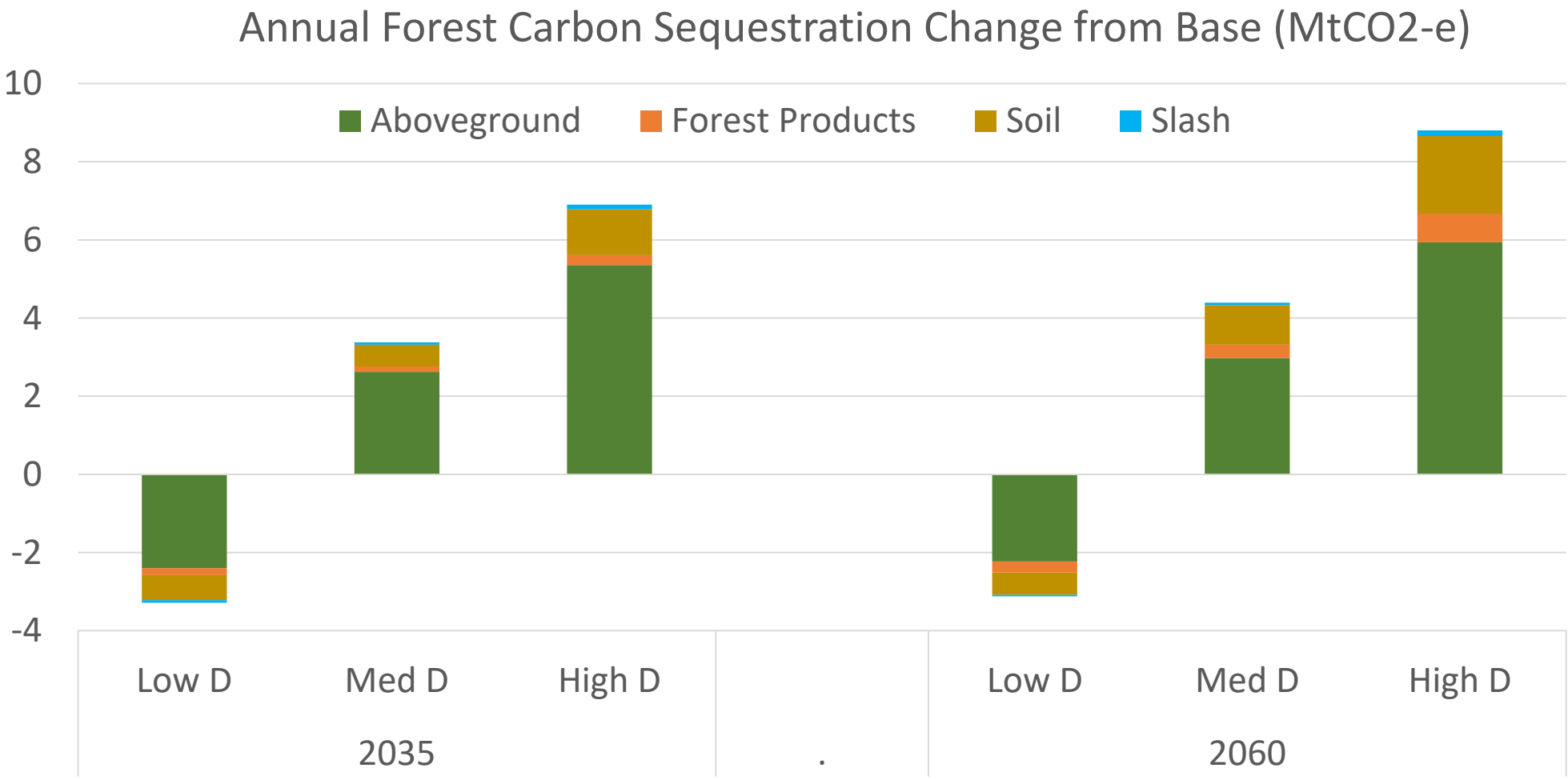






Increased demand → higher timber prices → increased forest area, improved forest management and overall harvests

DRAFT RESULTS – DO NOT CITE



Maine's forest carbon sequestration *increases* with demand for timber products
→ mix of increased management, area, and storage in harvested wood products

Key Findings: Maine Timber Demand Scenarios

- Timber demand scenarios indicate a wide range of impacts on timber prices:
  - Low demand → price *decreases* of 1%/yr
  - High demand → price *increases* of 2.5%/yr

- Increase in demand → more forest area → *increases* forest carbon sequestration
  - Occurs even when there are more harvests

- Forest carbon sequestration *increases* with timber demand
  - Primarily aboveground carbon → price induced management

Overall Summary

- **Scenario analysis** a structured way to assess alternative future pathways
- Modelling **socio-economic and biophysical** aspects of forest management provides more nuanced estimates
- Regardless of scale or product, increased timber demand → higher prices → improved forest management → greater forest area → higher forest carbon
- **More variation** when accounting for changes in demand for **specific products**
- Opportunities for Maine's forest products **sector to grow** → high feedstock availability to meet **multiple market/product demands**

Question: Which pathway is Maine currently on?

Thanks…Questions?

Adam Daigneault, Ph.D.
Assistant Professor of Forest, Conservation, and Recreation Policy
University of Maine
School of Forest Resources
adam.daigneault@maine.edu