Regional impacts of new manufacturing technologies on the forest estate of Northland, New Zealand

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Introduction to New Zealand Forestry

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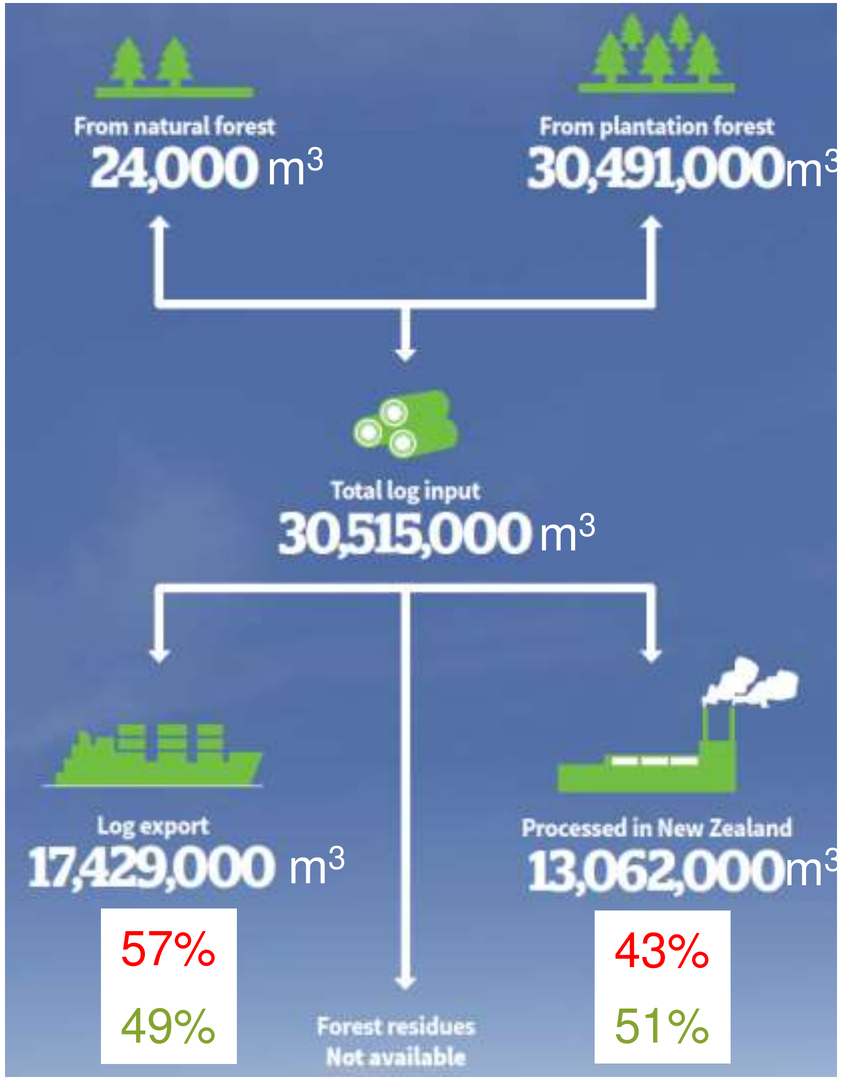
- Total area of forests in NZ is 9.5 million hectares
  - Natural: 7.8 million (82%)
  - Plantation: 1.7 million (18%)
- Plantation forests:
  - 92% is privately owned
  - 90% planted with *Pinus radiata*
  - Intensive commercial forests: fertilized and clearfell
  - 28-year rotation in average
- Predominant forest ownership structure:
  - Māori (native people of NZ) own the land
  - TIMOs own the forests
  - Recent trend: forests are being returned to Māori

Introduction to New Zealand Forestry

- New Zealand is the 2nd largest log exporter in the world after Russia
- Destination of annual harvest in 2017
  - 57% exported as raw logs
  - 43% domestically processed
- Value of exports in 2017 was NZ$5.5 billion
  - Raw logs: NZ$2.7 billion (49%)
  - Wood products: NZ$2.8 billion (51%)
- Opportunity to add value to current forest estate with new domestic processing technologies



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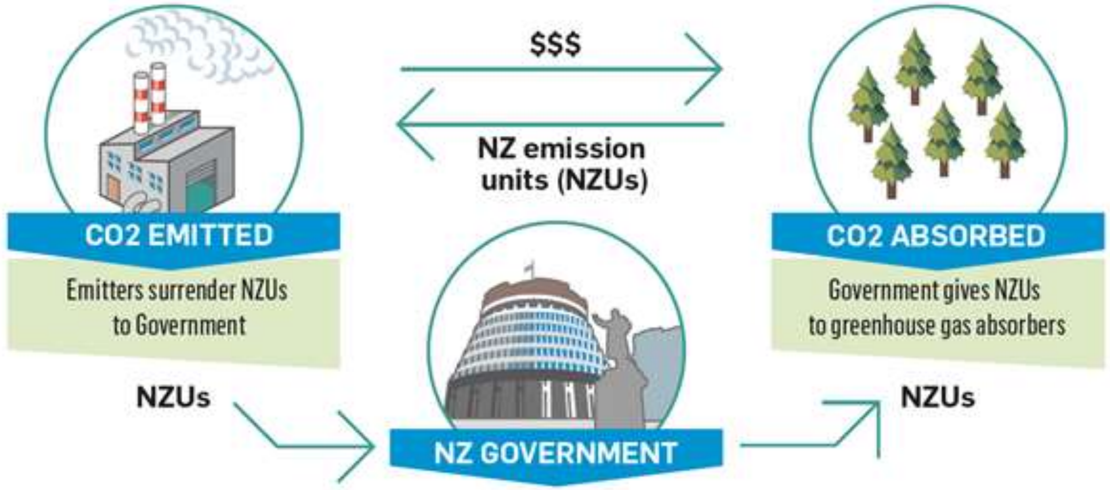
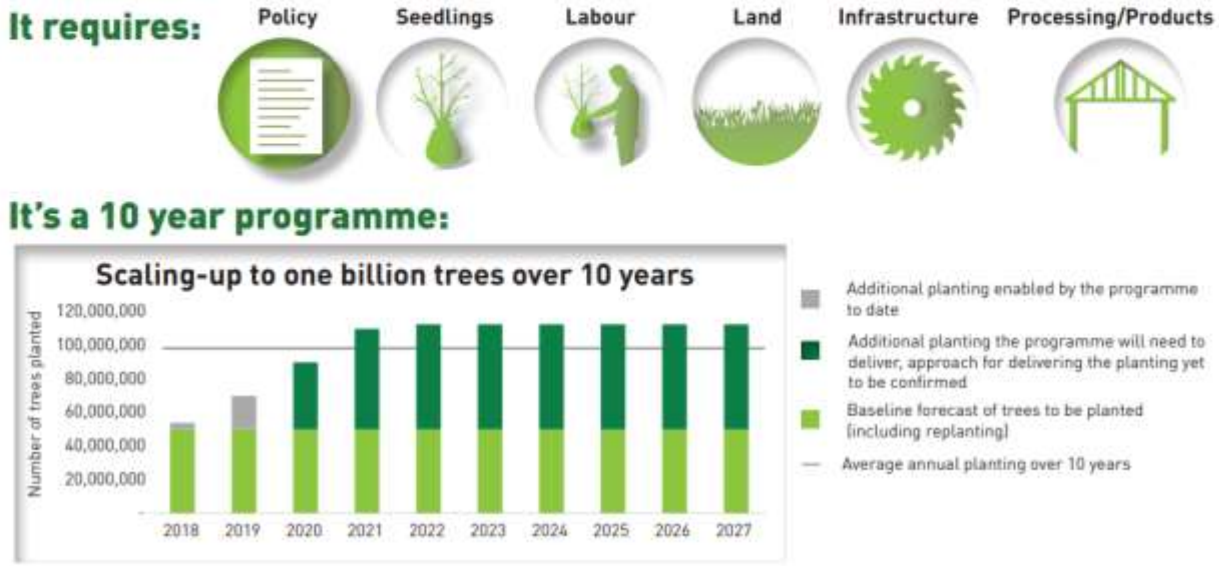
Policies incentivising afforestation

- New Zealand Emissions Trading Scheme (NZ-ETS)



- "One Billion Trees" (1BT) initiative



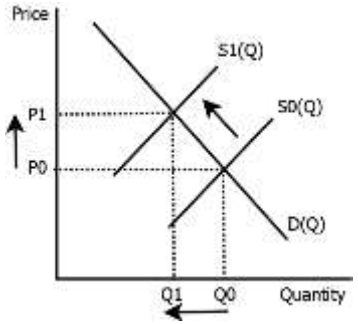
Opportunities to Increase Value of Forests

- Case study: Northland Region of New Zealand
- Area of forests: ~186,000 hectares
- Forests are predominantly owned by Māori
  - Māori are permanently attached to the land
  - Interested in investing in vertically-integrated, high-value chains
- Government policies incentivizing afforestation: ETS & 1BT
- Underinvestment in processing - only 7 small plants using traditional sawmilling technologies
- Two shipping ports
- No model linking the spatially distributed forest estate to potential manufacturing plants and markets

Methodology and Case Study

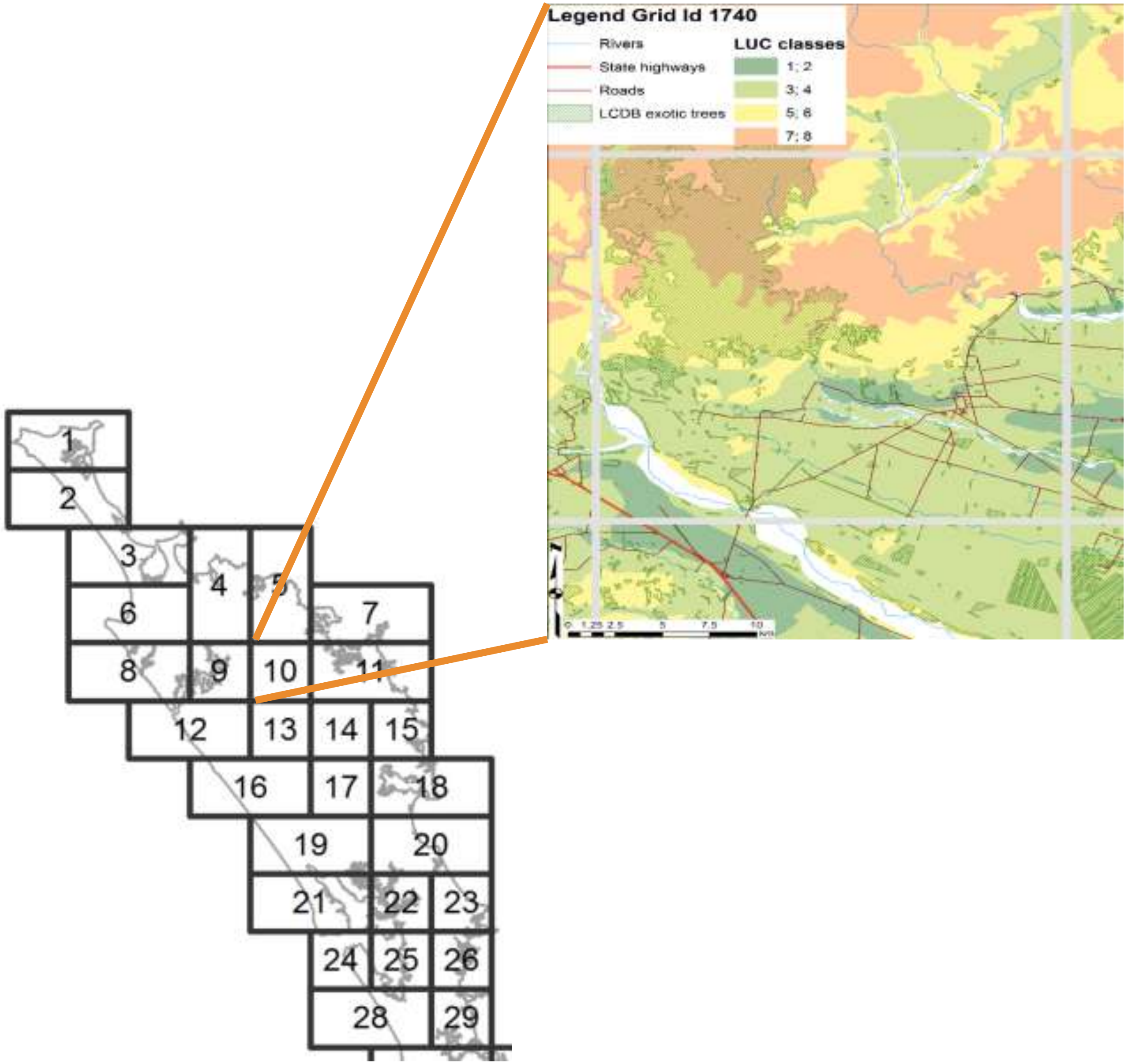
Primary Value Chains (PVC) Model

- Dynamic, geographically-explicit partial-equilibrium model representing various value chains in a specific region
- Maximises the net present value of a regional sector welfare, which is composed of producers' and consumers' surplus to identify equilibrium price
- The model is well suited to identify optimal harvest timings, manufacturing plant locations and transportation routes conditioned on resource limitations/locations and demand forecasts
- As opposed to currently aggregated models, the detailed spatial representation of the model is well suited to analyse the impacts from location-specific characteristics on entire value chains



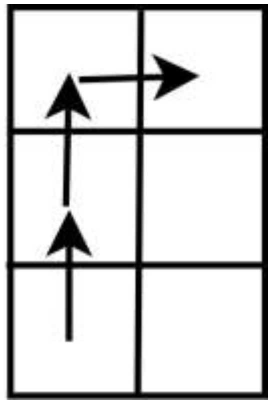
Spatial representation

- Discrete representation of space
  - Squared cells: 25x25km
  - Rectangular cells: 25x50km or 50x25km
- Every cell is further subdivided into:
  - Land use
  - Terrain impediments
  - Crop maturity for perennial crops
  - Land ownership
  - Categories for product quality
- Cells are useful to represent:
  - Separation of geo-climatic regions
  - Transport distances
  - Location of current plant capacity
  - Optimal location of new capacity
  - Location of ports

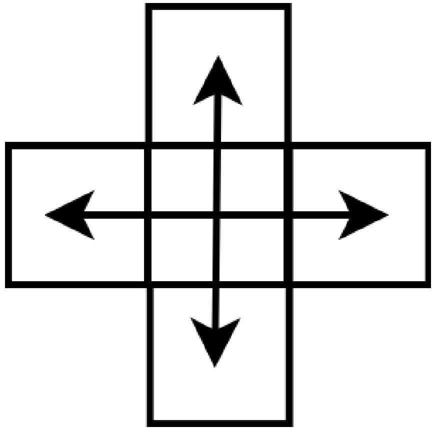


Transportation

- Road transport is characterized by:
  - Movement among adjacent cells (i.e. cell-to-cell)
  - Constrained to a Von Neumann neighborhood (i.e. N-E-S-W)
- Model tractability: Reduces potential combinations
- Euclidean distance between cells due to uniform shape
- Hindrance factor to consider geographical obstacles



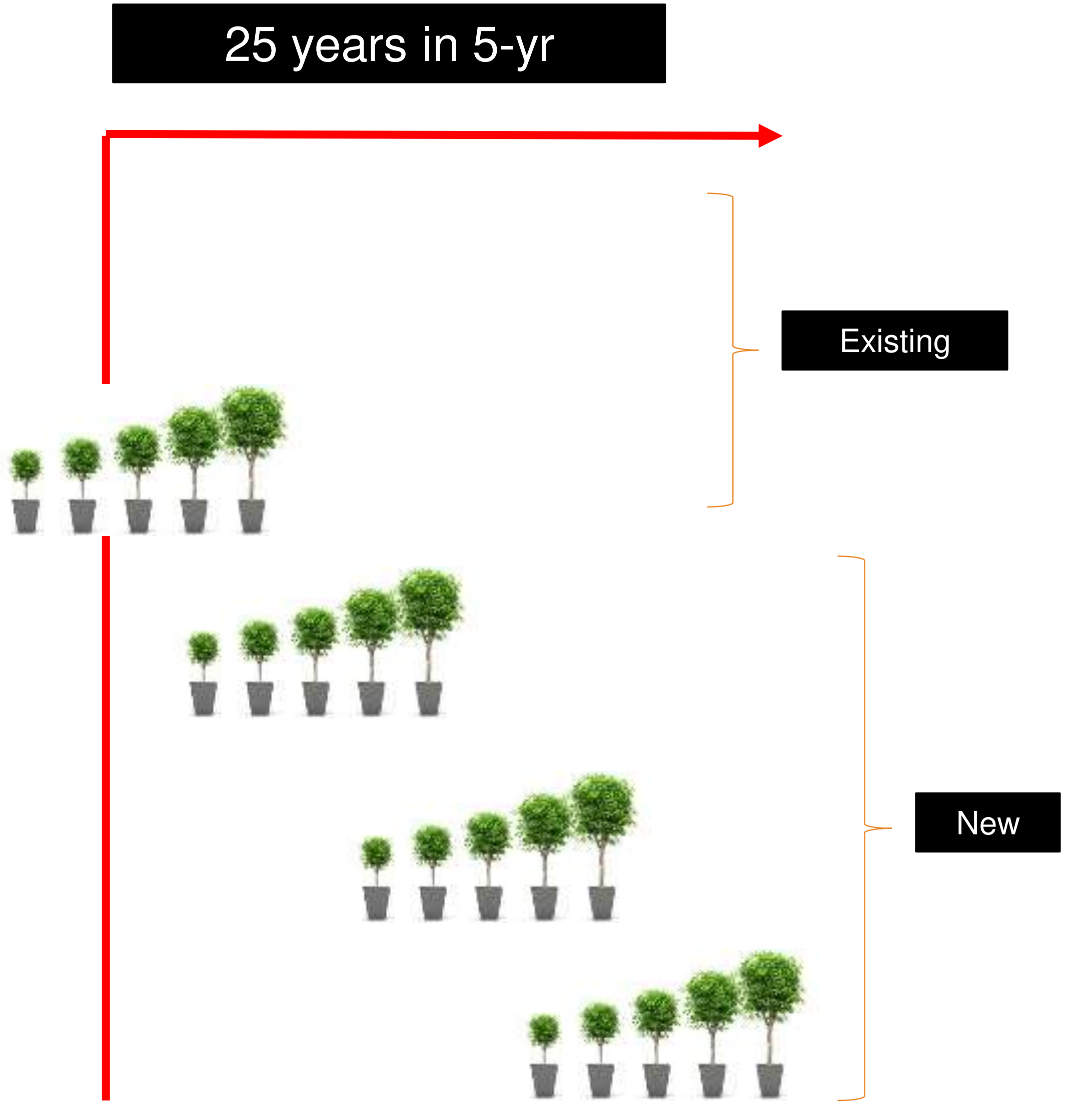
Cell-to-cell



Von Neumann neighborhood

Temporal representation

- Discrete representation of time
  - 5-year intervals
- The intervals are useful to:
  - Track existing crop inventories
  - Identify optimal harvest and plantings
  - Track existing processing capacities
  - Identify optimal timings to invest in new capacity
  - Forecast national and international demands



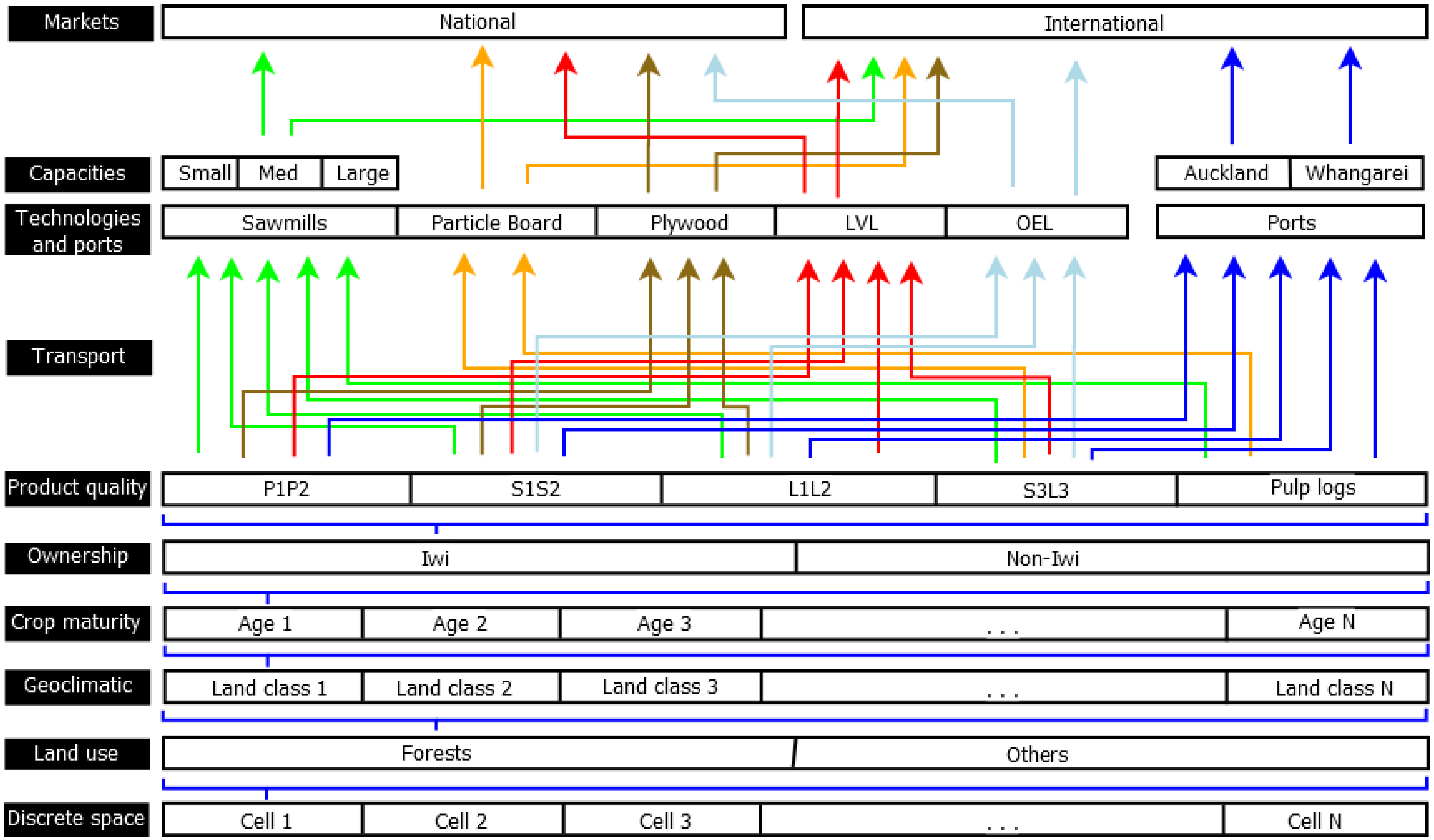
Characteristics and scenarios of case study region

- The productive forests have been divided by:
  - Existing forestry divided in 5-year age categories
  - Land classes conditioned on slope, which will affect harvest costs
  - Productivity divided in various log grades (i.e. quality)

- Traditional and new manufacturing technologies:
  - Traditional: Sawmills, LVL, plywood and particle board
  - Efficient: Sawmill with higher conversion rate
  - New: Optimized Engineered Lumber (OEL)

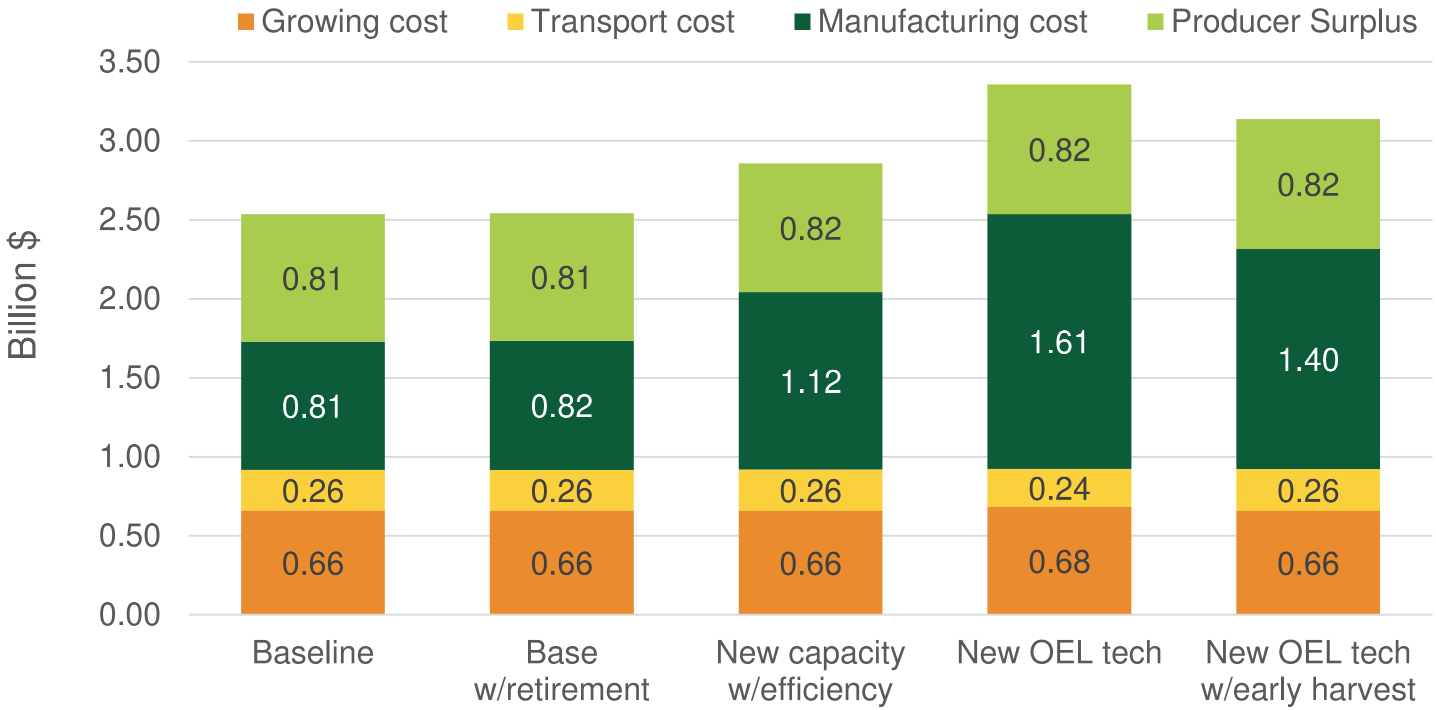
Scenarios	Harvest age	Technologies	Capacity	Retire existing plants
Baseline	25-35	Traditional	Current	☒
Base w/ retirements	25-35	Traditional	Current	☑ Except one
New cap w/ efficiency	25-35	Traditional and efficient	New	☑
New Tech	25-35	Traditional, efficient and new	New	☑
New Tech w/ early hrv	20-35	Traditional, efficient and new	New	☑

Transversal representation of potential value chains



Results from Case Study

Producers' surplus and costs separated by value chain activity for different scenarios



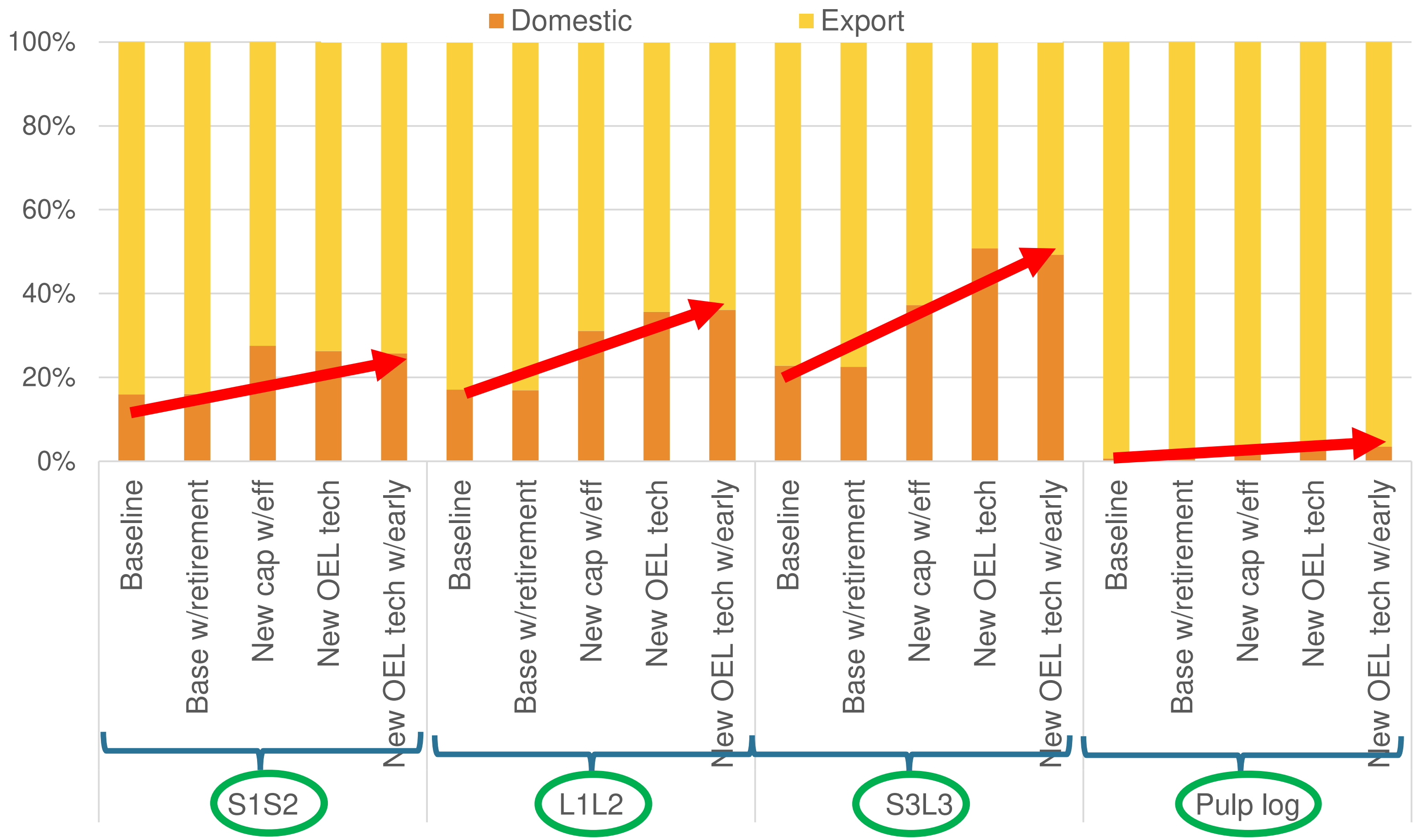
- 1st and 2nd scenarios are no different and with less plants → inefficiency in baseline
- 3rd scenario's producers surplus increases → gain in efficiencies
- 4th scenario with New OEL technology → higher value add
  - Highest producer surplus
  - Higher manufacturing costs, i.e. higher investment and employment
- Early harvests affect the 5th scenario's value chain and respective costs

Share of logs destined to the domestic and international markets for different log grades and scenarios

Destination %s

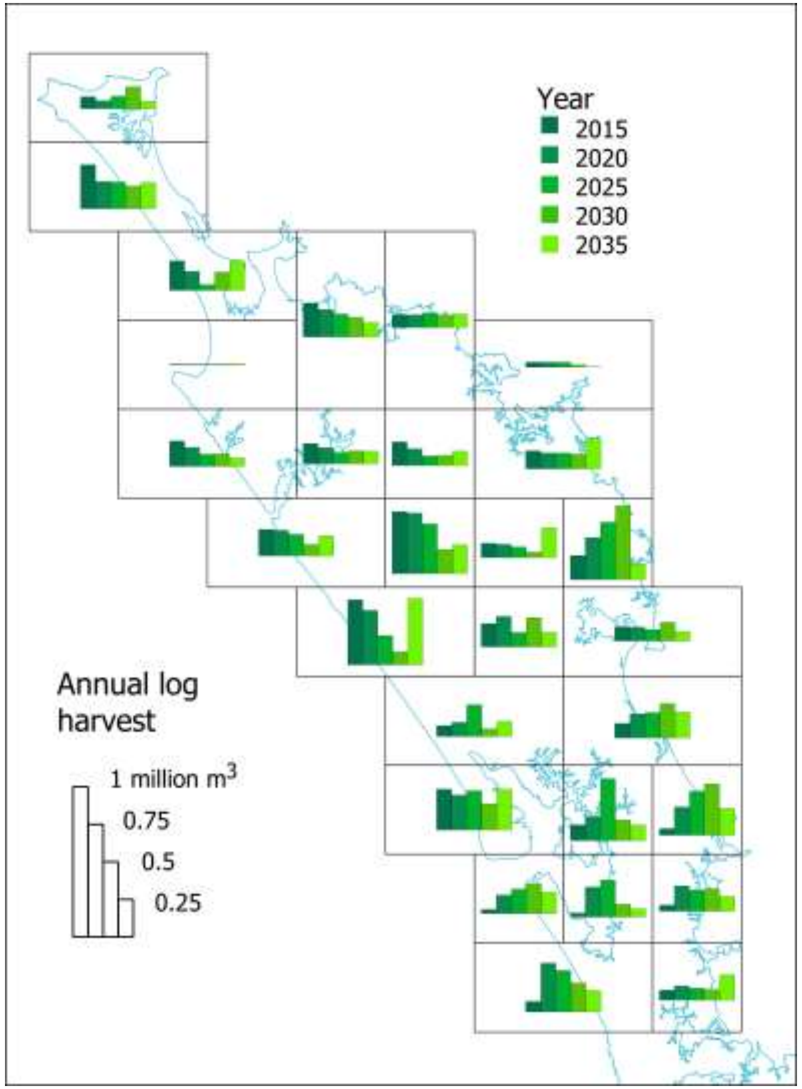
Scenarios

Log grades

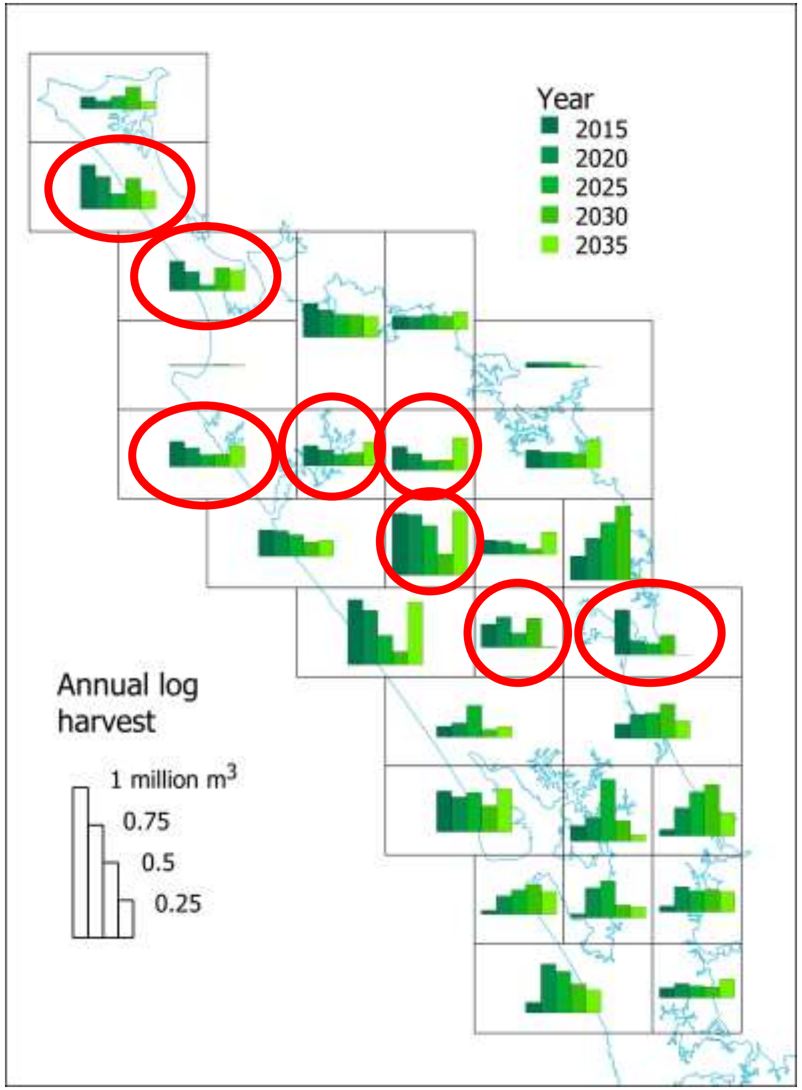


Regional optimized harvest schedules

Baseline

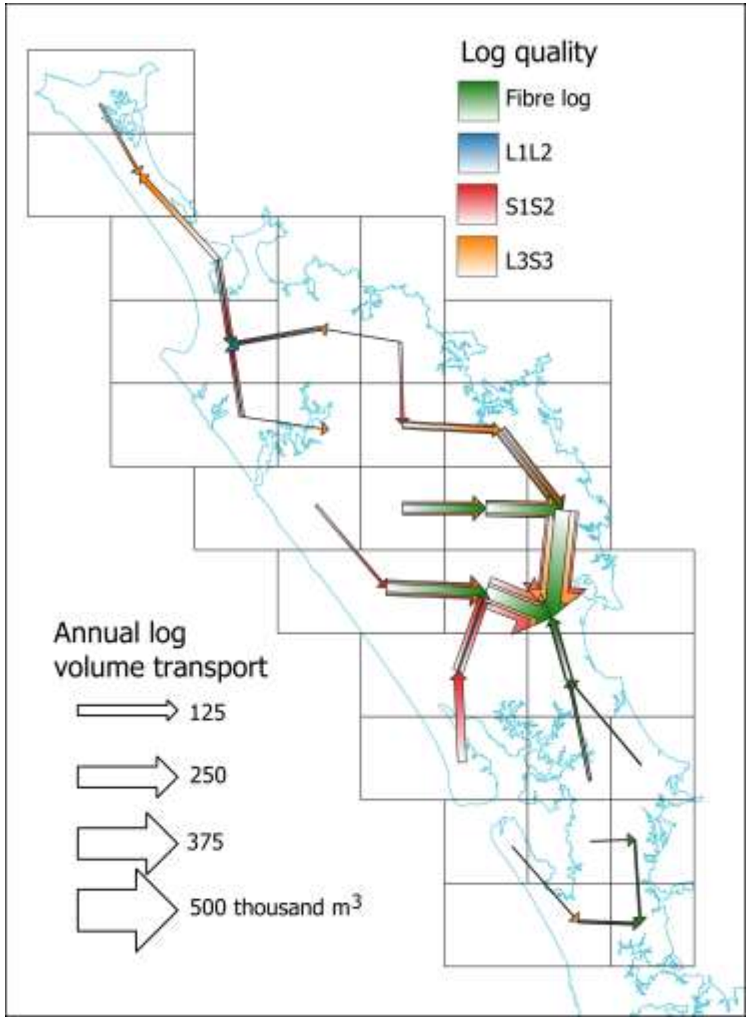


New OEL technology

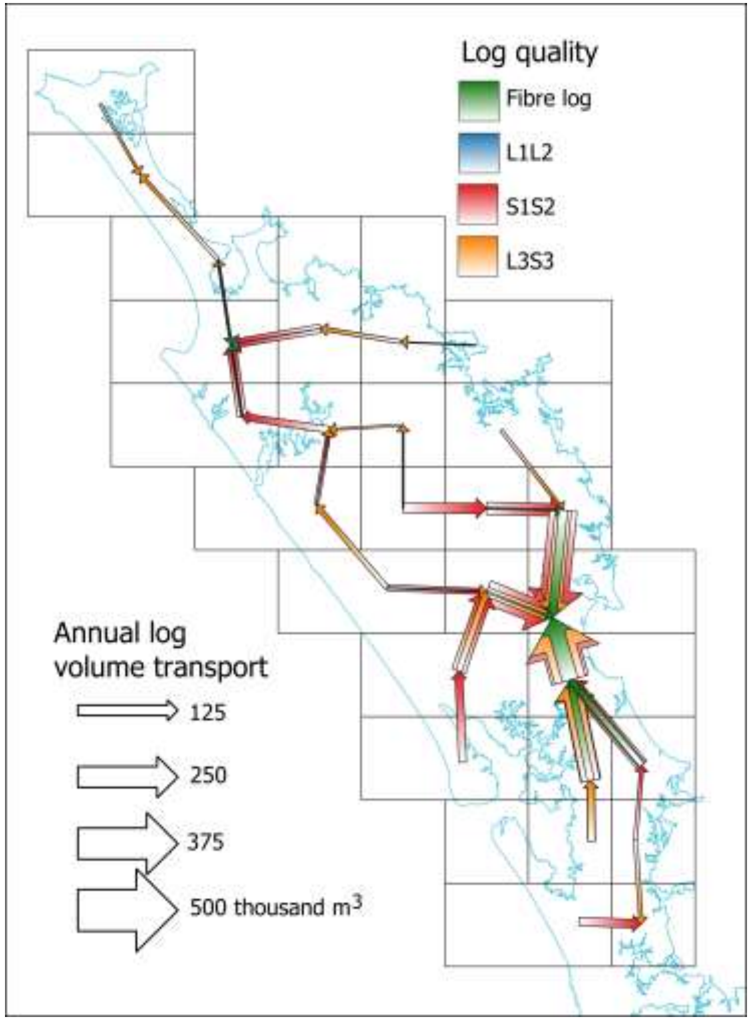


Transport routes for different log grades and periods for the New OEL tech scenario

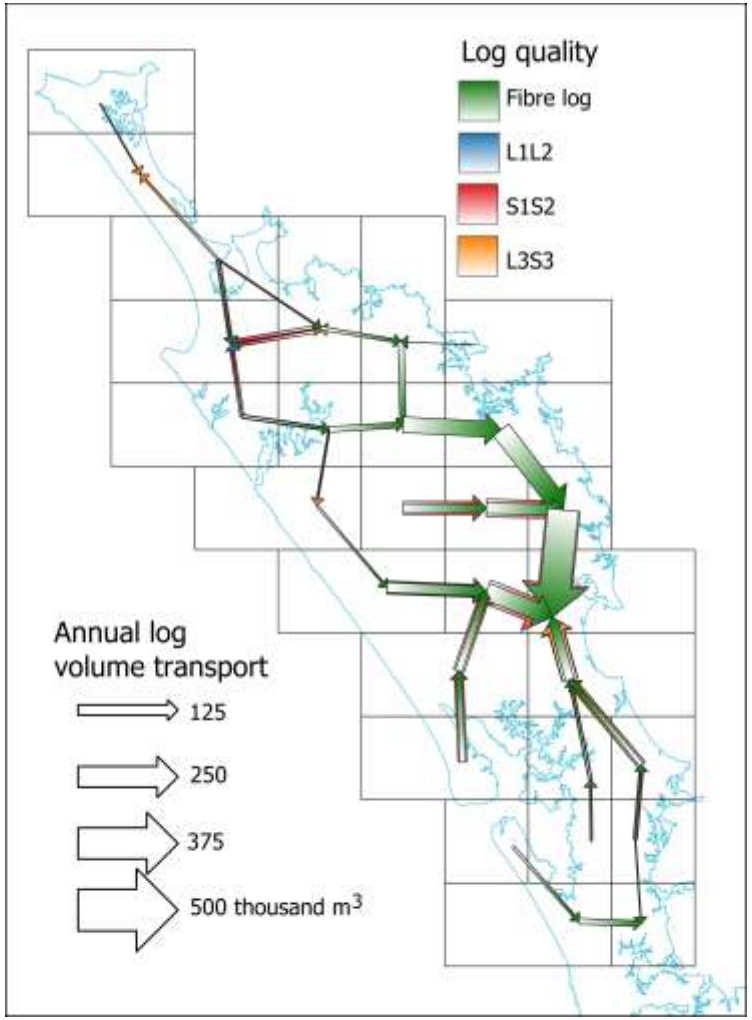
2015-2019



2025-2029

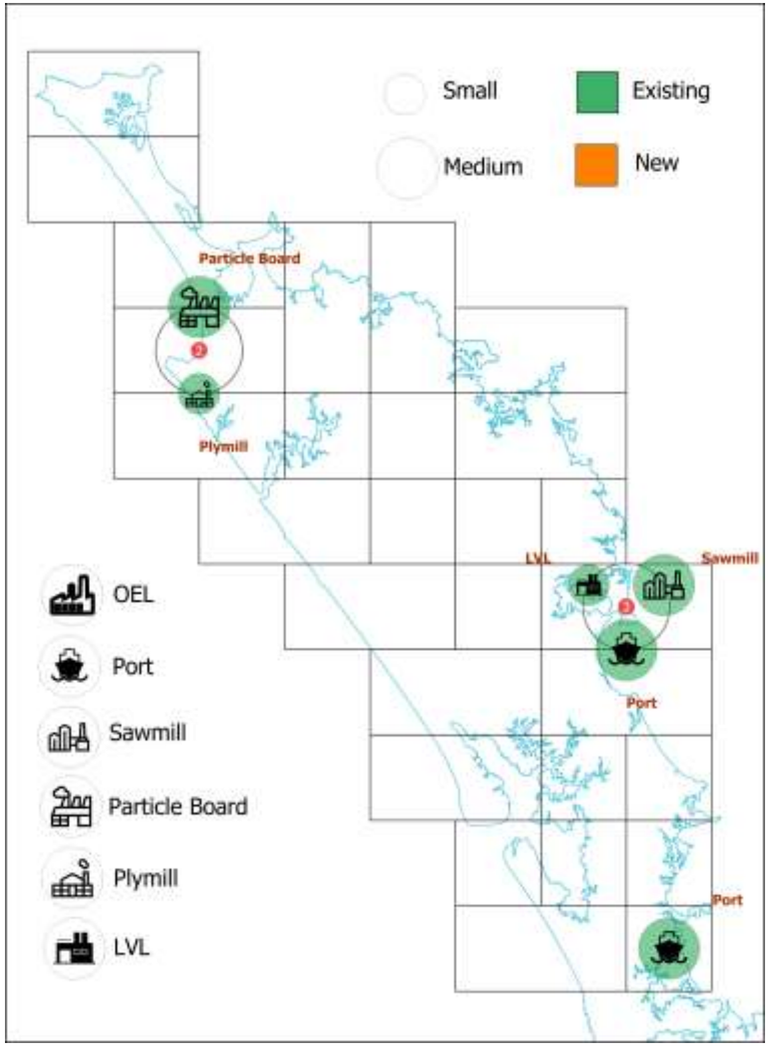


2035-2039

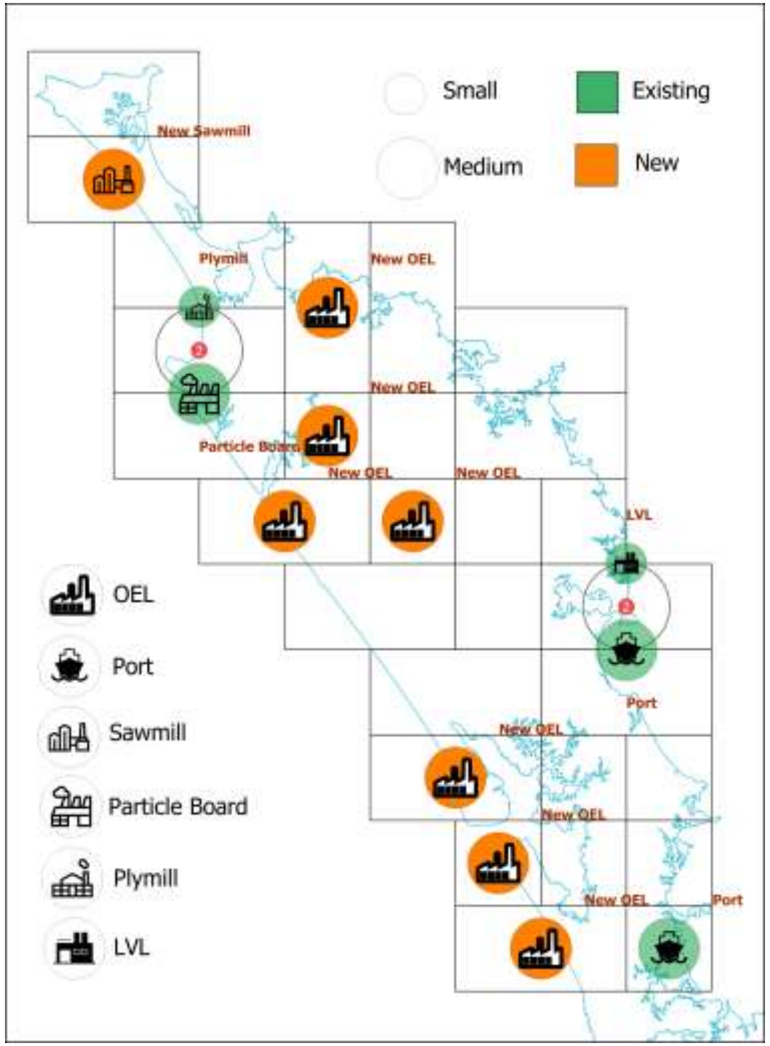


Optimal technologies and plant locations

Baseline



New OEL technology



Conclusions and future research

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- Potential gains from investments in higher value add technologies
- The forest resource would not increase but would gain value
- Take advantage of existing infrastructure: Roads and ports
- Take advantage of potential rise in demand for engineered lumber products
- Higher opex and capex mean higher employment and capital invested
- Future extensions:
  - Land-use change capability;
  - Consideration of carbon emissions and sequestration;
  - Consideration of ecosystem services;
  - Consideration of other pollutants such as nutrients and sediment from erosion;
  - Vertically-integrated value chains owned by different collectives such as Māori in New Zealand

- **Focus of Research**

  We assessed the regional impacts of investing in high value-add technologies as opposed to exporting low value raw logs. The research is important to the New Zealand economy as it opens the possibility of new employment in the community (people) and GDP increments based on a renewable resource (bio-economy).

- **Key Challenges**

  Our research identified a few critical factors that preclude investments in value-add technologies such as separation of the land and forest ownership and lack of government incentives recognizing the benefits of using wood products.

- **Suggestion to Address these Challenges**

  Investing in high value-add technologies with promising international markets and making a more efficient use of the forest estate by creating additional jobs and increasing the regional GDP.

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