Demand Analysis of Ontario Wood Market under Future Shared Socio-economic Pathways

By

Rasoul Yousefpour and Bingyi Hou

Forest Economy and DSS Lab, Mass Timber Institute,

University of Toronto

2023-03-20

Intermediate Project Report for **Centre for Research and Innovation in the Bio-Economy** (CRIBE)

Contents

List of Figures

List of Tables

1 Executive Summary

This study examines the demand for mass timber and solid wood in Ontario under climate change scenarios. The use of mass timber and solid wood is important in reducing carbon emissions in construction, but sawmills and building developers are conservative due to uncertainties in supply and demand. In addition, different pathways of future economic and socioeconomic development could significantly affect the supply and demand of wood market. Therefore, this project investigates future wood demand in Ontario subject to multiple plausible scenarios in 21st century. The scenarios make use of established stumpage price system in Ontario to provide insights into potential market trends and inform decision-making for not only forest sector but also and more specifically sawmills and building developers.

The mass timber industry in Ontario is an emerging sector. As for now, there are only 4 mass timber manufacturing facilities in Ontario (8 in British Columbia, and 19 in Canada). Element 5 is the only mass timber manufacturing plant in Ontario that offer Glulam and CLT, with an annual production capacity of 50,000 m3. Glulam and CLT has a great potential in construction industry due to their superb performance and sustainability. Building developers face timber supply risks when entering this new market, while forests and sawmills may not be able to increase their production capacity as industry emerges. Moreover, it is unclear whether extra supply or demand should appear first to promote wood utilization in mass timber industry and building construction. In order to facilitate the growth of mass timber industry, it is necessary to develop a scientific system that can reliably predict the future dynamics of supply and demand of the wood market, and eventually increase the efficiency of the market and promote better policymaking.

To fill the gap, we conducted a research starting from the analysis of stumpage price system in Ontario, which is an indicator of the relationship between supply and demand of the wood market. The residual value price, which is a component of the stumpage price, is dependent on the net market price of the lumber and the total production costs. Investigating the fluctuations in the historical residual value price and making projections for the future could reveal the patterns in the future demand of solid wood and engineered wood products.

Representative Concentration Pathways (RCPs) and Shared Socio-economic Pathways are developed by Intergovernmental Panel on Climate Change (IPCC) of United Nations (UN) to inform policy-makers about the future global change. These scenarios are used to define typical future development pathways assuming different level of e.g. population and economic growth and carbon emission, which all affect the demand for wood significantly. Supported by the IIASA database, we extracted the projection of above-mentioned factors in different RCP&SSP scenarios and used them in econometric analysis that we developed for wood demand studies in Ontario.

The historical residual value price and the market price of lumber was relatively stable during 2010-2019 but had a dramatic increase in the following years. We conclude that this is a result of the outbreak of Covid-19, which largely decreased the supply of the wood through health mandate. The future residual value price is expected to increase in the next few decades, because of the increased market price of lumber driven by the rising rate of population and economic growth.

The five SSPs considered in this study include SSP 1: the sustainable development pathway; SSP 2: assuming the current societal development for the future; SSP 3: bringing high challenges in adaptation and mitigation through regional rivalry; SSP 4: realizing great inequalities between countries in the future; and SSP 5: the highest consumption of fossil fuels and the highest greenhouse gas emission.

The future wood demand is projected to increase under all SSPs as shown in Figure 1. **By 2030, the wood demand could be as high as 11.4 million m3 in average** among all SSPs, which is 1 million m3 higher than the present demand level (10.5 million m3). The demand may reach a higher level (15.7 million m3 in average) at the end of 21st century. SSP5 scenario would realize the highest wood demand due to the boom in economy and population.

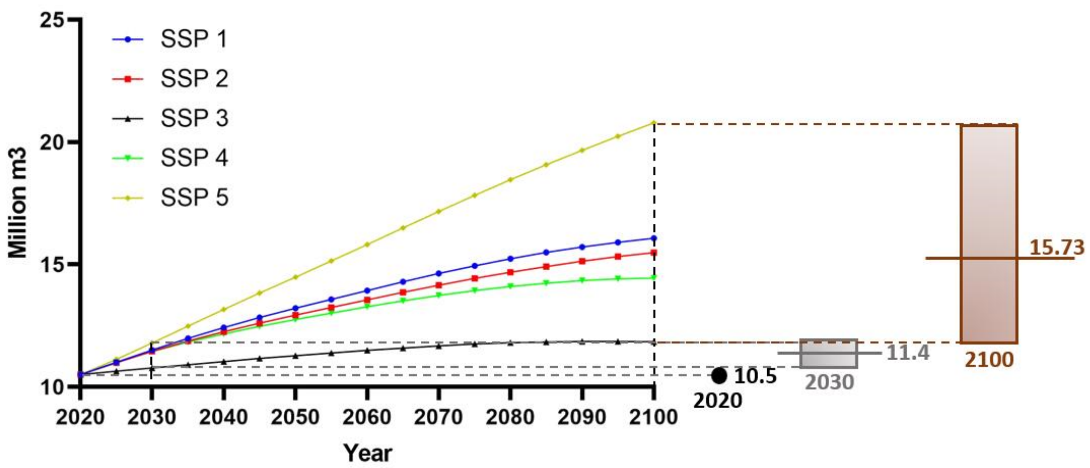

Figure 1. Projections of future wood demand in 2030 and 2100 in Ontario

In fact, Ontario is only harvesting half of the available forest area, i.e. the current annual harvesting volume is around 14 million m3 in recent years, including 2.4 million m3 for pulp production (Larry, 2021). However, the available volume of wood for harvest is around 30 million m3. To deal with the increase in future wood demand, it will be essential to increase annual cut and utilize the potentials of natural forests in Ontario or expand forestland by tree plantations. Otherwise, the price of timber would increase due to growing market imbalance between supply and demand. Also, the increased production of solid wood products can promote the flow of wood residuals from sawmills to pulp mills to increase utilization and eventually benefit the value chain. Finally, although there is a large uncertainty about the future level of demand for wood in Ontario, one of the main messages of this report with implications for forest and wood sector policies is **“take the necessary steps to harvest and utilize more wood in Ontario”.**

An essential part of mass timber products is CLT/Glulam, which can be used in constructions and could create a lot of benefits. CLT buildings are sustainable, cost-saving, holistic, and have special characteristics such as fireproof. However, there is only one plant in Ontario that can produce these products. It is clear that the future demand for CLT/Glulam materials is huge, and we should make necessary moves to capture the expanding market. The increased use of mass timber in construction could also promote the extraction of “whole tree value” for Ontario’s forest products industry, as longer logs could allow us to build higher buildings, and the side products could also be used for pulp production.

2 Background

Climate change will become the primary threat to the ecosystems in the next few decades and its mitigation is more urgent than ever. As a response, Canada has pledged to achieve net zero emissions by 2050 and carbon pricing in the recent COP27 (Environment and Climate Change Canada, 2022). Notably, more than one-tenth proportion of global carbon dioxide emissions comes from construction activities (Mantle Developments, 2020). Therefore, a more sustainable building material is crucial to achieve mitigation goals. Mass timber is an ideal construction material that is renewable and has a great ability in reducing embodied carbon of buildings (Gerilla et al., 2007), but the scale of its market is still relatively small. In 2015, 500,000 m3 of mass timber products were produced in the world (mostly in Austria, where the mass timber products were invented), while only 20% of them were produced in north America (Mantle Developments, 2020). In order to promote the development of mass timber constructions, an accurate supply and demand projection is necessary for both the sawmills, mass timber companies, and building developers to be confident enough to choose these new materials. Otherwise, supply may become passive expecting first increase in demand to react to the market needs or vice versa (the “chicken and egg” problem) and eventually hinder the growth of the market (Mantle Developments, 2020). For this, Ontario government oversees the changes in wood market and frequently adjust the stumpage fee, which is an ideal indicator of the dynamics of supply and demand in the market.

Using historical information in lumber price, import and export volume, production costs, and economic factors to predict future residual value price is a novel way to lead to the analysis of future wood demand. As we are exposed to great environmental and socioeconomic uncertainties in the future that could significantly change the demand of wood, we also need to analyze the wood demand and associated factors under different future climate and socio-economic scenarios, which are broadly used in relevant studies.

3 Sources of Information

The data and information used in this study are from the following sources:

Table 1. Source of data and information

Stumpage price system and associated data	MNRF[1]
Historical population and GDP	Statistics Canada
Wood production, import, export	FAO[2] STAT
Future population, GDP, and carbon price under RCP&SSP scenarios	IIASA[3] database
Lumber Market Price	Random Lengths

[1] Ministry of Natural Resources

[2] Food and Agriculture Organization

[3] International Institute for System Analysis

4 Analysis

Ontario Stumpage Price System

This study analyzed the demand of Ontario wood market through the lens of stumpage price, which is the price collected by the Ontario government for giving the permission of conducting forestry operations on crown lands. Stumpage price, as part of the costs of forestry activities, could reflect and affect the supply and demand dynamics of the wood market. The reason for this is that the stumpage price is determined as a certain percentage of the net profit of the end products being sold. The market price of the end products is calculated by extracting the cost from market price, which is certainly decided by the intersection of the supply and demand curve. Therefore, any shifts in supply and demand of the market could affect the stumpage price, and vice versa. The Ontario stumpage charge is consisting of three main components:

- Forest future trust charge

It is a fee that is the uniform for all products and tree species being harvested, and it is adjusted annually to account for inflation. The purpose of this charge is to assist in regeneration efforts following natural disasters and to fund forest inventory initiatives.

- Forest renewal trust charge

It is an annually adjusted fee that varies across forest management units and tree species but is uniform across product sectors. This charge is set up for post-harvesting forest renewal activities, including tree planting, tending, seeding, and site preparation. The amount of the charge may vary based on the cost associated with these activities.

- Stumpage price

The stumpage price is the primary component of the total stumpage charges, which is comprised of residual value price and minimum price. The minimum price is a charge for each cubic meter of timber harvested on crown land and is adjusted annually based on the inflation rate. The residual value price is calculated by subtracting the base cost allowance (BCA) from the market price of end products, representing the profitability associated with the wood products.

Future Residual Value Price Forecast

The forecast of future residual value price focus on the long-term changes of above factors, while incorporating new shifters such as economic growth and population growth. We assumed that future base cost allowance would be primarily driven by energy use. The payment for carbon tax is selected to be the indicator of energy consumption, calculated by multiplying the carbon price with carbon emission amounts. A risk and profit margin are used to adjust the future base cost allowance, which is consists of a fixed 20% plus the annual economic growth rate.

Further, we assumed that:

Wood Demand = Import + Production – Export

Given the historical data of import, export, and production of various forest products, we calculated the average price elasticity of demand in the past ten years and use it to predict for the future net market price of lumber with current price and demand information.

Calculation for future wood demand

It is evident that future demand of wood would be mostly affected by economic growth and the changes in population, we therefore developed the following equation to calculate for future wood demand using the historical information of Ontario GDP and population, we computed the average income elasticity of demand in the past ten years, and thus being able to calculate for further periods.

RCP & SSP Scenarios

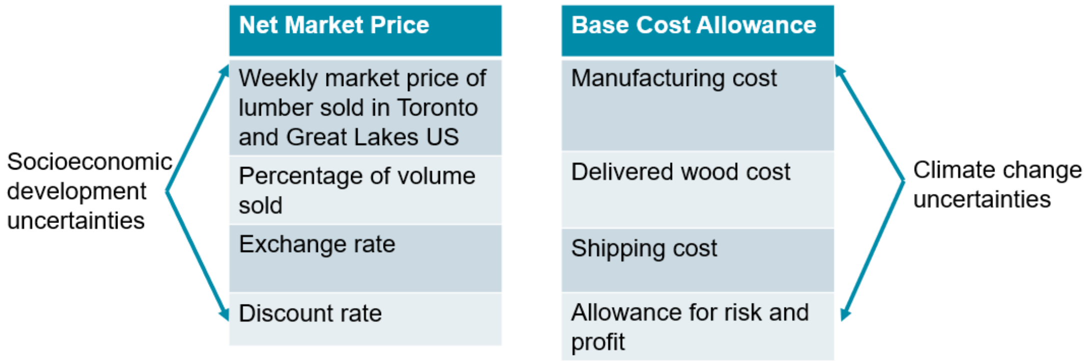

Figure 2. The societal and environmental impact on future residual value price

The calculation of future wood demand and residual value price is affected by various factors such as population growth, economic growth, and energy consumption, which are subject to future societal development and the extent of climate change. Due to these uncertainties, we conducted scenario analysis to provide possible futures of Ontario wood market. In order to simulate potential future climate change possibilities, this study uses three Representative Concentration Pathway (RCP) scenarios, which are RCP 2.6, RCP 4.5, and RCP 6.0 that describe different climate futures through radiative forcing levels. These scenarios are broadly used in research and the definition can be simplified as follows:

- RCP 2.6 is described as the most sustainable scenario with the lowest carbon emissions. It aims for net zero carbon emissions by 2050, and carbon emissions are predicted to decrease from 2020.
- RCP 4.5 is considered a moderate scenario, where radiative forcing will remain stable at 4.5 W/m2 until the end of the century, and carbon emission growth will be halted by 2050.
- RCP 6.0 is the scenario with the relatively higher carbon emissions, where radiative forcing is expected to continue increasing until the end of the century.

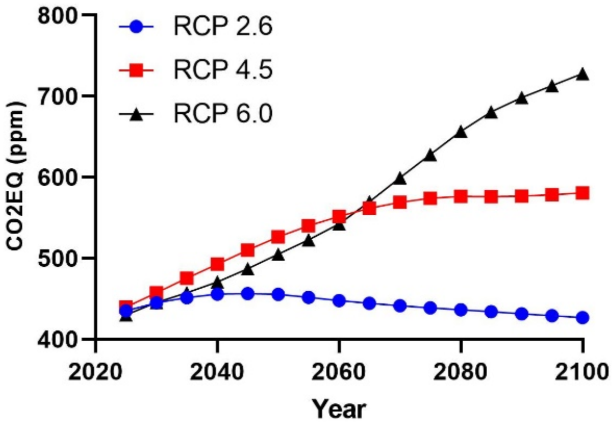

Figure 3. Projected Carbon dioxide equivalent by 2100 under RCP scenarios

In addition to the climate change uncertainties, future socioeconomic development also matters to the future wood demand. The predictions made in RCPs do not have direct relationships with certain social conditions (O'Neill et al., 2020). Therefore, this study also considers five different Shared Socioeconomic Pathways (SSPs) to demonstrate different societal development in the future.

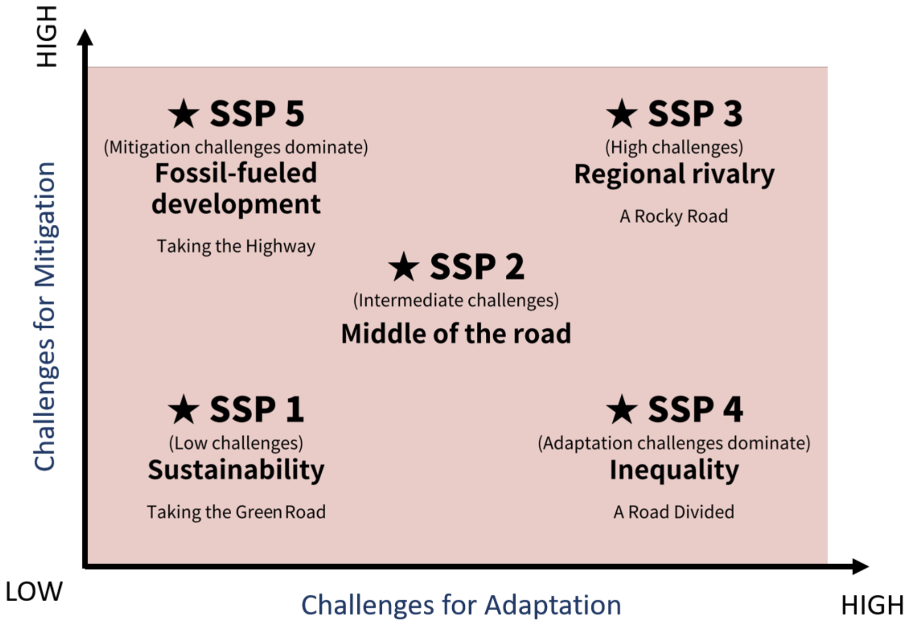

Figure 4. Challenges for adaptation and mitigation under different SSPs

SSPs are a set of descriptive projections of future societal situations in terms of population, economic growth, technology development, energy consumption preference, and changes in land use (Kriegler et al., 2014; Moss et al., 2010; O'Neill et al., 2014; Riahi et al., 2017).
The five SSPs considered in this study include SSP 1, which is described as the sustainable development pathway; SSP 2, which assumes that future societal development will remain the same as the current way; SSP 3, which brings high

challenges in adaptation and mitigation through regional rivalry; SSP 4, which creates great inequalities between countries in the future; and SSP 5, which has the highest consumption for fossil fuels and the highest greenhouse gas emission. It is certain that the future wood demand would be different under these scenarios, and it is important to reveal how do these factors affect the wood market.

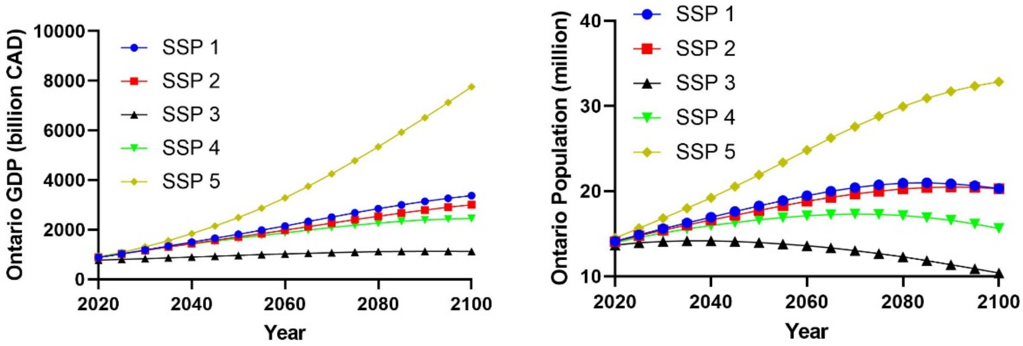

Figure 5. Projected Ontario GDP and population by 2100 under RCP scenarios

Different SSPs are combined with RCPs to create possible combinations of future development pathways. In those combined scenarios, the radiative forcing level and socioeconomic parameters are integrated together to make more comprehensive predictions. The scenarios filled with blue are the top priority ones, demonstrating that they are more realistic and representative than the others. In our study, the projections of caron price by the end of this century are given by scenarios “SSP1-26”, “SSP2-45”, and “SSP4-60”.

5 Results

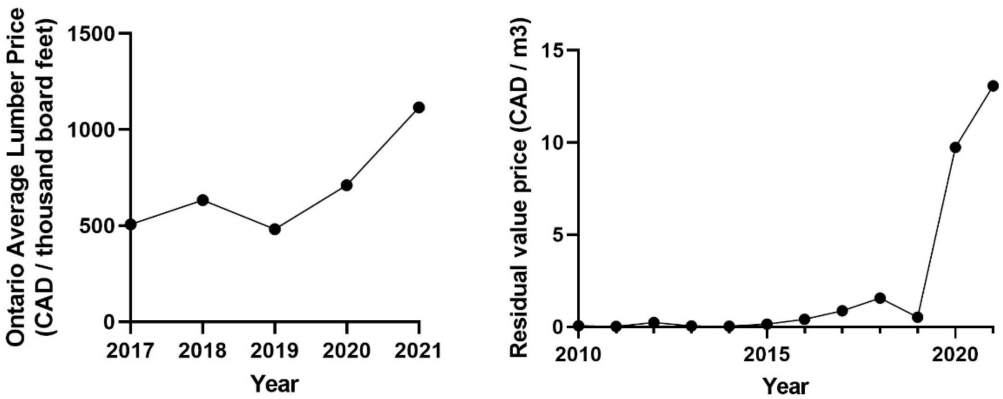

Figure 6. Ontario historical Residual Value Price and lumber price

As shown in the above figure, the Ontario stumpage price per cubic meter has a dramatic increase during the past decade, especially between 2019-2021. Combined with the change in average lumber price in Ontario during the same period, we can possibly conclude that the significant increase in residual value price has a relationship with the increase in the market price of lumber. Based on the previous analysis, the residual value price is calculated by subtracting the production costs from the net market price of the lumber. Therefore, a higher market price of lumber could lead to a higher residual value price. However, there are only subtle changes in both residual value price and lumber price change in most of the years, while the increase in both prices during 2019-2021 is shocking. Given the fact that the outbreak of the COVID-19 started at the end of 2019, we firmly believe that the pandemic is the primary cause of the above situations. Due to health restrictions, a lot of sawmills were closed, leading to a decrease in the production capacity and an increase in lumber market price. In addition, the rising number of people working from home increased the demand for wood used for home office, outdoor decking, and furniture.

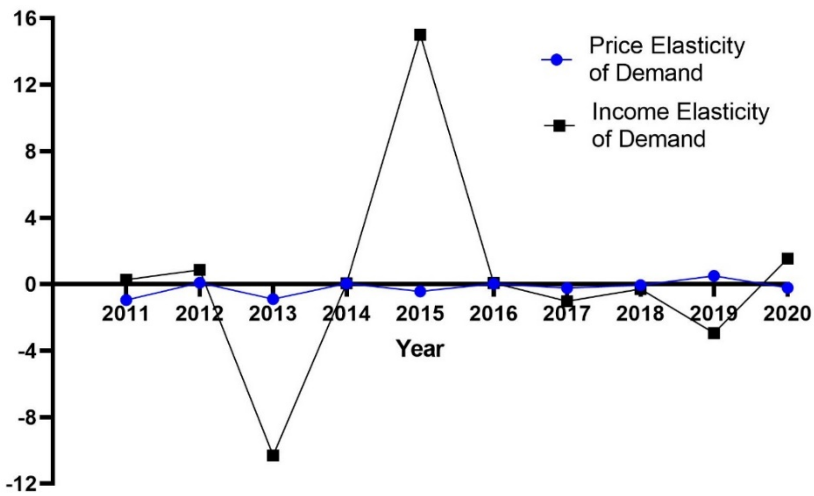

Figure 7. Income elasticity (β) and Price elasticity (α) of demand

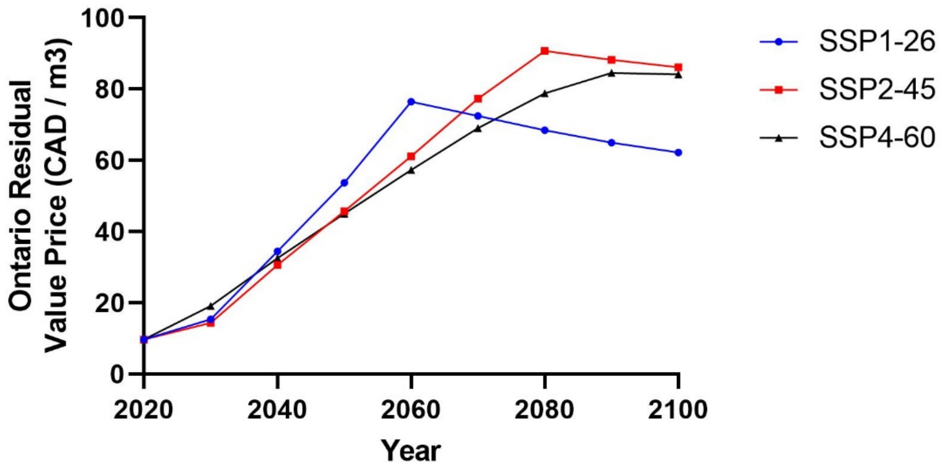

Figure 8. Projected Ontario Residual Value Price in the future

The income elasticity of demand was calculated and graphed using Ontario population, GDP, and wood demand data from 2010-2020. A positive income elasticity indicates that the demand for a product will increase with a rise in income, while goods with negative income elasticity, as known as inferior goods, will experience a decrease in demand when income rises. In our results, the income elasticity of demand for Ontario wood products was mostly close to zero from 2011-2020, except for an extremely low value in 2013 and a high value in 2015. This can be attributed to severe natural disturbances that impacted the forest in Ontario in 2013 (Larry, 2021), reducing the quality of salvaged wood. Consumption of wood may have experienced a rebound in 2015 following the recovery of timber quality after natural disturbances. The price elasticity of demand ranged from -1.0 to 0.5, with most years having negative elasticity, indicating that demand decreases when prices rise. However, the price elasticity of demand was positive in 2019, likely due to a decrease in wood supply, resulting in higher prices and sustained demand in the wood market.

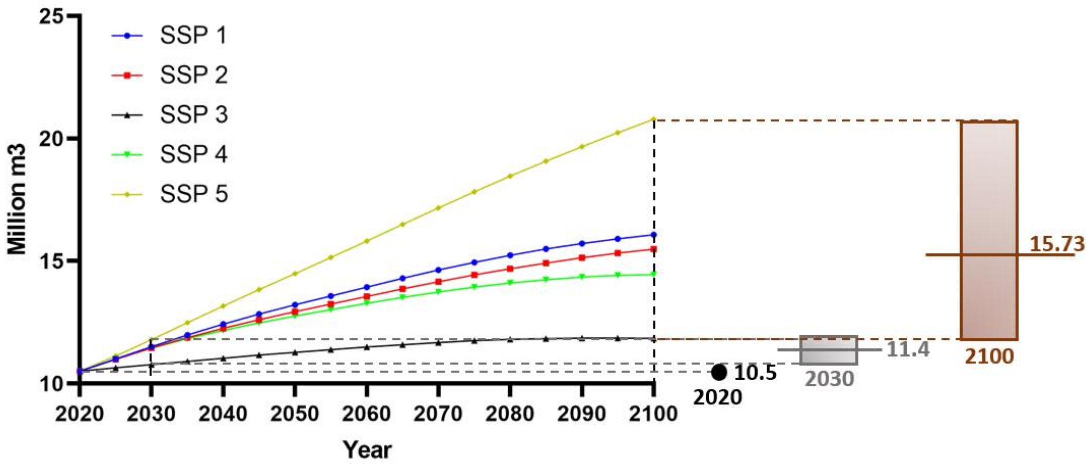

Figure 9. Projections of future wood demand by 2030 and 2100 in Ontario

As shown in the figure 9, the future wood demand in Ontario is predicted to increase under all five SSP scenarios. The average wood demand among five SSPs could reach 11.4 million m3 in 2030, and rise to 15.73 million m3 at the end of the 21st century by 2100. Specifically, the demand for wood under SSP 5 is predicted to reach 20.78 million m3, while SSP 3 may realize the lowest demand of 11.85 million m3 among all SP scenarios by 2100.

The results are consistent with our assumptions that the wood demand in the future would be driven by the economic and population growth. As shown in Figure 5, the projected population and GDP in Ontario is the highest under SSP 5, while being the lowest under SSP 3. In 2013, IIASA projected that the GDP growth under SSP 3 will be negative (-0.3%) at the end of this century, while the other four SSPs still have positive economic growth. Affected by this, the wood demand under SSP 3 also has a small decrease in 2095-2100. Compared to 2020, the wood demand in 2100 under SSP 5 nearly doubled, while SSP 3 scenarios only has a 12.86% increase.

6 Discussion and Conclusion

We analyzed the future trend of Ontario wood demand under different climate change scenarios and socio-economic development pathways. Our results show that the future wood demand would increase under all five SSP scenarios. The demand for wood would have an average increase of 49.81% over this century, rising from the current level of 10.5 million m3 to 15.73 million m3. Among all of the SSP scenarios, SSP5 has the highest demand for wood (20.78 million m3 by 2100), whereas SSP3 has the lowest (11.85 million m3 by 2100) due to the slowest economic growth. Although, there is a large uncertainty about the future level of demand for wood in Ontario, one of the main messages of this report with implications for forest and wood sector policies is **"take the necessary steps to harvest and utilize more wood in Ontario".** As Glulam and CLT products are important parts in the wood building construction, it is evident that the market potential for those will be huge. More domestic plants could be established to satisfy the demand from building sector.

The historical trend of residual value price and the market price of lumber in Ontario reflects the impact of Covid-19 on the local wood market. Both the market price and the stumpage price increased significantly because of the scarcity created by the outbreak of the pandemic. In 2020, the lumber market price (CAD $711.15 per thousand board feet) is 47% more than the previous year (CAD $481.75 per thousand board feet). More surprisingly, the residual value price increased from CAD $0.52/m3 (2019) to CAD $9.73/m3 (2020), saying that the market price of the lumber increases much faster than the production costs.

The fluctuation of income elasticity of demand could reflect the seriousness of natural disturbances that affect wood quality. In the years that natural disturbances are frequent and serious, customers may have a lower preference for wood products due to the decrease in wood quality.

In short, the overall demand for wood will increase in the coming decades, and the supply side need to be prepared for it by increasing the harvesting volume. Regarding potentials in Ontario forests to sustainably supply more timber and the current policies to expand forestland (tree plantation initiatives), it is possible to balance the demand by 2030 and beyond. We expect to combine the supply and demand model system in the future to produce results that are more integrated. Moreover, it is crucial to account for the effects of climate change and forest risks in realizing such a climate smart forecasting system.

7 References

Environment and Climate Change Canada. (2022). COP27 summary of outcomes. https://www.canada.ca/en/services/environment/weather/climatechange/canada-international-action/un-climate-change-conference/cop27-summit/summary-outcomes.html (Retrieved on 10 March 2023)

Gerilla, G. P., Teknomo, K., & Hokao, K. (2007). An environmental assessment of wood and steel reinforced concrete housing construction. Building and Environment, 42(7), 2778-2784.

Kriegler, E., Edmonds, J., Hallegatte, S., Ebi, K. L., Kram, T., Riahi, K., ... & Van Vuuren, D. P. (2014). A new scenario framework for climate change research: the concept of shared climate policy assumptions. Climatic Change, 122(3), 401-414.

Larry Watkins. (2021), Ontarios Forest Facts. Retrieved from https://public.tableau.com/app/profile/larlo/viz/OntariosForestFacts/Renewal

Lauri, P., Forsell, N., Gusti, M., Korosuo, A., Havlík, P., & Obersteiner, M. (2019). Global woody biomass harvest volumes and forest area use under different SSP-RCP scenarios. Journal of Forest Economics, 34(3-4), 285-309.

Mantle Developments. (2020). Mass Timber Market in Canada and Beyond. Retrieved from https://mantledev.com/insights/mass-timber/mass-timber-market-in-canada/

Mantle Developments. (2020). Mass timber’s carbon impact. Mantle Developments. Retrieved from https://mantledev.com/insights/embodied-carbon/mass-timber-carbon-impact/

Moss, R. H., Edmonds, J. A., Hibbard, K. A., Manning, M. R., Rose, S. K., Van Vuuren, D. P., ... & Wilbanks, T. J. (2010). The next generation of scenarios for climate change research and assessment. Nature, 463(7282), 747-756.

O’Neill, B. C., Carter, T. R., Ebi, K., Harrison, P. A., Kemp-Benedict, E., Kok, K., ... & Pichs-Madruga, R. (2020). Achievements and needs for the climate change scenario framework. Nature climate change, 10(12), 1074-1084.

O’Neill, B. C., Kriegler, E., Riahi, K., Ebi, K. L., Hallegatte, S., Carter, T. R., ... & van Vuuren, D. P. (2014). A new scenario framework for climate change research: the concept of shared socioeconomic pathways. Climatic change, 122(3), 387-400.

Riahi, K., Van Vuuren, D. P., Kriegler, E., Edmonds, J., O’neill, B. C., Fujimori, S., ... & Tavoni, M. (2017). The shared socioeconomic pathways and their energy, land use, and greenhouse gas emissions implications: an overview. Global environmental change, 42, 153-168.

Appendix

We selected three possible combinations of RCP and SSP scenarios to account for simultaneous changes in global biophysical and socio-economic conditions and applied the relevant downscaled data for Ontario.

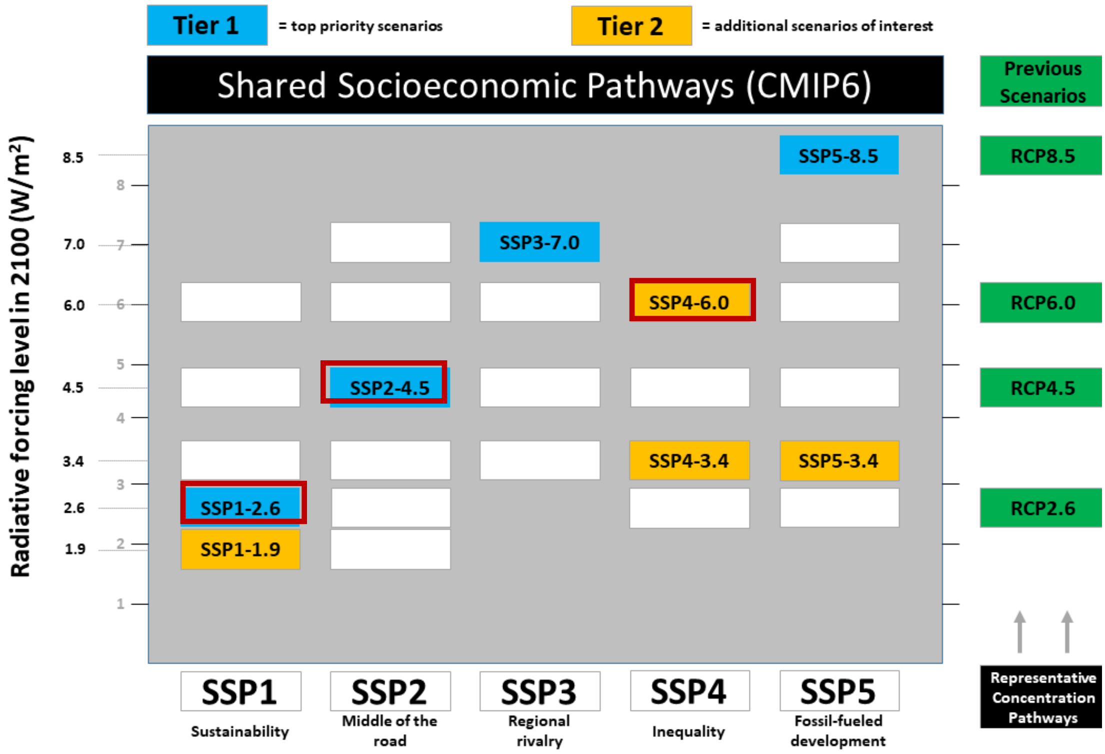

Figure 10. Possible combinations of SSP (Shared Socio-economic Pathway) and RCP (Representative Concentration Pathway) scenarios realizing a set of plausible future global change narratives (Source: Government of Canada) and selected scenarios for this study (SSP1-2.6, SSP2-4.5, and SSP4-6.0)

Econometric Equations:

We used the following equation, as suggested by Lauri et al. (2019), to determine future net market price of lumber:

$$\boldsymbol{P_{t+1} = P_t \sqrt[\alpha]{\frac{x_{t+1}}{x_t}}}$$

Where:

$\boldsymbol{P_{t+1}}$= Net market price of lumber in period t+1

$\boldsymbol{P_t}$= Net market price of lumber in period t

$\boldsymbol{x_{t+1}}$= Wood demand in period t+1

$\boldsymbol{x_t}$= Wood demand in period t

α= Price elasticity of demand

We therefore developed the following equation to calculate for future wood demand:

$$\boldsymbol{x_{t+1} = x_t \left(\frac{POP_{t+1}}{POP_t} \cdot \frac{g\,dp_{t+1}}{g\,dp_t}\right)^{\beta_t}}$$

Where:

$\boldsymbol{x_{t+1}}$**=** Wood demand in period t+1

$\boldsymbol{x_t}$**=** Wood demand in period t

$\boldsymbol{\frac{POP_{t+1}}{POP_t}}$ = Population growth rate

$\boldsymbol{\frac{g\,dp_{t+1}}{g\,dp_t}}$ **=** GDP per capita growth rate

$\boldsymbol{\beta_t}$= Income Elasticity of Demand