Potential International Market for Mountain Pine Beetle Killed Trees

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Abstract

The utilization of mountain pine beetle (MPB) killed wood and the diversification of the global trading market have been issues in the British Columbia's forest industry. Currently, almost half of the lodgepole pines in BC are attacked by MPB. The infestation of lodgpole pines is not only losing economic values but also damaging ecosystems and environments. MPB killed wood appears as blue stain in sapwood. However, the wood remains unaffected on the mechanical property, so it can be still used for producing many types of value-added products. The major challenges of using MPB killed wood are the extreme dryness, short shelf life, and limited markets. The Canada's forest industry has relied heavily on the U.S. market. The reliance of one country has shown serious problems by experiencing the recent global economic crisis. China's forest industry has become the most important client to the BC's forest industry by offsetting the decreased exports to U.S. Many markets have been examined to discover the potential markets for the MPB killed wood products. As a result, there should be markets specially aimed to utilize the MPB killed wood. However, there are uncertainties in optimizing processing wood products from MPB-killed wood and the long term fibre supply.

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Keywords: Mountain pin beetle, BC's forest industry, China, Blue stained, International markets, lodgepole pine, Dryness, Permeability

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1.0 Introduction

Canada's forest industry has been one of the important manufacturing sectors. In 2012, the revenue of Canada's forest industry was 57 billion dollars with 2 percent GDP shares (Forest Products Association of Canada, 2013). Also, this industry provided approximately 600,000 directed and indirected job opportunities.

Canada is the second largest net exporter of primary forest products in the world. The major target markets are U.S., China, and Japan. In 2011, U.S. purchased 95 percent of the importing softwood lumber, and China demanded 50 percent of their total imports from Canada (Wahl, Poon, & Toosi, 2012).

This industry's economy fluctuates cyclically. The forest economy reached their peak in 2005, due to the salvage of mountain pine beetle-killed wood. The amount of processing forest products increased rapidly, which consequently lead to increase the GDP of the forest sector. In 2008, forest products manufacturing was fatally wounded due to the global recession and the U.S. lumber market crashed which lead to shrink in harvesting activities. To recuperate from the global financial crisis, the BC forest industry has to resolve two issues: One is how to utilize the mountain pine beetle killed trees, and how to diversify the international market.

Mountain Pine Beetles have been a major problem in BC wood industry. The MPB outbreak covers about 14 million hectares of forest in the BC and killed 46% of pine in the province (Bogdanski, Sun, Peter, & Stennes, 2011). Since Mountain Pine beetle wood is also known as the blue stain wood which does not have an effect on the wood's mechanical strength properties. Also, the kiln dry ensures that there is no harmful organism left on MPB killed wood which means that MPB killed trees have possibilities to be used in many different products. Numerous studies have been published to utilize MPB killed wood and convert into value-added products such as engineered wood products and bioenergy products. However, as the attacked tree remains dead longer, it decays quickly and becomes less suitable for engineered wood products.

Currently, the Canadian wood exporting market heavily relies on the U.S with 65 percent export shares which is very risky. For instance, After U.S. market has gone down because of the sub-prime mortgage crisis, Canada wood industry has fallen dramatically as well (Wahl & Poon, 2012). The target market should be more diversified by expanding markets in Pacific Rim countries, Europe, and developing countries to establish a sustainable industry.

Thus, this research paper will be focusing on identifying potential international markets for the mountain pine beetle products by investigating various countries' markets.

2.0 Backgrounds

2.1Markets for BC wood products industry

Forestry is one of the most important natural resource industries in BC. Historically, B.C. people have depended on the forest. Originally, native people inhabit on the forest for shelter, food, tools and medicine. Then, first European settlers came to B.C. and used the forest for using the wood to construct buildings, timbers, ships, and even roads and railway trestles (B.C. Ministry of Forests, Mines and Lands, 2010). Currently, the industry's main products of trees are the dimensional lumber, panel boards, value-added products, and pulp.

The forest products market is the export oriented industry. In 2011, Statistics Canada states B.C. forest product exports $9.95 billion which is 30% of B.C's total products produced (B.C. Ministry of Forests, Lands, and natural Resource Operations, 2012). The market has been diversified compared to the past years. B.C. forest exports to China have increased, offsetting declining of exports in U.S and Japan. Table1 shows that, in 2001 and 2006, Canada exported forest products to U.S almost 80% and it decreased to 60% in 2011. On the other hands, Canada exported to China 15.5% in 2011 from 1.5% in 10 years ago. In BC market, BC exported $3.83 billion forest products to US and $ 3.24 billion to China in 2011 (B.C. Ministry of Forests, Lands, and natural Resource Operations, 2012).

Country	1996	2001	2006	2011
United States	71.3	79.5	78.2	61.5
China	1.2	1.5	3.3	15.5
Japan	10.9	6.2	4.9	5.3
European Union	9.1	6.6	5	4.6
South Korea	1.3	1	1.3	2
India	0.4	0.4	0.9	1.5
Rest of the world	5.7	4.8	6.5	9.5

Table 1- Canadian forest product export destination, 1996-2011 (B.C. Ministry of Forests, Mines and Lands, 2010)

British Columbia contains 95 million hectares (Figure 1) of forests which is larger than any European country except Russia (B.C. Ministry of Forests, Mines and Lands, 2010). The most common forest types in the province are lodge pole pine, spruces, true firs, hemlocks, and Douglas-fir.

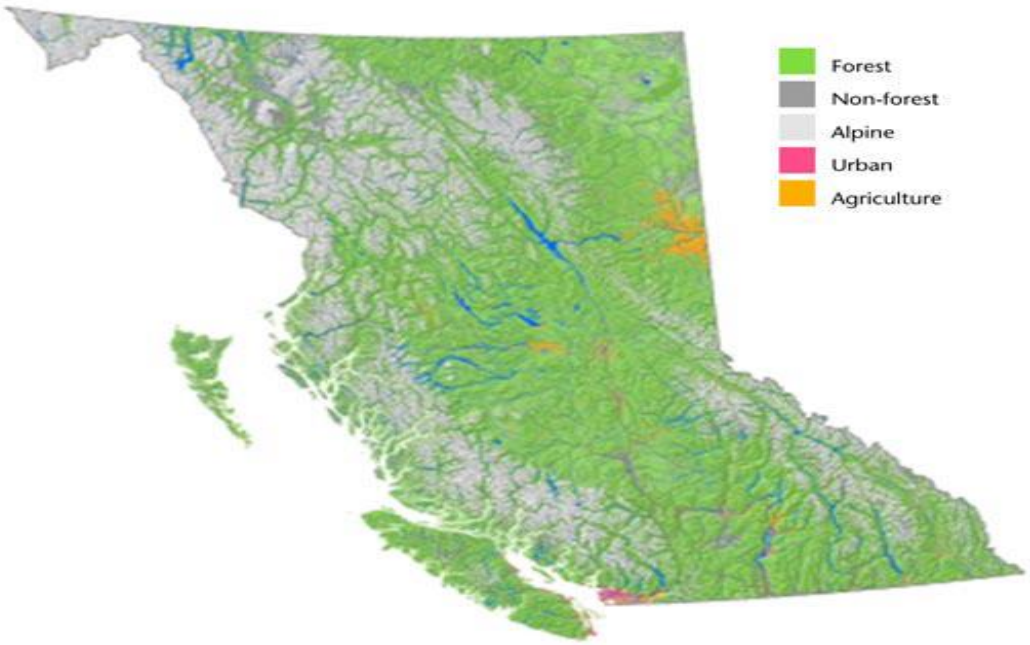

Figure 1 - Land types in BC (B.C. Ministry of Forests, Mines and Lands, 2010)

2.2 Impact of the recent economic recession on BC wood industry

In 2008, BC forest industry has experienced one of the worst downturn in history from the global recession. Canada's forestry industry has been affected by the U.S. market immediately duo to the heavy reliance. As U.S. housing markets dropped to the lowest levels in 40years, the price of Canadian lumber was directly affected by (B.C. Ministry of Forests, Mines and Lands, 2010).

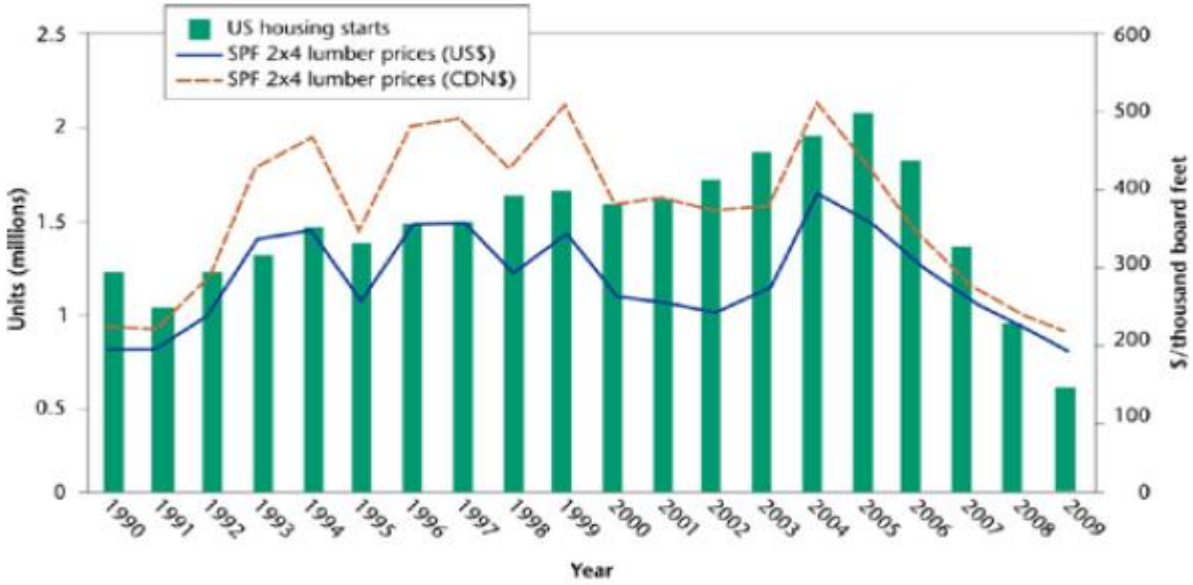

Figure 2 - U.S. housing starts and SPF 2x4 lumber prices 1990-2009 (B.C. Ministry of Forests, Mines and Lands, 2010)

According to the figure 2, U.S. housing starts were 558,000 units in 2009 which decreased 70 percent from 2 million units in 2005. It caused U.S. lumber consumption reduced to 31.0 billion board feet which is reduced almost half volumes from 2005 (B.C. Ministry of Forests, Mines and Lands, 2010). B.C. ministry of forestry expected that the U.S. economy will be recovered in very slow pace because of sinking home sales and high unemployment rates. Also, the demands of B.C. lumber to the U.S. market expect to remain weak, and the lumber price will remain low in the future.

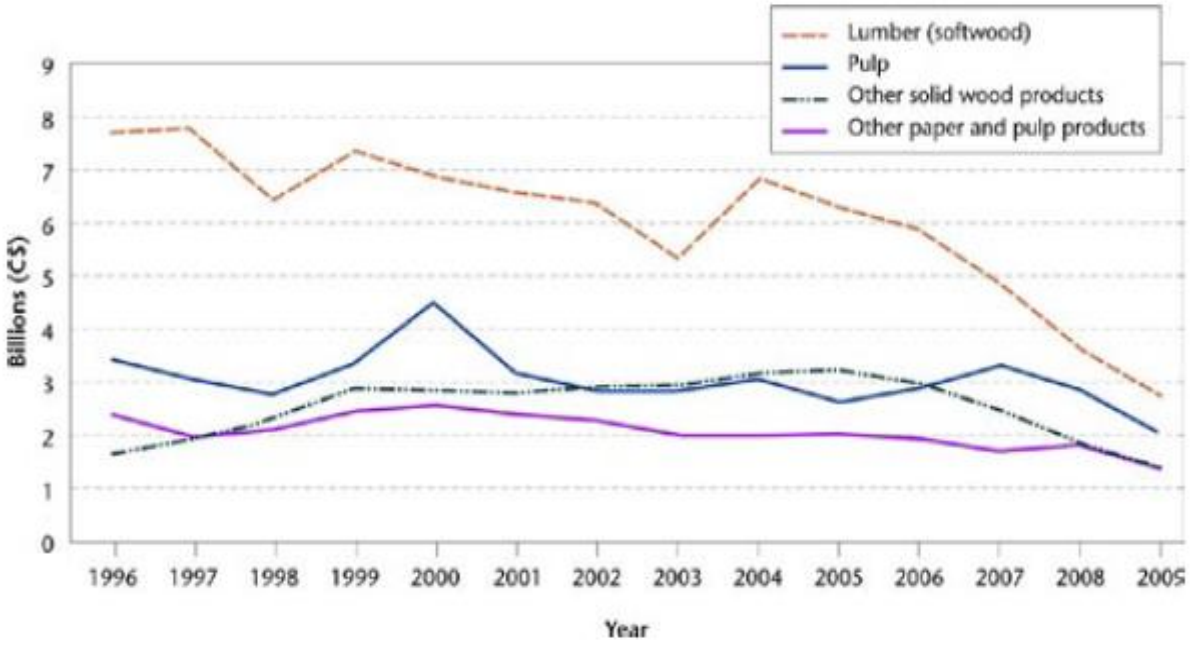

Figure 3 - Value of forest product exports (C$) from B.C. by product group, 1996-2009 (B.C. Ministry of Forests, Mines and Lands, 2010)

By reflecting housing market collapse, in 2009, B.C. forest industry exports fell to $7.6 billion. This is the lowest value in 15-years, and dropped 50 percent from 2004. B.C. softwood lumber exports decreased to $2.75 billion in 2009, down 60 percent from 2004 (B.C. Ministry of Forests, Mines and Lands, 2010).

To resolve the dependence of one country, BC forest industry along with the government have made various investments and funded programs to expand the market in China (Wang G. , 2009). As a Result, B.C. forest products exports to China have increased dramatically over the past decade.

2.3 The history of the bark beetle and its impact on the wood industry

Lodgepole pine and the mountain pine beetle have always co-existed as a natural part of ecosystem. According to the BC ministry of Forests, Lands and Natural Resources Operations, they estimates that the mountain pine beetle attacked a cumulative total of 710 million cubic

meters which is 53% of all pine in BC. They predicted to grow to 767 million cubic metres by 2017 (B.C. Ministry of Forests, Lands and natural Resoure Operations, 2011).

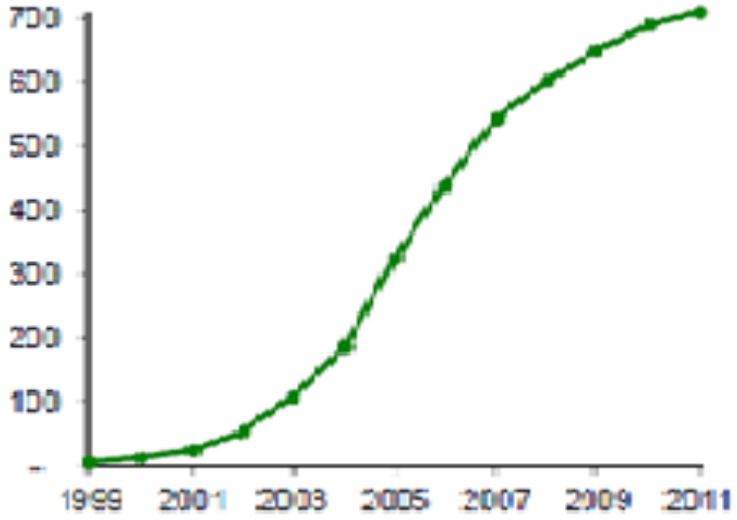

Figure 4 - Cumulative volume of valuable pine killed from 1999 to 2011 (B.C. Ministry of Forests, Lands and natural Resoure Operations, 2011)

The B.C. government has spent substantial amount of money to mitigate the future impact since they recognized the infestation. BC has spent $884 million dollars since 2001. Although, the B.C. government actively contributed to prevent the epidemic, the MPB infested area has continuously increased more than 1000 times. In 2001, almost 800,000 hectares were infested by MPBs (B.C. Ministry of Forests, Lands and natural Resoure Operations, 2011). BC forestry products industry will not only lose values of trees but they have to take risks of the devastating forest fire, floods, and the CO2 air pollution. While housing markets inevitably recover, the ongoing MPB epidemic attacks in interior B.C. forest areas will result in lower harvests, and negatively impact on the economic and employment prospects for B.C. community. Also, Central 1 Credit Union estimates that the 11,250 jobs opportunities will be lost by the MPB epidemic (Patten, 2010).

3.0 Issue of mountain pine beetle wood

3.1 Infestation of mountain pine beetle

There are three stages of beetle attacks which are green, red, and grey. At stage green, beetles initiate to attack lodgepole pine, and stay under the bark laying their eggs. At this stage, the infestation is invisible because the trees still look green like the non-infested lodgepole pine. At stage red, the movement of water and nutrients within the tree is stopped. Due to the insufficient resources, needles turn red, and the tree dies. The red stage can be prolonged for 2 to 4 years. The last stage is called grey attack. The trees look grey since needles have fallen to the ground (Council of Forest Industry, 2005). Before it dies, the government encourage harvesting trees by increasing annual allowance cut. The shelf life of the mountain pine beetle killed wood was estimated about 15 years. The shelf life tells the time that MPB-killed wood is suitable for a specific use (Byrne, Stonestreet, & Peter, 2006)

3.2 Blue stained wood

One of the distinctive characteristics of MPB Killed wood is blue-stained. When MPBs, Dendroctonus ponderosae, attack trees, the beetles introduce blue stain fungus (Ophiostoma) into the sapwood (Leatherman, Aguayo, & Mehall, 2013). Blue-stained wood loses the moisture contents because the fungus blocks the transportation water and nutrient with in trees. Moreover, it attacks the defence mechanism of tree. The blue stained trees dries faster due to the high permeability, which may create splits and checks during the process. In 2003, Forintek Canada released their project which compared mechanical properties of blue stain lodgepole pine and non-stained pines. After their standard test was done, they reported that there was only marginal difference in toughness and stiffness (Byrne, Stonestreet, & Peter, 2006).

3.3 Air pollution – Carbon dioxide

Not only BC forest industry losses the value of pines but also encounters the severe impact on the air pollution. Following the outbreak of the MPB, dead trees emit a large volume of carbon dioxide. Kurz estimates that 270 mega tonnes of carbon dioxide will be released during 2000-2020. Furthermore, it will contribute to the climate changes (Kurz, et al., 2008).

3.3 Fire hazard

Recently, a number of forest fires has increased across the western North America. Many people presume that dead tree increases the possibility of crown fire due because of canopy dead fuels. Smard's study suggests that at the red attack stages, it may have higher risks of crown fire because MPB creates the great quantities of dead trees and fuels. However, he also asserts that beetle outbreaks may reduce the probability of crown fire by thinning the forests and reducing canopy fuel loads. (Simard, Romme, Griffin, & Turner, 2011). Because fuel contents get decreased overtime, it is hard to support that there is a correlate relationship between the outbreaks and forest fire. However, dried pine and gusty weather conditions still create the risk of fire.

3.4 Water

Another potential hazard of MPB-killed wood is the hydrologic effect. Rita Winker from the BC Ministry of Forests and Range indicates a general overview of potential hydrologic effects. The most importantly, the volume of water will be increased in stream flow and the groundwater because of increasing a number of snowpack during winter. Also, the quality of water can be degrades by MPB and salvage harvesting (Redding & Bladon, 2009). Also, it causes the climate changes, the temperature increases, and water get warmer. This water can be mixed with forest disturbances.

4.0 Products can be made out of mountain pine beetle killed wood

Many different products can be produced by MPB-killed wood by applying appropriate strategies. As MPB-attacked wood is kiln dried, it can be exported to other countries like wood that does not have Pine Beetle attacks or the blue fungus. The high heat of kiln drying ensures that are no harmful organisms left on the wood. CLT and engineered wood only use kiln dried lumber as components so can be exported. Thus, many of the exported engineered wood products likely do contain MPB wood. However, the longer the attacked tree remains dead the more strength the wood from this tree is lost and the less suitable the wood is for engineered wood products. Also, bioenergy products and pulps are the other potential products.

However, due to the unique characteristics of MPB-killed wood, the manufactures in forest products industry have found problems in the processing especially in the drying stage. MPB-killed wood's permeability is very high compare to the non-stained pine. According to the Forintek's research, the permeability of MPB-killed wood is 8 to 25 times increased in the tangential direction and, 6 to 23 times in the radial direction. (Oliveira, Wallace, & Cai, 2005). This causes MPB-killed wood to dry faster which may causes splits and checks, and absorb more resins which is costly.

4.1 Blue Stained Lumber

Major problems of MPB-Killed wood are the appearance of blue stain in the sapwood and excessive dryness. The dead wood still can be used as lumber if it is harvested early but the grey stage logs have been reluctant to process since it is easily damaged and required more energy. Bogdanski states that 5-year-old dead lodgepole pine can produce lumber with the 12.5% less lumber recovery compare to the non-stain lodgepole pine. Also, the value of lumber is decreased of 6% due to the lowering lumber grade (Bogdanski, Sun, Peter, & Stennes, 2011). Also, the high permeability of trees causes the difficulty of producing lumber. From Byrne's article, oven-dry weight of regular lodgepole pine's sap wood is about 85 percent to 165 percent. On the other hands, the moisture content of 1year-infested wood is approximately 16 percent (Byrne, Stonestreet, & Peter, 2006). Thus, to dry MPB killed wood, it has to be separated from the non-infested to reduce the physical damages such as checks and splits with different drying method. Also, due to the dryness, the MPB wood tends to be more brittle so that it could be damaged in any processing stage. To compensate these problems, many researchers suggest producing value-added products such as engineered wood products or the bioenergy products.

4.2 Engineered wood products

To maximize the value recovery, converting the MPB killed wood into the engineering wood would be an ideal idea. By using mountain pine killed wood, many different types of engineered wood products such as cross laminated timber (CLT), laminated veneer lumber (LVL), and glulam, can be made. However, because MPB-killed wood has different characteristics in permeability compare to unstained-wood, it requires different manufacturing strategies in drying, grading, gluing, and hot-pressing.

4.2.1 Cross Laminated Timber

Cross laminated timber (CLT) one of the most recent engineered wood products, can be made from the MPB Killed wood. By illustrating figure 1, CLT is a multi-layered made from lumber. Each of layer wood is stacked perpendicularly on the layer. The CLT can be used as the material for the mid-rise building. The CLT market has been grown faster in Europe due to the environmental friendly. CLT provides a lot of advantage in the construction industry such as high strength properties, cost saving, environmental friendly and faster construction. It can compete with steel and concrete as a primary building material.

Figure 5 - 7 Layers Cross-laminated timber panels (Hunter, 2012)

Recently, the earthquake-resistant experiment has done with 7-storey building made of CLT in Japan. As a result, it can endure the significant earthquake activity without critical damage or collapse (Hunter, 2012).

4.2.2 OSB & MDF

Oriented strained board (OSB) and medium density fibreboard (MDF) are the one of most common engineered wood products in BC. OSB is made up with strands of any low-density species such as southern yellow pine (SWY) and aspen. MPB killed wood can be used for OSB as well. The challenges of using MPB killed wood is that it consumes excessive resin because of its high permeability which increases the cost of manufacturing (Bogdanski, Sun, Peter, & Stennes, 2011). To reduce the issue, the early stages of beetle attack wood should be used. MDF also can be made up using any species of particles. However, MDF plants require a

lot of electrical power and cost to process fibre. Also, the long term availability of MPB-killed wood is uncertain so, it is very risky to invest significant amount of money (INRS, 2011).

4.2.3 Plywood/LVL

Forintek investigated the possibility of manufacturing plywood and laminated veneer lumber (LVL) by using MPB-killed wood. Like other products, it requires to control suitable drying, grading, gluing, and hot-pressing methods. Based on Forintek's study, the MPB killed-wood veneer is denser and stronger than the veneer from the typical white wood mix such as white spruce and subalpine fir it would be more suitable for producing higher stiffness LVL and Plywood (Wang, Dai, & Wharton, 2007). These two products can be used as headers, flooring, decking, concrete forming, and I-joists. The major problem of using MPB killed wood is lower veneer yields and the reduction in full-sheet recovery. In 2004, Wang asserted dryness of MPB killed wood can be beneficial of processing veneer. The salvaged log can be thawed more easily in winter and dry faster than normal wood. It provides 35 percent reduction in dry time (Byrne, Stonestreet, & Peter, 2006).

4.3 Bioenergy

Bioenergy products have a potential to produce from the MPB-killed wood in future. The biomass has been made from waste of wood production. It generates electricity, heat, and energy. Wood pellets have been widely used. For example, one plant in BC produces 200,000 tonnes of pellets per year. Also, there are co-generation plants produce 600 to 605MW per year by using more than 3 million tonnes of wood residue (Byrne, Stonestreet, & Peter, 2006). Currently, by processing pellets from MPB-killed trees are not feasible since it is too expensive compare to current material. The current materials cost very little or free. Nonetheless, MPB killed wood could be used for bioenergy products in future due to the salvage of MPB killed wood, carbon credit benefits, and the long term fibre supply

4.4 Pulp

Another possibility of utilizing MPB-killed wood is making pulp. Kedla asserts that there is no significant difference in chemical and mechanical properties between the MPB-killed wood and lodgepole pine (Kadla, Lam, & Zaturecky, 2008) . Therefore, a large number of MPB killed wood could be an alternative source for pulp and paper mills.

5.0 Potential international markets and obstacles of mountain pine beetle killed wood

Historically, Canada forests products industry has been highly dependent on U.S market. According to the figure, Canada exports about 80% of total export products to US 10 years ago and dropped to 60%. Canada exports 1.5 percent of their exporting products to china 10 years ago and increased to 15% (Statistics Canada merchandise trade data, 2012). In order to export the MPB killed-wood products, Canada should have variety of trading partners. Every country has different perceptions on MPB-wood, and need different types of products. It is essential to determine what each international market's demand.

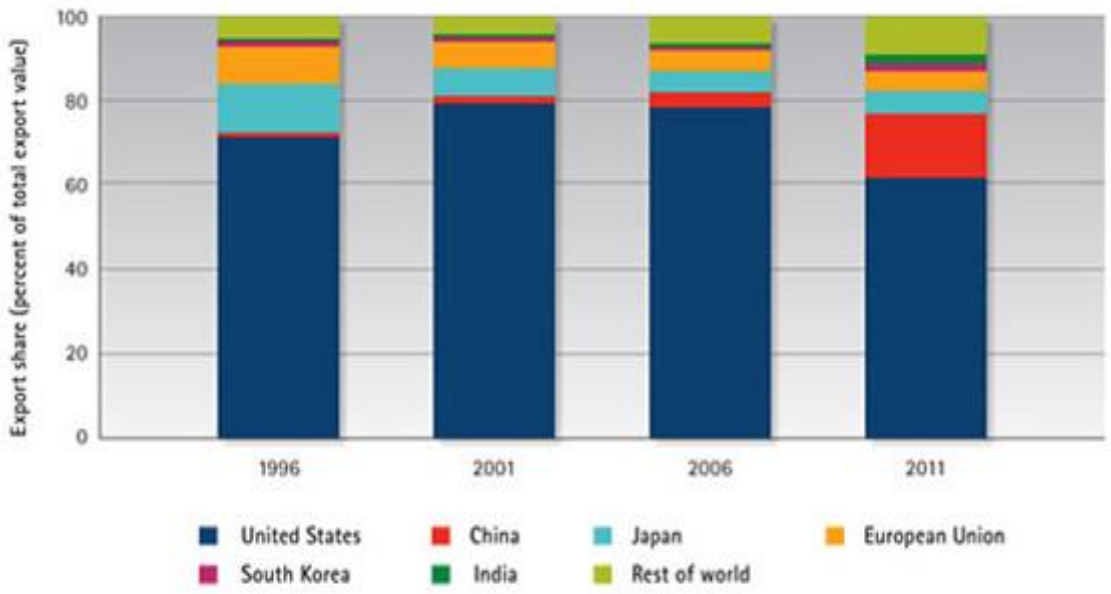

Figure 6 - Canada's exports share (Statistics Canada merchandise trade data, 2012)

5.1 China

China is one of the most rapid growing markets in the world. Currently, China is the second highest GDP country. Simultaneously, China's forest industry has grown rapidly which becomes a target for many countries' export destination. Figure 7 shows in 2010, imports forest products increased more than two times compare to 2001. It dropped in 2009 due to the world economy crisis. It is expected to grow continuously due to the limited resources.

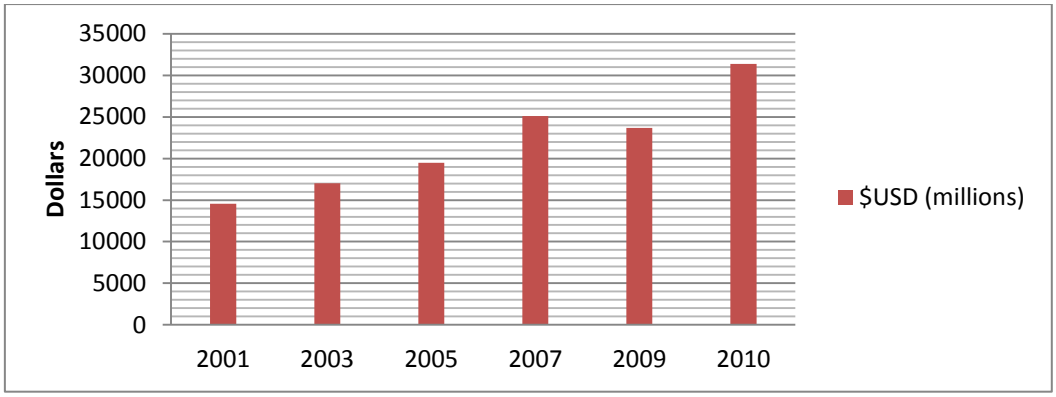

Figure 7 -Total Forest Products (in Million USD$) imported in China (FAO, 2013)

According to the Statistics Canada, B.C. forest products exported value increased dramatically from 6.6 percent in 2006 to 32.6 percent in 2011 (B.C. Ministry of Forests, Lands, and natural Resource Operations, 2012). The one of the most needs forest products of China is softwood lumber. BC shares 49.3% of Chinese softwood lumber consumption (Wahl, Poon, & Toosi, 2012). Canada supplies more than half of China's total softwood consumption which is 31.2 million cubic metres. The imported lumber is mainly use for the general construction, concrete frame and packaging. Cost of lumber is very sensitive to Chinese market. 90 percent of the lumber from Canada is lowest grade lumber (Hein, 2010). FPInovaiton predicts that the volumes of economically feasible MPB-killed wood are decreasing so BC may lose the softwood lumber market share in China in the future.

5.2 Japan

Japan is the Canada forest industry's third largest trading partner. In 2011, 5.3 percent of Canada's forest products and 11.6 percent of BC's forest products exported to Japan (Statistics Canada, 2012). Main products shipped to Japan are structural materials such as softwood lumber, plywood, and OSB. Unfortunately, the Japanese Agricultural Standards (JAS) states that the Japanese 2x4 construction does not permit stain (Zaturescky & Chiu, 2005). Thus, softwood lumber which produced from MPB-killed trees cannot be shipped to Japan.

Canada supplied OSB to Japan over 70 Percent (215,000 cubic metre) of the total consumption in 2011 (Wahl, Poon, & Toosi, 2012). The consumption of OSB was increased in

2011 due to the limited resource of plywood, and price. Moreover, Japan did not have domestic OSB manufacturing facilities.

The 'Act of promotion of Use of Wood in Public building' was introduced in 2010. Japan planned to use wood in low-rise public building from 7.5 percent to 20-30 percent. FPInnovation projected that the usage of structural materials such as CLT, Glulam, and midply shear walls will increase.

5.3 U.S.

The U.S. market has been the most important market for Canada's forest industry. Table 2 illustrates U.S. imported the massive amount of Canada's forest products compare to other major importers. The 95 percent of imported softwood lumber, 34 percent of imported softwood plywood, 100 percent of OSB were imported from Canada forest industry in 2011 (Wahl, Poon, & Toosi, 2012). Canada forest industry reflected to the U.S housing market directly. As, U.S. housing market crashed, Canadians suppliers of building materials, such as Softwood lumber, flooring, plywood, and prefabricated building lost considerable market share (Bogdanski, Sun, Peter, & Stennes, 2011). US forest markets has slightly recovered in 2011. Bogdanski states that the outlook of U.S. market is difficult to predict because U.S. market can be affected significantly by world events

Product	China	U.S.	Japan
Softwood lumber	7,523	20,737	2,730
Plywod	6.3	142	105
OSB	21.8	256	215
MDF	0.46	560	0.005
Particle Board	0.78	685	0

Table 2: Volume of Canada's imported forest products to major trading partners in 2011, Volumes = 1000 m^3 (Wahl, Poon, & Toosi, 2012)

Both the B.C. and the U.S. forest industries have put efforts to create the market for the blue stained products. After the enormous epidemic, U.S promoted blue stained siding, fencing and furniture under name "Primitive pine" and "Blue Mountain pine" (Byrne, Stonestreet, & Peter, 2006). Similarly, a group of manufactures in BC has been promoting blue-stain wood under the name, "Denim Pine." However, the markets seem to be very limited.

6.0 Conclusion & Recommendation

Technically, MPB killed wood can be produced a various type of products and export to different markets as long as products are kiln dried. However, realistically, it is not feasible to manufacture various types of wood products from the MPB wood. It is very risky to invest a lot of money to change the entire manufacturing system which is suitable to the MPB killed wood. Also, there are uncertainties in the long term blue stained wood supply.

Two important keys of producing products from MPB killed wood are harvesting in early attacks and controlling the dryness of blue stained wood.

Currently, the softwood lumber which is produced from savage pine has the highest potential for the international markets. Many countries' demand of softwood lumber is higher than other wood products. The B.C. forest industry definitely requires diversifying the trading partners. However, the B.C. industry is not necessary to produce diversified wood products from MPB-killed wood.

The most potential market would be China's forest market. China is very sensitive to the price and they have imported the low graded lumber which is from MPB wood. Furthermore, China's major supplier Russia has been losing market share due to the log export tariff.

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