Carbon flux in British Columbia's forests: Methods to Track Carbon Flux

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Introduction

- To mitigate the effects of climate change, carbon reducing strategies are becoming increasingly important.
- The ability of forests to sequester carbon is playing an important role in mitigating global warming.
- Canada is the third largest forest growing country in the world, covering 347.58 million ha forest land with the growing stock of 47, 320 million m^3 (FAO 2010, Natural Resources Canada 2012).

Literature Review

- Hennigar et al.(2008) presented an optimization forest management model to maximize carbon storage in both forest and wood products.

  Several alternative objective functions were evaluated to maximize the harvested volume: the carbon stored in wood product, the carbon stored in forests, and the carbon stored in both forest and wood products.

  Results show that it underestimates the contributions of forest to carbon sequestration when only accounting for carbon stored in forest.

Literature Review

- van Kooten et. al (2014) examined the feasibility of carbon offset credits via forest conservation and preservation.

  Results show that a high discount rate on carbon results in greater harvests, while a low discount rate generates lower harvests. It is also found that forest carbon sequestration is highly sensitive to the post-harvest use of wood products, particularly substitution of wood for concrete and steel in construction.

- In the previous study, the carbon flux is tracked by the weight parameter of carbon in green wood for various species, or tracked by Carbon Budget Model developed by provincial government.
- The effects of including various carbon pools, considering carbon values and carbon discount rates are examined.
- In the current study, we developed the forest management model in van Kooten et. al's study (2014) by comparing the two carbon tracking methods: the weight parameter of carbon in green wood, and the Carbon Budget Model.

Methods

- The objective function to maximize the Net Present Value:

$$NPV = \sum_{s}^{S}\sum_{a}^{A}\sum_{z}^{Z}\sum_{m}^{M}\sum_{t}^{T}\beta^{t}[(p_l\varepsilon_l + p_c\varepsilon_c + p_f\varepsilon_f)v_{s,a,z,m}x_{s,a,z,m} - C_t + p_{co2}CO2_t]$$

- Methods to track the carbon flux:

a: By the weights parameter: $C = C_{sq1} + C_{sq2}$

$$C_{seq1} = (1+r_{sub}).w.v_{s,a,z,m}x_{s,a,z,m} - C_{emi}.w.v_{s,a,z,m}x_{s,a,z,m}$$

$$= (1+r_{sub} - c_{emi}) \cdot w \cdot v_{s,a,z,m}x_{s,a,z,m}$$

$$= (1+r_{sub} - c_{emi}^{'} - \frac{d_k}{d_k + r_c}) \cdot w \cdot v_{s,a,z,m}x_{s,a,z,m}$$

$$C_{seq2} = w \cdot v_{s,a,z,m}s_{s,a,z,m} - w \cdot v_{s,a-1,z,m} \cdot s_{s,a-1,z,m}$$

Methods

- b: By the carbon budget model: $C = C_{sq1'} + C_{sq2'}$

$$C_{seq1'} = (1 + r_{sub} - c_{emi}) \cdot c_{s,a,z,m} \cdot x_{s,a,z,m}$$

$$= (1 + r_{sub} - c_{emi}^{'} - \frac{d_k}{d_k + r_c}) \cdot c_{s,a,z,m} \cdot x_{s,a,z,m}$$

$$c_{emi} = c_{emi}^{'} + \frac{d_k}{d_k + r_c}$$

$$C_{seq2'} = c_{s,a,z,m} s_{s,a,z,m} - c_{s,a-1,z,m} \cdot s_{s,a-1,z,m}$$

Results and Conclusions

- Substitution rate: fixed at 0.5;
- Carbon discount rate: fixed at 0.04;
- Carbon prices increase from $0 to $100 per ton CO2,

a: CO_2 tracked by the weight parameter

The harvested area decreased by 40% on average,

the total sequestered CO2 increased by 206% on average.

b: CO_2 tracked by the Carbon Budget Model

The harvested area decreased by 19% on average,

the total sequestered CO2 increased by 14% on average.

Results and Conclusions

- a: CO_2 tracked by the weight parameter

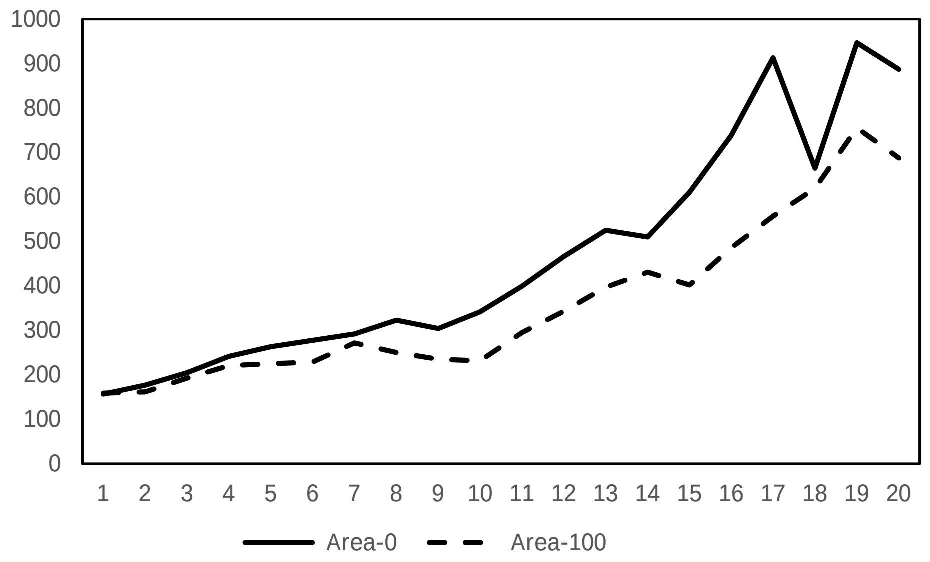

Fig. 1 Harvested Area

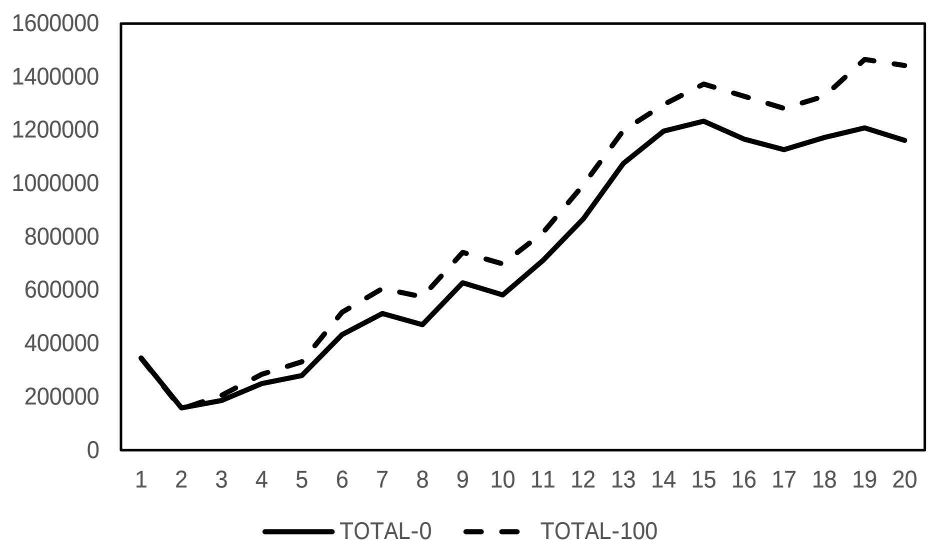

Fig.2 Total CO_2 Sequestered

Results and Conclusions

- b: CO_2 tracked by the Carbon Budget Model

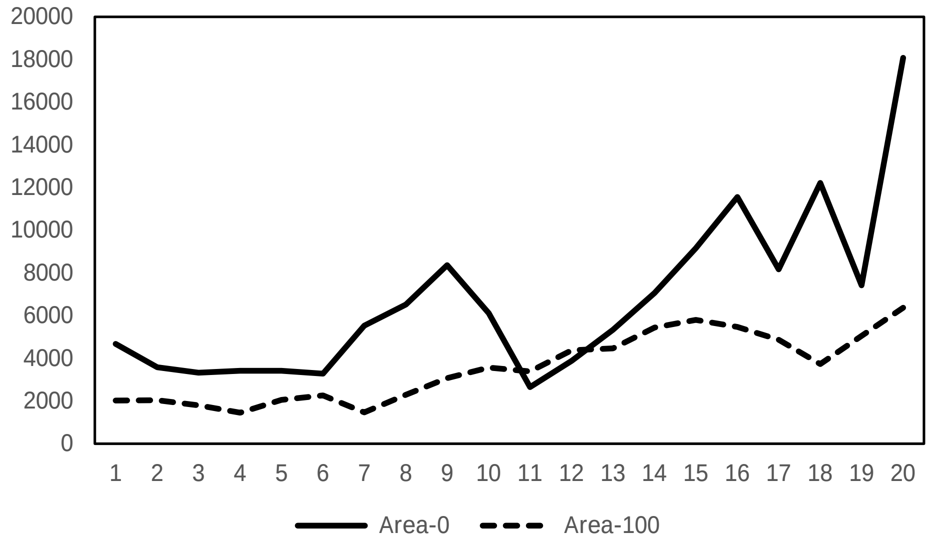

Fig. 3 Harvested Area

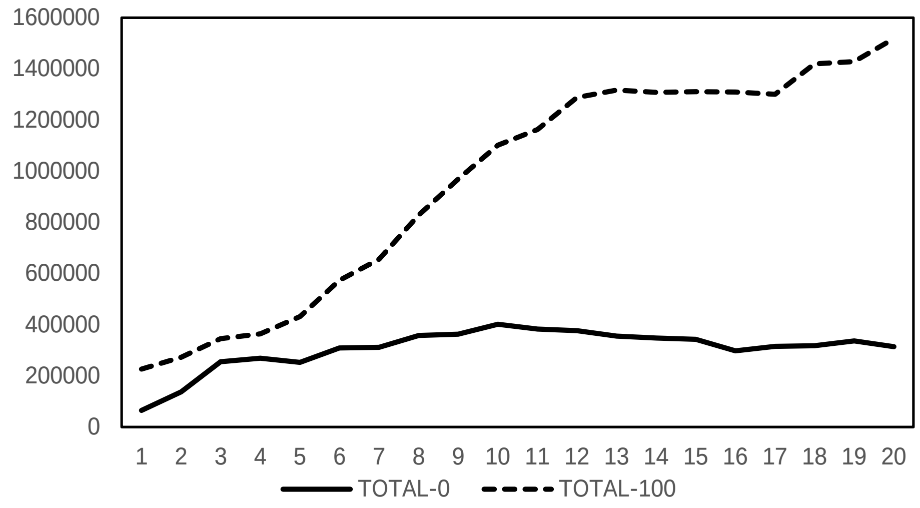

Fig.4 Total CO_2 Sequestered

Results and Conclusions

When the substitution rate and the discount rate are fixed, the results of the two methods to track CO_2 changes indicate that:

- The increase of the CO_2 price decrease the total harvested area, and increase the total sequestered CO_2;
- The percent changes, the amount of harvested area and sequestered CO_2 are much higher when the CO_2 is tracked by the Carbon Budget Model.

- Thank you for your attention !