CLEAN AIR NOW

READING LIST
ON WOOD BURNING AND CARBON EMISSIONS -- ANNOTATED

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2016 December 16

Definitions of "slash," "residue," etc.

See the B.C. Air Quality document "Slash and Wood Residue Burning," at http://www.bcairquality.ca/topics/slash-burning.html.

Rationale for burning slash and wood residue

For slash, see the B.C. Air quality document "Slash and Wood Residue Burning," referred to above: http://www.bcairquality.ca/topics/slash-burning.html. According to that document, "The forest industry uses burning to dispose of leftover slash and wood residue to abate fire hazards as required under the *Wildfire Act* and Wildfire Regulation. The obligation to abate fire hazards does not require forestry operators to burn the debris, just dispose of it. In some cases, burning is the best option, as long as it is carried out so as to minimize air pollution — following the rules set by the Open Burning Smoke Control Regulation."

It seems that burning is the best option, in the minds of logging companies and the B.C. Ministry of Forests, Lands and Natural Resource Operations, simply because it is cheap and now virtually a seldom examined custom. There are even businesses specialized in slash piling and burning (see http://www.wildfireinterface.ca/content/slash-and-pile-burning).

It is fairly obvious that disposing of slash and wood residue in the cutblocks would reduce fire hazards, but nothing in the literature I have examined indicates that reduction of fire hazards in the cutblocks justifies increasing the hazards to human health from smoke and adding huge amounts of carbon dioxide to the atmosphere. In 2015 there was one death of a person involved in fighting wildfires; "This was the first 'on the ground' firefighting death in British Columbia in decades.' (See "Wildfire Season Summary," http://www2.gov.bc.ca/gov/content/safety/wildfire-status/wildfire-statistics/wildfire-season-summary and http://www2.gov.bc.ca/gov/content/safety/wildfire-status/wildfire-statistics/wildfire-season-summary.) Consequently disposal of slash and wood residue must be intended to reduce fire hazards not to people but to valuable standing timber in the neighbourhood of a cutblock. I can find no studies on the value of timber saved from burning in forest fires through preemptive burning of slash and wood waste. In an average year, the cost of wildfire suppression in B.C. is about $122 million (B.C. Wildfire Season Summary; http://www2.gov.bc.ca/gov/content/safety/wildfire-status/wildfire-statistics/wildfire-season-summary).

Amount of slash and wood residue burnt

Possibly explaining the *amount* of slash and wood residue currently being burnt in the cutblocks are changes the Government of B.C. made in the early 2000s from a zero-waste policy in forestry to a "take-or-pay" policy. See Ben Parfitt, "Forestry firms burning jobs," *The Tyee*, 29 Nov 2006: https://thetyee.ca/Views/2006/11/29/WoodWaste/.

According to the *BVLD Airshed Management Plan: A Community Action Plan for Clean Air* (https://www.google.ca/?gws_rd=ssl#q=blvd+airshed+management+plan), p. 27, "Large forest licensees burn between 10,000 and 20,000 piles [[of logging debris]] in any given year in the BVLD airshed, which represents the vast majority of open burning in the airshed." The *Airshed Management Plan* also states that "Open burning of piled land clearing debris, forestry harvesting debris and agricultural debris – activities governed under the Open Burning Smoke Control Regulation – are the largest single source of PM 2.5 in B.C. outside the Lower Mainland."

Amount of CO_2 emissions from burning of slash and wood residue

According to the Sierra Club BC document *B.C. Forest Wake-up Call: Heavy Carbon Losses Hit 10 Year Mark*, "Emissions from logging and slash burning alone were 577 million tonnes of carbon dioxide in the period 2003-2012." "This number is close to B.C.'s entire official emissions during the same 10 year period (638 million tonnes). Contrary to the provincial data, the Sierra Club BC estimate accounts for carbon stored in wood products. Based on our literature review we estimate that 23 percent of the carbon removed through harvesting remains stored in wood products (only a portion long-term)." (See http://sierraclub.bc.ca/bc-forest-wake-up-call-heavy-carbon-losses-hit-10-year-mark/ and hit link to full report.)

On 2016 December 1, Jay Baker, manager of the Wetzin'Kwa Community Forest, gave me his considered estimate of 10-20 cubic metres of "processing waste" per hectare of WCF cutblock, plus 10-50 cubic metres of dead and dry, heavily checked material, plus an unknown amount of "non-utilization material like tops, branches, rot, etc."). I am uncertain, but it sounds to me as if the total volume for these three kinds of waste wood and slash would be something like 30 to 100 cubic metres per hectare. The weight of this organic matter would be somewhere between 15 and 50 tonnes per hectare, since wood is typically a little lighter than water. Burnt, the waste would produce roughly 30 to 100 tonnes of CO_2 per hectare – see references on p. 3.

According to the Government of British Columbia document "British Columbia's Forests and their Management, September 2003 (https://www.for.gov.bc.ca/hfd/pubs/docs/mr/Mr113/BC_Forest_Management.pdf), "Each year, an average of about 193,000 hectares (477,000 acres) of B.C. is logged, amounting to roughly 75 million cubic metres of timber. About 70% of the harvest comes from B.C.'s interior…. About 90% of logging takes place in public forests, where annual harvest rates average 184,000 hectares (455,000 acres), or roughly 65 million cubic metres of timber." If we apply the Wetzin'Kwa figures to the 193,000 hectares of annual cut in 2003, the total amount of CO_2 produced by burning in the cutblocks of B.C. public forests would be 30-100 tonnes x 193,000 hectares = 5,790,000 to 19,300,000 tonnes per year (say 6 to 19 megatonnes per year).

The Sierra Club B.C. document referred to above, using Government of B.C. statistics, states that emissions from slash burning in B.C. for the period 2003-12 were 82 million tonnes of CO_2, or on average 8.2 million tonnes per year, a figure in the same ballpark as the Wetzin'Kwa figures. However, the Sierra Club BC document notes that "Emissions from logging, (after considering carbon stored in wood products)" amounted to an additional 4.95 million tonnes per year for the 2003-12 period averaged. So Wetzin'Kwa and the Sierra Club BC are in rough agreement that cutblock burning would be somewhere around 12 megatonnes of CO_2 per year.

Government of British Columbia statistics bury greenhouse gases from slash and waste wood burning in a category labelled "Forest Management." The Government of British Columbia Excel document "Summary of B.C. Greenhouse Gas Emissions by Gas for 2014" (http://www2.gov.bc.ca/gov/content/environment/climate-change/reports-data/provincial-ghg-inventory) gives the CO_2 total for "Forest Management" as about 53 megatonnes and the CO_2e (= CO_2 equivalent, counting other greenhouse gases) total for Forest Management as over 62 megatonnes. This latter figure is just slightly less than the CO_2e total for nearly *all other British Columbia sources* of man-made greenhouse gases, roughly 64 megatonnes of CO_2e.

Why should greenhouse gases produced by "Forest Management" be excluded from the total for B.C. emissions? The only explanation available is the one in Footnote 1 in the "Summary" document cited in the previous paragraph: "National totals exclude all GHGs from the Land Use, Land-use Change and Forestry Sector." Again, see http://www2.gov.bc.ca/gov/content/environment/climate-change/reports-data/provincial-ghg-inventory.

Carbon dioxide and carbon dioxide equivalent from burning wood

Figures for carbon dioxide and carbon dioxide equivalent emissions produced by burning wood are available from many Web sites. Different kinds of fuelwood produce different amounts of greenhouse gases and the greenhouse implications of burning them vary according to the climate in which the trees furnishing the wood have grown; in cold climates, trees grow slowly (http://sciencenordic.com/wood-fuels-far-less-climate-friendly-assumed). As a first approximation, 1 kg of wood burned produces 1.9 kg of CO_2. (See https://www.transitionculture.org/2008/05/19/is-burning-wood-really-a-long-term-energy-descent-strategy/, quoting from the quasi-technical journal *Agroforestry News*.)
For detail and comparison with other fuels, see http://www.volker-quaschning.de/datserv/CO2-spez/index_e.php.

The B.C. Carbon Tax and wood burning

The B.C. Carbon Tax is described and explained in the Ministry of Finance document "Carbon Tax: Overview of the Revenue-Neutral Carbon Tax," available at http://www.fin.gov.bc.ca/tbs/tp/climate/carbon_tax.htm. The tax applies to a wide range of fuels but not wood. See the Ministry of Finance Tax Bulletin "Tax Rates on Fuels: Motor Fuel Tax Act and Carbon Tax Act," revised August 2016 (http://www.fin.gov.bc.ca/tbs/tp/climate/carbon_tax.htm) for current rates. Rates on coal,

another dirty fuel, vary between $53.31/tonne and $62.31/tonne. For peat, the rate is $30.66/tonne. If wood destined for burning in slash piles and as waste were taxed at the same rate as peat, and if an average slash pile contained 10 tonnes of wood, the 10,000-20,000 slash piles burnt annually in the BVLD region would garner a carbon tax of between $3,066,000 and $6,132,000. If the carbon tax were applied to all emissions from "Forest Operations" and for the province as a whole, it would amount to $1,907,818,500.

Sequestration of carbon and alternatives to burning cutblock slash and wood residue

Wikipedia offers the following definition of carbon sequestration: "**Carbon sequestration** involves long-term storage of **carbon** dioxide or other forms of **carbon** to either mitigate or defer global warming and avoid dangerous climate change" (https://en.wikipedia.org/wiki/Carbon_sequestration). Since wood is about 50% carbon, trees sequester carbon until they, or the products made from them, are burnt or biologically metabolized.

Natural Resources Canada has a Web page on forest carbon at https://www.nrcan.gc.ca/forests/climate-change/forest-carbon/13085. It has a Web page on using forests to mitigate climate change at https://www.nrcan.gc.ca/forests/climate-change/13097. [[Both these documents gloss over or completely ignore serious problems with using Canadian forests to mitigate climate change, in particular the slow growth rates of trees in Canadian forests, the low sequestration efficiency of wood products such as particle board, and the short residency times of carbon in construction materials made of wood. See below.]]

Natural Resources Canada has also developed a Carbon Budget Model of the Canadian Forest Sector: see http://www.nrcan.gc.ca/forests/climate-change/carbon-accounting/13107.

Carbon sequestration in wood products is a very complicated subject. It seems to be necessary to read a lot of scientific literature before forming opinions about it. Although it is dated, I have found the following paper very helpful and a good lead to further searches for relevant literature:

Profft, Ingolf, Martina Mund, Georg-Ernst Weber, Eberhard Weller, and Ernst-Detlef Schulze. 2009. Forest management and carbon sequestration in wood products. *European Journal of Forest Research 128*(4): 399-413. (http://miun.diva-portal.org/smash/get/diva2:2032/FULLTEXT01.pdf)

Another useful paper is http://miun.diva-portal.org/smash/get/diva2:2032/FULLTEXT01.pdf).

A 2013 Simon Fraser master's thesis by Adam Roger Kamp, *Policies for the Reduction of Slash Pile Burning in B.C. Forests*, would surely be useful, but I could not access it over the Web. The abstract is available at http://summit.sfu.ca/item/12916.

My impression is that generally, schemes to sequester carbon by harvesting more wood than British Columbia already does take no account of mean residence times – how long the wood products are actually used in buildings, for example, before they are disposed of and the carbon in them is released as CO_2 – or how much CO_2 is produced in the course of harvesting and

manufacturing the wood. Schemes to increase levels of harvesting of mature forest and to replace the cut trees with fast-growing seedlings, even when sincere, may actually turn out to be worse than useless for reducing CO_2 emissions. Manufacturing of pellets for burning may substitute a renewable source of energy for fossil fuels, but the end result is still more $C0_2$ in the atmosphere at a time when even the near-future 2030 and 2050 Canadian targets for shrinking CO_2 emissions will just moderate catastrophic global overheating, not avert it.

Burial of slash and wood residue

One method of avoiding cutblock burning of slash and other wood residue in the cutblocks is burial. Several old research papers from U.S. government forestry scientists concluded that burial has much to recommend it. For example, a 1966 U.S. Forest Service publication by Harry E. Schimke and Ronald H. Dougherty, Disposal of Logging Slash, Thinnings, and Brush by Burying, says that "This method of slash disposal shows promise and has some distinct advantages over disposal by chipping and burning. … It proved cheaper than chipping but somewhat costlier than piling and burning." (Go to https://babel.hathitrust.org/cgi/pt?id=umn.31951d02995579i for a photographic reproduction of the paper.) The abstract for a 1970s publication by Franklin R. Ward and Hugh R McLean, *Burying Forest Residue: An Alternative Treatment*, states that "Burying forest residue in a mixed conifer stand which had been shelterwood cut was economical and effective. The fire hazard was reduced to an acceptable level…. The operation cost was about $83 per acre." Of course early research of this kind antedated the present-day concern with emissions of carbon dioxide and other greenhouse gases.

A different form of burial of slash and wood residue is called "hugelkultur." Web sites such as https://www.permaculture.co.uk/articles/many-benefits-hugelkultur describe and illustrate the technique, which is said to be employed by some municipalities to make beneficial use of waste wood up to the size of whole trees. Hugelkultur burial promotes rapid growth of new vegetation, including replacement trees. I have seen no research on the emissions of greenhouse gases it generates.

Possibly the most promising of all alternatives to slash and wood residue burning is conversion of organic matter to biochar. *Biochar* is really just charcoal; but its proponents claim that it sequesters CO_2 and other greenhouse gases for thousands of years, dramatically enhances soil fertility, and can be produced at a variety of scales. The Smithers Public Library has a book on it: Albert Bates, *The Biochar Solution: Carbon Farming and Climate Change* (Gabriola Island BC: New Society Publishers, 2010). A popular science account of what is going on in biochar research is available at http://pubs.acs.org/doi/pdf/10.1021/es0726097. A good bibliography of "Biochar Articles and Research Papers" is on the Web at: https://www.biochar.info/biochar.biochar-articles.cfml. For research on use of biochar production in carbon offsetting, see https://www.researchgate.net/profile/John_Gaunt/publication/5263646_Energy_Balance_and_Emissions_Associated_with_Biochar_Sequestration_and_Pyrolysis_Bioenergy_Production/links/552fb4410cf27acb0de61d73.pdf).

A first-rate synopsis on the potential role of biochar production in addressing carbon emissions by utilizing forestry and other organic waste in British Columbia, co-authored by a former colleague of mine at the University of Northern British Columbia, is Geoff de Ruiter, Steve Helle, and Michael Rutherford, *Industrial and Market Development of Biochar in British Columbia*, 2014, published by the Pacific Institute for Climate Solutions and available over the Web at
https://pics.uvic.ca/sites/default/files/uploads/publications/Biochar%20Paper%20Feb%202014%5B1%5D.pdf.
This document covers just about every heading in the present reading list, including how carbon offsets relate to biochar, it makes recommendations in line with the tendencies of my annotations, and it is highly favourable to the idea of using biochar for dramatically reducing greenhouse gas emissions and forestry smoke in British Columbia.

Carbon Offsets

The exclusion of Forest Operations from the B.C. Carbon Tax is a scandal but also an opportunity. Forest operations such as slash and wood residue burning in the cutblocks emit huge quantities of carbon dioxide and other greenhouse gases unnecessarily, since there are low-carbon alternatives to burning, such as conversion of wood waste to biochar – see above. Consequently corporations and government bodies which find it impossible to reduce their own emissions to socially acceptable levels or at a cost they wish to pay could make up for their own shortcomings by buying **carbon offsets** from logging companies. Likewise wealthy and prominent individuals with a well-developed social conscience could buy slash-and-wood-waste-burning offsets. The David Suzuki Foundation has a good Web site for basic information on how carbon offsets work. See:

http://www.davidsuzuki.org/issues/climate-change/science/climate-change-basics/carbon-offsets/?gclid=CLOTy4TY9tACFcO3wAodVWkPdw

The Pembina Institute has published a free booklet, *Purchasing Carbon Offsets: A Guide for Canadian Consumers, Businesses, and Other Organizations*. To download the PDF, go to: http://www.pembina.org/pub/1866 and hit the link.

Here's the logic. (1) Currently there is no carbon tax on burning wood, so there is no incentive for forest companies to sequester the carbon in their waste wood. (2) The forestry companies (and B.C. Timber Sales) use the cheapest and most convenient means of carrying out their regulatory obligation to rid their cutblocks of slash and residual wood, and that is burning. (3) There are Canadian, British Columbian, and international markets for carbon offsets. Through independent brokers, companies, institutions, and wealthy individuals negotiate with other corporate entities or individuals to keep forests intact in return for cash. The benefit to the buyer of the carbon offset is that he, she, or it can carry on with his, her, or its carbon dioxide production in the manner to which he, she, or it has become accustomed while still helping to reduce overall global, national, or provincial carbon dioxide levels. (4) Since slash and wood residue burning in BC has no serious purpose except to meet regulatory requirements, even a modest flow of carbon offset money might be enough of an economic margin to persuade forest companies to sequester their waste by burial or manufacture of long-residence-time construction

board or the like. (5) In addition to deflecting criticism for the carbon dioxide they generate, buyers of carbon offsets in interior BC would be able to point out that by bringing forestry wood burning to an end they are promoting better (smokeless) health in tens of thousands of B.C. residents.

To ensure honest dealing and compliance, independent, arm's-length, third-party organizations broker offset arrangements between buyers and sellers. Some of these organizations are listed and ranked in the Suzuki Foundation and Pembina Institute sites referred to above. The Province of British Columbia has its own offset program, mainly aimed at public-sector organizations within B.C. See http://www2.gov.bc.ca/gov/content/environment/climate-change/stakeholder-support/developing-emission-offset-projects).

The Province of British Columbia has legislation and regulation governing carbon offsetting; see http://www2.gov.bc.ca/gov/content/environment/climate-change/policy-legislation-programs/climate-action-legislation#GGECR. "The Greenhouse Gas Emission Control Regulation establishes the infrastructure and requirements for issuing emission offset units and funded units which are foundational elements that enable compliance with the performance standards listed within a Schedule to the *Act*. The Regulation also establishes the BC Carbon Registry which will enable the issuance, transfer and retirement of compliance units (emission offset units, funded units and earned credits) on an electronic platform."