Global Stakes: Potential Agricultural Productivity Losses from Full Exploitation of Canada's Oil Sands

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CGD Notes

Combustion of the Alberta deposit would increase the atmospheric concentration of CO2 by 99 ppm, or 21.3 percent of the increase already projected to occur by 2100.

Scientific consensus attributes recent climate change to anthropogenic greenhouse gas emissions with a probability greater than 90 percent (IPCC 2007). This consensus incorporates scientific research on past greenhouse gas releases, including the Paleocene-Eocene Thermal Maximum (PETM) event that occurred around 56 million years ago (Sluijs et al. 2007; Ridgwell and Schmidt 2010). The estimated magnitude of the PETM release was four to eight times total anthropogenic CO_2 emissions since 1750 (Boden, Marland, and Andres 2009), and similar to the potential release from remaining fossil fuel deposits (Caldeira and Wickett 2003). The resulting increase in atmospheric CO_2 concentration raised the average global temperature by at least 5° C (Pagani et al. 2006).

The IPCC has repeatedly warned that an increase of this magnitude will be catastrophic for the world (IPCC 2007). By implication, political decisions have mortal stakes when they accelerate depletion of massive fossil fuel deposits. To illustrate, this note assesses potential global losses from full exploitation of the vast, largely untapped oil sands of Alberta, Canada. In future work, I will expand the analysis to other global deposits and consider the benefits and costs of alternative strategies for reducing the rate of depletion.

My assessment draws on IPCC emissions scenarios that make different assumptions about the future effects of economic, technological, and regulatory changes (IPCC 2000). I focus on IPCC scenario A2,[1] which has been comparatively accurate in tracking actual greenhouse emissions since its publication. Using this scenario, Cline (2007) has projected country-level impacts on agricultural productivity through 2080, and I (Wheeler 2011) have extended Cline's estimates to a broader set of countries.

In this note, I estimate the proportion of projected A2 impacts that could be attributable to carbon emissions from the Alberta oil sands. My estimate is conservative because it focuses on emissions from combustion of extracted crude oil, without incorporating additional emissions from oil-sands processing and the forest clearing necessary for full access to the oil sands deposit.

The Alberta Energy Resources Conservation Board currently estimates the deposit's potential yield at 1,804 billion barrels of crude oil (AERCB 2011). For this analysis, I assume that the entire deposit will be mined and the extracted crude oil burned by 2100. Using standard conversion factors, full combustion would produce an atmospheric release of 209 gigatons of carbon, which would in turn raise the atmospheric CO_2 concentration by 99 parts per million.[2] This is 21.3 percent of scenario A2's projected global increase of 464 ppm by 2100.[3]

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1. In the A2 scenario, IPCC (2000) projects "a very heterogeneous world. The underlying theme is self-reliance and preservation of local identities. Fertility patterns across regions converge very slowly, which results in continuously increasing global population. Economic development is primarily regionally oriented and per capita economic growth and technological change are more fragmented and slower than in other storylines."

2. Conversion factors are drawn from Battle, et al. (2000), and CDIAC (2011).

3. From the current level (392 ppm), A2 projects an increase to 856 in 2100.

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Drawing on Cline (2007) and Wheeler (2011), I apply this percentage to projected country-level losses of agricultural productivity.[4] For full results of the calculations, see the tables and figure at www.cgdev.org/content/publications/detail/1425525.

The results provide a sobering perspective on the potential global impact of exploiting Canada's massive oil sands deposit: Agricultural productivity losses affect the livelihoods of over 3 billion people in the developing world.[5] The median projected loss is 5.6 percent, with 25 percent of countries experiencing losses of 7.1 percent or greater. Africa suffers disproportionately, with a median loss of 7 percent and impacts extending to a 12.8 percent loss in the worst case. India, with a rural population of 804 million, suffers a 7.9 percent productivity loss. Significant losses are also suffered by other large Asian countries: Pakistan (114 million rural residents), Bangladesh (110 million), and Indonesia (115 million). Among African states, large countries with heavy losses are Sudan (24 million rural residents),

Ethiopia (69 million), and Nigeria (76 million). In Latin America, serious losses are suffered by Mexico (25 million) and Brazil (28 million).

There is striking asymmetry in regional impacts. Full exploitation of the oil sands deposit by Canada, a high-income country, would have the most severe impacts on regions where the poorest countries are concentrated. Substantially smaller losses are projected for high-income, higher-latitude countries in Europe, North America, and Oceania.

To summarize, the estimates in this note suggest that full exploitation of Canada's oil sands deposit would impose significant agricultural productivity losses on over 3 billion people in the developing world, and particularly in sub-Saharan Africa. Of course, individual country estimates are subject to considerable uncertainty. Overall, however, there can be little doubt about the destructive implications. A fuller accounting of potential losses in Wheeler (2011) indicates that a carbon release of this magnitude would also generate extreme weather events and sea-level rise that would victimize hundreds of millions of people. Put simply, the potential destructive power in Canada's oil sands exceeds anything modern civilization has witnessed to date. And this case is far from unique: similar losses will be generated by full exploitation of other massive fossil fuel deposits.

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4. My approach assumes that carbon emissions from oil sands extraction will sustain this percentage through 2100. To a first approximation, atmospheric radiative forcing and temperature increase in year T relative to an initial year (0) are linear in the log-ratio of atmospheric CO_2 concentrations [ln (CT/C0)] where C0 is conventionally set at the estimated concentration in 1750. By implication, incremental warming from unit increases in CO_2 concentration will decline through time as the atmospheric concentration increases. My exercise will therefore underestimate the impact of the oil sands if their extraction is faster in the first half of the century, and overestimate the impact in the converse case.

5. This estimate reflects rural populations in 2008. Population growth and rural-urban migration will both continue in the 21st century, and their net effect will determine rural populations in 2080. My estimate of 3 billion people is extremely conservative in any case, since it does not account for intergenerational totals.

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