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Case Study of Soil C Quantification: Alberta GHG Offset System

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This paper will describe the experience of a soil carbon sequestration protocol for adoption of NoTill practises in annual cropping in the Northern Great Plains. Alberta has had a GHG offset system in place for a decade that included a NoTill protocol from the beginning.

Alberta greenhouse gas emissions context

Agriculture in Canada and Alberta produces about 10% of the total greenhouse gas emissions (Environment Canada, 2015). Alberta has only 10% of the national population but a vibrant oil/gas resource extraction industry and a coal-based electrical generation result in the province comprising 37% of the total national inventory of GHGs, the largest provincial contributor (Environment Canada, 2015). On a national basis, agriculture emission in Alberta produces 32% of the country's total due to the size of the agriculture industry. Alberta has nearly one third of the agriculture land in Canada and more than half the national beef cow herd. Alberta's ranking as number one in both total emissions and agriculture emission was the impetus for government to enact mitigation policies. Similarly, what Alberta does is of a national interest as changes in the Alberta emissions will have a visible impact on national reporting.

Enabling legislation and policy

Subsequent to the development of a national awareness of climate change in the 1990s and elucidation of the concerns and needs for government action, Alberta became the first province in Canada with a climate change action plan in 2002 which included emissions reporting requirements of large emitters. The Climate Change and Emissions Management Act (CCEMA) was amended in 2007 to require industries with emissions (CO_2e) greater than 100 kt per year to report and reduce their emissions to established targets. The 100 or so facilities with emissions over 100 kt contributed the most to the provincial emissions profile. Nearly half of the total regulated industrial emissions are from coal-based power companies and one third is from oil and gas. Fourteen percent of the total emissions are classed as "other" which includes refining, cement, manufacturing, forest products and fertilizer industries. Alberta chose to begin its regulatory framework on an emission intensity basis for emission reduction targets. The emission intensity approach (GHG emissions/unit of production) made sense for Alberta because it was the first jurisdiction in North America to implement a carbon constraint on its economy. From a competitiveness point of view, and Alberta being so export-focused in agriculture and energy products, particularly with the USA – this more economically friendly way of reducing emissions is important.

Under the CCEMA the large emitters that have to comply to reduce their emissions by -12% below their baseline. The act regulations have three options to reduce emissions to come into compliance to reach their reduction targets in any particular year.

1. Emission Performance Credits. Obtain performance credits (buy, trade, etc) from other regulated companies that have reduced their emissions beyond their 12 % target.
2. Emission Offsets. Companies may offset their emissions by purchasing emission reduction offsets from unregulated companies who voluntarily undertake projects to reduce emissions. Projects must be based upon credits developed in Alberta using government approved protocols.
3. Technology Fund Credits. Companies pay into the Climate Change and Emissions Management Fund at a set price of C$15/tonne CO2e. Funds collected are to be used to develop or invest in Alberta based technologies, programs, and other priority areas. Recently, the price of carbon was increased by government to C$20/t in 2016 and C$30/t in 2017.

The Alberta Offset System operates under a set of policies, rules, standards (known as Offset Quantification Protocols) and Guidance Documents to ensure that offsets are of the highest rigour and quality to 'offset' regulated company's requirements. Alberta Environment and Parks (2017) are the ministry responsible for the legislation.

Enablers and rules

In order for a carbon market to function well, simply laying out the science of GHG accounting through emission factors and quantification formulae, or by having the generation of policy, are by themselves not enough. The market place needs a range of science-based quantification protocols developed transparently with technical review to help provide certainty to buyers and sellers and reduce transaction costs. Governments don't need to do all of this (and shouldn't). Non-government organizations (NGOs) can work with research institutions and prospective markets to develop appropriate protocols.

In Alberta, another key entity is aggregator companies that group together tonnage created from offset projects on different farms and deliver those offsets to market. Individual farms do not generate enough offset credits to take to market and/or the cost and effort of assembling a project on a farm is prohibitive. Aggregators can aggregate credits from a number of sources to assemble projects that interest the buyers. Aggregators can also develop processes and data systems that keep transaction costs down. Initially there was as many as a dozen interested companies in Alberta however the realities of effort, economics and government regulatory policy has resulted in a reduction to about three aggregator companies at present.

Enabling characteristics of aggregators include:

- Create interest amongst the offset suppliers (farmers).
- Allows farms with small amounts of offsets to participate in the market.
- Ability to review protocols in the final stages of development to ensure practicality.

- Explain protocols and requirements to clients.
- Provide data support to clients.
- Create a quality aggregation business model that withstands third party verifications.
- Provide entrepreneurial skills and innovations for the offset market to work smoothly.
- Provide feedback to protocol developers and market regulator.

The roles of NGOs and aggregators can facilitate the development and operation of a market without a heavy burden upon government of additional staff and infrastructure. They play a pivotal role in reducing transaction costs so that individual farms can participate in the carbon market and generate revenues – thereby driving increased uptake of positive practices.

Offset protocols

Protocol development is neither easy or quick. The International Standards Organization has a Standard for development of offset protocols, ISO 14064-2:2006 which Alberta follows that includes expert engagement, defensible scientific methodologies, a rigorous peer review process, and documented transparency.

Alberta started protocol development early on around 2002, becoming involved in national interests subsequently until a change in the national government put a stop to national developments and provinces moved forward on their own. When Alberta created a compliance market in 2007, Alberta was working unilaterally in protocol development and was quick to bring protocols to the market.

Protocol development is initiated with the development of the science and technology in what is termed a Technical Seed Document (TSD). This represents the result of science consultations to provide a synthesis of the best available science and paths towards quantification approaches of GHGs. Alberta policy includes a 10 step process to develop a protocol outlined in a Guidance document for protocol development. The TSD and a protocol plan is reviewed by government and approved for continued development. The TSD is drafted into a protocol framework and goes through several consultation steps, each step with a progressively larger group of stakeholders.

Some key points of the Alberta system include:

1. Protocols rely on Best Practice Guidance – IPCC Guidance, WRI GHG Protocol, Canada's National Emissions Inventory methodology; applicable standards and procedures; other System methodologies and protocols.
2. Verification and harmonization or linkage factors are considered. It will be more valuable if it is compatible with future national or other provincial protocols. Where possible, the protocols are applicable across Canada.
3. They are real, demonstrable, quantifiable, and measurable – they must be net of all relevant GHG sources and sinks stated in the Act. Suppliers, buyers and the public must be confident in what is being created and sold.

4. Protocols account for all GHGs (CO2, N2O, CH4 and consideration of all 21 GHGs listed in the Act).
5. Verification is completed after the credits have been created (ex poste). There is no project approval or validation step, so well articulated protocols are critical to the function of the marketplace. Verification is done by a qualified third party (eg. engineer or an accountant).
6. Ownership is established and clear.
7. They are only counted once for compliance purposes (they are unique).
8. They occur at a place other than a regulated facility and from actions not otherwise required by law.
9. Credits occur from Alberta-only projects.

Conservation Cropping Protocol

Although several protocols for agriculture have been developed the Conservation Cropping Protocol (CCP) previously known as the Soil Tillage Management Protocol (version 1) will be introduced. This is the protocol focused on sequestration of soil organic carbon from a change in annual cropping practice to a NoTill system. It was the first agriculture protocol to become available in 2007, in part because of effort done in the previous year at a national level to do the needed science consultations.

The Soil Tillage System Management Protocol has been the most sought after agricultural project type and conservation tillage offsets have made up roughly 30% or better of the annual market share to deliver over 1.5 million tonnes of offsets since the system began. This is largely due to the ease of implementation of the Tillage management protocol.

The protocol is based upon Canada's National Emissions Inventory Tier II methodology. The methodology develops carbon sequestration coefficient(s) based on model output, developed and validated with research data (eg. Century 4.0 for soil carbon). The modeling accounts for the local crop rotations, soil/landscape types, interannual climate variation, all incorporated into a Conventional/NoTill scenario on the polygon system of the national ecostratification system. The modeling is underpinned by verification science using all the long-term plot data and field monitoring sites across western Canada. N20 and Energy CO2 emissions are also derived from the national inventory Tier II quantification. The protocol presents a simplified way of accounting for changes in these gases through providing emission factors.

Data collection at the project level requires monitoring and verification of the type of tillage activity – not direct measurement of gases. This minimizes administration costs and treats large groups of farmers the same. It's cheaper to monitor/verify activity than direct GHG impacts, yet the environmental performance of the activity is still linked through the emission factor quantification approach.

SOC changes

Typically, eligible actions for offsets must be new and additional to business as usual. Since reduced and no tillage practices are being adopted already in western Canada, this proved particularly challenging, since there was a desire at the policy level to have these sink-creating practices continue and maintain the sink built to date. The solution was to develop a 'moving baseline' to accommodate early adopters as well as late adopters of the practice. Essentially the sequestration coefficient was discounted for the slope of the increase of no-till and reduced till adoption as accounted for by the national agriculture census taken every 5 years.

More specifically, the tillage system protocol used unique approaches to meet additionality and permanence criteria of the Offset System. To satisfy additionality, the quantification science uses a discounted or 'adjusted baseline' to subtract out carbon accrued (i.e. before the 2002 start year of the offset eligibility criteria) from current adoption rates of zero or reduced tillage from a region – deriving regional discounted baselines. In this manner, only the additional or incremental carbon going forward from 2002 onwards due to the continuation of the practice post 2002 is allowed to count as an offset credit. Thus, the adjusted baseline, is only applied to activities that sequester carbon on a go-forward basis (Figure 1). In this manner, all tillage management projects get a 'haircut' off their carbon tonnes, but early adopters are allowed to participate to maintain the practice, and late adopters get a smaller coefficient (laggards get less). The discount rates can be high - coefficients in some regions are nearly zero due to high rates of adoption and fuel combustion of reduced till (as opposed to no till fuel savings), or discounted by 30 to 40% in others. The federal government's cross-ministry Working Group on Offsets in December 2006 adopted this policy as a fair and equitable means to recognize early adopters in activity based projects where practices that create sinks could be reversed quite easily. It was recognized that maintenance of the sink is as important as the creation of a larger sink by farmers from their tillage practices on the prairies.

The permanence concern of sequestered soil carbon for No-Till projects in Alberta is ensured by a government-backed policy approach known as an "Assurance Factor", which is applied to every tonne of carbon offset created under the protocol. Development of the assurance factor relies on a risk-based assessment of the probability of a reversal of a no till or reduced till practice occurring over a set period of time. The risk-assessments were conducted by polling agricultural extension specialists and examining industry practice surveys over the last couple of decades, deriving a reversal risk percentage projected into the future. The Alberta prairies have over 20 years of experience with reduced tillage management and experts who do not have a market interest (government and not for profit extension staff), were consulted to derive the assurance factors. Each coefficient is discounted by the reversal risk percentage derived for a given region in Alberta and set aside by the government (e.g. 10% discount on every verified tonne creates a set-aside, resulting in 0.1 t CO_2e collected by the government for each verified

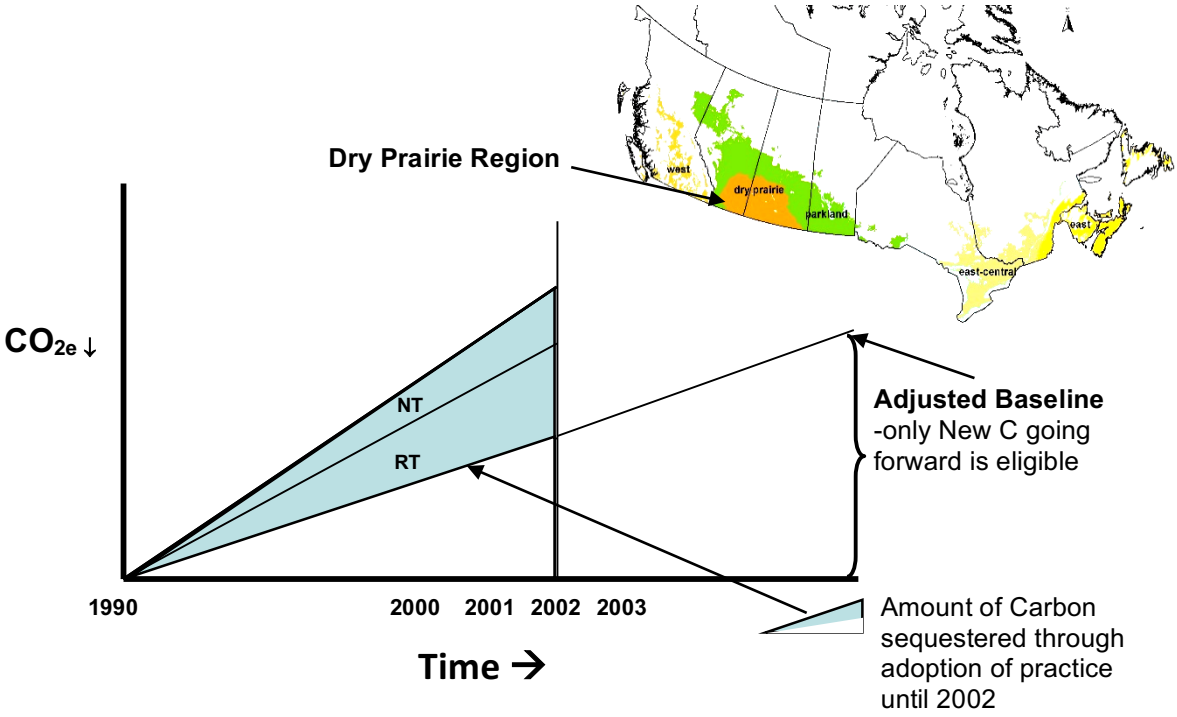

Figure 1. Schematic of the Adjusted Regional Baseline for the Dry Prairie Region - discount based on adoption rate of reduced till (RT) and no-till (NT) practice for the Baseline Year (2002).

tonne). This pool of carbon is used to cover the risk of a reversal. This reserve assures against carbon lost to the atmosphere via reversals in the future – it functions as a reserve holdback that is operationalized through government policy.

Alberta has a range of agro-climatic regions that result in different sequestration rates and different maximum or equilibrium rates of SOC. Rather than developing a large number of coefficients for every small polygon, the prairie region was divided into two parts – Dry Prairie and Parkland (moister region) according to the recommendation of the previously mentioned federal cross ministry working group. That group however did not determine how to represent the border in the reality of on-the-ground. Alberta decided the line would be "one fence post wide" and released a listing of legal land locations which contained the boundary (the last Parkland parcel). One boundary line would be less likely to cause problems than several lines would if a transition zone approach had been taken. Farms could have fields on both sides of the boundary which would effectively result in a blended coefficient for the farm.

The definition of No-Tillage, based on the degree of soil disturbance, surfaced early on in the application of the protocol. The working definition in the original protocol was not specific enough and would vary depending up individual soil and equipment circumstances. That would have made verification untenable. A maximum disturbance percentage was adopted based upon the ratio of seed row opener width to shank spacing and it was deemed to still yield the same carbon sequestration values across the range of seed type (eg. canola, fava bean). A clarification document was produced. Interestingly, farmers considering new equipment

purchases made certain the equipment configuration would meet the definition and purchased equipment that perhaps provided even less soil disturbance than originally intended. Thus the Protocol has created a more conservative (rigorous) concept of NoTill than what is interpreted through the national agriculture census.

Verification and transaction costs

Regardless of how good the science basis is for a protocol, it can fail for a variety of other reasons. A number of policy and regulatory decisions can add to the burden of transaction costs. Governments focus on science-based systems and often do not consider transaction costs when designing offset markets. The momentum of scientists to measure everything in time and space and not consider other pragmatic aspects can endanger the economics of fungible protocol applications. Alberta Agriculture and Forestry (2017) have kept a website active to help inform the industry stakeholders of rules and guidance materials for the sector in order to minimize risks and keep transaction costs from escalating.

Independent verification of projects is another tenant of GHG offsets and agriculture projects bring another step of verification complexity as they are non-metered biologic systems. They do not conform to discrete records of financial transactions or recording meters on factory pipes or smokestacks. Similar to designing a project with the end in mind, offset design should keep in mind the verification needs and associated costs. Unlike voluntary offset systems, government offsets become part of the financial records of that government and are subjected to audits by government audit officers.

Verification of agriculture projects merge several disciplines together such as accountants working with agronomists and/or engineers and/or livestock specialists, following ISO 14064-3:2006 and ISO 14065 standards. The Alberta NoTill protocol requires the ownership of soil carbon to be verified which in most cases is a land title verification. Alberta's system also created the impetus for federal lawyers to decide on how best to transfer biologic carbon rights on First Nations lands. Farms had to allow access to their NoTill planting equipment to ensure compliance to the required metrics. Verifiers needed to review the data systems developed and employed by the aggregator companies. Verification costs were initially several tens of thousands of dollars and then came down somewhat as everyone "learned to do by doing". They did rise again however as the Alberta government required audits to move to a "reasonable" level of assurance. The higher transaction costs bounded by a market that had pricing controlled by government (floor price) put agriculture projects on a trajectory for "market failure" in economic parlance. The recent increase from C$15 to C$30/tonne has provided some increased interest by the aggregator and farm sector to re-examine the potential of offsets.

Summary

Alberta was a pioneer in agriculture offset protocol development 15 years ago. The government regulations in 2007 enabled the prior work to become 'real' and a process of

learning and revising started. The spatial and temporal scale of soil organic carbon needs to be addressed in a pragmatic sense which we found could be done with modeling initiatives from the national inventory work (as reviewed by the IPCC). Many other policy decisions need to be made to build the whole offset protocol. Government needs to be involved if the offsets are intended for their systems. After a decade of experience, many revisions, refinements, adjustments and standards have emerged as all disciplines learned how to harness non-metered biologic systems to be recognized as a significant contributor to mitigation of GHG emissions.

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