ENSURING PERMANENCE OF CARBON STORED IN AGRICULTURAL SOILS:
THE PRACTITIONER'S PERSPECTIVE

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What is Permanence and why is it important?

When we discuss the permanence of carbon credits, we're referring to how long the carbon removed or avoided (measured in terms of equivalent tonnes of carbon dioxide) will be kept out of the atmosphere, as well as the degree of confidence we have that a particular project will keep that carbon out of the atmosphere for a given period of time. Project activities designed to avoid, mitigate, and/or drawdown greenhouse gases (GHGs) such as carbon dioxide (CO_2), nitrous oxide (N_2O), and methane (CH_4) can be an effective tool to mitigate the impacts of climate change. Different GHGs have different atmospheric residence times, and thus a range of impacts on overall radiative forcing (a measure of how much they either trap heat or reflect solar radiation) following their emission. While carbon dioxide molecules may only remain in the atmosphere for a matter of years, the net change to the atmospheric reservoir – and to the resulting impacts on the climate – can last from centuries to millennia after the initial emission.[1] Drawing down and sequestering atmospheric carbon is crucial to mitigate climate change. However, carbon must be sequestered for long periods of time without re-release to provide material benefits for the atmosphere. Carbon crediting programs address this temporal component via permanence requirements.

While permanence is relevant for both carbon credits as well as removals that are reported in inventory accounting, this paper focuses only on the former, as the rules for inventory accounting of removals are still in development. High quality carbon crediting programs define permanence as requiring that the carbon removed by the project's activities be stored in a reservoir (e.g., in soils, trees, or other organic materials) for no less than 100 years.[2] A monitoring and compensation period of 100 years aligns with the preferred permanence approach of the Integrity Council on the Voluntary Carbon Market (IC-VCM) for storage and protection of carbon in biogenic reservoirs including agricultural soil carbon sequestration.[3] Mechanisms for permanence are essential for projects that sequester carbon from the atmosphere and store it. For projects which avoid or reduce GHG emissions from sources where no storage is involved (e.g., reducing application of nitrogen fertilizers, or destroying halocarbons recovered from use as refrigerants or blowing agents), no additional monitoring or reporting is required – a project being shut down doesn't negate the benefits it previously provided. For credits related to stored carbon stocks, we consider permanence at the project level. For example, each year some trees in a forest grow larger, while others may die, decompose, or burn up, but the permanence of the credit relates to the total pool of carbon in the forest, not one individual tree.

All carbon storage projects must manage risks of non-permanence. If stored carbon that was previously credited is later released, this is called a "reversal." Nature-based carbon storage, including agricultural carbon, forest carbon, and blue carbon projects, face the challenge of addressing these risks as climate change causes an increase in flooding, droughts, and wildfires globally. Additionally, projects related to agricultural soil carbon must consider unique challenges in balancing unique land ownership, spatial management (i.e., field-to-field or within-field management choices), and temporal management (i.e., management decisions or changes from season to season or even day-to-day).

To ensure high-integrity carbon credits, project developers must address the role of permanence, develop credible permanence risk management approaches, and identify opportunities to improve the carbon credit market through evolution of permanence requirements.

[1] Matthews, H. D. & Caldeira, K. Stabilizing climate requires near-zero emissions. Geophysical Research Letters, 35, L04705 (2008).
[2] See Section 2.8 of the Climate Action Reserve Offset Program Manual (September 2023), available at: https://www.climateactionreserve.org/wp-content/uploads/2023/09/Reserve_Offset_Program_Manual_Septmeber-2023-Final.pdf.
[3] See the IC-VCM Core Carbon Principles and Assessment Framework (July 2023), available at: https://icvcm.org/wp-content/uploads/2023/07/CCP-Section-4-R2-FINAL-26Jul23.pdf.

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Permanence is an essential component of GHG reduction strategies

Climate change mitigation projects can be put into two categories: emissions reductions and carbon storage.

Emissions reductions refers to a reduction in the volume of GHGs emitted during a GHG-producing activity (e.g., capturing and destroying CH_4 from landfills), or an action that avoids the GHG-producing activity altogether (e.g., avoiding N_2O emissions by reducing the use of nitrogen fertilizers). Emissions that are prevented, rather than stored in a reservoir, immediately satisfy requirements for permanence.

Carbon storage includes removing CO_2 from, or preventing loss of stored carbon to, the atmosphere by natural (e.g., soil-mediated sequestration) or engineered (e.g., direct air capture) means. The associated carbon is held in a biological, geological, or industrial reservoir. A process that leads to the carbon removed by offsetting projects being released back into the atmosphere within the required permanence period (i.e., prior to 100 years after the project activity) is called a reversal. A reversal occurs when the total amount of carbon stored by a project becomes less than the total number of credits issued to the project related to stored carbon. Projects earning credits from carbon storage must satisfy permanence requirements to ensure that those credits accurately represent the claimed atmospheric benefits.

Some losses of stored carbon are a result of **unavoidable** reversals, which are beyond human control (e.g., flooding, droughts, and wildfires). Other reversals of stored carbon are considered **avoidable** (e.g., land being developed for other uses, or timber being over-harvested, long-term no-till fields being returned to conventional tillage over multiple years). Avoidable reversals can occur due to gross negligence on the project owner's part (e.g., forest owners not taking steps to avoid preventable pest damage), project termination before a 100-year permanence period, or a breach of project terms that causes automatic project termination.

The reason to distinguish between unavoidable and avoidable reversals is because they are typically handled with different compensation mechanisms (discussed in the next section).

The following discussion focuses on considerations for permanence in tonne-tonne accounting, where a project is credited for the full atmospheric benefit of each tonne of stored carbon over a 100-year monitoring period. This is the approach used by the vast majority of carbon storage projects and programs in the market today. An alternative accounting approach, known as tonne-year accounting, which reduces the credits issued to the project based on the atmospheric benefit of a permanence commitment of less than 100 years (e.g., a 30-year commitment could result in receiving credit for only 30% of the stored carbon tonnes)[4], is beyond the scope of this paper.

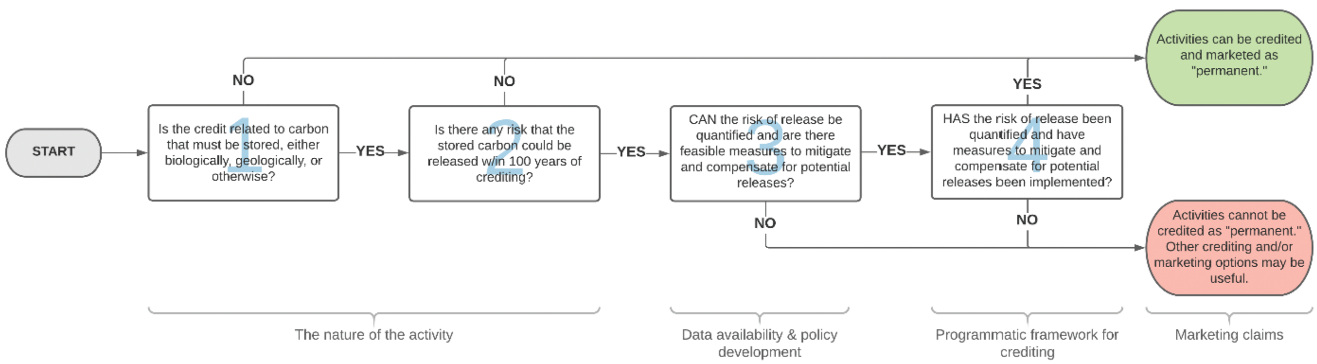
[4] For example, see Appendix F of the Climate Action Reserve Mexico Forest Protocol v3.0, available at: https://www.climateactionreserve.org/wp-content/uploads/2022/10/Mexico-Forest-Protocol-V3.0_ENG.pdf.

Due Diligence in Carbon Credit Permanence Assessment

Managing permanence risk involves three main components:

1. Estimating the risk of future reversals;
2. Project monitoring to detect and quantify reversals; and,
3. Mechanisms for compensation of identified reversals.

The figure below provides a conceptual framework for determining whether credits generated from a project meet the standard of permanence defined at the start of this brief. The third and fourth steps in the flowchart capture the three components listed in this section.



Estimating risk of future reversals. Project activities should be evaluated to determine if they can be credited and designated as permanent.[5] This multi-step process includes assessing project activities (e.g., farmer and rancher behavior in agricultural projects), data availability on risk of stored carbon release, and developing and implementing a programmatic crediting framework (see Figure 1). Verra, a leading registry, has also developed and published a non-permanence risk tool that illustrates how to conduct non-permanence risk analysis (including internal, external, and natural risks) and outlines a process for determining a project's non-permanence risk rating and buffer determination.[3] Other programs, such as the Climate Action Reserve, consider non-permanence risk factors in a standardized manner during protocol development and offer more prescriptive default tables to determine project-specific risk ratings.[6] In both cases, these risk ratings drive the calculation of the number of credits which must be contributed to a shared risk buffer pool.

Long-term monitoring. Long-term project monitoring is essential to detect avoidable and unavoidable reversals within projects. A project area should be continually monitored – even after a portion of the project is removed (for grouped or aggregated projects) or the crediting period ends. Remote monitoring systems can be used to collect field management data on events and activities linked to reversals (e.g., tillage, land conversion, natural disasters) and serve as an effective component of a project's long-term monitoring plan. These systems can also monitor overall land use classification, identifying if a portion of the project area is converted to a land use that would result in loss of stored carbon (e.g., conversion of cropland to commercial development) With today's technology, it is possible to build automated remote monitoring algorithms which leverage detected changes in metrics such as land cover or NDVI (normalized difference vegetation index) to identify reversal events. When paired with a spatial database of credits issued for carbon storage over time, the **quantification** of reversals may then be automated as well.

[5] For example, see the Verra Non-Permanence Risk Tool, available at: https://verra.org/wp-content/uploads/2023/10/AFOLU-Non-Permanence-Risk-Tool-v4.2-FINAL.pdf.
[6] See Table 5.9 of the CAR Soil Enrichment Protocol v1.1, available at: https://www.climateactionreserve.org/how/protocols/ncs/soil-enrichment/.

Compensation for reversals. Effectively managed carbon programs deploy several strategies to compensate for future reversals. When an avoidable reversal has been identified and quantified, the buyers of the credits from that project should hold no liability, meaning the project developer must compensate the registry to make the system "whole." In many cases, this compensation occurs in the form of a reduction in the subsequent credit issuance for an ongoing project. Project developers may elect to create their own internal buffer pools by managing credits in their registry accounts which they hold back from sales to end users. This allows more flexibility over time to increase or decrease the internal risk pool based on project trends. Absent these approaches, the project developer would be required to purchase credits from another project to surrender to the registry.

Unavoidable reversals are commonly compensated for by registry-held buffer pools. A buffer pool functions as a holding account for carbon credits and acts as an insurance mechanism providing coverage for reversals of stored carbon. In a registry-held, shared buffer pool, individual projects contribute credits to the pool according to their reversal risk ratings (described in the previous subsection). Each project calculates their appropriate buffer pool contribution with size relative to the risk of reversals due to natural phenomena or financial risks.

"All told, with carbon removal processes still in early stages of development, the structuring and pricing of insurance offerings for the industry will remain challenging for some time. More projects, performance data and loss history are needed for insurers to build credible loss expectations."

Project developers are beginning to explore other mechanisms, such as insurance products, to help manage their permanence obligations. As better data are available on reversal risk estimation and mitigation, the insurance industry will become more comfortable with the unique nature of managing permanence of carbon stored in biological systems.[7] Paired with the automated, remote monitoring described above, this would also enable legal and financial mechanisms that would allow compensation of avoidable reversals far into the future without the direct involvement of the original project developer.

Mitigating Permanence Risks

Reversal risks cannot be, and should not be expected to be, diminished to zero. Instead, project developers should employ solutions to mitigate reversal risk to the maximum practicable extent, and policymakers should provide public-sector support to encourage climate-smart agricultural practice adoption.

Within agriculture, permanence relates to stored carbon stocks throughout a project area and not in a single field. As such, permanence risk is pooled through project aggregation. Project developers should prioritize large-scale projects that aggregate sites across diverse climates, geographies, crop types, soil types, land management practices, and timeframes to reduce risk of catastrophic losses associated with environmental circumstances and individual farmer actions. Another key positive outcome from aggregating across many farms is that small farms will see even greater risk management benefits.

Climate-smart agricultural practices provide additional co-benefits, including improvements in soil health, water availability, crop productivity and yield, and resilience to extreme weather events. Reversal risks are expected to decrease as farmers experience these added benefits, not wanting to lose the benefits gained. Further, enrolling in agricultural carbon crediting programs enables farmers to sell a new commodity and improve their per acre profitability. This profit incentive can help to ensure practice stickiness, decreasing the likelihood of a reversion to conventional practices, and further bolster permanence of the stored carbon.

[7] SwissRe Institute, July 2021. "The insurance rationale for carbon removal solutions." Available at: https://www.swissre.com/dam/jcr:31e39033-0ca6-418e-a540-d61b8e7d7b31/swiss-re-institute-expertise-publication-insurance-%20rationale-for-carbon-removal-solutions.pdf.

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Conclusion

Permanence is a necessary and achievable goal in efficacious agricultural carbon projects. Agricultural carbon crediting can be a significant mechanism to incentivize climate smart practice adoption and thus to help farmers both mitigate and adapt to climate change. The challenges in assessing carbon permanence and managing reversal risks should not prevent leveraging agricultural lands as carbon sinks, especially given actualized and imminent climate threats. These agricultural carbon credits satiate the growing carbon market demand for high-quality credits. Viable permanence risk management approaches exist and should be a required credit attribute for any agricultural credits bought in voluntary markets or certified and included in compliance markets. Meeting rigorous permanence criteria will protect farmers and ranchers who are investing in climate smart agricultural practices, ensuring that the credits they generate will satisfy market requirements, yielding long-term value for their good stewardship.

As policymakers and buyers continue to engage in this space, they should only support efforts to scale-up climate-smart agricultural carbon credit projects that meet robust permanence requirements. This can include endorsing enabling legislation and investing directly in large-scale projects with vetted permanence management strategies. Such programs present the clearest and nearest opportunity to transform working agricultural lands into carbon sinks.

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This policy brief is part of a series developed by Indigo Ag, in collaboration with our scientific and policy thought partners. Other past and future topics include data interoperability, a general overview of agricultural GHG emissions, soil health, uncertainty, permanence, and others. All Indigo policy publications may be accessed at: https://www.indigoag.com/carbon/science/advancement.