Carbon Credit Conundrum Webinar Series: Resources Guide

Recordings of Webinars

Part 1: Carbon Credits 101
Part 2: Carbon Market Case Studies
Part 3: Evaluating Whether a Carbon Project is Right for you
Part 4: Emerging Opportunities in Carbon Markets and Beyond

Glossary

Compliance carbon markets support a regulatory program that requires GHG emission reductions from particular emission sources. A traditional example of such a mandatory program is a GHG emission cap-and-trade system, which creates a cap on GHG emissions for covered entities while providing flexibility in how these entities comply. In some cases, covered entities may be able to use carbon offsets as a compliance option (USDA, 2023[3]).

Voluntary carbon markets encompass the voluntary buying and selling of carbon credits outside of a regulatory framework to achieve a voluntary emissions reduction goal. There are several voluntary carbon market platforms, but there is not a single authoritative marketplace. Carbon credit transactions typically occur with the assistance of a carbon credit broker who facilitates the transaction rather than directly between those who generate credits (e.g., farmers, ranchers, landowners) and buyers (USDA, 2023[3]).

Third-party verifiers are entities unaffiliated with project activities, carbon registries, and carbon programs, which independently verify that projects correctly follow the requirements in carbon offset protocols (USDA, 2023[3]).

Project Developers are entities who formally represent offset projects by engaging proponents (such as landowners or operators), defining and documenting interventions, interfacing with third-party verifiers and registries, and often marketing credits on behalf of the project (USDA, 2023[3]).

Protocols are the criteria and standards under which carbon credits are generated. They include requirements for participant eligibility and what sources of emissions must be included. They also include procedures for the measurement, monitoring, reporting, and verification of GHG reductions or carbon sequestration (USDA, 2023[3]).

Measurement, Monitoring, Reporting, and Verification (MMRV) refers to activities undertaken to quantify GHG emissions and sinks (through direct measurement and/or modeling), monitor emissions over time, verify estimates, and synthesize and report on findings (USDA, 2023[3]).

A **carbon registry** generally performs three functions: (1) development and approval of protocols (standards) that set criteria for the generation of carbon credits; (2) oversight of the project review and verification against these standards (usually with the help of third-party verifiers); and (3) operation of registry systems that issue, transfer, and retire credits (USDA, 2023[3]).

Carbon credit refers to a GHG unit that is issued by a carbon crediting program and represents an emission reduction or removal of greenhouse gasses. Carbon credits are uniquely serialized, issued, tracked, and canceled using an electronic registry (Ebersold et al. 2023[1]).

Additionality refers to a criterion for assessing whether a project has resulted in GHG emission reductions or removals in addition to what would have occurred in its absence. This is an important criterion when the goal of the project is to offset emissions elsewhere. (GHG Protocol, 2024[2]).

Offset(s) are discrete GHG reductions used to compensate for (i.e., offset) GHG emissions elsewhere, for example, to meet a voluntary or mandatory GHG target or cap. Offsets are calculated relative to a baseline that represents a hypothetical scenario for what emissions would have been in the absence of the project. (GHG Protocol, 2024[2]).

Carbon insetting refers to reducing emissions within a company's own supply chain. Insetting has recently become attractive to corporations interested in reducing greenhouse emissions associated with the goods and services they purchase, also referred to as Scope 3 emissions. These emissions are often the largest sources of a company's GHG emissions. By developing stronger relationships with the entities in their supply chain, both corporations and their suppliers have a mutual interest in the products and production practices of farmers, ranchers, and private forest owners (USDA, 2023[3]).

[1] Ebersold, F., Hechelmann, R.-H., Holzapfel, P., & Meschede, H. (2023). Carbon insetting as a measure to raise supply chain energy efficiency potentials: Opportunities and challenges. Energy Conversion and Management: X, 20, 100504. https://doi.org/10.1016/j.ecmx.2023.100504
[2] World Resources Institute and World Business Council for Sustainable Development. (2004). The GHG Protocol: A Corporate Accounting and Reporting Standard. https://ghgprotocol.org/sites/default/files/standards/ghg-protocol-revised.pdf
[3] USDA. (2023). Report to Congress: A General Assessment of the Role of Agriculture and Forestry in U.S. Carbon Markets.https://www.usda.gov/sites/default/files/documents/USDA-General-Assessment-of-the-Role-of-Agriculture-and-Forestry-in-US-Carbon-Markets.pdf

Annotated Bibliography

Bossio, D. A., Cook-Patton, S. C., Ellis, P. W., Fargione, J., Sanderman, J., Smith, P., Wood, S., Zomer, R. J., von Unger, M., Emmer, I. M., & Griscom, B. W. (2020). The role of soil carbon in natural climate solutions. *Nature Sustainability*, *3*(5), Article 5. https://doi.org/10.1038/s41893-020-0491-z

> This study examines the role of soil carbon in nature-based climate solutions. The authors emphasize the importance of implementing strategies such as reforestation, cover cropping, and agroforestry to enhance soil carbon stocks. They discuss the significant contribution of soil carbon to achieving global climate targets and suggest policy interventions to promote the adoption of sustainable land management practices. The article underscores the urgency of prioritizing soil carbon sequestration as a fundamental component of climate action strategies and estimates soil carbon could deliver up to 25% of the potential of all-natural climate solutions combined (total potential, 23.8Gt of CO2-equivalent per year), of which 40% is the protection of existing soil carbon and 60% is rebuilding depleted stocks. Specifically, soil carbon comprises 9% of the mitigation potential of forests, 72% of wetlands, and 47% of agriculture and grasslands.

Liptzin, D., Norris, C., Cappellazzi, S., Bean, G., Cope, M., Greub, K., Rieke, E., Tracy, P., Aberle, E., Ashworth, A., Tavarez, O., Bary, A., Baumhardt, R.L., Gracia, A., Brainard, D., Brennan, J., Briones, D., Bruhjell, D., Carlyle, C., Honeycutt, C. (2022). An evaluation of carbon indicators of soil health in long-term agricultural experiments. *Soil Biology and Biochemistry*. https://doi.org/10.1016/j.soilbio.2022.108708

> This study assesses soil organic carbon (SOC) and other soil health indicators (potential C mineralization, permanganate oxidizable C, water extractable organic C, and -glucosidase enzyme activity) from the North American Project to Evaluate Soil Health. Researchers found that indicators had greater soil health at cooler temperatures, and most were greater in wetter climates and soils with higher clay content. The indicator values responded positively to decreased tillage, inclusion of cover crops, application of organic nutrients, and retention of crop residue, but not the number of harvested crops in a rotation. The effect of decreased tillage on the C indicators was generally greater at sites with higher precipitation.

Ivy S., Haya, B., Elias, M., (2023). Voluntary Registry Offsets Database, Berkeley Carbon Trading Project. *University of California, Berkeley*. https://gspp.berkeley.edu/research-and-impact/centers/cepp/projects/berkeley-carbon-trading-project/offsets-database

> This database, developed by the Berkeley Carbon Trading Project, contains a list if all carbon offset projects, credit issuances, and credit retirements listed globally by four major voluntary offset project registries—American Carbon Registry (ACR), Climate Action Reserve (CAR), Gold Standard, and Verra (VCS).

Barbato, C. T., & Strong, A. L. (2023). Farmer perspectives on carbon markets incentivizing agricultural soil carbon sequestration. *Npj Climate Action, 2(1), Article 1.*

https://doi.org/10.1038/s44168-023-00055-4

Research-based on interviews with conventional and organic farmers to get their perspectives on soil carbon offset programs. The findings suggest carbon programs are largely reaching farmers who were already implementing practices that increase soil carbon or were already strongly interested in implementing these practices. The payments from offsets are seen as a 'gravy on top'. This suggests that soil carbon offset markets face strong challenges in ensuring true additionality essential to effective climate mitigation.

Ritten, J., Bastian, C., & Rashford, B. (2012). Profitability of Stocking the Range with Carbon: Insights from Recent Market Events. *Rangeland Ecology & Management, 65, 340*. http://dx.doi.org/10.2111/REM-D-10-00191.1

This 2012 paper examines potential revenues from voluntary carbon offset programs, such as the now-defunct Chicago Climate Exchange (CCX) Rangeland Soil Carbon Offset program. The study estimates revenues for short-term voluntary offsets given historical prices and prices projected with potential cap-and-trade legislation and also estimates revenues assuming one-hundred-year offsets are required to meet international sequestration standards. The analysis suggests that carbon prices or low-end projected prices from cap-and-trade legislation are not likely to encourage producer participation. Medium and high carbon price projections for cap-and-trade legislation may make carbon sequestration a more attractive option for rangeland managers. Still, given potential requirements for projects to meet international guidelines for greenhouse gas offset projects, many issues remain before range managers may be interested in carbon sequestration as an enterprise.

Bai, Y., & Cotrufo, M. F. (2022). Grassland soil carbon sequestration: Current understanding, challenges, and solutions. *Science, 377(6606), 603–608.* https://doi.org/10.1126/science.abo2380

This study synthesizes research on the effects of climate change on grassland soil organic carbon (SOC) storage by modifying the processes of plant carbon inputs and microbial catabolism and anabolism. The study found that improved grazing management and biodiversity restoration can provide low-cost and/or high-carbon-gain options for natural climate solutions in global grasslands. The achievable SOC sequestration potential in global grasslands is 2.3 to 7.3 billion tons of carbon dioxide equivalents per year (CO_2e $year^{-1}$) for biodiversity restoration, 148 to 699 megatons of CO_2e $year^{-1}$ for improved grazing management, and 147 megatons of CO_2e $year^{-1}$ for sown legumes in pasturelands.

Paustian, K., Lehmann, J., Ogle, S., Reay, D., Robertson, G. P., & Smith, P. (2016). Climate-smart soils. *Nature, 532(7597), Article 7597.* https://doi.org/10.1038/nature17174

This 2016 study summarizes climate mitigation practices and potentials for soil-based carbon removal. The study also identifies gaps in data and understanding and suggests ways to close such gaps through new research, technology, and collaboration. The authors call for more publicly available high-resolution soil maps and improved uncertainty management, which are needed to improve GHG modeling. Furthermore, the potential for climate change mitigation through global soil management requires understanding cultural, political, and socioeconomic contexts, which are rarely studied. The researchers found that a greater level of engagement with land users and managers is needed, as they will implement practices that abate GHG emissions and sequester carbon.

Windh, J. L., Ritten, J. P., Derner, J. D., Paisley, S., & Lee, B. (2020). Effects of long-term cattle market conditions on continuous season-long and rotational grazing system revenues. *The Rangeland Journal*, *42*(3), 227. https://doi.org/10.1071/RJ20067

This study evaluates the combination of long-term market conditions and prices in the cattle market, comparing revenues associated with continuous and rotational grazing systems. The authors used actual herd average starting and ending weights in this market analysis and analyzed the outcome using five years' data from a continuous and rotational comparative grazing study. The study found consistently lower weight gains with rotational grazing, but variable gross revenue results. This showcases the complexity of having both differences in end-of-grazing season weight classes between the grazing systems and the differential effects of price slide among weight classes.

Windh, J. L., Ritten, J. P., Derner, J. D., Paisley, S. I., Lee, B. P., Windh, J. L., Ritten, J. P., Derner, J. D., Paisley, S. I., & Lee, B. P. (2019). Economic cost analysis of continuous-season-long versus rotational grazing systems. *Western Economics Forum (Invited – Special Issue), 17(1): 62-72.* https://doi.org/10.22004/AG.ECON.287315

This study examines five grazing management scenarios, all with the same total acreage (3,200 acres) and different fencing, water infrastructure, and labor costs for season-long continuous grazing with one large pasture (1), rotational grazing with the one large pasture cross-fenced into ten 320-acre pastures with permanent barbed-wire fencing (2), with temporary electric fence (3), season-long continuous grazing with ten 320-acre pastures that are noncontiguous (4), and rotational grazing with the ten 320-acre noncontiguous pastures (5). This study found that noncontiguously grazed pastures required substantially greater annualized costs for ranchers compared to the baseline season-long grazing scenario. Increasing gross revenues from steers is necessary to cover these increased costs for ranchers.

Sharififar, A., Minasny, B., Arrouays, D., Boulonne, L., Chevallier, T., van Deventer, P., Field, D. J., Gomez, C., Jang, H.-J., Jeon, S.-H., Koch, J., McBratney, A. B., Malone, B. P., Marchant, B. P., Martin, M. P., Monger, C., Munera-Echeverri, J.-L., Padarian, J., Pfeiffer, M., ... van Zijl, G. (2023). Chapter Four - Soil inorganic carbon, the other and equally important soil carbon pool: Distribution, controlling factors, and the impact of climate change. In D. L. Sparks (Ed.), *Advances in Agronomy* (Vol. 178, pp. 165–231). Academic Press. https://doi.org/10.1016/bs.agron.2022.11.005

This study evaluates whether soil inorganic carbon (SIC) plays an important role in soil carbon sequestration and climate regulation. Using digital mapping of soil inorganic carbon, the authors surveyed SIC distribution and mapping efforts in Australia, South Africa, Chile, the Mediterranean basin, Iran, China, France, and the United States. They found that current detailed spatial information on SIC distribution and stock is relatively scarce and digital soil mapping (DSM) efforts to address this are modest. More robust soil C models are needed to account for all sources and sinks of soil carbon. This review showed that many aspects of SIC and soil C studies have been so far and that SIC has a crucial role in climate regulation.

Campbell, J. L., Sessions, J., Smith, D., & Trippe, K. (2018). Potential carbon storage in biochar made from logging residue: Basic principles and Southern Oregon case studies. *PLOS ONE*, *13*(9), e0203475. https://doi.org/10.1371/journal.pone.0203475

This study evaluates the temporal dynamics of biochar carbon stocks, relative to carbon of unmodified logging residue, and evaluates the sensitivity of carbon storage to various biophysical and production parameters. The study uses a generalized model to attribute net carbon storage to several potential biochar production scenarios specifically engineered to use wood recovered from harvests prescribed to reduce fire hazards in mixed-conifer forests of South Central Oregon. The study found that relative to a baseline scenario where logging residue is left to decay on site, the net carbon storage attributed to twenty years of biochar production is generally negative for the first several decades and then remains positive for several centuries at levels approximately one-fourth of the total feedstock carbon processed. The magnitude of net carbon storage, and the time required for it to become positive, are largely similar across the range of production facility types. The time required for net carbon storage to become positive, and its magnitude over the first one hundred years is notably insensitive to biochar decomposition rates provided biochar decays at least ten times slower than the logging residue it is made from.

Zheng, L., Barry, K. E., Guerrero-Ramírez, N. R., Craven, D., Reich, P. B., Verheyen, K., Scherer-Lorenzen, M., Eisenhauer, N., Barsoum, N., Bauhus, J., Bruelheide, H., Cavender-Bares, J., Dolezal, J., Auge, H., Fagundes, M. V., Ferlian, O., Fiedler, S., Forrester, D. I., Ganade, G., … Hautier, Y. (2024). Effects of plant diversity on productivity strengthen over time due to trait-dependent shifts in species overyielding. *Nature Communications*, *15*(1), 2078. https://doi.org/10.1038/s41467-024-46355-z

This study synthesized data from sixty-five grassland and forest biodiversity experiments to demonstrate the temporal strength of diversity effects at the community scale is potentially underpinned by temporal changes in the species that yield. The study found that in grasslands, the temporal strengthening of biodiversity effects on community productivity was associated with increasing biomass overyielding of resource-conservative species, increasing over time, with overyielding of species characterized by fast resource acquisition either decreasing or increasing. In forests, temporal trends in species overyielding differ when considering above versus below-ground resource acquisition strategies. The study found that overyielding in stem growth decreased for species with high light capture capacity but increased for those with high soil resource acquisition capacity. The results imply that a diversity of species with different, and potentially complementary, ecological strategies is beneficial for maintaining community productivity over time in both grassland and forest ecosystems.

Hulvey, K. B., Mellon, C. D., & Kleinhesselink, A. R. (2021). Rotational grazing can mitigate ecosystem service trade-offs between livestock production and water quality in semi-arid rangelands. *Journal of Applied Ecology*, *58*(10), 2113–2123. https://doi.org/10.1111/1365-2664.13954

This study examines the potential for managers to mitigate trade-offs between livestock production and water quality in semi-arid rangelands with cattle present with two elements of rotational grazing. The two rotational grazing elements the study uses are the length of time cattle spend on rangeland (i.e. duration), and the season grazed (i.e. timing), affected stream Escherichia coli (E. coli concentrations). This study also modeled how grazing duration and timing affected the ability to meet regulatory benchmarks for water quality throughout a grazing season. The study found that grazing duration controlled the length of time E. coli concentrations were high in streams and stream E. coli concentrations showed a consistent seasonal pattern, starting low in spring, peaking in summer, and declining towards fall. Researchers found grazing duration and timing can be used as tools to mitigate ecosystem service trade-offs between cattle production and water quality in rangeland streams.

York, E. C., Brunson, M. W., & Hulvey, K. B. (2019). Influence of Ecosystem Services on Management Decisions by Public Land Ranchers in the Intermountain West, United States. *Rangeland Ecology & Management*, *72*(4), 721–728. https://doi.org/10.1016/j.rama.2019.02.002

In this study, the authors interviewed ranchers to learn the basis for their management decisions and identify services they believe rangelands provide. A total of nineteen ecosystem services were identified. The study then conducted a mail survey of Bureau of Land Management grazing permittees in six states to understand the importance they place on different services, as well as the extent to which they manage with those services in mind. This study found that fourteen of the nineteen ecosystem services were identified in at least 50% of the survey sample as influencing their management decisions. Most respondents reported trying to manage deeded and leased land to the same standard. The study also found that ranchers tended to report managing for more ecosystem services if they had larger operations, earned at least 50% of their income from ranching, spent more time out on the ranch, and relied on multiple sources for information about range management.

Ritchie, M. E. (2020). Grazing Management, Forage Production, and Soil Carbon Dynamics. *Resources*, *9*(4), Article 4. https://doi.org/10.3390/resources9040049

This study describes the integration of two models, a soil carbon dynamics model called SNAP that is based on the Serengeti ecosystem and an episodic herbivory model (EHM). The goal is to model grazing management decisions and their effects on grassland production and soil carbon. The resulting combined model, SNAPGRAZE, assesses the potential effects of grazing management on soil organic carbon with only eight climate, soil, and management input variables. The SNAPGRAZE is then applied to examine the effects of high stocking densities and short-duration grazing schemes on soil carbon, relative to continuous grazing, showing that this management approach can enhance forage production and increase stocks of soil organic carbon.

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Online resources Shared During Four-Part Webinar Series

https://query.prod.cms.rt.microsoft.com/cms/api/am/binary/RWGG6f - Criteria for high-quality carbon dioxide removal, Carbon Direct and Microsoft, (2023).

http://farmlandinfo.org/publications/top-10-things-ag-carbon-markets - Top 10 things you wanted to know about agricultural carbon markets, Farmland Information Center, (2024).

https://ilsustainableag.org/programs/ecomarkets/ - An overview of voluntary carbon markets for Illinois farmers, Illinois Sustainable Ag Partnership, (2024).

https://extension.illinois.edu/blogs/nutrient-loss-reduction/2023-03-22-down-and-dirty-soil-carbon-and-carbon-markets - The down and dirty on soil carbon and carbon markets, Illinois Extension, (2023).

https://www.extension.iastate.edu/agdm/crops/pdf/a1-77.pdf - How do data and payments flow through ag carbon programs?, Ag Decision Maker, (2022).

https://carbonplan.org/research/soil-protocols-explainer - A buyer's guide to soil carbon offsets, Carbon Plan, (2021).

https://www.i4ce.org/en/publication/global-carbon-acounts-2022-climate/ - Global carbon accounts in 2022, Institute for Climate Economics, (2022).

https://carboncredits.com/carbon-prices-today/?sl=cc-google-ads&gad_source=1&gclid=CjwKCAiA98WrBhAYEiwA2WvhOovRt-BRBt4nUpInUBsIOu0p6cc_DanL9NCP_WYqRHBdjjbSbY6HchoCXjsQAvD_BwE - Real-time carbon pricing, Carbon Credits,
92024).

https://www.extension.iastate.edu/agdm/crops/pdf/a1-76.pdf- How to grow and sell carbon credits in agriculture, Ag Decision Maker, (2021).

http://comet-planner.com/ - Tool to help evaluate potential carbon sequestration and greenhouse gas reductions from adopting NRCS conservation practices, USDA, CSU, (2024).

https://www.trustinfood.com/- Trust In Food, Farm Journal Initiative, (2024).

Trust In Food™ is a social-purpose initiative of Farm Journal, working to accelerate the transition to more sustainable and resilient agricultural systems. They deploy the unparalleled business intelligence, data, reach, and trust of the nearly 150-year-old Farm Journal company to unleash the potential of every dollar invested in sustainable ag.

https://www.usgs.gov/fire-danger-forecast - Fire Danger Forecast, USGS, (2024).

In a joint effort between the USGS and the U.S. Forest Service, the Fire Danger Forecasting Project focuses on research and development of digital map products suited for monitoring and forecasting fire potential within the conterminous U.S.

https://ecosystemservicesmarket.org/eco-harvest/eco-harvest-resources/ - Participating in Eco-Harvest: A Producer Guide, Ecosystem Services Market Consortium, (2024).

https://it.innovateteam.com/nicc/?views=map - NICC Tier 1 Carbon and Co-Benefits App Data Overview, (2020).

https://quiviracoalition.org/resilience-44/ - Resilience, Quivira Coalition, (2023). Page 16 features Anna Jones-Crabtree, who talks about her CSSA program that pays for some of her good stewardship practices and why carbon markets didn't work for her.

Audience Shared Resources

https://holisticmanagement.org/featured-blog-posts/carbon-credit-opportunities-in-new-mexico/

-Carbon Credit Opportunities in New Mexico, HMI, (2024).

https://www.youtube.com/watch?v=aVNmM5dkG-Y - The Science of Holistic Planned Grazing, Dr. Richard Teague, Savory Institute, (2021).

https://www.canyouchangethefuture.org/ - Ecological Benefits Framework, The Lexicon, (2024).

https://www.savimbo.com/ -Fairtrade climate credit organization created by, and for, indigenous small farmers in the Colombian Amazon, Savimbo INC., (2023).

https://native.eco/project/northern-great-plains-regenerative-grazing-project-hb/ - Northern Great Plains Regenerative Grazing Project, Native, (2023).