# Carbon Credits and the Environment: A Vision for the Economic and Environmental Future of Texas

**By Jim Blackburn, Elizabeth Winston Jones and James Fitzgerald[1]**

**May, 2025**

**Note: The work presented in this article was derived from multiple projects supported by several foundations, institutions, and individuals over the last fifteen years through support to the Severe Storm (SSPEED) Center at Rice University, the Texas Coastal Exchange (TCX), the Baker Institute at Rice and BCarbon, a non-profit carbon credit registry. Among those contributing were The Houston Endowment, the Meadows Foundation, the Cynthia and George Mitchell Foundation, the Lyda Hill Foundation, the Horizon Foundation, the Trull Foundation, the Ed Rachal Foundation through Palacios Marine Agricultural Research (PMAR), the Bia Echo Foundation, the Baker Institute at Rice University, and the Trinity Edwards Springs Protection Association (TESPA), along with several corporations and individuals. Although these entities and individuals offered financial and other assistance to support the groundwork for BCarbon and/or its various projects, these organizations are not owners or board members of BCarbon and opinions expressed herein are those of the authors. In this paper, we explore many of the issues associated with carbon credits using the BCarbon experience as an example. However, there are many other carbon credit protocols that offer various benefits and the use of BCarbon is not intended as being exclusionary but rather as an example known to the authors.**

In the future, nature-based carbon credits have the potential to transform ecological conservation in Texas, the United States and the world. Nature-based carbon credits create a system of payment to landowners for managing their working lands to provide ecological services such as carbon dioxide removal from the atmosphere and storage in the soil of the prairies and croplands, the trees of our forests and the coastal wetlands that surround us all. In addition to these natural ecological functions, carbon credits may also contribute to cleaning up many of the abandoned, idled and orphaned oil and gas wells that are leaking methane.

---

[1] Blackburn is CEO, BCarbon; Professor of the Practice in Environmental Law, Co-Director of the SSPEED Center, Faculty Scholar, Baker Institute, Rice University. Jones is an attorney and Executive Director of the Texas Coastal Exchange who has been involved in developing these concepts with Blackburn since their inception at the SSPEED Center. Fitzgerald is Research Director at BCarbon and a recent graduate of the University of Cambridge, where he studied environmental policy under the Herchel Smith Fellowship.

The promise of the nature-based removal and abatement systems is substantial. Estimates indicate that nature-based carbon credits will provide between 10% and 20% of the carbon dioxide abatement and atmospheric removal needed for the world to reach net zero greenhouse gas emissions by 2050, representing between 4 to 8 billion tons of carbon dioxide abatement and removal. At the same time, these credits promise to transform the reality of ecological protection.

There are many issues that stand between this vision and the reality of ecological protection at scale. None of these are impossible to address. However, they are going to take work, concerted effort and creative thinking. This is a young market. This is a young concept. There will be errors made. There will be tremendous progress. And the future is unlimited relative to contributing to both the movement to net zero and the need to protect our important ecological systems.

## 1. Introduction to the Carbon Market

In 2010, the Houston Endowment funded the Severe Storm (SSPEED) Center at Rice University to study lessons learned from Hurricane Ike. Among those lessons was the fact that undeveloped, low-lying marshes and prairies recovered very quickly from inundation, unlike the human development on the Bolivar Peninsula which was destroyed and had to be rebuilt at great cost over the next decade.

On the Texas Coast, there are approximately six million low-lying acres that should never be developed for human habitation due to this flooding risk. However, in Texas, it is unlikely that we will ever regulate to prevent this development. Other pathways had to be found to address this significant flood hazard, and from that observation came investigation into nature-based carbon credits.

Around 2015, one branch of research at the SSPEED Center became focused on various concepts of payment to landowners for ecological services including research on the voluntary carbon market which is becoming more and more important as we evolve to a different energy economy in the future. This energy evolution will be a key element of the future of Texas, the United States, and the world. Climate responses are required and will occurt, and carbon credits,

particularly nature-based carbon credits, will unite ecology and economy in ways never experienced before this time.

A conceptual diagram of the concept of payment for carbon credits and flood storage showing the synergistic relationship between urban and rural areas is shown in Figure 1. This synergy between rural and developed areas will become more and more important as we rediscover the economic importance of "working lands" such as cattle ranches.

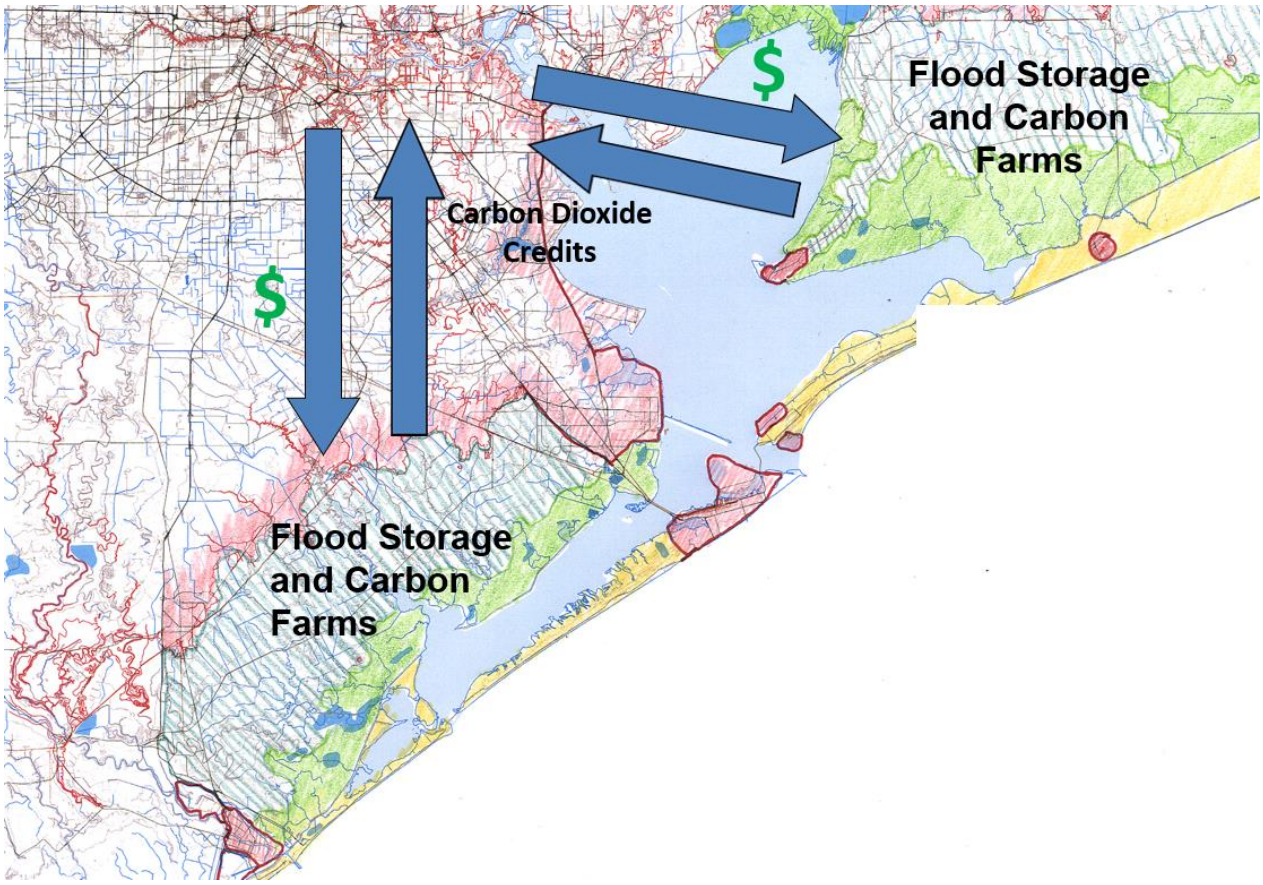


Figure 1. Illustrative diagram of the synergy between carbon dioxide emitters in the Houston region and farmers and ranchers in the lower lying areas adjacent to Galveston Bay. Image from SSPEED Center, circa 2012.

Through a stakeholder process at the Baker Institute, these concepts were debated and discussed, leading to the formation of BCarbon, a carbon credit registry that was formed to develop carbon crediting protocols that are aligned with Texas values and are scientifically rigorous. These protocols must

complement ranching, farming and industry economics and will help address the needs for carbon reduction solutions that will take us to net zero emissions and even to net negative in the future.

Rigorous measurement and verification protocols ensure soil and forest carbon is enhanced and/or preserved and form the basis by which the carbon credit system benefits both landowners and industrial emitters. It is the mutual economic benefits of these protocols that make a robust private market in soil and forest carbon credits viable without government mandates or heavy-handed regulation.

. It is difficult to overstate the potential impact of the voluntary carbon market on the environmental future of Texas. The key word here is voluntary. This is not a regulatory situation. Climate change and its responses are not directly regulated by any federal statute. It is unique in our environmental protection experience.

Instead of regulation, each company may choose how they will meet their carbon goals if they have them (and most do). A good rule of thumb is that all companies should develop a plan to reduce their carbon footprint by avoiding and reducing emissions as much as possible. When that is done, they will need other options to further reduce their carbon footprint. It is at this stage that nature-based carbon credits can become incredibly important in achieving these long-term goals.

Before delving into the ecological implications of this nascent market, it is useful to understand a bit about how the carbon market operates. As can be seen in figure 2, there are many parts to the carbon market, and each has a distinct and important role. For nature-based credits a landowner is the key starting point. The landowner is in control of the ecological systems within their property. The landowner can make management decisions that increase or decrease carbon removal and storage. In most systems, the landowner contracts with a project developer who actually develops the carbon credit proposal and submits it to a registry such as BCarbon. The registry is responsible for creating rules for credit issuance, and the project developer must work with the landowner to submit a package to the registry that meets their requirements.

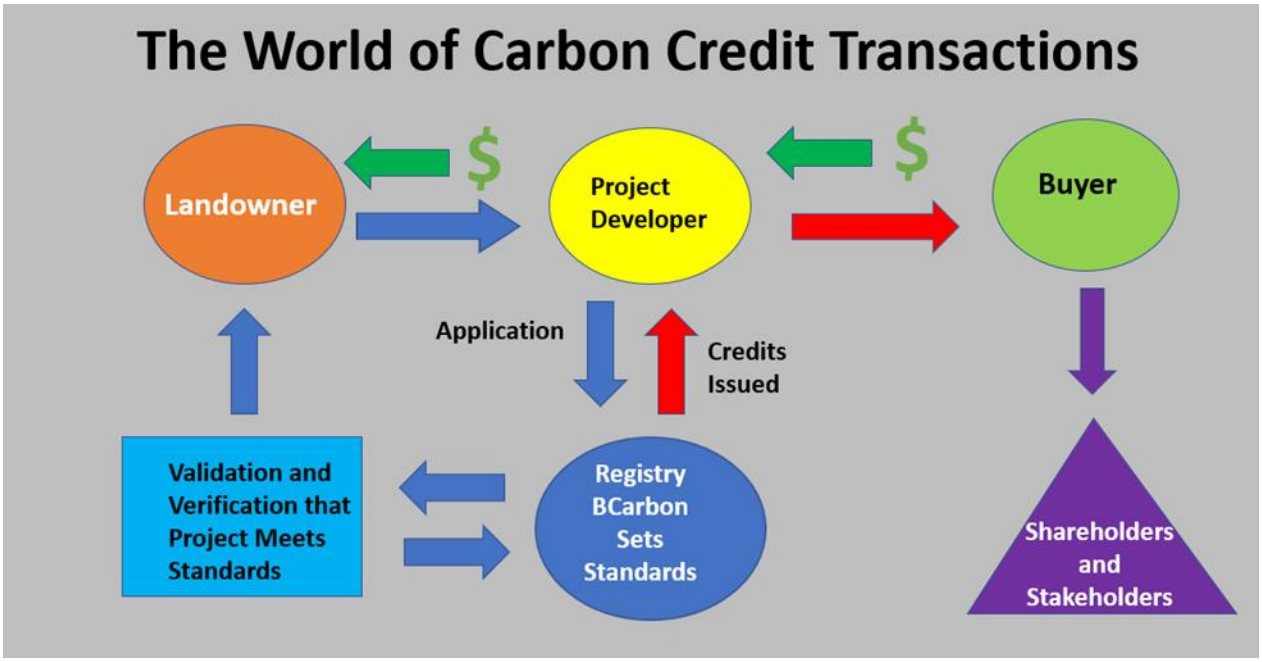


Figure 2. The process of the "minting" of carbon credits is complex, with the rules being set by the registry who works with the project developer and the landowner to receive and review an application for carbon credits that must be validated and verified, and once issued, sold for a market price to the buyer that must explain and/or defend their credit purchase to stakeholders and shareholders. Image from BCarbon by author.

The registry is responsible for issuing carbon credits in compliance with the rules that the registry has adopted. All registries are not the same, but all registries do have some type of process for verifying and validating a project developer's proposal. This review could include field investigations, calculation review and contractual review to determine if the rules of the registry have been met. Assuming that the rules of the registry have been met, the registry will issue the credits to the project developer.

The next step is a critical one where the project developer finds a buyer for the credits. We are learning more about this interaction as the market matures, but buyers have learned to ask hard questions about the science and credibility of the credits. Assuming the buyer agrees to purchase, money is paid to the project developer which is then split in some manner with the landowner. Because this is a voluntary market, the buyer does not have to meet regulatory requirements but

instead must present and defend carbon credit transactions to both their stockholders and interested stakeholders, creating a dynamic and evolving set of relationships throughout this market.

Over time, the credibility of these nature-based carbon credits has become more and more the center of discussion. More recently, a set of core carbon principles was developed by the Integrity Council for the Voluntary Carbon Market. As with all free markets, integrity is the most important characteristic of the carbon market, and the CCPs core principles are intended to underpin the integrity of the carbon credit system. These elements include the following issues:

**Governance** – having appropriate and legitimate governance structures and skills in place

**Tracking** – using a registry to identify, record and track carbon credits

**Transparency** – ensuring carbon credits are genuine and accurately reflect the reduction of greenhouse gas emissions

**Emissions Impact** – ensuring that carbon credits result in emissions removal

**Additionality** – ensuring that the activity for which the credit is awarded goes above and beyond normal business activities

**Permanence** – ensuring that the carbon sequestered from the atmosphere remains stored

**Robust Quantification** – ensuring that emission reductions and removals are robustly quantified based on scientific methods

**No Double Counting** – ensuring that there is no double counting

**Verification and validation** – ensuring credibility and transparency of the issued credit

Of these, additionality and permanence have posed difficulties for Texas and many United States landowners. Additionality refers to the concept that the carbon credits offered are “additional” and the carbon dioxide would not be removed or emitted “but for” the changes due to the carbon credits. Here, it is important to have actual measurement to be sure that carbon is being added to

the forest or to the soil, and it is important to understand that cash flow is important in preventing the conversion of "working lands" to home and subdivision development if not ranchettes. Similarly, permanence of 50 to 100 years – while desirable – is not acceptable to many private landowners. Until the market has been demonstrated, most landowners are reluctant to commit to more than 15 to 20 years without having the option of converting from one land use to another. A strong price for nature-based carbon would solve many of these problems.

With that brief introduction, we will now delve into the potential impact these nature-based carbon credits might have on the ecological future of Texas and the United States. It promises to be huge.

## 2. Saving Coastal Wetlands

It is a fact that the coastal tidal grassland wetlands of Texas and much of the world will be lost to sea level rise if action is not taken soon. This issue is urgent for the Texas coast, and the Texas Coastal Exchange issued a white paper back in April 2022 that proposed creating 1000 miles of living shoreline to protect the wetlands of the Texas coast from sea level rise. To expedite the construction of these living shorelines, BCarbon has developed a protocol to issue carbon credits to pay for constructing these living shorelines.

Coastwide, approximately 400,000 acres of Texas coastal wetlands could be lost to sea level rise if we don't attempt to protect them. And what a loss it would be. In Figure 3, the 203,506 acres are shown that could be lost in Orange, Jefferson, Chambers, Harris, Galveston, and Brazoria Counties by 2075 as indicated by the Sea Level Rise Affecting Marshes Model (SLAMM), which was developed by the Harte Research Institute. These wetlands are owned by private landowners and by state and federal agencies. Private landowners seldom realize significant income from marshlands as they are generally too wet for cattle grazing and there is at this time no payment made to these landowners for the significant ecological services provided by these wetlands.

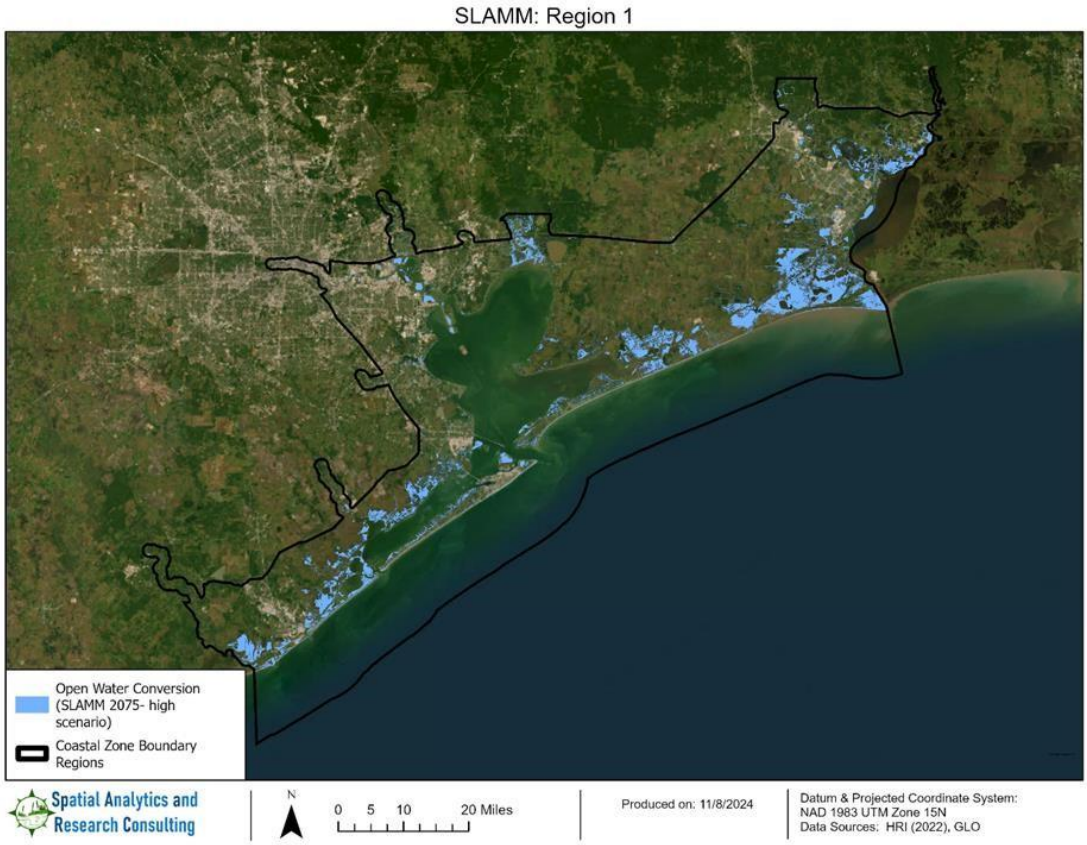


Figure 3. Sea level rise modeling (SLAMM) results for 2075 in Jefferson, Orange Chambers, Galveston Counties and Brazoria Counties. Areas in blue are wetlands that are permanently submerged which in this upper sector of the coast represent 203,506 acres of wetlands permanently lost. The boundary of the Texas coastal zone is shown in black. Image by SPARC, Spatial Analytics and Research Consulting.

From a carbon perspective, there are two aspects to this wetland loss. First, there is the fact that wetland vegetation will drown due to continuing inundation. This is an ecosystem that lives within the ebb and flow of the tide. Inundation for extended periods will kill the grass. Once the grass dies, the root system loses its ability to hold the marsh soil together, and that soil will be quickly eroded by the daily wind-blown waves that will remove thousands of feet of carbon-containing soil, liberating the carbon stored within the upper meter or so.

To address this issue, the protocol developed by BCarbon proposes to only issue carbon credits for wetlands that have been protected by living shorelines. Living

shorelines are concrete or rock breakwaters that are constructed just offshore from the wetland. These living shorelines break the waves that would erode the marsh edge and allow for sediment deposition behind the breakwater back into the marsh. Over time, oysters attach and grow, allowing the structure to rise with sea level, hence living. An example of a living shoreline is shown in Figure 4. Under this system, one-time credits are awarded for preventing the loss of the carbon stored in the wetland soil and annual credits are issued for the drawdown of carbon dioxide by the remaining wetland grasses which must be monitored, most likely by remote satellite or drone sensing.

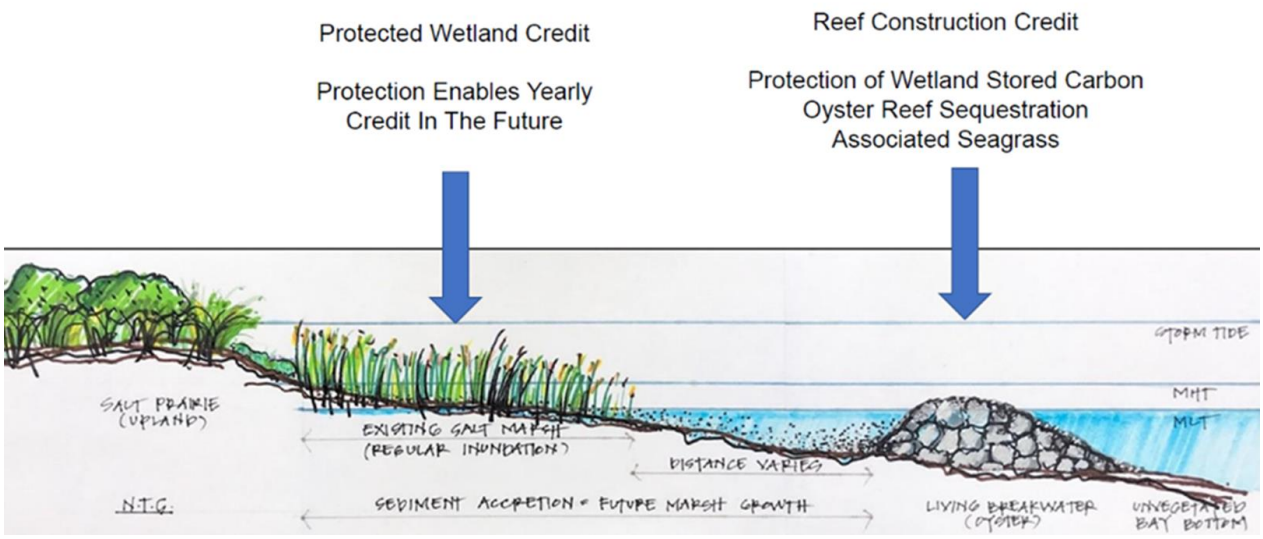


Figure 4. Diagram of the living shoreline and its placement relative to the coastal marsh. Under the BCarbon methodology, credit is given first for the protection of the stored carbon by the construction of the living shoreline. Once the shoreline is operational, an annual credit may be issued based on removal of carbon dioxide from the atmosphere by the remaining grassland which must be determined by remote sensing. Image by Lalise Mason for BCarbon.

From an ecological standpoint, this program could have a huge impact on our coastal fisheries because coastal wetlands are the nurseries for the Gulf of Mexico. Coastal *Spartina alterniflora* grasslands produce about 6000 white shrimp, brown shrimp, and blue crabs per acre as well as flounder and various species of smaller finfish. These wetlands are also home to countless bird species and also pull down about 2 tons of carbon dioxide per acre, which is added each

year to the several hundred tons per acre of carbon dioxide already stored in wetland soils. Collectively, these wetlands provide huge economic benefits from both a recreational and commercial fishery standpoint.

By building living shorelines, a barrier is established between the wetland and the waves that pound these systems every day as shown in Figure 5. And while this daily erosive force can be absorbed without major problems by a healthy wetland, wetlands that are weakened and dying from sea level rise will be destroyed unless protected. Once protected, the sedimentation rate within the protected marsh will increase and hopefully offset the sea level increase.

Figure 5. Living shoreline image.

Wetlands protected by a living shoreline clearly meet the requirement of “but for” causation needed for additionality. “But for” the construction of the living shoreline, the wetland and its soil platform both would be lost. Dr. Rusty Feagin of Texas A&M Main Campus has created a carbon database for BCarbon that identifies the amount of stored carbon that is found in the marshes of the Texas coast, offering the basis for carbon credit issuance for protecting these wetlands. And under the protocol, arrangements must be made for the maintenance of the living shoreline for 50 years into the future.

The environmental community and the government have been fighting for decades to save coastal wetlands. And now, when we need it most, we have

another tool to save these wetlands from sea level rise, and that tool is provided by living shorelines financed with carbon credits. And in 2023, the Texas Legislature authorized Texas Parks and Wildlife to participate in the ecological services market, a breakthrough authorization of carbon trading to protect coastal wetland.

A key here is buyer participation. If buyers do not purchase these credits, this needed wetland protection will not occur at the pace needed for the future. All who are interested in the coast, coastal fisheries and coastal birding might consider publicly supporting those who purchase these voluntary carbon credits. This market is voluntary, and the buyers can choose which carbon credit policies they choose to follow. These buyers need public support for their positive policy decisions.

### 3. Soil and Forest Protection

One of the key rationales of the effort within the SSPEED Center to investigate the carbon market was the potential of keeping undeveloped “working lands” working for the landowner and nature. And while residential, commercial and industrial land development will be an important part of the future, maintenance of our rural way of life and our private property heritage is also very important.

Our rural heritage is based around pastures and cattle grazing, cropland of various types, and forest maintenance. From a nature-based crediting perspective, native pasture lands and forested lands have both carbon crediting potential and substantial ecological value. In Figure 6, the various ecological systems of Texas are shown.

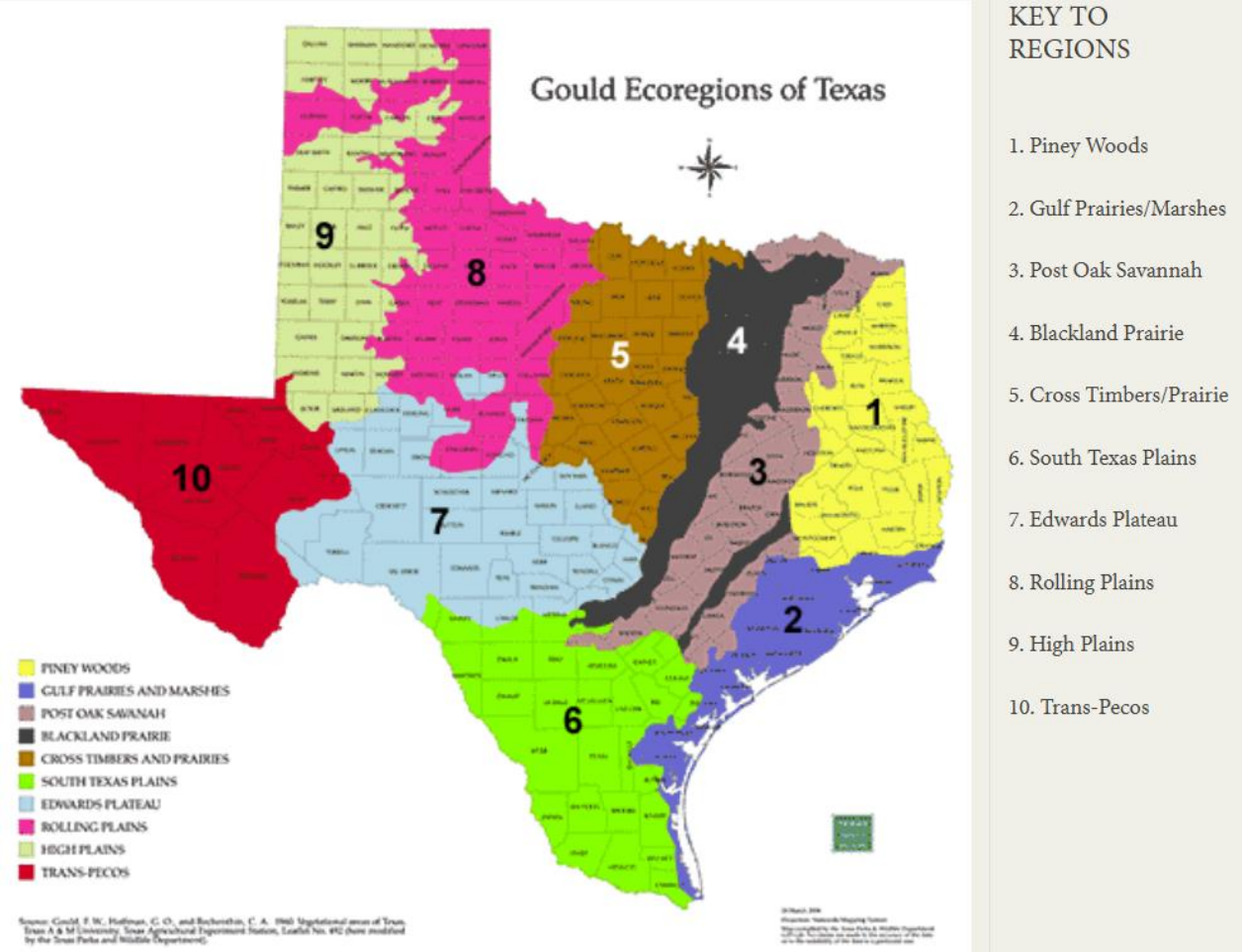


Figure 6. Various ecoregions of the State of Texas as depicted by Frank W. Gould in "Texas Plants - A Checklist and Ecological Summary". https://aggieclover.tamu.edu/map/.

Many of these ecoregions were comprised primarily prairie ecosystems, including the tall-grass prairie in the east and the short-grass prairie in the west. These would include the Gulf prairie/marshes, the Post Oak Savannah, the Blackland Prairie, the Cross Timbers/Prairie, the South Texas Plains, the Rolling Plains, the High Plains and the Trans-Pecos. The Piney Woods are dominated by forested lands, and much of the Edwards Plateau as well as the bottomlands of many rivers and creeks are dominated by forests of various types.

Much of this prairie has been lost to cropland or to land development, with much more in danger of being lost to urban expansion. Of particular concern is the difficulty of meeting traditional “but for” causation with changed management

practices for forests or for grazed pastureland. Here, different types of additionality are quite important to both understand and apply in order to gain landowner participation. And once the landowners have agreed to participate, the issue then becomes one of the buyers becoming comfortable with the new concepts.

There are scenarios in Texas, particularly in and around the major metropolitan areas, where the potential for ecological loss due to land conversion and development is significant. Texas is growing. Land is being developed. In such a situation, it is possible to develop data to demonstrate that there is an imminent threat of conversion of carbon-storing land to other uses such as residential, commercial, or industrial due to the scale of land development and population growth that is currently occurring in Texas.

Where such conditions exist, a landowner is placed in a situation where the financial pressure to convert their land to other uses is substantial because it is often difficult to generate cash flow sufficient for taxes or to distribute income to heirs. Many landowners in such a situation need additional income to offset internal pressures to sell their land, often for very high prices. In such situations, both avoided conversion and financial additionality (e.g., but for the carbon income, the land would have been sold and converted) may be added to the BCarbon methodology that requires testing to demonstrate that carbon has been added to the soil or forest ecosystem, providing an enhanced level of additionality.

The potential use of this methodology can be illustrated using the Houston Galveston Area as an example. This area includes 13 counties and has some fabulous ecological resources. In Figure 7, the seven basic ecological systems of the region are set out as found before development.

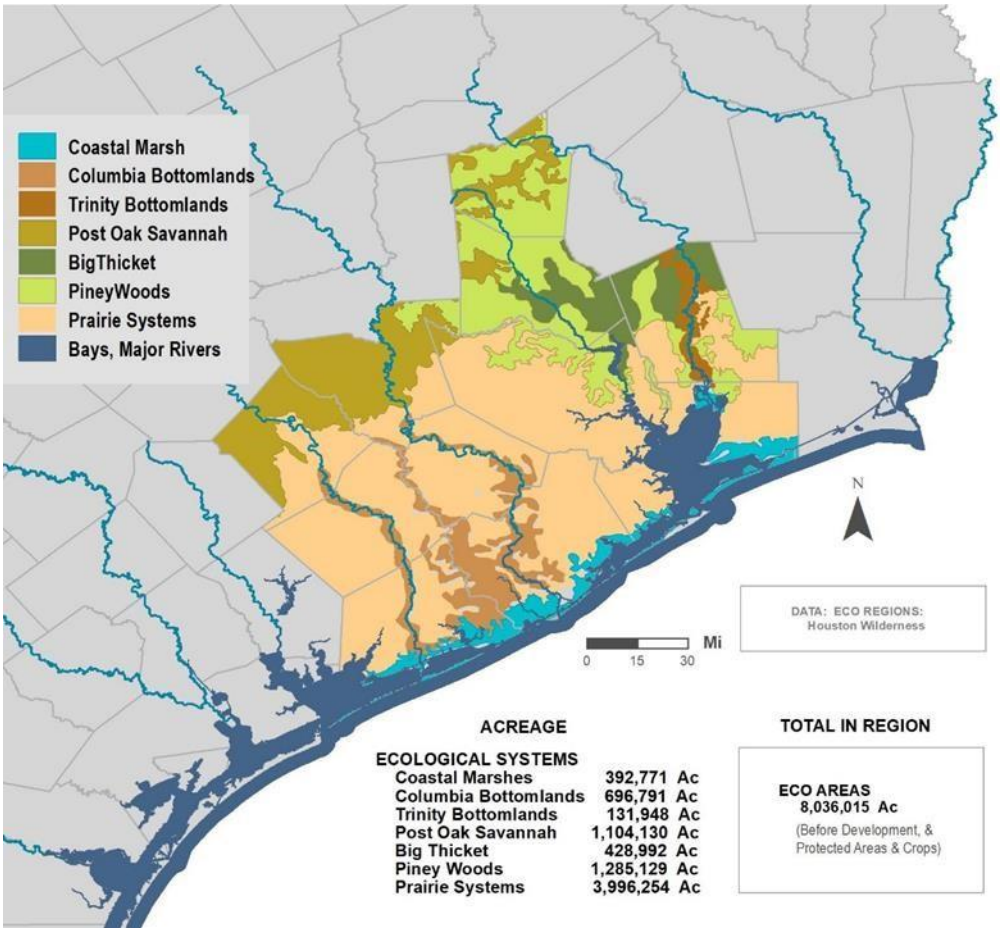


Figure 7. Historic ecological resources of the Houston-Galveston Area. Image by Christina Walsh for the author.

In Figure 8, the current status of those ecological systems is set out with land development shown in black, cropland shown in pink and protected lands shown in yellow and red. Once those three classifications are determined, the developable inventory of remaining ecological resources can be calculated.

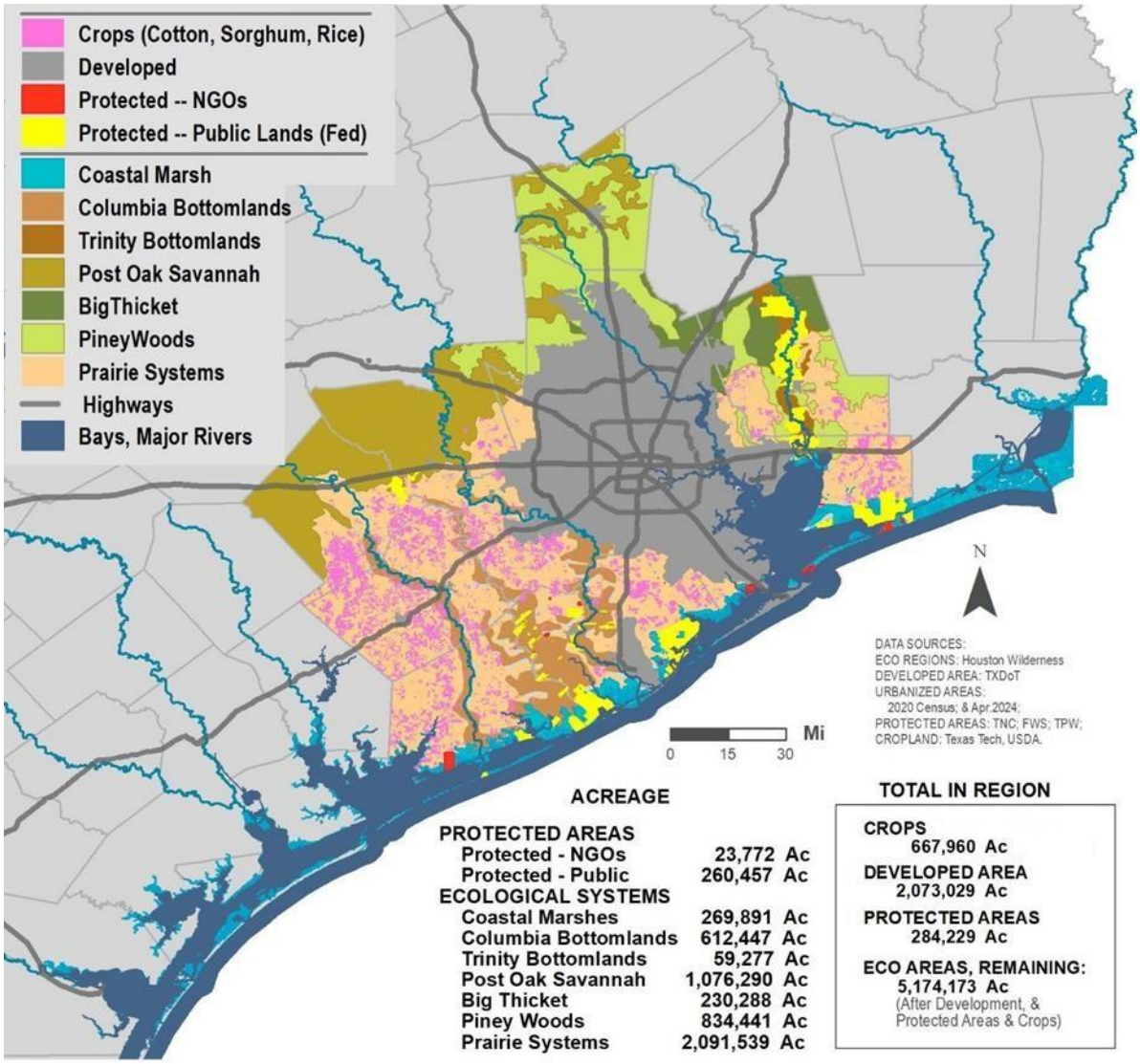


Figure 8. Impact of development within the 13-county metropolitan region surrounding Houston and Galveston. Image by Christina Walsh for the author.

The basis for avoided conversion and/or financial additionality credits is the data on the prior rate of land development and the projected increase in population and land demand in the future. As can be seen from Table 1, there is substantial development pressure coming in the next 20 years. Eight of the thirteen counties have had projections completed by the Houston-Galveston Area Council (HGAC) and that entity predicts that from 2020 to 2045, an additional 3.3 million people will be coming to these eight counties.

| County | Household Population (Thousands) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1980 | 1990 | 2000 | 2010 | 2015 | 2020 | 2025 | 2030 | 2035 | 2040 | 2045 |
| Brazoria | 162 | 183 | 231 | 303 | 344 | 386 | 438 | 482 | 517 | 605 | 699 |
| Chambers | 18 | 20 | 26 | 35 | 38 | 44 | 48 | 51 | 52 | 63 | 84 |
| Fort Bend | 127 | 221 | 348 | 579 | 714 | 826 | 941 | 1,043 | 1,133 | 1,250 | 1,362 |
| Galveston | 193 | 215 | 246 | 287 | 323 | 359 | 384 | 412 | 442 | 473 | 504 |
| Harris | 2,389 | 2,789 | 3,358 | 4,048 | 4,444 | 4,810 | 5,189 | 5,567 | 5,959 | 6,212 | 6,434 |
| Liberty | 47 | 52 | 65 | 70 | 82 | 85 | 91 | 99 | 107 | 133 | 164 |
| Montgomery | 128 | 181 | 292 | 453 | 522 | 652 | 765 | 887 | 1,001 | 1,111 | 1,220 |
| Waller | 17 | 20 | 29 | 40 | 47 | 53 | 57 | 65 | 73 | 99 | 125 |
| Region | 3,082 | 3,681 | 4,596 | 5,814 | 6,513 | 7,215 | 7,913 | 8,605 | 9,282 | 9,946 | 10,593 |

Table 1. Population projections for eight counties in and surrounding Houston and Galveston. Data from Houston Galveston Area Council.

A slightly different approach is offered by Texas Land Trends (https://txlandtrends.org/). This group has determined that between 1997 and 2022, in the 13-county HGAC region, 615,000 acres of working lands were lost with population growth of over 3 million people. Additionally, the market value per acre of working lands went up 496%, creating significant pressure to sell these working lands. Using that rate of land loss for the future, it is reasonable to assume that the additional 3 million people projected to come by 2045 will consume at least another 600,000 acres within this thirteen-county area. And that does not consider the rural spread of ranchettes and larger acreage tracts, which is also substantial.

These same trends are applicable to the major metropolitan areas of Texas, which are shown in Figure 9. Each of these areas is experiencing significant growth pressure just like Houston-Galveston. In each area, there is a substantial risk of "working lands" being lost. A similar rationale of avoided conversion and financial additionality can be used for carbon credit projects within these metropolitan areas. To apply this rationale to each of these areas, an analysis would have to be undertaken similar to that done for the Houston Galveston region, identifying the scope of the land areas at risk.

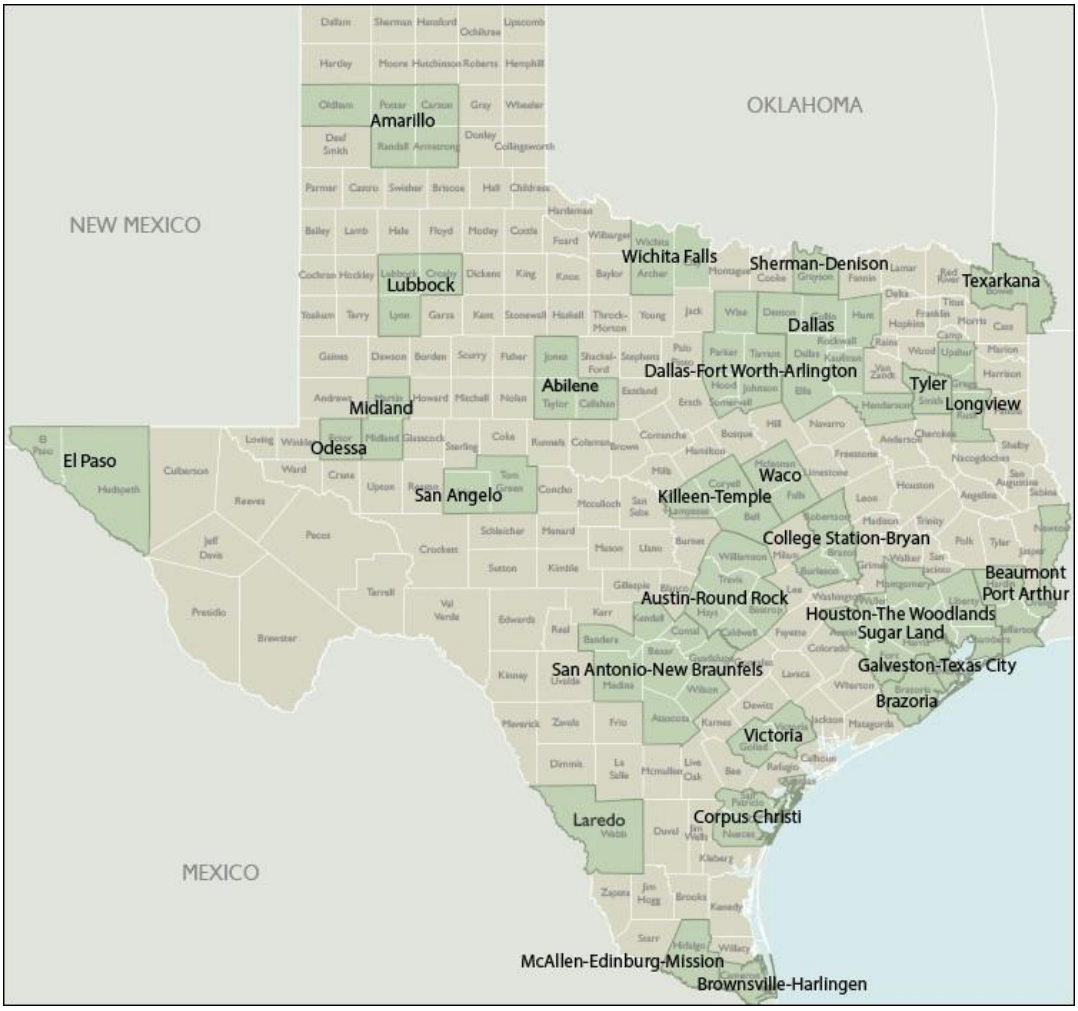


Figure 9. Map of Standard Metropolitan Statistical Areas (SMSAs) that are the minimum area to be considered as “urban sprawl impact areas”.

The addition of avoided conversion and financial additionality to the carbon credit issuance documentation may be of great importance to many buyers who are hesitant to purchase credits simply based on a measured increase in carbon in the soil or forest. By adding the issue of the imminence of conversion and the need for greater income considering development pressures, the carbon credit created within these metropolitan areas will address all aspects of additionality. In the process, a significant acreage of important ecosystems can be saved from development.

Permanence under the BCarbon system is 15 to 20 years with longer term protection based on the future market price for carbon credits, which could be well beyond the current value. Prices already often exceed $40 per ton for soil

carbon credits, providing and strong and growing incentive for landowners to keep their land enrolled in carbon projects.

This same thinking can be applied to the loss of "working lands" generally. In Texas, we are losing land at a rapid rate. This trend is shown in Figure 10 which was prepared by Dr. Roel Lopez at Texas A&M University. And while much of this land loss was within urbanized areas, significant losses occurred throughout the State. Indeed, from 1997 to 2022, Texas lost almost 3.7 million acres to land conversion with over 1.8 million acres lost over the last five years. And that trend is expected to accelerate into the future.

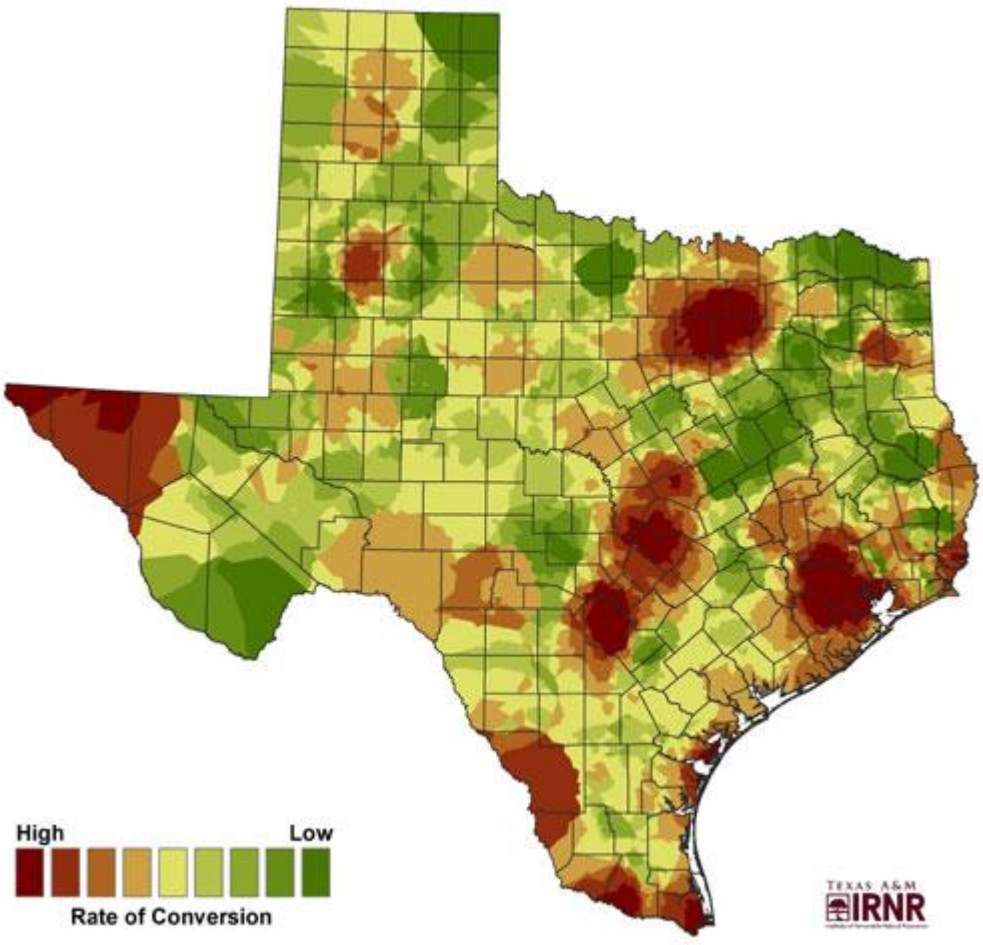


Figure 10. Land loss from 1997 to 2012 as depicted by Dr. Roel Lopez. https://www.ntxe-news.com/cgi-bin/artman/exec/view.cgi?archive=71&num=91888&printer=1.

The point here is that the risk of land conversion is significant. Where landowners wish to continue working their land, carbon credits should be available to keep these lands working and ecologically significant, and in the process, millions of acres of ecologically significant prairie and forest lands can be protected and preserved.

**4. Endangered Species and Biodiversity Protection**

Once sufficient documentation exists to demonstrate additionality and permanence, the opportunities for ecological protection through soil, forest and coastal marsh carbon credits open substantially. This is particularly true regarding endangered species protection and biodiversity.

In far South Texas and along the Nueces River, there are documented examples of the occurrence of ocelots, an endangered small cat. Ocelots depend upon dense brush for their habitat and can be protected by either soil or forest drawdown credits, or both. An image of an ocelot is shown in Figure 11.

This opportunity will only occur on ranches that are willing to publicly admit that these cats have been confirmed on their properties, and many landowners are reluctant to make such a public statement. Interestingly, such admissions are now beginning to be made publicly as landowners begin to appreciate that the presence of endangered species might thwart condemnation efforts for pipelines, among other things. As these admissions grow, carbon crediting will also emerge to help these landowners benefit financially from their presence and protection.

Figure 11. An endangered ocelot shown in South Texas habitat.

A second major opportunity is represented by the whooping crane and coastal blue carbon credit issuance. Whooping cranes winter in the marshes of Aransas, San Antonio and Copano Bays and certain specific marsh habitats are returned to each winter by the same pair, often with a young bird in tow. By protecting these marshes with living shorelines, the winter homes of pairs of cranes and their cinnamon-colored juveniles can be protected. These winter habitats are shown in Figure 12. These habitats are within coastal wetlands that will be inundated and converted to open water by 2075 if not sooner unless protected.


Figure 12. Whooping crane wintering territories shown in yellow circled areas. Data from Tom Stehn as mapped by Lalise Mason for BCarbon.

Relative to whooping cranes, there is an opportunity to integrate this carbon credit protection program into a Habitat Conservation Plan (HCP) being developed by the Guadalupe Blanco River Authority (GBRA) that will, among other things, set forth protection concepts for whooping cranes. Currently, the inclusion of coastal living shoreline carbon credits is being considered, and we are investigating the opportunity for the living shoreline carbon credit to increase in value due to the dual role of wetland protection and endangered species habitat protection.

These are just two of the many opportunities that exist in Texas. Restoring prairies as part of a pastureland carbon credit concept can create needed habitat for monarch butterflies and many bird species that are declining due to loss of prairie habitat. Protecting mature cedar tracts in central Texas with carbon credits will benefit the endangered golden-cheeked warbler that nests in those trees. And saving marshlands in the middle and upper coast can benefit the endangered black rail.

In addition, BCarbon is developing a method of assigning a biodiversity “score” to a carbon project. This will create an incentive for project developers to seek out and protect biodiverse areas. It will also allow buyers to discern which projects carry ecological benefits beyond carbon sequestration. A carbon credit with a

higher score is expected to command a premium on the market because of the ecological co-benefits it carries.

**5. Protecting Texas Hill Country Springs**

One of the most important natural resources of the Texas Hill Country are the springs that provide cold, refreshing surface flow that feeds the Blanco, the Guadalupe, the Colorado, the San Antonio, the Nueces, and the Sabinal Rivers, to name a few. Without these springs, central Texas would not be the recreational playground it is, not to mention the home to numerous endangered species such as river mussels, blind salamanders and other unique flora and fauna. These springs are also the source of surface water that will no longer be available to support residential, industrial, and agricultural users if they go dry. This is a real problem exacerbated by the droughts that are becoming more frequent and more severe.

Figure 13. Downstream from the spring called Jacobs Well near Wimberley which forms Cypress Creek, which flows into the Blanco River and then the Guadalupe, a spring which has recently failed to flow during recent droughts due in part to over pumping of groundwater.

Springs are already beginning to dry out in many areas of the Hill Country, particularly those nearest to Interstate 35 that are experiencing rapid growth.

Carbon credits can protect springs by conserving the land surrounding them and preventing groundwater withdrawal.

The key to protecting springs is to issue carbon credits for cedar, mesquite, or live oak forest drawdown, for soil carbon drawdown, or for both in locations where they surround a spring. In this situation, a condition association with the issuance of carbon credits will be that no groundwater withdrawal will occur other than perhaps a couple of small household or agricultural wells. In this way, spring sources will be protected. The scope and location of these springs is shown in Figure 14 with many of them being relatively proximate to the fast-growing IH-35 corridor.

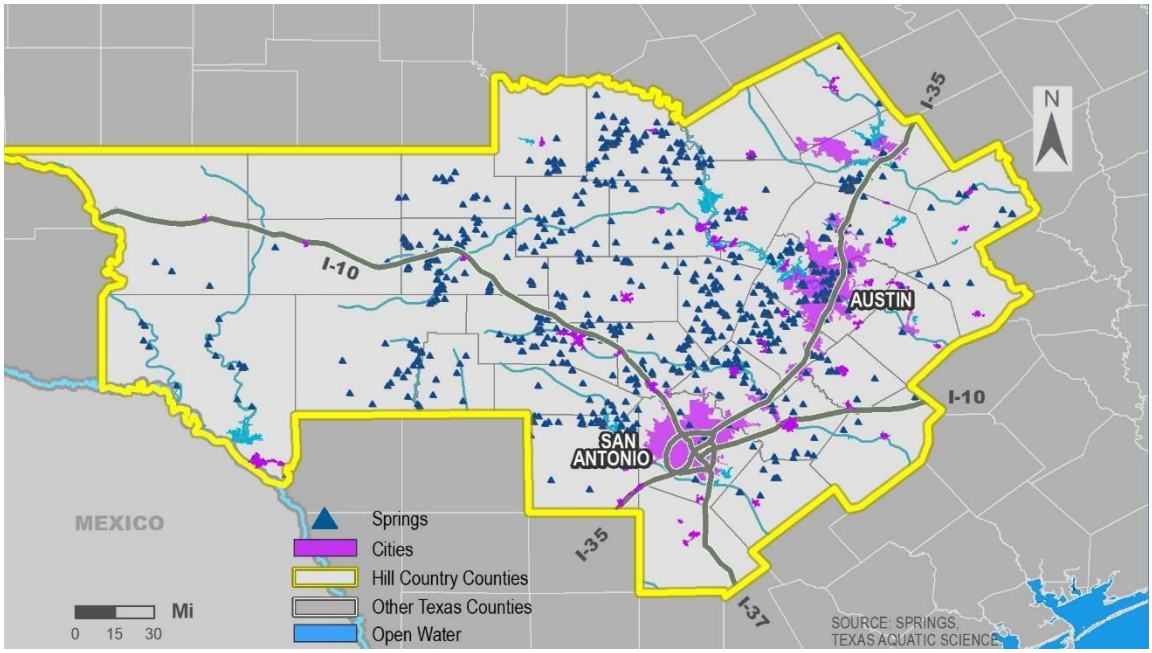


Figure 14. The scope and distribution of springs across the Hill Country of central Texas. Image by Christina Walsh for the author.

It is also worth noting that endangered species habitat also overlaps with the same geographic areas where these springs are found. For example, the habitat of the endangered golden cheeked warbler covers much of the area where springs are found. This area is shown in Figure 15.

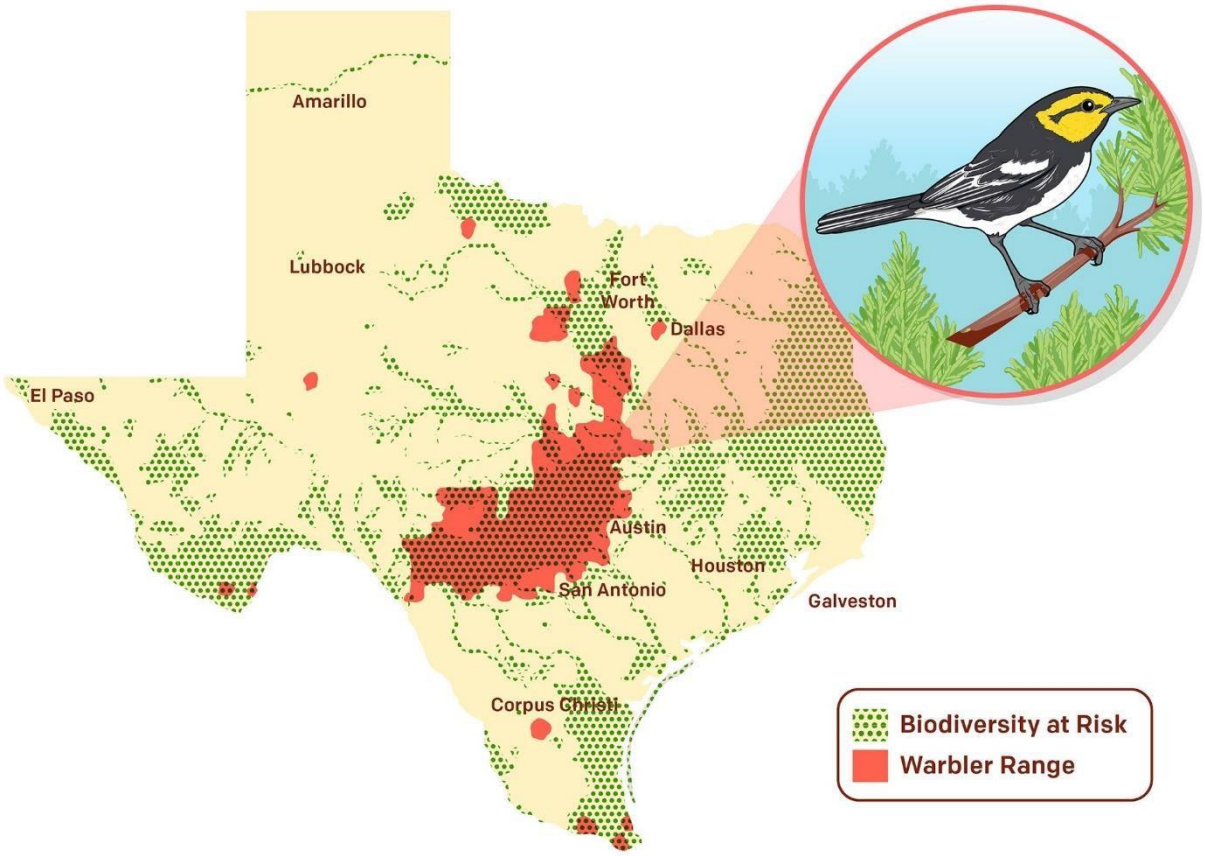


Figure 15. Location of critical habitat of the endangered golden-cheeked warbler. Image from EarthJustice.

The point here is that a focused aggregation of properties surrounding springs could occur in association with the issuance of either forest or soil carbon credits.

**6. Cleaning Up Our Oil and Gas Fields**

Another area where carbon credits can make a difference to the Texas landscape is with plugging leaking and abandoned oil and gas wells. The Texas Railroad Commission has identified about 146,000 abandoned wells in Texas with most of those in South and West Texas. Additionally, it appears that 13,000 or more wells are being added to this number each year. A map showing the counties with the most abandoned or orphaned wells is shown in Figure 16.

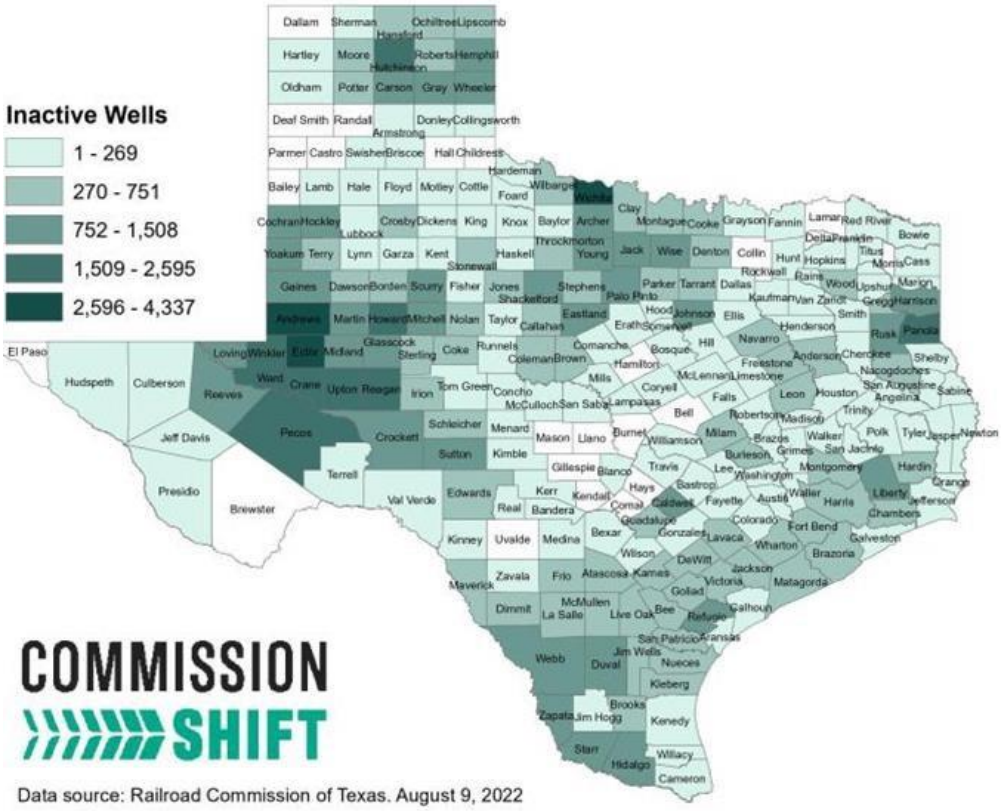


Figure 16. Map of inactive wells in various Texas counties. Map created by Commission Shift.

Although there is government funding for plugging orphaned wells, there are many more orphaned and abandoned wells than the governmental allocations can handle. Here, private capital can supplement governmental funding and make a real difference in emissions of methane, a very potent greenhouse gas.

For many landowners, particularly in west and south Texas, these abandoned wells are a nightmare. Many of them are leaking methane containing hydrogen sulfide, a compound that smells like rotten eggs and can kill a person at high concentrations. Oftentimes the fields are littered with oil field debris. A typical scene can be viewed in Figure 17.

Figure 17. Oil field debris is often left behind and will be required to be removed as part of the methane leak plugging protocol.

Under the methane leak plugging program developed by BCarbon, the well is tested to determine whether leakage is occurring, and then the well is plugged and then retested to determine if the leak has been stopped. Assuming that these steps are affirmative, credits can be issued, but only after clean-up of the surface has been accomplished. This surface clean-up is an important element to landowners along with the stoppage of methane and related gas leakage.

With an active carbon credit program, the potential exists for thousands of wells to be plugged each year. Currently, the leak-plugging voluntary market has only begun, and buyers in the voluntary market are still trying to determine their comfort with methane plugging credits. Here, there is no doubt about the additionality of these methane plugging credits – "but for" the carbon credit, plugging would not occur in the next couple of decades. And permanence is insured by holding back 20% of the credits until a second round of testing is completed after one year to confirm that the well continues to not leak. Once a well has been successfully plugged for at least a year, failures rarely occur.

At this time, there is growing appreciation among landowners that this carbon credit program might be a way of solving a long-standing contamination and nuisance issue and in a way that can have a net economic benefit for the landowner. If that promise is realized by credit purchase, this issue could transform the rural Texas landscape, as well as perhaps some municipal landscapes as well. Again, the key to this promise being achieved is industrial and other buyers deciding that these methane leak abatement credits are the right voluntary credit for their needs.

## 7. Conclusion

Currently, there are over 50 billion tons of carbon emissions occurring globally with just under 6 billion of those tons here in the United States. As shown in Figure 18, the movement to net zero and net negative is needed to keep our global temperature increase below 2 degrees centigrade. In the scenario shown in Figure 18, between 10 and 20 billion tons of carbon dioxide are projected to be removed by either direct air carbon removal technologies or nature or both. Based on this and other data, it is reasonable to anticipate that nature will ultimately be responsible for the removal of from 10% to 20% of our carbon emissions. And the price of that removal will only increase over time.

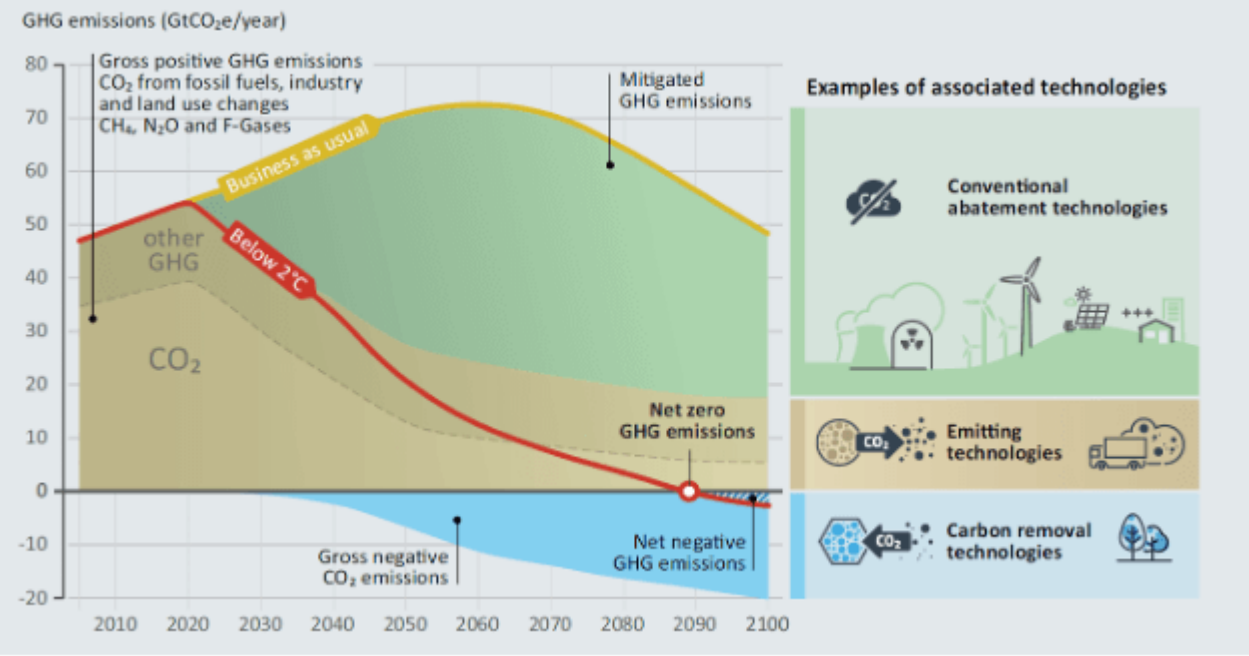


Figure 18. Graphic depiction of carbon emission reductions needed to reach net zero with area in blue indicating nature-based and technological carbon drawdown. Source: IPCC 2017 Report

There is no reason that advocates and critics of the voluntary carbon market cannot work together to find innovative approaches for the future – approaches that set up long term carbon dioxide removal and storage strategies using nature-based solutions that benefit both rural economies and cities with an extensive industrial base without the need for government funding or heavy handed regulation The world is in the process of the most massive transition ever attempted as we reduce fossil fuel emissions, mitigate the impacts of those emissions, and then continue to draw down carbon dioxide from the atmosphere beyond the amount we emit. This negative carbon economy will be needed for us to address climate change, and we cannot do it without nature.

As indicated in Figure 19, the Earth and nature need to be at the center of a coherent climate policy for the future. This will involve an economy that produces less and less carbon dioxide with the Earth as an integral part of that solution. Ultimately, this approach will bring us back into balance with the carbon cycle of the Earth and will help create a circular economy for the future. And nature will be at the center of this evolving economy.

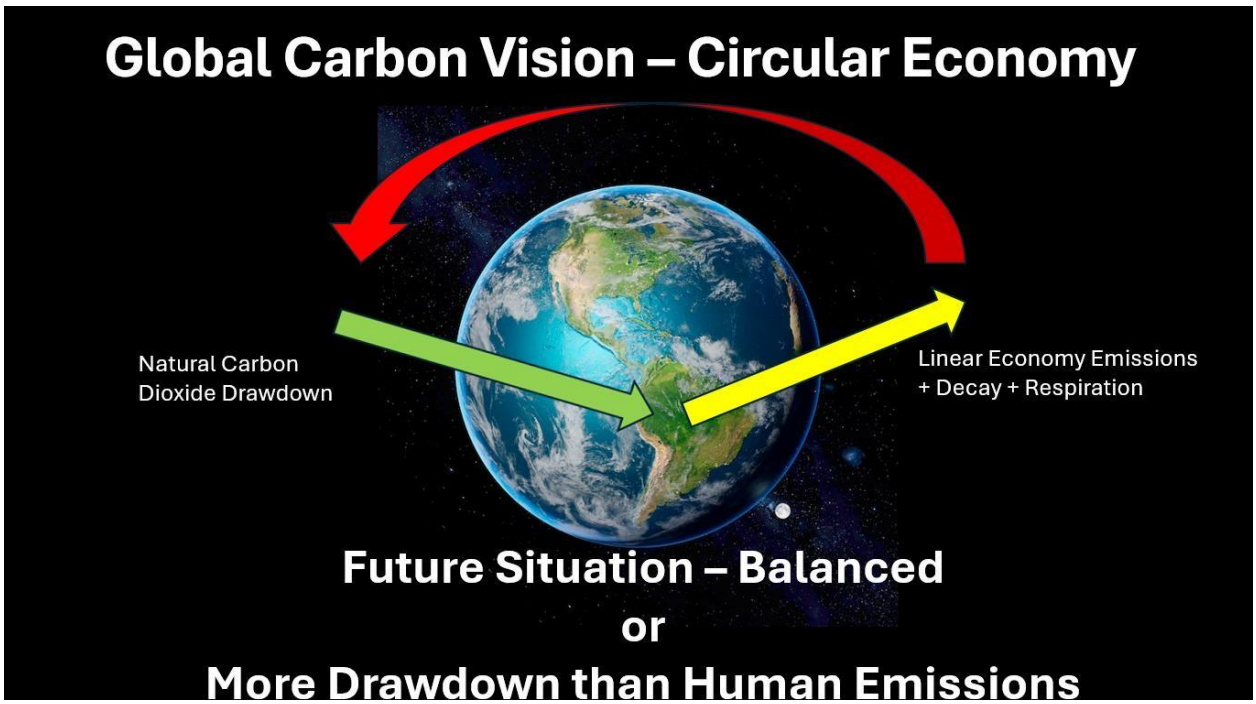


Figure 19. Graphic depiction of a global carbon vision where the carbon cycle is restored through a circular human economy. Image by the author.