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Carbon Offsets in San Diego County: An Analysis of Carbon Offset Policy Effectiveness, Best Practices, and Local Viability in the San Diego County Region

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Executive Summary

Carbon offsets are features of emissions reduction policies where a carbon emitting entity can pay for atmospheric carbon to be sequestered or emissions to be avoided elsewhere to subtract this amount of carbon from their total emissions. Where emissions reductions are required by law, carbon offsets give carbon emitting entities flexibility in how they meet emissions reductions. In addition, some carbon emitting entities choose to voluntarily invest in offsets to meet their own zero net emissions goals.

While carbon offset policies theoretically work to meet climate goals and provide more flexible ways for carbon emitters to reduce their net reductions, they often meet criticisms for not working as well in reality. Carbon offsets are criticized for not truly meeting net neutrality goals because it is nearly impossible to tell if a carbon offset project is additional, i.e., would not have happened without the influence of the offset incentive. Non-additional projects would not meet offset goals but are difficult to identify. Carbon offsets are also criticized for being prohibitively difficult to measure and verify and for slowing progress on emissions reductions strategies.

The shortcomings of carbon offsets can be addressed with strategic design. Where offsets are required by law, policies can incorporate a trade ratio that discounts offsets relative to directly reduced emissions. For example, a trade ratio of 1.25:1 would require the purchase of offsets for 125 tons of carbon to count for 100 tons of carbon emissions reductions. Both required and voluntary offsets can benefit from investing in local projects where they are easiest to verify and the co-benefits (such as green space or clean energy production) are kept local to the carbon emissions they are offsetting and the negative externalities of those operations.

The San Diego region many opportunities for potential offsets. San Diego County incorporated carbon offsets as an addition to their climate action plan but faces legal challenge from the Sierra Club over the integrity of the policy they designed, specifically about the unbounded geographic distance allowed between offset projects and emissions sources. In 2021, the State of California will increase stringency on carbon offsets by cutting the percent of emissions reductions that can be accounted for by offsets in half and requiring half of them to be local. Simultaneously, voluntary offsets are becoming more and more popular.

With carbon offsets being such a timely opportunity in San Diego, the region has options to maximize carbon offsets. In particular, I recommend the following policy options:

Incorporate trade ratios. The State of California, the County of San Diego, and voluntary offset registries do not currently utilize trade ratios that could account for unmeasurable additionality.

Include local requirements. Requiring a portion of offset projects to be developed locally improves ability to measure and verify projects. Local projects keep co-benefits of the projects local to the communities that may experience negative externalities of emissions being offset.

Invest in local offset projects. Currently, there are no carbon offset projects in the San Diego Region. A preliminary analysis of wetland restoration opportunities suggests that wetland restorations will not be enough to meet local offset demand and other project types should be investigated further.

Introduction

Carbon offsets are a part of a carbon emission reduction policy that allows carbon emitting entities added flexibility in meeting carbon emission reductions. Because carbon is well mixed in the atmosphere[1] carbon emissions from a factory on one side of the world theoretically have the same effect on our climate in terms of radiative forcing as a factory on the other side of the world. Extending this theory, limiting emissions or removing carbon from the atmosphere would have the same net climatological regardless of where these activities occur. Carbon offsets allow entities to pay for carbon reductions or carbon sequestration projects elsewhere to count toward their own business emissions reductions. Such policies have become popular facets of carbon emissions reduction policies and are incorporated in international policy under the Kyoto Protocol; California state policy under AB 398, which established the cap-and-trade program; and in San Diego County's Climate Action Plan.

Carbon offsets are a popular way to balance economic and climate goals; however, they come with a set of risks and trade-offs. Carbon offset policies have been critiqued for not truly creating a carbon neutral standard, being difficult to verify, and slowing progress on direct emissions reductions. However, because they the gap between emissions reductions goals and low carbon technologies, they are widely used in climate policy and will likely remain widely used in the future. Because carbon offsets are now built into our climate policy landscape, it's important to know how we can most efficiently use carbon offset policies. Using data and policy design elements, carbon offset policies can meet goals in a more efficient way.

This report explores the current use of carbon offset policies pertaining to the San Diego region, what the best practices for carbon offset policy design are, and how the San Diego region can best implement effective carbon offsets.

Policy Analysis

Brief History of Carbon Offset Policies

Who Uses Carbon Offsets?

Carbon offsets provide more flexibility for carbon emitting entities to reduce their net carbon emissions. They can be used voluntarily for businesses seeking to reduce their emissions by their own motivation or as a feature of a law that requires emissions reductions. However, offsets are highly complex and as such have become highly regulated. Carbon offsets are often incorporated into carbon emission reduction laws. Where emissions reductions are required by law, carbon offsets help provide carbon emitting entities with options to meet the required reductions in the most cost-effective way. Carbon emitting entities can meet some reductions onsite with low cost methods and readily available technology and the rest of the reductions with offsets while working on developing technology for further on-site reductions. The offset projects they invest in can be any project that sequesters atmospheric carbon or avoids emissions elsewhere. Examples of offset projects include renewable energy development, energy efficiency upgrades, methane capture, biosequestration, carbon farming, and carbon capture and storage.

Some companies may decide to purchase offsets even when they are not required by law to reduce emissions. If companies purchase offsets equivalent to amount of emissions they produce, they can claim that their business is 'net carbon neutral' and qualify for carbon neutral certifications. Carbon emitting entities participate in these voluntary carbon neutrality programs to differentiate themselves as 'green' options in the market place. Carbon offset registries, such as American Carbon Registry (ACR), Climate Action Reserve (CAR), Verra, and Gold Standard, support voluntary carbon offsets by developing and verifying projects for carbon emitting entities looking to purchase offsets. Carbon offset registries often work closely with government agencies and government regulations to verify voluntary offsets. Given the close ties between voluntary and legally required offsets, this report will focus primarily on legally required offsets.

International

Carbon offsets first entered the international policy sphere in the Kyoto Protocol in 1997. Article 3 of this agreement legally bound developed, industrialized countries (known as Annex I countries) to emissions reductions by a minimum of 5% below their 1990 emissions levels by 2012[2]. Article 12 laid out the possibility for offset projects by allowing Annex I countries to invest in emissions reducing activities in countries not included in Annex I to claim ‘Certified Emissions Reductions’ (CER) that can count toward the emissions reductions required in Article 3[2]. Furthermore, Article 12 indicated that CERs will be certified under the Clean Development Mechanism (CDM) by rules agreed upon by the United Nations Framework Convention on Climate Change (UNFCCC)[2]. At the first UNFCCC Conference of Parties (COP), parties decided on specific modalities and procedures for each type of potential offset project to ensure uniform standards and reliability of projects[2].

California State

The State of California utilized carbon offsets as a piece of the cap-and-trade program established under Assembly Bill 32 (A.B. 32), the state’s ambitious and overarching emissions reduction legislation. Chapter 3 of A.B. 32 included stipulations for offsets referred to as ‘Alternative Compliance Mechanisms.’[3] Alternative Compliance Mechanisms are defined as “an action undertaken by a greenhouse gas emission source that achieves the equivalent reduction of greenhouse gas emissions over the same time period as direct emission reduction and that is approved by the state board”[3]. Entities covered under the cap-and-trade program may use carbon offsets to meet up to 8% of their emissions reductions during the current period of 2013-2020[3,4].

California’s cap-and-trade program was then expanded under AB 398 which delegated the management of these projects to the California Air Resources Board (CARB)[5] which verifies offset projects and issues credits in accordance to carbon emissions avoided or atmospheric carbon captured by a project[4]. CARB accepts projects that are established using a ‘Compliance Offset Protocol’ which is a set of project guidelines that establish standards for projects and capitalize on best practices. Compliance Offset Protocols are highly specific to project size and scope to maintain consistency of permits across a wide variety of offset project possibilities and include detailed instructions and guidelines for the specific project. They are developed collaboratively between CARB and other state agencies or independent carbon offset registries that submit protocols to be reviewed by CARB. Examples include the US Forest Projects Protocol, Urban Forestry Protocol, Livestock Digester Protocol, and Rice Cultivation Protocol[4]. In developing Compliance Offset Protocols, CARB considers factors including the potential for projects to be done in California rather than elsewhere, the potential offset supply, the cost-effectiveness, and co-benefits of project types[4].

CARB has also established standards that are used across all Compliance Offset Protocols in establishing and approving Compliance Offset Protocols. Offset projects will only be approved if the emissions reductions come from sources outside of the scope of California’s cap-and-trade programs to avoid double counting[4]. Projects outside of the state that would be covered if they were inside the state are also not eligible for offset credits. Only Scope 1[*] emissions reductions, meaning reductions occurring immediately from the actions of the projects are counted[4]. While projects not directly related to emissions, such as reducing electricity use, may reduce emissions from the reduction of energy used (Scope 2 emissions[*]), these emissions would not be counted in a compliance offset protocol to maintain a higher confidence in emissions reduction calculations and to avoid double counting in a growing carbon offset market. Carbon offset projects must also ensure the permanent avoidance of emissions[6]. For example, methane flaring would permanently destroy methane, while methane storage would not. Restoration based projects have a standard of permanence of 100 years[6]. This means that a restoration project must ensure it will be preserved for at least 100 years to qualify as a carbon offset project. Lastly, any project seeking to qualify as a carbon offset must be quantified using the most conservative estimates and must be verifiable[4,6]. 'Additionality,' meaning the verification that carbon offset credits represent carbon that would not be sequestered or avoided without the investment of a carbon offset project, is a common concern for the integrity of offset projects. To account for these concerns, CARB outlines plans for verifying that a carbon offset is truly an additional avoidance or sequestration of carbon above what would have occurred without the intervention of an offset program. Primarily, CARB conducts an assessment of standard practices in an area where a project is suggested. If a carbon reducing or sequestering practice is already commonplace in a community, those projects cannot apply toward carbon offsets in said community as they likely would have occurred without the intervention of a carbon offset program[4,6]. CARB addresses the possibility that projects with sizeable co-benefits may qualify for other types of environmental credits such as wetland or stream mitigation credits[4]. However, receiving other types of environmental credits will not disqualify a project from receiving offset credit so long as the other credits they receive are not carbon emissions credits. CARB recognizes the benefit of keeping projects and their co-benefits local but does not require qualifying projects to occur in the state. Because the cap-and-trade program covers a significant portion of the California economy, CARB believes limiting offset projects to the state would significantly limit the offset supply such that there would not be enough available[4].

San Diego County

San Diego County Climate Action Plan

In February of 2018 San Diego County adopted their current Climate Action Plan (CAP) that outlined the county's emissions goals and strategies to reach them[7]. Among their strategies, San Diego County included a plan (Strategy T-4) to invest in local projects to offset carbon emissions resulting from the county's activity[7] . Strategy T-4 leans on the pre-established compliance offset protocols and verification methods established by CARB, the California Air Pollution Control Officers Association (CAPCOA), and the San Diego County Air Pollution Control District (SDAPCD) to confirm emissions reductions[7]. Emissions reductions, avoidance of emissions, and sequestration of carbon under Strategy T-4 will be verified by a third party under these standards, then maintained in a registry designed by the SDAPCD that may become an independent registry or may be built into an existing one. These offsets will be paid for by the county, verified, and

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[*] Scope 1 emissions are emissions that are a direct result of the entity's activities. For example, emissions resulting from fossil fuels burned on site or used in their own shipping fleets would be counted under Scope 1. Scope 2 are emissions that are indirectly caused by the entity's activities. For example, the emissions associated with the electricity used to power the lights in the entity's offices are not scope one as the electricity generation is not occurring on site, but are scope 2 because they are an indirect result of the activities occurring on site.

immediately retired rather that sold on as offset credits. Through this program, San Diego County hopes to retire 176,614 tons of carbon by 2030[7].

Strategy A-2 focuses on increasing carbon sequestration under its agriculture and conservation goals. Plans under Strategy A-2 focus on tree planting both in residential areas and on unincorporated lands. In residential areas the County will plant and maintain two new trees per additional dwelling unit on county-owned lands in residential areas to maximize co-benefits[7]. Furthermore, the County plans to plant 3,500 trees in more rural unincorporated areas each year[7]. The county anticipates sequestering 1,244 tons of CO_2 from residential projects and 1,735 tons of CO_2 from projects in unincorporated areas for a total of almost 3,000 tons of CO_2 sequestered[7].

Legal Challenges

In 2011 San Diego County did a comprehensive update to its general plan for the first time since 1978[8]. This plan acknowledges the existence of climate change, lays out the County's strategies to meet state goals under AB32 and other environmental policies, and establishes the County's own sustainability and environmental goals[8]. As a part of this plan, San Diego County acknowledged that sustainable housing development methods would play a role in how the County meets its climate goals[8]. The 2011 General Plan outlined goals for environmentally sustainable development and approved a level of development that would fit within their climate goals[8]. The rules for environmentally sustainable development were then altered under the Climate Action Plan[9].

CAP Mitigation Measure M-GHG-1 stated any housing developments not already approved under the 2011 General Plan would be required to purchase carbon offsets to offset emissions from further development[9]. M-GHG-1 specified that all sustainability measures to reduce on-site emissions should be taken, then any remaining emissions must be offset by purchasing carbon credits from a reputable registry[9].

This carbon offset policy for housing development has become a point of contention for environmental groups that believe the offset regulations are not sufficiently thought out and will result in net environmental degradation of the San Diego region. On September 14, 2018, the Sierra Club challenged San Diego County arguing that CAP Mitigation Measure M-GHG-1's allowance the purchase of offsets from projects anywhere in the world to offset further development was not consistent with the County's previously stated climate action goals in the 2011 General Plan[10,11,12]. The Sierra Club argued that allowing development under the rules in CAP Mitigation Measure M-GHG-1 would be substantially harmful to environment in the San Diego Region and undermine the County's climate goals[10,11]. San Diego County argued that offsets from projects anywhere in the world should be allowed because greenhouse gases are well mixed in the atmosphere so geography of offsets relative to the housing development does not affect adherence to climate goals[10,11]. The judge has preliminarily sided with the Sierra Club by issuing a stay and preliminary injunction preventing the County from applying CAP Mitigation Measure M-GHG-1 to approve development[11,12,12].

Policy Design

Common Critiques of Carbon Offsets

Carbon offsets can provide useful flexibility for carbon emitting entities to work toward emissions reductions goals before significant emissions reductions technologies are available for their direct emissions. However, anecdotal, economic, and scientific evidence suggest that carbon offsets may not be a perfect substitute to bridge this gap as the basic theory of offsets suggests. Common critiques of carbon offsets can be grouped into three categories: additionality, accountability, and verifiability. The following section breaks down each of these critiques.

Additionality

The Waxman-Markey Bill (H.R. 2454), a comprehensive environmental bill introduced in 2009 which never passed, defines the term 'additional' in reference to carbon offsets as follows:

> "The term additional, when used with respect to reductions or avoidance, or to sequestration of greenhouse gases, means reductions, avoidance, or sequestration that result in a lower level of net greenhouse gas emissions or atmospheric concentration than would occur in the absence of an offset project."[13]

Proving the 'additionality' of carbon offset projects is challenging and as such, problems of additionality are a common critique of carbon offset policies. For an offset project to function as the policy intends, it must be a project that would not have occurred without the influence of a carbon offset policy. Proving whether a project would occur without a carbon offset policy, in a 'business-as-usual' world, is exceedingly difficult because it cannot be observed and is estimations are rough due to the many competing factors involved and the asymmetry of information between the buyer, seller, and regulator. As a demonstration of how difficult establishing a baseline is, leading institutions like the Intergovernmental Panel on Climate Change (IPCC) rarely reference a single estimate for aggregated emissions projections, but rather provide a variety of scenarios or a range of confidence. Without a known baseline of business-as-usual emissions for every individual firm which adds only more uncertainty, it is impossible to tell exactly which projects would occur without a carbon offset policy and which are truly additional as a result of the policy[14]. The US General Accountability Office (GAO) attempted to determine the effect of the CDM on greenhouse gas emissions but determined that it was nearly impossible due to the uncertainties of additionality[15].

Without addressing the additionality problems, carbon offset policies encounter adverse selection problems that will undermine the no-net-impact goals of offsets[16]. Adverse selection describes a situation where poor incentives and asymmetric information lead to the selection of the lowest quality options[16,17]. Because there is not an accurate business-as usual baseline, one cannot rule out all projects that would occur in the absence of a carbon offset policy. Furthermore, there is an asymmetry of information and incentives between potential offset sellers and regulators. Potential offset sellers know their project well and know whether their project would occur without an offset policy but have an incentive to keep this information secret to seek the added benefits from the offset policy[18]. When a carbon offset policy is introduced to this pool of potential projects, the ones that would have occurred in a business-as-usual scenario are the ones most likely to be developed and take advantage of the carbon offset policy[16,17].

A common policy response to the imperfection of carbon offsets is to limit the number of offsets that can be used[17]. Limiting the number of offsets being purchased on the market exacerbates the adverse selection problem. The lowest quality offsets will be the least expensive and therefore the first to be purchased and developed[16,17].

Accountability

There is a geographic trend in offset projects where most projects are purchased to offset emissions in developed countries with projects occurring in developing countries[19,20,21]. Many view this as mutually beneficial wherein businesses in developed countries gain access to economically viable offset projects and developing countries receive help with conservation, restoration, and sustainable development. Offsets across great geographic distances work theoretically as climate policy because greenhouse gases are well mixed in the atmosphere, meaning that carbon sequestered, or emissions avoided in one part of the world generally have the same positive effects on reducing anthropogenic global warming as they would elsewhere[1]. However, this theoretical framing fails to account for co-benefits of carbon offset projects and other negative externalities associated carbon emitting practices such as local pollution. Moving offset projects geographically distant from emission sources limits any potential benefits wherein those harmed by the negative externalities of carbon emitting activities receive the co-benefits of the offset projects.

Added geographic distance and crossing political borders between those purchasing CERs and the CDM projects they are funding can also decrease the accountability to ensure the projects are beneficial or at least neutral to the surrounding community[17]. Many offset projects make clear efforts at carbon sequestration or emission avoidance and are beneficial or benign to the surrounding communities. However anecdotal evidence shows cases in which particularly poor incentives lead to projects that harm surrounding communities. For example, one Scottish company purchased offsets from a eucalyptus tree planting project in Brazil that drained local water resources and displaced native communities[15]. In another case, Forests Absorbing CO_2 Emissions (FACE), a non-profit that restores forests as carbon offset projects, evicted 6,000 villagers with 9 days' notice from their desired restoration site. The evicted villagers were left homeless with nowhere to graze their cattle. The land they were evicted from was never fully restored15. Projects that cause significant negative externalities less likely to exist when geographically closer to the region demanding carbon offsets as there are more opportunities for whistle blowers in the community to call attention to the effects of the project [22,23].

Verifiability

Carbon offset projects rely on the ability to accurately measure carbon emissions avoided or atmospheric carbon sequestered. Emissions avoided from energy-related projects (such as building solar farms or investing in energy efficiency projects) can be closely calculated using the energy data. However, it is significantly more difficult to calculate the carbon offset by biomass and ecosystem-based projects. Biomass sequestration projects require more time to develop and have more uncertain factors that make them more difficult to estimate than energy-based projects[24,25]. These projects are also most accurately measured using long-term methods to determine the amount of carbon sequestered[24,25]. The variability involved in estimating carbon sequestration rates of natural systems makes determining the number of credits to issue for a project difficult and less accurate.

Misaligned incentives between governments and between developers and regulators add to the difficulty of verifying offset projects. The majority of carbon offset projects are established in developing countries and the even larger majority of the CERs from these projects are purchased in developed countries[20,21,21]. Developing countries that desire the foreign investment in offset project to boost their sustainable infrastructure or aid in conservation or restoration efforts have an incentive to underreport[17]. Underreporting the level of development, restoration, or conservation that would happen without the intervention of an offset project would qualify their country for more investment in CDMs17. Developed countries purchasing CERs from CDMs in developing countries have a complimentary incentive not to question whether developing countries are underreporting the business-as-usual estimates. The underreported numbers provide more supply of cheaper offsets[17]. Similar perverse incentives exist between all offset project developers and carbon credit purchasers[26]. Developers will always have an incentive to overestimate the amount of atmospheric carbon that will be sequestered or emissions that will be avoided by a project to qualify more projects and receive more credits[26]. Purchasers do not have the incentive to check estimates more closely to preserve the supply of cheap offset credits[26]. In both exchanges between governments and between developers and purchasers, regulators have little ability to sort out which projects are truly additional due to the asymmetry of information and the same limited science as offset developers[17,26].

Incentive for Slow Growth in Carbon Reduction Technology

Carbon pricing and offset policies aim to transition economies away from carbon intensive practices by providing carbon emitting entities with alternative venues for meeting emissions reductions in the most economically viable way possible[17]. While offsets do add options for carbon emitting entities, they may also create potentially perverse incentives that limit environmental gains by commodifying emissions reduction of certain types[17]. Allowing for alternatives to direct emissions reductions slows the incentive for switching systems to lower carbon alternatives. Without the option of offsets, carbon emitting entities would have a stronger incentive to change their practices to avoid paying fines or carbon taxes[15].

Economic incentives for specific offset projects may also interfere with projects that may be net better for the environment in the long run[17]. For example, oil drilling often results in leaked methane. With proper infrastructure established, leaked methane can be captured and used as natural gas to fuel activities. However, oil companies like Shell and Chevron have found it more profitable to flare the methane under CDM project guidelines for offset credits[15]. The use of methane as energy would be more sustainable and would be more economically efficient under a direct carbon pricing policy, but carbon offsets has made flaring more profitable.

Effective Policy Design for Carbon Offsets

Despite critiques, carbon offsets are often used as a bridge that provides alternatives to carbon emitting entities that cannot yet reduce their onsite emissions without reducing their activities while they work on direct reduction technologies. As such, carbon offsets are a still a popular policy feature and a reality of our current policy landscape. A thorough understanding of the critiques of carbon offset policies can help inform more effective policy design for policies moving forward. Two options to address the various critiques of carbon offset policies are developing offset projects locally and incorporating trade ratios.

Local Projects

Keeping offset projects local to the activities that they are offsetting helps bridge the gap between the co-benefits of offset projects and the added negative externalities of carbon emitting practices. The theoretical basis of carbon offset policies is that atmospheric carbon is well mixed, so the geography of the projects relative to the emissions source should not matter. However, carbon emitting processes often have other externalities that are not accounted for in the greenhouse gas emissions pricing scheme like particulate matter that stay local[26]. Conversely, carbon offset projects often have co-benefits such as additional energy production, creation of greenspace, or habitat restoration[22,26]. These tradeoffs are not lost on members of communities where carbon offsets or considered nor on the carbon emitting entities considering them. A 2015 study in Mexico showed that both citizens of areas affected by a carbon offset policy and the purchasers of offsets exhibited a preference for the projects to be local at a marginally higher cost when given the option[22]. When asked why, citizens quoted specific co-benefits that they were interested in seeing developed in their community that would make up for negative environmental effects they had experienced[22]. Offset purchasers similarly sited an interest in developing projects co-benefits in their community[22]. For example, a community that had experienced wildfires that caused dangerous air quality in the past volunteered a strong preference for afforestation and other projects they believed would improve air quality[22]. The co-benefits of offset projects do not necessarily offset the specific local externalities that a carbon emitting entity contributes to in the way that the carbon offsets equally counteract their carbon emissions. These projects may still contribute to the advancement of other environmental goals and net improvement of local environment.

The State of California is taking steps toward including local offsets in their carbon pricing policies. Under A.B. 398, the bill that established California's cap-and-trade system, carbon emitting entities covered under the law may use offsets to account for 8% of their emissions reductions from 2013-2020[27]. These offsets must be certified by CARB but have no geographic limitations. California did not include geographic restrictions in this phase of the policy because they believed that the carbon price would cover a significant portion of the economy and limiting the geographic scope of offsets would create a shortage of supply[4]. However, beginning in 2021, carbon emitting entities will only be allowed to use offsets to account for 4% of their emissions reductions and at least half of the offset projects they invest in must take place in the state[27]. This phase of the policy is a significant step toward onsite emissions reductions in the state and keeping co-benefits of offsets local.

Trade Ratios

Policies can be designed to account for 'non-additional' offsets that cannot be easily excluded. One policy design to address this problem is including a trade ratio. A trade ratio discounts offsets to account for additionality and 'low quality' offsets by requiring more units of offsets to account for a single unit of emissions[16]. The CDM under the Kyoto Protocol includes a 95% discount rate meaning a trade ratio of 1.05:1[16]. Research suggests that more than 5% of offsets are likely non-additional meaning that the CDM trade ratio moves carbon offsets under the Kyoto Protocol closer to being truly neutral offsets but is not a completely neutral policy[16]. Offsets in the EU and California programs have a 1:1 trade ratio but limit the percentage of emissions reductions that offsets can account for[18]. The proposed Waxman Markey legislation would have included a more aggressive 1.25:1 trade ratio for offsets[18].

A trade ratio works theoretically by requiring a higher reported sequestration and/or more emissions avoided than an emitting entity will receive in credits. If the trade ratio is calculated appropriately, the ratio matches the proportion of carbon offsets on the market that are not additional, and the additional carbon sequestered and emissions avoided match the amount of emissions the purchasing entity is accounting for exactly[16]. A perfect trade ratio is difficult to calculate as it meets many of the same obstacles to estimating additionality in general. Trade ratios are particularly susceptible to adverse selection problems[16,18]. Because purchasers are required to invest in more projects, the incentive for cheaper, lower quality increase which makes the fraction of low-quality offsets to high quality ones greater[16,18]. Trade ratios should not be a substitute for strong vetting of the quality of offsets but should be an additional method of valuation included regulations. Vetting regulations for their quality and additionality is important to ensure that the supply of offsets is more inelastic and limits adverse selection[16].

Local Carbon Offset Opportunities in San Diego Region

I was unable to find any carbon offset projects in the San Diego region. Furthermore, CARB has not yet approved a Compliance Offset Protocol for wetland restorations to be counted as carbon offsets in California's cap-and-trade program.

Carbon offset projects based in the San Diego region are a valuable opportunity because of the co-benefits generated from local projects and available resources for more thorough monitoring. Local projects are particularly timely given the legal challenges to San Diego County's offset program on the basis that non-local projects are not sufficient and the upcoming addition to the State of California's offset regulations that will require entities investing in carbon offsets to have half of their offset projects be in the state.

Carbon offset projects can take many forms from energy efficiency upgrades, to energy generation, to restoration projects. My analysis focuses specifically on opportunities for wetland restoration in San Diego County. Wetland restorations are outstanding opportunities for carbon offset projects because wetlands are one of the most carbon dense ecosystems[28,29,30,31,32], provide many local co-benefits[†] and there are many opportunities for restoration wetlands are lost at a higher rate than almost any other ecosystem at up to 3% of total wetlands lost per year[28]. Wetlands are lost at such high rates because wetlands can be repurposed as highly productive agricultural lands and are often on coastlines that are highly valued for development[28]. It is more likely for wetland restorations to be truly additional offset projects because wetlands often have more profitable alternative uses. Wetland restorations also have risks of being non-additional due to other incentives to restore wetlands such as California's wetland mitigation banking credits[33]. However, records of these credits may improve ability to assess additionality and wetland restoration projects are more likely to be additional than many other projects due to the abundance of other uses for wetlands such as beachfront property or productive agricultural land [28,34,35].

Analysis

Using data from the National Oceanic and Atmospheric Association (NOAA)[36] and the San Diego Association of Governments (SANDAG)[37], I identified wetlands that were already in areas zoned to qualify for restoration and wetlands within a quarter mile of those that were not already zoned to qualify for restoration. Wetlands that were already zoned to qualify for restoration are defined as the portion of wetlands that are within zoning areas S80, defined as "Open Space – intended for recreation areas or areas with severe environmental constraints"[38]. For the purpose of this analysis, I excluded all sites zoned as open space regardless of restoration status as a measure to increase the confidence in additionally of all identified sites. I found wetlands within a quarter mile of those already zoned for restoration using a buffer analysis. Wetlands within a quarter mile of wetlands already zoned for restoration should be the lowest hanging fruit for new restoration projects as they are either connected to wetlands already eligible for restoration resources or extremely geographically close. After finding wetlands zoned for restoration and those within .25 miles of the wetlands zoned for restoration, I overlaid NOAA data for coast line changes with 1.83 meters (6 feet) of sea level rise. It is important to incorporate a scenario of 6 feet of sea level rise as a conservative estimate of sea level rise within

[†] Wetlands provide benefits to local communities including flood protection, streambank and shoreline protection, water quality improvements for surrounding bodies of water, stormwater management, greenspace, and tourism and recreation[43,44].

the next 100 years as estimated by the Center for the Blue Economy[39] because CARB's definition for permanence of carbon sequestration is that carbon must be stored for at least 100 years. Figure 1 shows an example of a wetland in Encinitas that is vulnerable to sea level rise. I eliminated this site and all wetlands vulnerable to sea water intrusion from this analysis as sea water intrusion into a freshwater wetland will change the dynamics and carbon sequestration of a wetland.

The remaining wetlands were all freshwater emergent wetlands or freshwater forested/shrub wetlands[‡]. Figures 2 and 3 show the five largest potential restoration sites for freshwater emergent wetlands and freshwater forested/shrub wetlands by acreage. Because all ten potential restoration sites are freshwater wetlands, it is important to note that freshwater wetlands are known to emit significant amounts of methane[46]. Methane has a significantly stronger global warming potential than carbon dioxide[47]. Carbon sequestration by a wetland should be discounted by the amount of methane and other greenhouse gases released by a wetland project. This analysis does not include an assessment of greenhouse gases released by the sites identified and only estimates carbon sequestration.

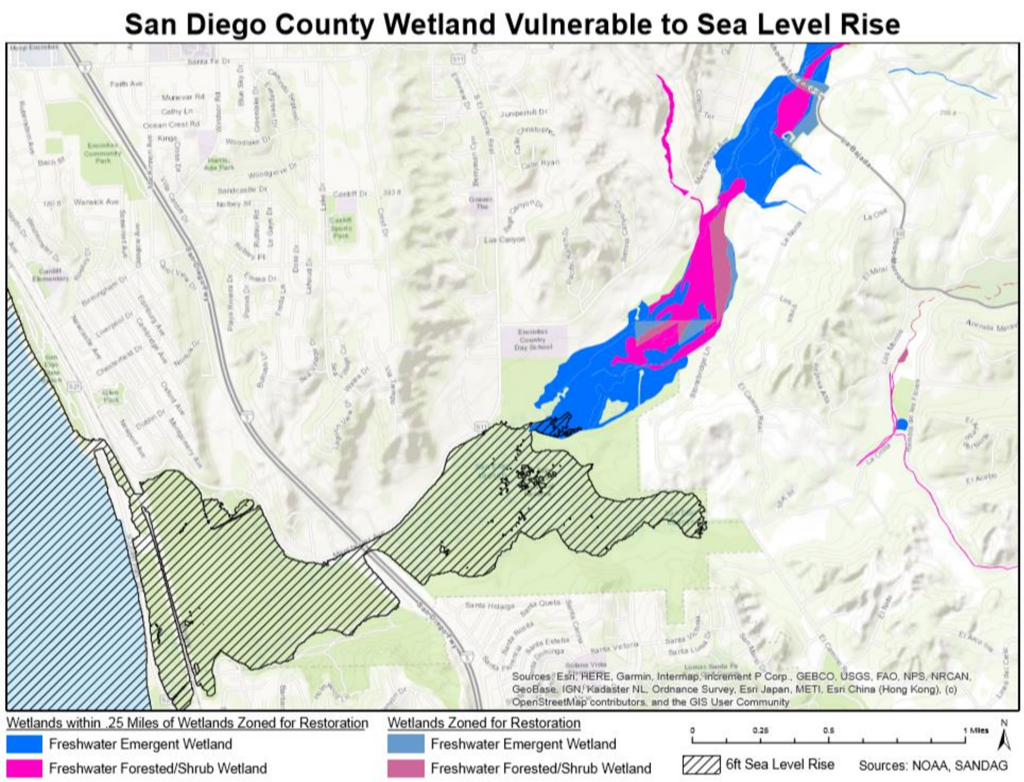

Figure 1: San Diego County Wetland Vulnerable to Sea Level Rise. Based on a Center for the Blue Economy estimate of sea level rise in the San Diego region and NOAA sea level rise data, this Encinitas wetland is vulnerable to the effects of sea level rise in the next 100 years. This wetland was excluded from further analyses.

‡ Freshwater emergent wetlands are areas that are flooded with freshwater for the majority of the year and are characterized by emergent, herbaceous plants. Freshwater emergent wetlands are sometimes also called riverines, lacustrine, or cattail-sedges[45]. Freshwater forested/shrub wetlands are similarly flooded by freshwater for the majority of the year but are characterized by larger trees and woody plants.

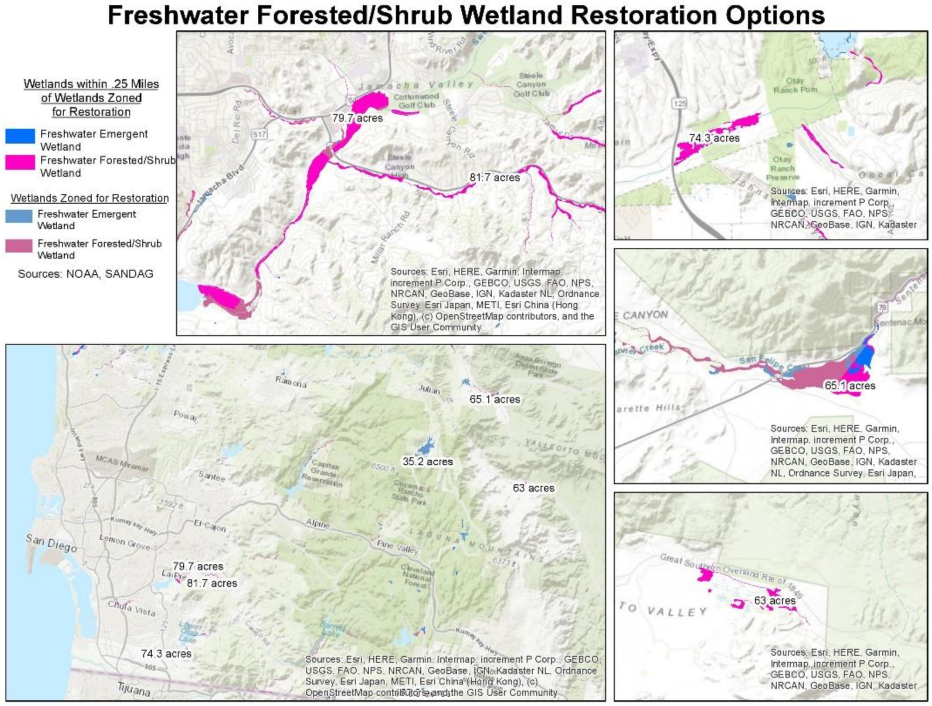

Figure 2: Freshwater Forested/Shrub Wetland Restoration Options. This map displays the locations of the 5 largest potential freshwater forested/shrub wetland restoration sites by acreage. The map in the bottom left shows the locations in the county and the surrounding maps detail specific sites.

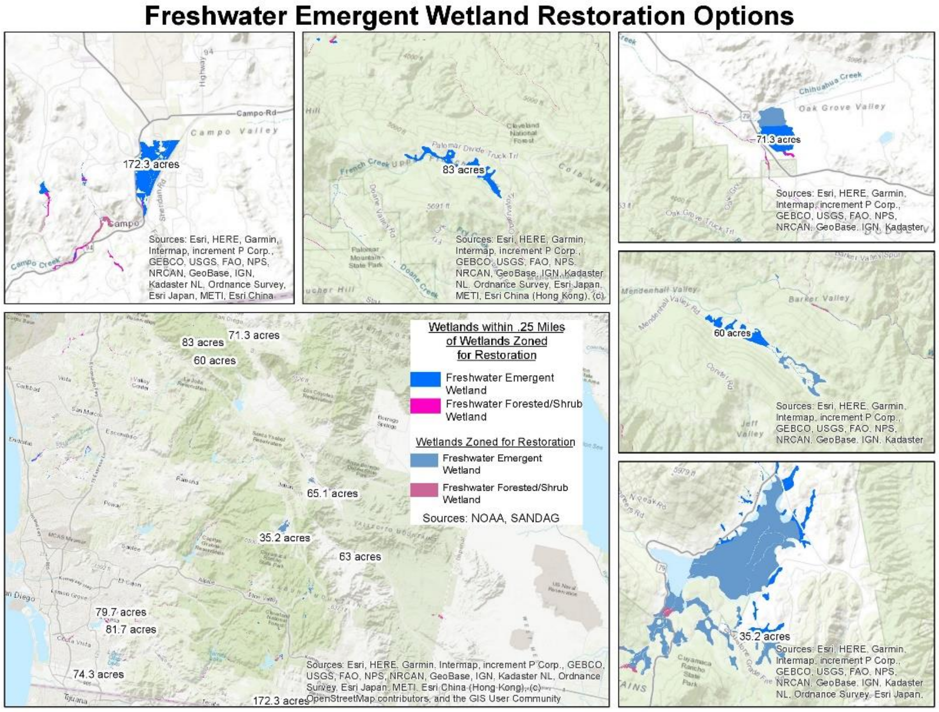

Figure 3: Freshwater Emergent Wetland Restoration Options. This map displays the locations of the 5 largest potential freshwater emergent wetland restoration sites by acreage. The map in the bottom left shows the locations in the county and the surrounding maps detail specific sites.

Carbon sequestration by wetlands is best measured over long time periods and is affected by factors including dominant vegetation, tidal dynamics, and climate[25,40,41]. These measurements do not currently exist for the particular wetlands identified. Additionally, there is no CARB Compliance Offset Protocol defining how wetlands can be restored and their sequestration rates calculated to meet CARB standards. To estimate the carbon that could be sequestered by implementing these projects I reviewed papers that used long term measurements to observe sequestration rates for wetlands from with similar vegetation, tidal dynamics, and from similar climates and used the most conservative measurements. Based on a measurement from an emergent wetland in California with dominant vegetation that is also commonly found in the San Diego region[42], I estimate that freshwater emergent wetlands will accumulate carbon at a rate of 105g C/m^2/year[31]. Data on forested/shrub wetland in similar climates with similar dominant vegetation is lacking. Based on average observations from Ohio forested and shrub wetlands[30] and observations that carbon density in freshwater wetlands in the Midwestern and Western regions are similar[29] that freshwater forested/shrub wetlands will accumulate carbon at a rate of 337.5 g C/m^2/year[30]. These carbon accumulation rates were used only to estimate potential carbon accumulation rates of the wetlands identified. Onsite observations should be gathered before issuing carbon credits.

Results and Discussion

Table 1 combines the data from the analysis of the wetlands most eligible for restoration and literature review to estimate the opportunities for carbon offset projects in the San Diego Region. If the top five largest wetlands in close radius to those already zoned for restoration were restored, they could sequester an estimated 744 tons of carbon each year providing as many permits for carbon offsets. These figures are rough estimates that should be updated with actual observations from the region before administering permits, but show the order of magnitude of opportunity for local wetland restoration carbon offset projects in San Diego County. These figures also do not account for methane and other greenhouse gases that would be released by these sites that would reduce their eligibility for carbon credits. 744 tons of carbon offsets is a low number compared to the demand for offsets in the San Diego Region. For example, the San Diego International Airport, which is interested in offsetting emissions, claims approximately 19,000 tons of direct carbon emissions. The UC System is currently looking to develop local carbon offset projects to account for its 250,000-500,000 tons of carbon emissions.

Wetland Type	Acres in SD Region Near Wetlands Eligible for Restoration	Estimated Carbon Accumulation Rate	Offset Opportunities
Freshwater Emergent Wetland	421.8 acres	105 g C/m^2/year	197 tons C/year
Freshwater Forested/Shrub Wetland	363.8 acres	337.5 g C/m^2/year	547 tons C/year
Totals	785.6 acres		744 tons C/year

Table 1: This table shows the combined results of an analysis of low hanging fruit for wetland restoration sites and their estimated carbon accumulation rates to determine the offset opportunities from wetland restoration in the San Diego region.

Recommendations

Incorporate Trade Ratios into Offset Policies

Trade ratios help to account for low quality offsets that cannot be filtered out through other vetting processes. The Clean Development Mechanism under the Kyoto Protocol incorporates a small trade ratio of 1.05:1, however California's cap-and-trade program and the County of San Diego's proposed offset policy in their Climate Action Plan do not. Incorporating a conservative trade ratio on non-local can help increase the integrity of the State of California and County of San Diego's offset policies. Because offsets taking place far from the activities that they are offsetting are the most difficult to monitor, introducing a trade ratio on non-local offsets first may help increase their veracity. Introducing a trade ratio first on non-local offsets or a more aggressive trade ratio on non-local offsets will also increase their price. Local offsets are often not considered because they are more expensive than non-local projects. Such a policy could even the playing field and help aid investment in local offsets which are more easily verifiable and keep co-benefits close to the emissions sources.

Calculating an adequate discount rate for an offset trade ratio is difficult because it requires estimating the proportion of non-additional offsets which cannot be observed. More accurate estimates can be made for specific types of offsets than for offsets as a whole. California State offset policy is already broken down by project type by the requirement to use CERs for offset projects to qualify for offset credits. The State of California has the opportunity to incorporate more specific trade ratios defined with each CER. However, multiple trade ratios for different offset policies may also make policy more complex where requirements are not already specified by project type. San Diego County and voluntary offset registries may incorporate a trade ratio that reflects an average of the additionality risk in all offsets. Research suggests that this average would be greater than the 1.05:1 ratio in the Kyoto Protocol, however the inclusion of any trade ratio will be an improvement.

Include Local Requirements in San Diego County Offset Policies

San Diego County is currently facing a legal challenge from the Sierra Club to a policy in their Climate Action Plan that allows for carbon offset projects from anywhere in the world to offset local development. The judge issued a preliminary injunction and stay on the policy until it can be heard in court on the basis that the offsets would be unverifiable. San Diego County can update the policy to require all or a portion of the offsets to take place in the San Diego region. The county might also enforce a hierarchical approach where those looking to purchase offsets must document attempts to establish offsets in the region first before looking elsewhere. Keeping offset projects in the San Diego region will make monitoring projects easier and more reliable.

While wetland restorations may not be an adequate match for the demand for offsets in the San Diego Region, there are many other local offset projects that can be explored. Exploring other options for local projects is important because keeping offsets local will also keep the co-benefits of the offset projects local. The Sierra Club was motivated to sue the county by a concern that relaxed offset regulations would lead to low quality offsets and sprawl that would harm natural, undeveloped areas. Requiring carbon offset projects to be local would limit the available supply of offset credits which would limit the amount of sprawl. Keeping carbon offset projects local would also provide an influx of funds for valuable environmental projects that could restore local lands and help make any further development more sustainable.

Develop Local Options with Offset Registries

Entities that are not required to offset emissions under neither California's cap-and-trade program nor San Diego County's offset regulations can participate in voluntary offset programs. Emitters that participate in voluntary offset programs are motivated by their own desire to make their business activities more sustainable rather than regulation and as such have a greater vested interest in verifying that they are investing in the best option they can. Research has shown that both citizens and emitters understand that investing in local projects keeps the valuable co-benefits of these projects local and further that when given the choice, they prefer to invest in local projects. Working with carbon offset providers like the Good Traveler Program which works with the San Diego International Airport to provide offset options for individual flights and common voluntary offset registries like American Carbon Registry, Climate Action Reserve, Verra, and Gold Standard to provide local options in the San Diego region at a premium rate can help increase investment in local projects. Building interest in carbon offset projects in the San Diego Region is also timely as demand for offsets in California will increase in 2021 when entities covered under the cap-and-trade program will be required to have half of their offsets come from projects in the state.

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