ADDITIONALITY, PERMANENCE, AND LEAKAGE: COMPARING FOREST CARBON OFFSET PROGRAMS UNDER THE CLEAN DEVELOPMENT MECHANISM AND THE CALIFORNIA CAP AND TRADE PROGRAM

Changfeng Lu

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SUPERVISORY COMMITTEE APPROVAL

of a dissertation submitted by

Changfeng Lu

This dissertation has been read by each member of the following supervisory committee and has been found to be satisfactory.

4/2/20 Jonathan Cannon

DATE

Chair: Jonathan Z. Cannon, Blaine T. Phillips Distinguished Professor of Environmental Law

4/2/20 William Shobe / JZC

DATE

Reader #1: William Shobe, Professor of Public Policy

4/2/20 Michael A. Livermore / JZC

DATE

Reader #2: Michael A. Livermore, Edward F. Howrey Professor of Law

Abstract

Climate change has had increasingly severe effects over the last few decades. Market-based approaches, such as cap and trade programs, have been applied worldwide to combat climate change. To lower the cost of emission reductions still more, many cap and trade programs accept carbon offsets. My dissertation focuses on forest carbon offset programs because forests play a vital role in the world's carbon cycle. My research compares the forest carbon offset programs under two separate compliance mechanisms, the Clean Development Mechanism (CDM) and the California Cap and Trade Program. I assess how each program treats the critical issues of additionality, permanence, and leakage. I aim to determine which program is more effective at addressing these issues and producing sound forest projects. Moreover, as carbon markets can be involved in larger environmental credit markets, my dissertation also analyzes the ways that these markets' funding activities benefit soil, water, and wetlands, since carbon markets can interact with other environmental credit markets through credit stacking.

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Chapter 1

Introduction

The term "climate change" refers to a rise in the average surface temperature of the earth. It is also called "global warming." The change results from the increasing aggregation of greenhouse gases in the atmosphere. Since the Industrial Revolution, human activities have played a primary role in climate change. Recently, the topic of climate change has attracted increased public attention, appearing frequently in journals, magazines, and other news sources, and has given rise to heated debates. There is not much doubt about the fact that the earth is warming. As the Intergovernmental Panel on Climate Change (IPCC) has stated, "scientific evidence for warming of the climate system is unequivocal."[1] Phenomena such as rising global temperatures, warming oceans, shrinking ice sheets, glacial retreat, decreased snow cover, rising sea levels, declining Arctic sea ice, extreme weather events, and the increased acidity of the oceans,[2] all indicate that the globe is warming. In addition, observation data have confirmed that the earth is on a path toward a warmer climate.

However, people cannot agree on whether we need to combat that change right now. Some people argue that the current climate change is part of a natural cycle in the earth's

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[1] *Climate Change Evidence: How Do We Know?*, NASA Global Climate Change, https://climate.nasa.gov/evidence.
[2] *Id*.

climate, so there is no need for human intervention. Some others, while granting that it is necessary to mitigate climate change, maintain that the future generations may be in a better position to deal with it because they will be smarter and have more resources. Still others believe that people must act immediately to tackle climate change before global temperatures reaching a tipping point that will lead to an irreversible path of extreme warming.

Despite the controversy, one thing is certain – climate change might have disastrous consequences for the human race. With so much at stake, many countries have begun to control their greenhouse gas emissions, because these contribute to climate change. The Kyoto protocol of 1997 marked the start of global efforts to combat climate change. Limiting greenhouse gas emissions is not an easy task, and it demands an enormous amount of money. To cut costs, many countries have implemented cap and trade programs, also called "emission trading programs." Typically, under a cap and trade program, a country sets a cap on the total amount of greenhouse gas emissions that it allows its industries, then gradually reduces it. Each facility may emit in accordance with its allowances, which countries allocate to them for free or which they obtain through auction. They can trade these allowances; thus facilities whose emission reduction costs are low can cut more than their required emissions and sell their surplus allowances, while facilities for which doing so is costly can buy these allowances to offset their emissions, rather than making direct reductions. In this way, the cap and trade programs allow economical reductions in greenhouse gas emissions.

The United States initially adopted a cap and trade program as an economic way to reduce sulfur dioxide emissions from its coal-fired power plants. The Clean Air Act of 1990 established the first national cap and trade program in the U.S., the "Acid Rain Program" (ARP), using allowance trading to control sulfur dioxide emissions. This market-based method proved to be successful. With a gradually decreasing cap and free trade of allowances among facilities, the ARP achieved its emission reduction goals at a low cost. Through allowance trading, facilities with high abatement costs purchased allowances from emitters that generated allowances with low costs, resulting in a decrease in the overall costs of achieving the emission reductions. The success of the ARP led the United States to promote the application of the same kind of cap and trade program to the area of greenhouse gas emissions during the negotiations for the Kyoto Protocol.

To lower costs still more, countries and states have introduced a mechanism called "carbon offset" into many cap and trade programs. The basic idea is that some unregulated sources have the ability to reduce their emissions at a cost even lower than regulated sources with the lowest abatement costs. For example, the emissions reduction that a hydroelectric power plant creates when it replaces a coal power plant in a developing country usually comes at a lower cost than that of a coal power plant's reductions. The CDM issues offset credits for this hydroelectric power plant project, and facilities in developed countries can purchase these credits to compensate for their emissions. Therefore, by applying a carbon offset, these unregulated sources can use their reductions to compensate for the emissions of regulated sources at a lower cost, which further reduces the overall costs of achieving emission reductions.

In practice, offset programs accept a variety of sources with the potential to reduce greenhouse gas emissions economically. One of these sources is the forest project. I chose forest offset programs as my area of research because forests play a significant role in the carbon cycle. Each year, forests absorb 30% of all man-made greenhouse gas emissions globally. At the same time, however, forests account for nearly 17% of the world's annual greenhouse gas emissions. In addition to carbon storage, forest projects generate co-benefits to the environment, such as soil and water protection, and biodiversity, as well as social benefits, including community involvement, climate adaptation, and job creation.

This dissertation compares forest carbon offset programs under the CDM and the California Cap and Trade Program, aiming to determine which program is better. The CDM is by far the largest carbon offset market in the world, having registered about 8,000 projects since its inception. The California program, operating in the technology hub of the world, is well known for the advanced technology that it has incorporated. I chose to research these programs because they represent two types of offset programs. The CDM uses a project-based approach, under which each project submits documents, including specific project information, to prove that the project has met certain requirements. In contrast, the California program adopts a standardized approach, under which the program provides standardized quantitative methods, so that with basic project data one can easily generate the required information.

My research will focus mainly on three critical issues of forest offset programs – additionality, performance, and leakage. “Additionality” means that the offset project should be additional; it would not have come into existence without funding from an offset program. In other words, financial support from the offset program allows the project’s existence. “Permanence” literally means that the emission reductions should be permanent. Since trees do not store carbon forever, but eventually release it, programs must take measures to ensure that each forest project will compensate for this inevitable reversal. “Leakage” refers to the situation in which emissions within a project’s boundaries shift to other locations. A simple example occurs when the trees in one project site are protected for the purpose of offset credits, but trees in other locations are cut for the original purpose, leading the supposedly reduced emissions to occur in locations outside the project site.

In addition to assessing forest offset programs under the CDM and the California program, I will analyze the co-benefits of forest projects and environmental credit markets’ funding activities that benefit the soil, water, and wetlands, because carbon markets might be involved in the larger environmental credit markets, interacting with other environmental credit markets through credit stacking. I have structured my dissertation as follows:

Chapter 2 will introduce the background of forest carbon offset programs. I will briefly describe the hotly debated topic of climate change and how it gained momentum worldwide. Then I will elaborate on the global efforts to combat climate change. Finally, I will introduce forest carbon offset programs and their current status under the CDM and the California program.

Chapter 3 will assess the additionality of forest offset projects under the CDM and the California program. For the CDM, I will examine every forest project that it has registered so far, mainly looking at the project documents of each one. I will not focus on the project documents for the California program because the program's use of standardized methods renders them largely similar one to another. Instead, I will examine the content of its forest protocol, the process by which it adopted that protocol, the legal challenges to California program, some scholars' research on the additionality of California forest offset program, and its implementation procedures.

Chapter 4 will analyze the different methods that the two programs employ to address the issue of permanence. First, I will analyze the CDM's approach to permanence and explain why this method decreases the attractiveness of its forest projects. Then, I will analyze the way that the California program ensures that forest carbon sequestration will be permanent.

Chapter 5 will evaluate how the two programs address leakage in forest projects. I will evaluate the CDM's leakage estimation tool and will examine every registered forest project that applies this tool. Since the CDM relies on a project-based approach, it is worth understanding how each used it. Regarding the California program, I will assess three approaches that the three types of projects in the program use. Again, I have not spent much time on the project documents of registered forest projects under the California program because the usage of a standardized approach results in simple and standardized project documents.

Chapter 6 will describe the co-benefits of forest projects and will analyze environmental credit markets. I will briefly present three main benefits to the environment – soil, water, and biodiversity. Then I will introduce the environmental credit markets that use market-based methods to promote various conservation activities. Finally, I will address the hotly debated issue of credit stacking.

Chapter 7 will present the dissertation's conclusion, summarizing the comparisons of forest offset programs under the CDM and the California program in terms of additionality, permanence, and leakage, and the co-benefits of forest projects.

Chapter 2

Background

2.1 Introduction

This chapter describes the background of forest carbon offset programs. Climate change is getting worse, and in response, countries around the world have adopted cap and trade programs that aim to reduce greenhouse gas emissions. The cap and trade program as a market-based mechanism can lower the costs of mitigating climate change. Carbon offsets can further cut these costs. Forests play a vital role in the global carbon cycle. This makes forest carbon offsets a significant part of global efforts to combat climate change. Here I present the background information that supports these concepts.

I have organized this chapter as follows: Section 2.2 briefly introduces climate change and its current severity. Section 2.3 describes global efforts to mitigate climate change, from the recognition of this issue to the corresponding measures that the United Nations and individual countries have taken. Section 2.4 discusses the carbon offsets that countries have introduced to lower the cost of climate change mitigation, mainly focusing on the CDM and the California Cap and Trade Program. Section 2.5 points out the significant role of forests in climate change mitigation. Section 2.6 extends carbon offsets to forests, introducing forest carbon offset programs under the CDM and the California program.

2.2 Climate Change

Climate change refers to a rise in the average surface temperature of the earth. Greenhouse gases in the atmosphere affect the climate on earth. Sunlight passes through the atmosphere and heats the planet, which then radiates that heat back to space. Atmospheric greenhouse gases trap part of that heat, which in turn warms the earth's surface. This process is known as the "greenhouse effect." Scientists have increasingly linked climate change to extreme weather, such as tornados, although they have not been able to establish a causal relationship because the data are still limited. We can already observe some of the impacts of global warming — glacial ice is melting; the numbers of many species are dwindling; the sea level is rising; some animals and plants are shifting ranges; floods are increasing in frequency and severity; and some invasive species are thriving.[3]

Human activities, such as burning fossil fuel, deforestation, and farming, seem to be contributing to climate change. We can date the inception of the massive discharge of anthropogenic greenhouse gases back to the Industrial Revolution that started in Britain in the 18th century, and then spread to other parts of the world. However, climate change

[3] *Global Warming Effects*, National Geographic (Jan. 14, 2019), https://www.nationalgeographic.com/environment/global-warming/global-warming-effects/.

did not draw public attention until recent decades. It was only in 1957 that the U.S. Weather Bureau began monitoring atmospheric carbon dioxide levels.[4] One year later, an observatory in Mauna Loa, Hawaii, started to measure carbon dioxide concentration.[5] This observatory recorded a mean level of 316 parts per million (ppm) in 1959, which was above 300 ppm, the highest carbon dioxide concentration discovered in a 420,000-year-old ice-core.[6] Since then, the carbon dioxide concentration level has experienced steady growth. It reached 380 ppm in 2008 and surpassed 400 ppm in 2013.[7] It is evident that climate change has become increasingly severe.

2.3 Global Efforts to Combat Climate Change

As one of the most significant challenges the human race has ever faced, climate change is a global issue, because greenhouse gasses have the same effect on the planet no matter which country discharges them. To illustrate, a ton of carbon dioxide released from the United States has the same greenhouse effect on earth as a ton released from China. Thus, to combat climate change effectively, all countries must limit their greenhouse emissions simultaneously. If some major emitters do not restrain their emissions, it will be difficult to achieve the desired result, even if others do. For this reason, global collaboration is

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[4] *Carbon Dioxide: One Year - 2012*, National Oceanic and Atmospheric Administration, https://sos.noaa.gov/datasets/carbon-dioxide-one-year-2012/.
[5] Eric T. Sundquist & Ralph F. Keeling, *The Mauna Loa Carbon Dioxide Record: Lessons for Long-Term Earth Observations*, *in* 183 GEOPHYSICAL MONOGRAPH SERIES 27 (Brian J. McPherson & Eric T. Sundquist eds., 2009).
[6] Massachusetts v. E.P.A., 549 U.S. 497, 507 (2007).
[7] *Monthly Average Mauna Loa CO2*, ESRL Global Monitoring Division, https://www.esrl.noaa.gov/gmd/ccgg/trends/full.html.

necessary in order to ameliorate the negative effects of global climate change. However, different countries have made different historical contributions to the climate change that we are now experiencing. They also vary in their development levels, economic situations, geographic locations, and other dimensions of national interest. Given these differences, it has been challenging to bring all nations together to combat climate change.

2.3.1 IPCC

Climate change first came to global attention in the 1970s. In 1988, the World Meteorological Organization and the United Nations Environment Programme established a scientific intergovernmental body — the Intergovernmental Panel on Climate Change (IPCC) — with the goal of assessing evidence on climate change and its impact. In 1990, shortly after its establishment, the IPCC released its first assessment report, concluding that "emissions resulting from human activities are substantially increasing the atmospheric concentrations of . . . greenhouse gases [which] will enhance the greenhouse effect, resulting on average in an additional warming of the Earth's surface."[8] After that, concern about climate change began to gain momentum worldwide. The IPCC issued additional comprehensive assessment reports in 1996, 2001, 2007, and 2013, all with the same message.

2.3.2 UNFCCC

[8] *Massachusetts v*, 549 U.S. at 508–9 (citing IPCC, Climate Change: The IPCC Scientific Assessment, p xi (J. Houghton, G. Jenkins, & J. Ephraums eds. 1991).

As the threat from climate change gradually escalated, countries around the world gathered in Rio de Janeiro in 1992, to negotiate an international environmental treaty that would limit global greenhouse gas emissions. The eventual result of this was the "United Nations Framework Convention on Climate Change" (UNFCCC). The UNFCCC aims at "stabiliz[ing] greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system."[9] The UNFCCC itself does not set any binding emission limit of greenhouse gases for its member countries; it is legally non-binding. Instead, it prescribes rules for the negotiation of binding agreements, known as "protocols," for reducing greenhouse gas emissions. On 12 June 1992, 154 countries signed the UNFCCC, and it came into force in 1994. The number of parties to it grew to 197 by December, 2015.

To achieve the aim of the UNFCCC, the parties to it signed the Kyoto Protocol in 1997. This went into force in 2005. Currently, the number of parties to the Protocol stands at 192.[10] The United States signed the Protocol but has not ratified it. The UNFCCC divides countries into two categories, Annex I and Non-Annex I Parties. Annex I Parties are industrialized countries and countries with economies in transition, while Non-Annex I Parties are mainly developing countries.[11] The key feature of the Kyoto Protocol is that it requires Annex I Parties to reduce greenhouse gas emissions, while Non-Annex I Parties

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[9] The United Nations Framework Convention on Climate Change, Article 12 (1992).
[10] *The Kyoto Protocol - Status of Ratification*, United Nations, https://unfccc.int/process/the-kyoto-protocol/status-of-ratification.
[11] *Parties & Observers*, United Nations, https://unfccc.int/parties-observers.

only need to report their emissions. After finishing the first commitment period (2008–2012), four Annex I Parties, Canada, Japan, New Zealand, and Russia, chose not to participate in the second commitment period (2013–2020). The Protocol covers six main greenhouse gases — carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF6).[12] For Annex I Parties, the Protocol sets the binding target of a 5% reduction in greenhouse gas emissions from 1990 levels in the first commitment period, which ran from 2008 to 2012.[13] In 2012, these Parties adopted the Doha Amendment to the Kyoto Protocol, agreeing that the second commitment period would run from 2013 to 2020.

The Kyoto Protocol introduced a market-based approach — emission trading, also called a cap and trade program — to control greenhouse gas emissions. Usually, under a cap and trade program, a country sets a cap on the total amount of greenhouse gas emissions that it allows its industries as a whole to discharge. Each facility must hold allowances to justify its emissions. Governments allocate allowances for emissions to industries through auction or for free, and a facility that does not use all of its allowances may trade them. The cap and trade program is an economical way to reduce greenhouse gas emissions because facilities that can reduce their emissions at a low cost can cut more emissions than their regulatory obligation and sell their surplus allowances to other

[12] *Kyoto Protocol - Targets for the first commitment period*, United Nations, https://unfccc.int/process-and-meetings/the-kyoto-protocol/what-is-the-kyoto-protocol/kyoto-protocol-targets-for-the-first-commitment-period.
[13] The United Nations Framework Convention on Climate Change, *supra* note 9, Article 3.

facilities, while facilities for which doing so has a high cost can buy allowances to offset their emissions rather than make direct reductions.

In addition to the emission trading, the Kyoto Protocol established two additional flexible mechanisms that would allow industrialized countries to cut the costs of achieving their target reductions. These are the “Joint Implementation” (JI) and the “Clean Development Mechanism” (CDM). Both the JI and the CDM are carbon offset programs, generating offset credits that industrialized countries can use to meet their Kyoto commitments. While the JI allows an industrialized nation to reduce emissions in other industrialized countries as an alternative to domestic reduction, the CDM spurs industrialized countries to invest in emission reduction projects in developing countries.

The parties to the UNFCCC adopted the Paris Agreement on December 12, 2015, and it went into force on November 4, 2016. The Paris Agreement represented the first global efforts by both developed and developing countries to combat climate change and adapt to its effects.[14] As of July 2019, 195 countries had signed the agreement, and of these, 186 have ratified and become parties to it.[15] The goal of the Paris Agreement is to keep the increase in global average temperature less than 2 ℃ above pre-industrial levels and

[14] *The Paris Agreement*, United Nations, https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement.
[15] *Status of Treaties*, United Nations Treaty Collection, https://treaties.un.org/pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XXVII-7-d&chapter=27&clang=_en.

to limit the temperature increase to 1.5 ℃.[16] Under the Agreement, each party can determine its contribution to the global response to climate change, but the contribution must show “ambitious efforts,” which “represent a progression over time” and are able to “achieve the purpose of this Agreement.”[17]

2.3.3 Specific Countries

After the ratification of the Kyoto Protocol, many countries began to control their domestic greenhouse gas emissions. Although the United States has not ratified the Protocol, some states have nonetheless started to take measures to limit emissions. Since developing countries are not obliged to limit their emissions under the Kyoto Protocol, I will not describe the situation in these countries. Instead, in the following sections, I will present what happened in European countries and the United States.

2.3.3.1 European Union

European Union countries jointly agreed to fulfill their commitments under the Kyoto Protocol, making them its main advocates. To achieve the Protocol’s goals, the Europe Union launched the European Union Emissions Trading System (EU ETS) in 2005, the first and largest greenhouse gas emission trading program in the world. Adopting a market-based approach, the EU ETS serves to reduce greenhouse gas emissions cost-

[16] Paris Agreement, Article 2 (2015).
[17] *Id.* Article 3.

effectively for member states. The EU ETS operates in 31 countries, including all 28 EU countries plus Iceland, Lichtenstein, and Norway, and covers heavy energy-using installations and airlines operating in these countries.[18] The EU countries divided the implementation of the EU ETS into certain trading periods. The first trading period, a trial commitment period, lasted from 2005 to 2007, and the second, from 2008 to 2012. Together these cover the same amount of time as the Kyoto Protocol's first commitment period. The current third trading period began in 2013 and will end in 2020, matching the Kyoto Protocol's second commitment.

2.3.3.2 United States

The United States actively participated in the negotiation of the Kyoto Protocol and subsequently signed it, but eventually, the U.S. Congress refused to ratify it. So the U.S. has not established a national scheme for reducing greenhouse gas emissions. However, some states have taken individual action in this area, as I will discuss below. Others have established regional cap and trade programs to limit emissions of greenhouse gases.

2.3.3.2.1 RGGI

In 2005, several northeastern states took the lead, establishing the "Regional Greenhouse Gas Initiative" (RGGI), with the goal of reducing carbon dioxide emissions. It was the

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[18] *EU Emissions Trading System (EU ETS)*, European Commission, https://ec.europa.eu/clima/policies/ets_en.

first mandatory cap and trade program in the United States. Initially, ten states joined the RGGI –Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont. New Jersey left the program in 2011. The RGGI covers only the power sector, requiring fossil fuel power plants with certain capacities to obtain allowances for carbon dioxide emission. As a market-based program, the RGGI allows power plants to obtain allowances through auction and trade, and to use offset credits to meet their obligations under the program.

2.3.3.2.2 California Cap and Trade Program

California took action shortly after the launch of the RGGI. In 2006, the California legislature passed the "Global Warming Solutions Act of 2006." Also called "Assembly Bill 32" (AB 32), it required the state to reduce its greenhouse gas emissions to 1990 levels by the year 2020. The Act requires the California Air Resources Board (ARB) to adopt regulations and market mechanisms to achieve this goal. The ARB adopted a cap and trade program as one of its market mechanisms. It launched the program on January 1, 2012, and set the beginning of compliance obligation for one year later, January 1, 2013. The California program covers large electric power plants, large industrial plants, and fuel distributors.[19]

[19] *California Cap and Trade*, Center for Climate and Energy Solutions (Oct. 5, 2017), https://www.c2es.org/content/california-cap-and-trade/.

The goal of the California Cap and Trade Program was to reduce emissions from covered entities by more than 16% during the period from 2013 to 2020.[20]

2.4 Carbon Offsets

A cap and trade program is an economic way to reduce greenhouse gas emissions. To lower the cost still further, countries and states have introduced carbon offsets into their cap and trade programs. Carbon offsets are reductions of greenhouse gas emissions that compensate for emissions made elsewhere. Generally, the regime allows regulated entities that bear the obligation to limit their emissions under cap and trade programs to purchase carbon offsets as a way to meet their compliance obligations. For example, a power plant under a cap and trade program must reduce its greenhouse gas emission, but the cost of installing equipment for the purpose of emission reduction is expensive. Instead of reducing its own emission, the power plant may purchase carbon offset credits from offset projects, and use these credits to compensate for its emission, thus meeting its obligation under the cap and trade program. The program is cost-effective because the offset projects can reduce their emissions at a lower cost.

In fact, the main advantage of the carbon offset is its cost-effectiveness. Low-cost projects outside of a cap and trade program can generate carbon offset credits that will

[20] *Id*.

significantly lower the cost of implementing the program.[21] Hence, regulated entities that use carbon offset credits to fulfill their obligations directly benefit from the low prices of these offset credits. Other regulated entities that do not use offset credits also benefit. This is because when these offset credits become available, the demand for allowances (which allow a certain amount of emission) decreases, and the prices of allowances fall accordingly.[22] EPA studies reveal that international offsets can drive down domestic allowance prices. In its analysis of the Waxman-Markey bill that the House passed in 2009, the EPA indicated that domestic allowance prices could increase by 89% were it not for the use of international offsets.[23] The EPA's 2010 modeling of the Kerry-Lieberman American Power Act showed that domestic allowance prices could rise between 34 and 107% without the involvement of international offsets.[24]

The carbon offset plays a role in two types of carbon market — the compliance market and the voluntary market. The compliance market is "created and regulated by mandatory national, regional, or international carbon reduction regimes."[25] The JI, CDM, EU ETS, RGGI, and California Cap and Trade Program are all such carbon reduction regimes. The voluntary market "functions outside of the compliance market,"[26] allowing individuals,

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[21] Tatsutani, Marika and Pizer, William A., *Managing Costs in a U.S. Greenhouse Gas Trading Program: A Workshop Summary*, RFF Discussion Paper No. 08-23 (2008).
[22] Raphael Trotignon, *Combining Cap-and-Trade with Offsets: Lessons from the EU-ETS*, 12 CLIMATE POLICY 273, 274 (2012).
[23] Michael Gillenwater & Stephen Seres, *The Clean Development Mechanism: Review of the First International Offset Program,* Pew Center on Global Climate Change, 12 (2011).
[24] *Id.* at 12,13.
[25] Anja Kollmuss, Helge Zink, Clifford Polycarp, *Making Sense of the Voluntary Carbon Market: A Comparison of Carbon Offset Standards*, WWF Germany, 4 (2008).
[26] *Id.* at 6.

companies, governments, and NGOs to purchase offsets to compensate for their emissions.[27] In the voluntary market, the trades rely on individual's or entities' voluntary demand. Naturally, the voluntary market is small compared to the compliance market, making the compliance market more important than the voluntary one in fighting climate change. My research focuses on the compliance market, specifically, the CDM and the California Cap and Trade Program.

2.4.1 CDM

As one of three flexibility mechanisms under the Kyoto Protocol, Article 12 of the Protocol defines the Clean Development Mechanism (CDM) as a means for helping developing countries achieve sustainable development and assisting industries in meeting their reduction commitments.[28] The United States initially introduced the CDM into the Kyoto Protocol, although it never ratified the Protocol. The negotiations over the CDM'S terms were not simple, and the final version represents a compromise between developed and developing nations,[29] as these have markedly different interests and priorities.

The CDM was the first global offset scheme and is still the largest one in the world. The CDM issues certified emission reduction credits (CERs), each equivalent to one ton of CO2, to greenhouse gas emission reduction projects. Annex 1 countries, which are

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[27] *Id.*
[28] Kyoto Protocol to the United Nations Framework Convention on Climate Change, Article 12 (1997).
[29] Bernhard Schlamadinger, Gregg Marland, *Land Use and Global Climate Change: Forests, Land Management, and the Kyoto Protocol,* Pew Center on Global Climate Change (2000).

obliged to reduce their greenhouse gas emissions, can use these CERs to meet their emission limitation targets. They can purchase CERs either directly from the developers of CDM offset projects, or from markets, for example, the EU ETS. In fact, regulated entities under the EU ETS are major buyers of CERs, and the program allows them to use offset credits (also including JI-generated credits) to achieve up to half of their reductions over the period from 2008 to 2020.[30]

The CDM is a project-based mechanism, providing financial support for projects that reduce greenhouse gas emissions in developing countries. The economic basis for funding emission reduction projects in these countries is that the cost of emission reductions is lower in developing countries than in developed countries.[31] To illustrate, suppose a coal power plant in a developing country does not have any equipment for disposing of greenhouse gas emissions. With the installation of equipment widely used in developed countries, which is generally expensive, the plant can reduce 90% of its emissions. In contrast, a similarly scaled coal power plant in a developed country that has already installed this equipment could upgrade it to best-in-class technology, allowing it to eliminate 100% of its emissions, but only achieve an additional 10% emission reduction, at a high cost, since best-in-class equipment tends to be expensive. The potential for commercial greenhouse gas emission reduction in developing countries is

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[30] EU Directive 2009/29/EC, Article 11a.

[31] Goldemberg, J. et al., *Introduction: scope of the assessment*. In: Climate Change 1995: Economic and Social Dimensions of Climate Change. Contribution of Working Group III to the Second Assessment Report of the Intergovernmental Panel on Climate Change (J.P. Bruce et al. Eds.), Cambridge University Press, 30 (1996).

enormous.[32] Enkvist et al.'s research indicates that the abatement potential for greenhouse gases in developing countries is much higher than in their developed counterparts.[33] Figure 2.1 shows the potential for each region with quantified data.

The CDM not only enables developed countries to meet their domestic emission reduction targets under the Kyoto Protocol with lowest costs globally,[34] but might also help to address the distributional inequities that climate change imposes on developing countries. It is mainly industrialized countries that are causing climate change. Research indicates that developed countries have contributed 79% of historical carbon emissions.[35] However, developing countries do not share equally in the benefits of fossil fuel usage, and global warming has seriously harmed many of them.[36] In fact, developing countries are affected most severely by climate change, bearing 78% of its cost in 2015.[37] By transferring funds and technologies to developing countries, the CDM could create sustainable development in developing countries and help them adapt to climate change. Thus, the development of offset projects in developing countries presents a win-win opportunity for both developed and developing countries.

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[32] McKinsey (a consulting firm) estimated that developing countries account for 67% of the global greenhouse gases emissions abatement potential. *See* Gillenwater & Seres, *supra* note 23, at 5 (citing McKinsey [2009] and IPCC [2007] for estimates of global cost-effective GHG emission reduction potentials).

[33] Per-Anders Enkvist, Tomas Nauclér, and Jerker Rosander, *A cost curve for greenhouse gas reduction*, https://www.mckinsey.com/business-functions/sustainability/our-insights/a-cost-curve-for-greenhouse-gas-reduction.

[34] Michael Grubb, *The Economics of the Kyoto Protocol*, 4 World Economics 143, 159 (2003).

[35] *Developed Countries Are Responsible for 79 Percent of Historical Carbon Emissions*, Center For Global Development, https://www.cgdev.org/media/who-caused-climate-change-historically.

[36] Noah S. Diffenbaugh & Marshall Burke, *Global Warming Has Increased Global Economic Inequality*, 116 Proc. Natl. Acad. Sci. U.S.A. 9808 (2019).

[37] *Climate Change and Development in Three Charts*, Center For Global Development, https://www.cgdev.org/blog/climate-change-and-development-three-charts.

2.4.2 Carbon Offset in the California Cap and Trade Program

The California Cap and Trade Program embraces carbon offsets for the same economic consideration, without which the cost of compliance would be too high for most industries. So far, the ARB has adopted five compliance offset protocols, including U.S. Forest Projects, Urban Forest Projects, Livestock Projects, Ozone-Depleting Substance Projects, and Mine Methane-Capture Projects. These protocols prescribe the specific requirements and procedures for the issuance of offset credits. The ARB is considering additional compliance protocols that would add more types of projects to the cap and trade program.

However, the California Cap and Trade Program limits the usage of the offset credits. It allows regulated entities to use offset credits of up to 8% of their compliance obligation. The purpose of adopting this 8% limit is to ensure that regulated entities reduce their own emissions to a certain degree. The initial aim of the California program was to reduce greenhouse gas emissions in an economical way. The introduction of offsets lowered the cost for industries, but were they to rely fully on these offsets, they would not act to reduce their own emissions. This 8% limit forces industries to reduce their emissions, while at the same time relieving their financial pressures.

2.5 The Role of the Forest in Climate Change Mitigation

Forests are an integral part of the global carbon cycle, and carbon stored in forests is crucial to efforts to combat global climate change. Forests cover about 30% of globe's land surface.[38] Figure 2.2 illustrates the distribution of forests on earth. Forests make up one of the largest carbon reservoirs on earth, accounting for 45% of the carbon stock on land.[39] Forests play a two-part role in the carbon cycle, not only absorbing carbon from the atmosphere but also releasing carbon back into it. In the first part of the cycle, forests absorb carbon dioxide from the atmosphere through photosynthesis and store it in their woody biomass (their roots, trunks, and branches).[40] Young trees continuously sequestrate carbon until they are mature. In the second part, when trees decompose or are subject to wildfire, they discharge their stored carbon back into the atmosphere. Thus, when forests sequestrate more carbon than they release, they serve as a net carbon sink, but they become a net carbon source when they discharge more carbon than they store.[41] Every year, forests around the world absorb a combined 30% of annual global anthropogenic carbon dioxide emissions;[42] meanwhile, carbon dioxide emissions from forests account for nearly 17% of global emissions.[43]

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[38] *Seeing Forests for the Trees and the Carbon: Mapping the World's Forests in Three Dimensions*, NASA Earth Observatory (Sept. 1, 2012), https://earthobservatory.nasa.gov/features/ForestCarbon.
[39] *Id.*
[40] EPA REPORT ON THE ENVIRONMENT, CARBON STORAGE IN FORESTS (2018), https://www.epa.gov/report-environment.
[41] *Id.*
[42] Valentin Bellassen & Sebastiaan Luyssaert, *Carbon Sequestration: Managing Forests in Uncertain Times*, 506 NATURE NEWS 153, 153 (2014) (citing Yude Pan et al., *A Large and Persistent Carbon Sink in the World's Forests*, 333 SCIENCE 988 (2011).
[43] CLIMATE CHANGE 2007 SYNTHESIS REPORT: SUMMARY FOR POLICYMAKERS 5 (Report, 2007).

Forests have huge potential for further sequestering carbon. A recent study by Bastin et al. (2019) projected that 0.9 billion hectares of land, or approximately 2.2 billion acres, could support new forests, and after afforestation, could sequester 205 gigatonnes of carbon (GtC) from the atmosphere. This is about two-thirds of the total global anthropogenic carbon (300 GtC) that countries have released since the inception of the Industrial Revolution.[44] Enkvist et al. (2007) identified six sectors – power, manufacturing, buildings, transportation, forestry, and agriculture/waste — of which forestry has the greatest potential to reduce greenhouse gas emissions.[45] Figure 2.3 shows their research results, indicating the abatement potential of each sector. Thus it is clear that forests are crucial to efforts to reduce greenhouse gas emissions.

2.6 Forest Carbon Offset

Forest carbon offsets are carbon offsets that forest projects produce when they absorb carbon dioxide from the atmosphere and store it within their biomass. Typically three types of forest projects can achieve this purpose — afforestation, forest management, and avoided deforestation projects. The UNFCCC recognized that activities in the land use, land-use change, and forestry (LULUCF) sectors, such as planting trees, managing forests, or curbing deforestation, provide a relatively cost-effective way of offsetting

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[44] Jean-Francois Bastin et al., *The Global Tree Restoration Potential*, 365 SCIENCE 76 (2019).
[45] Per-Anders Enkvist et al., *supra* note 33.

emissions.[46] Moreover, forest carbon projects promote biological diversity, which brings additional social and economic benefits.[47] Forest carbon projects also provide opportunities for developing countries with low emission levels to sequester carbon.[48]

2.6.1 Forest Carbon Offset under the CDM

Currently, the CDM accepts two types of forest projects, afforestation and reforestation projects. These are essentially the same, as both involve planting trees on non-forested lands and thus turning them into forested lands. The only difference between the two types of projects is the length of time during which the area has not been forested. Afforestation applies to land that has not been forested for 50 years, while reforestation applies to land that has not been forested since before 1990. So fundamentally, the CDM only recognizes one of the three typical forest projects, but does not accept forest management and avoided deforestation projects.

For the CDM to accept forest projects required a lengthy process of negotiation. Initially, when adopting the UNFCCC, countries promoted forestry activities as a way to combat

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[46] *Land Use, Land-Use Change and Forestry (LULUCF)*, UNFCCC, https://unfccc.int/topics/land-use/workstreams/land-use--land-use-change-and-forestry-lulucf/background.

[47] Steven Ruddell et al., *Forest Carbon Trading and Marketing in the United States*, Report to the North Carolina Division of the Society of American Foresters (2006), https://www.fs.fed.us/ecosystemservices/pdf/forest-carbon-trading.pdf.

[48] *Id.*

and adapt to climate change,[49] and the UNFCCC defined land use, land-use change, and forestry (LULUCF) as a greenhouse gas inventory sector, which "covers emissions and removals of greenhouse gases resulting from direct human-induced land use, land-use change and forestry activities."[50] However, the participating countries did not agree on issues relevant to forestry activities during negotiations for the Kyoto Protocol.[51] When they adopted it in 1997, the Kyoto Protocol did not include either afforestation or reforestation in its list of sectoral scopes.[52] Negotiations regarding forestry activities continued after the adoption of the Protocol, and in 2001, the parties reached an agreement, formalized in the Marrakech Accords, in which the CDM accepted afforestation and reforestation projects.[53] However, these Accords set a cap that limited credits from forestry projects to an offset of no more than 1% of each participating nation's assigned emission amount during the first commitment period.[54] The CDM adopted the modalities and procedures for afforestation and reforestation projects in 2003,[55] and the modalities and procedures for small-scale afforestation and reforestation projects in 2004.[56] With these two programs in place, the CDM had complete modalities and procedures for forest offsets.

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[49] SECRETARIAT OF THE ANDEAN COMMUNITY, UNITED NATIONS ENVIRONMENTAL PROGRAMME AND SPANISH INTERNATIONAL COOPERATION AGENCY, FORESTS AND THE CARBON MARKET - FORESTRY CDM POTENTIAL IN THE ANDEAN COMMUNITY 14 (2007).
[50] *Glossary of climate change acronyms and terms*, UNFCCC, https://unfccc.int/process-and-meetings/the-convention/glossary-of-climate-change-acronyms-and-terms.
[51] SECRETARIAT OF THE ANDEAN COMMUNITY, UNITED NATIONS ENVIRONMENTAL PROGRAMME AND SPANISH INTERNATIONAL COOPERATION AGENCY, *supra* note 49.
[52] Kyoto Protocol, *supra* note 28, Annex A.
[53] UNFCCC Decision 11/CP.7 (2001).
[54] *Id.*
[55] UNFCCC Decision 19/CP.9 (2003).
[56] UNFCCC Decision 14/CP.10 (2004).

2.6.1.1 CDM's Project-Based Approach

The forest carbon offset program under the CDM adopts a project-based approach, in which each project provides documents to prove that it meets the program's requirements. Under this project-based approach, it is each project's "unique location and circumstances," that determines its baseline emissions and additionality, while the CDM imposes key parameters according to "site-specific data or measurements."[57] In theory, this approach is precise, because it takes project-specific conditions fully into account.[58] However, in practice, the project-based approach has some inherent problems. First, the evaluation of each project involves the subjective judgment of the verifiers and regulators[59] who must verify the project documents and evidence that the project developers submit on a case-by-case basis. Since there is no rigorous standard of additionality, the personal opinions of the verifiers and regulators inevitably come into play as they determine whether a project is additional or not. Because of the involvement of subjective judgment, project developers can never be quite sure whether a project will be approved. In other words, project developers cannot predict whether they will be able to register a project successfully or not, which causes them a high degree of uncertainty.[60]

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[57] Derik Broekhoff, *Expanding Global Emissions Trading: Prospects for Standardized Carbon Offset Crediting*, World Resources Institute, 5 (2007).
[58] The World Bank, *Overview of Carbon Offset Programs: Similarities and Differences*, Partnership for Market Readiness technical papers; no. 6. Washington, DC: World Bank Group, 10 (2015), http://documents.worldbank.org/curated/en/891711468309365201/Overview-of-carbon-offset-programs-similarities-and-differences.
[59] *Id.*
[60] Derik Broekhoff, *supra* note 57, at 6.

Second, the long-term maintenance of forest projects relies on the integrity and consistency of the regulators' judgment, but the involvement of that subjective judgment can impair the integrity and consistency of the projects themselves. In the long term, there is always the chance that the personal opinions of the people engaging in the work might change, and thus there is no guarantee of integrity and consistency. This means that the long-term maintenance of forest projects is difficult in the context of a project-based approach.[61]

Third, the project-based approach is prone to gaming.[62] To illustrate, under this approach, project developers provide specific project information that can be hard to evaluate. If they manipulate some data to lower the baseline emission, they can gain more offset credits, which is to their advantage. Finally, although determining cost is relatively cheap to do, the application of the project-based approach can be expensive and time-consuming for both project developers and evaluators,[63] and therefore runs the risk of deterring potential project developers.

2.6.1.2 The Process for the Issuance of Carbon Offset Credits under the CDM

[61] *Id.*
[62] *Id.*
[63] The World Bank, *supra* note 58.

The CDM prescribes a detailed process by which a forest project can earn offset credits. Generally, this process consists of project design, national approval, validation, registration, monitoring, verification and certification, and the issuance of credits. Figure 2.4 illustrates this process step by step.

To obtain offset credits, a forest project must go through a process that starts with the initial project planning. Though not a formal requirement of the CDM, it is necessary for the project developer to assess the feasibility of the project's activity at this nascent stage.[64] The project developer usually considers the eligibility of the project land, the eligibility of the host party (the country where the project is physically located), the overall financing of the project, and issues related to greenhouse gas removal.[65] After finishing the initial project planning, the project developer must prepare the project design document (PDD), which describes in detail the development and operation of the project. [66] Then, the project developer must acquire a letter of approval with confirmation of voluntary participation from the designated national authority (DNA) of each party (country).[67]

After that, the developer submits the project design documents, along with a letter or letters of approval (if more than one party is involved) to the designated operational

[64] *Afforestation and Reforestation Projects under the Clean Development Mechanism: A Reference*, UNFCCC 12 (2013), https://cdm.unfccc.int/public_inputs/2013/arcdm_01/AR_CDM_Manual_Draft_01.pdf.
[65] *Id.*
[66] *Id.* at 13.
[67] *Id.* at 14.

entity (DOE) for validation. The DOE validates the project's activity, and then forwards the documents to the CDM Executive Board (CDM EB) to request registration. Approval of the CDM EB officially registers the project.

When the project realizes the desired emission reduction or removal, the project's participants[68] must prepare a monitoring report that presents the data supporting the project's performance.[69] They submit the report must to a DOE, which carries out on-site inspections and data-checking tests to verify it. Once it determines that the monitoring report has proved the claimed emission reductions or removals, the DOE publishes a verification and certification report on the CDM's official website.[70] Ultimately, the CDM EB issues the project offset credits, either tCERs or lCERs (which I will discuss in a later section).

2.6.1.3 The Current State

The CDM is by far the largest carbon offset market in the world. Projects under its aegis fall into 15 sectors, one of which is afforestation and reforestation. As of May 31, 2019, the CDM had registered 7,806 projects since its inception in 2005.[71] However, the

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[68] CDM project participants may vary from project to project and the key participants include project developer/operators, CDM investors/CER purchasers, host governments and designated national authorities. *See The Clean Development Mechanism: A User's Guide*, United Nations Development Programme, 20–22 (2015), https://www.undp.org/content/undp/en/home/librarypage/environment-energy/climate_change/mitigation/undp_cdm_manual.html.
[69] UNFCCC, *supra* note 64, at 16.
[70] *Id.* at 16-17.
[71] *Project Activities*, UNFCCC, https://cdm.unfccc.int/Statistics/Public/CDMinsights/index.html#iss.

number of forest projects is negligible compared with those in other sectors, with only 66, or 0.8% of all CDM projects registered as afforestation or reforestation.[72] The fact that these afforestation or reforestation projects are not financially feasible might explain why the CDM has registered such a small number of forest projects thus far.

2.6.2 Forest Carbon Offset in the California Cap and Trade Program

On October 20, 2011, three months before the start of the California Cap and Trade Program, the ARB adopted the first Forest Offset Protocol.[73] The ARB further amended the Forest Offset Protocol in 2014 and 2015.[74] Originally, it limited forest projects to locations in the lower 48 states, excluding Alaska, Hawaii, and the U.S. Territories.[75] The current Forest Offset Protocol has brought Alaska's forestland into its scope.[76]

The Forest Offset Protocol accepts three types of forestry projects – reforestation, improved forest management, and avoided conversion projects. Reforestation projects restore tree cover on lands that have possessed less than a 10% tree canopy cover for more than 10 years or have survived significant disturbance. Improved forest

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[72] *Distribution of Registered Projects by Scope*, UNFCCC, http://cdm.unfccc.int/Statistics/Public/files/201607/proj_reg_byScope.pdf.
[73] California Air Resource Board, Compliance Offset Protocol U.S. Forest Offset Projects (2011), https://ww3.arb.ca.gov/regact/2010/capandtrade10/copusforest.pdf.
[74] *Compliance Offset Program*, California Air Resources Board, https://www.arb.ca.gov/cc/capandtrade/offsets/offsets.htm.
[75] *U.S. Forest Projects 2011*, Califronia Air Resources Board, https://www.arb.ca.gov/cc/capandtrade/protocols/usforest/usforestprojects_2011.htm.
[76] *U.S. Forest Projects 2015*, Califronia Air Resources Board, https://www.arb.ca.gov/cc/capandtrade/protocols/usforest/usforestprojects_2015.htm.

management projects require applicants to take measures to increase the carbon stock on forested land. Avoided conversion projects prevent the deforestation of forest lands, are expected to demonstrate the higher value of the non-forest land use, and set up a conservation easement.

2.6.2.1 Standardized Approach

The forest carbon offset under the California Cap and Trade Program adopts a standardized approach under which the program provides uniform quantitative methods for the development of each project. The key feature of this kind of approach is that it applies a common standard to the same type of project.[77] For instance, the forest protocol under the California program provides standardized quantitative methods for determining additionality, permanence, and leakage. Although the standardized approach lacks precision for each project, it can accurately or conservatively measure total emission reductions over a number of projects.[78] The main advantage of this uniform approach is that the review process is simple and transparent.[79] With established quantitative methods, it is easy to determine the result. Moreover, the transaction costs are low when applying this standardized approach.[80] However, this approach has its limitations. It unfairly punishes projects with real baselines higher than the standardized baseline and unfairly

[77] The World Bank, *supra* note 58.
[78] Derik Broekhoff, *supra* note 57, at 8.
[79] *Id*.
[80] *Id*.

benefits projects with true baselines lower than the standard baseline.[81] In addition, the design of the standardized approach is costly and time-consuming,[82] and it is difficult to design an effective generic protocol in practice.

2.6.2.2 Process for Issuing Carbon Offset Credits

Under the California Cap and Trade Program, if a forest project seeks the issuance of offset credits, it has to undergo a process containing listing, carbon inventory, modeling, reporting, verification, registration, and the issuance of ARB credits. Figure 2.5 shows this process for the issuance of carbon offset credits. The key feature of this process is that after an ARB-approved registry issues temporary registry offset credits (ROCs) for the project, the project owner can apply to convert these ROCs to Air Resource Board offset credits (ARBOCs). If the ARB approves the project owner's request, it transfers these ROCs to ARBOCs.

The whole process begins when the developer lists the project on one of three ARB-approved registries — the American Carbon Registry, the Climate Action Reserve, or the Verra (formerly the Verified Carbon Standard).[83] Listing is viewed as an application for

[81] *Id.* at 9
[82] The World Bank, *supra* note 58.
[83] According to California Cap and Trade Regulation, the California Air Resource Board is allowed to approve Offset Project Registries that participate in implementing the California Cap and Trade Program. Section 95986 of the regulation specifies the requirements for an Offset Project Registry, and potential registries submit applications to the ARB. After ARB approval, a registry can perform relevant services, including the listing, reporting, and verification of offset projects in accordance with the California Program's protocols, and it can issue registry offset credits. Currently, the ARB has approved three Offset

developing the carbon offset project,[84] and the fact that a project is listed indicates that the registry has verified the basic information and eligibility of the project,[85] and has approved its further development.

The next step for the project owner is to perform a carbon inventory for the project site, including merchantable wood as well as non-merchantable trees and tree parts.[86] After it has inventoried and verified the initial carbon stocks, the project owner conducts annual modeling, which takes into account the current amount of biomass, growth within the project site, planned harvests, and the end use of the harvested wood.[87]

Within 24 months of listing the project, the owner must submit to the ARB the first Offset Project Data Report (OPDR), containing initial inventory and modeling data.[88] Subsequently, the project owner must submit an OPDR every year. Failure to do so results in voluntary termination of the project.[89] An ARB-approved third-party verification body must confirm all OPDRs. After verification of the first report, verification can cover up to six reporting periods. The verification body issues an offset verification statement after confirming the reliability of the report.

Project Registries. The ARB can consider a variety of factors, including workload and market conditions, in deciding whether to approve extra registries. *See* California Air Resources Board, *supra* note 74.

[84] Keeping Maine's Forests, *Adoption of Carbon Credit Programs among SFI Participants in Maine—Keeping Maine's Forests*, Center for Research on Sustainable Forests, 7 (2017), https://crsf.umaine.edu/publication/adoption-carbon-credit-programs-among-sfi-participants-maine/.

[85] *Id.*

[86] *Id.* at 8.

[87] *Id.*

[88] *Id.* at 9.

[89] *Id.*

After a project receives its offset verification statement, and if it meets the protocol's requirements, the registry will issue it temporary registry offset credits (ROCs). The project owner can choose to request issuance Offset Credits from the ARB by submitting relevant documents to that body. In this case, it is the ARB that will conduct the final review of the project. This is similar to the registry review and is more than just rubber-stamp approval.[90] The ARB may consult with outside experts such as staff from offset projects registries and employees of the United States Forest Service.[91] If the ARB approves the project, the registry that issues ROCs will cancel them and then the ARB will issue it corresponding ARB Offset Credits.[92]

2.6.2.3 Current State

The ARB launched the California Cap and Trade Program on January 1, 2012, and started compliance obligations on January 1, 2013. The compliance offset program under the Cap and Trade Program accepts early action offset credits to ensure that voluntary reductions receive appropriate credit and to help create an initial supply of offset credits.[93] It issued these early action offset credits to qualified existing voluntary

[90] Personal communication with Sarah J. Wescott, Senior Forest Program Manager, Climate Action Reserve (August 2019).
[91] *Id.*
[92] *Register a Compliance Offset Project*, Climate Action Reserve, https://www.climateactionreserve.org/how/california-compliance-projects/register-a-compliance-offset-project/.
[93] *Early Action Offset Credits*, California Air Resources Board, https://ww3.arb.ca.gov/cc/capandtrade/offsets/earlyaction/credits.htm.

reduction projects, which were eligible only until the end of 2014. Starting in 2015, all voluntary reduction projects had to comply with the ARB's Compliance Offset Protocol in order to continue to be eligible for the compliance offset program.[94]

As of December 11, 2019, the ARB had issued 167,740,508 metric tons of CO2 equivalent (MTCO2e) offset credits, which consisted of 24,187,917 MTCO2e early action offset credits and 143,552,591 MTCO2e compliance credits.[95] Notably, the forestry project has become the most essential part of the compliance offset program under the California Cap and Trade Program. Forest projects have generated credits of 133,924,967 MTCO2e, or nearly 80% of the total credits of 167,740,508 MTCO2e.[96] Most registered forest projects under the California Program are improved forest management projects, which reduce emissions quickly at a moderate cost. This may be the reason why the forest project dominates the California Program.

Forest projects inevitably involve critical issues such as additionality, permanence, and leakage. Offset program design must address these issues adequately and each forest project's implementation must ensure that there are real greenhouse gas reductions. The following three chapters will assess how the CDM and the California program address these criteria.

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[94] *Id.*
[95] California Air Resources Board, *supra* note 74.
[96] *Id.*

Chapter 3

Additionality

3.1 Introduction

This chapter examines the additionality of forest carbon offset programs under the CDM and the California program. A project is additional if it would not have existed without the financial support of an offset program. It is vital to evaluate whether a project is additional. However, this evaluation is difficult because it involves predicting what would have happened without the funding. In 2009, Lambert Schneider came up with a method that has evaluated 93 CDM projects.[97] It has been widely accepted in the literature and received court endorsement in *Our Children's Earth Foundation v. State Air Resources Board*. In this chapter, I use Schneider's method to assess the additionality of all forest projects under the CDM. Because of the standardized approach that the California program adopts, the documents for all forest projects are similar. So rather than examining those, I focus on the specific design of the forest project protocol, how the forest project protocol was adopted, the court's opinion regarding the additionality of the California program, existing research on the additionality of the California forest carbon offset program, and the implementation of the program.

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[97] Lambert Schneider, *Assessing the Additionality of CDM Projects: Practical Experiences and Lessons Learned*, 9 CLIMATE POLICY 242 (2009).

I have organized this chapter as follows: Section 3.2 introduces the concept of additionality. Section 3.3 provides a literature review. Section 3.4 evaluates the additionality of the forest carbon offset under the CDM, describing the CDM's approach to demonstrating additionality and my research methods, and assessing the additionality of CDM forest projects. Section 3.5 evaluates the additionality of California's forest carbon offset program, describing California's definition of additionality, its approach to addressing additionality, the thorough process of adopting the forest protocol, the legal challenges to the California program, research that confirms the effectiveness of the program, and its implementation. Section 3.6 presents the conclusion.

3.2 Concept of Additionality

The concept of additionality first arose in 1995 during the initial meeting of the United Nations Framework Convention on Climate Change (UNFCCC).[98] Additionality is an essential criterion by which to evaluate an offset project. The UNFCCC defines additionality in the modalities and procedures for the CDM, stating that "a CDM project activity is additional if anthropogenic emissions of greenhouse gases by sources are reduced below those that would have occurred in the absence of the registered CDM project activity."[99] To put it another way, additionality requires that an offset project would not have occurred without funding from an offset program. If a project would have

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[98] Wu Yunna, Chen Quanzhi, *The Demonstration of Additionality in Small-Scale Hydropower CDM Project*, Renewable Energy 36, 2663-2666, 2663 (2011).

[99] Decisions Adopted by the Conference of the Parties Serving as the Meeting of the Parties to the Kyoto Protocol, FCCC/KP/CMP/2005/8/Add.1, 30 March 2006.

come into existence anyway, regardless of the support from the offset program, issuing credits for it would allow some regulated facilities to discharge extra greenhouse gases.

Additionality is arguably the single most contentious issue under the carbon offset program.[100] Mark Trexler said that "never has so much been said about a topic by so many, without ever agreeing on a common vocabulary, and the goals of the conversation."[101] The controversy over additionality stems from the challenges that the application of additionality faces. First, it is almost impossible to predict precisely what would have happened without funding from an offset program.[102] This unobserved baseline is established through the scenario of the absence of the offset program.[103] Inevitably, the analysis involves uncertainty. Second, the evaluation of additionality faces the challenge of perverse incentives and asymmetric information.[104] Project developers have an incentive to provide biased information in order to increase the possibility that the program administrators will deem the project additional.[105] The administrators might not be able to discover this bias because of asymmetric information.[106] Third, the assessment of additionality and the prediction of baselines inherently involves

[100] Trexler, Mark C., Derik J. Broekhoff and Laura H. Kosloff, *A Statistically-driven Approach to Offset-based GHG Additionality Determinations: What Can We Learn?*, Sustainable Development Law & Policy, Winter 2006, 30-40, 30 (2006).
[101] *Id.*, citing Mark C. Trexler, presentation at Additionality Side Event, COP-10 in Buenos Aires (2004).
[102] Leigh Raymond, *Beyond Additionality in Cap-and-Trade Offset Policy*, Issues in Governance Studies, Number 36, 4 (2010).
[103] Michael Gillenwater, *What is Additionality? Part 1: A long standing problem*, Greenhouse Gas Management Institute Discussion Paper No. 001 (version 03) 5 (2012).
[104] *Id.* at 6.
[105] *Id.*
[106] *Id.*

subjectivity,[107] whether the approach is project-based or standardized. As I mentioned in the last chapter, a project-based approach involves the personal opinions of the verifiers and regulators who determine emission baselines and additionality. The standardized approach can be more objective, but the process of establishing those standards involves some subjective judgments[108] in that the final standards are affected by the personal opinions of those who design them.

3.3 Literature Review

In 1998, Kenneth Chomitz discussed baselines for greenhouse gas reductions and the issue of additionality.[109] He regarded additionality as "the determination of which technology would have been adopted in the absence of offset sales" in baseline-setting.[110] Axel Michaelowa and Emmanuel Fages (1999) recognized a certain degree of uncertainty in developing a baseline and proposed to compare the costs and benefits of doing so.[111] They discussed several potential approaches to this challenge. Leif Gustavsson et al. (2000) described four basic principles — "accuracy, comprehensiveness, conservativeness and practicability" — that can play a role in the formation of

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[107] *Id.*
[108] *Id.*
[109] Kenneth Chomitz, *Baselines for Greenhouse Gas Reductions: Problems, Precedents, Solutions*, Washington, DC, Development Research Group, World Bank, Draft for discussion (rev. 1.4) (1998).
[110] *Id.*
[111] Michaelowa, A. and E. Fages, *Options for baselines of the clean development mechanism*, Mitigation and Adaptation Strategies for Global Change 4(2): 167-185 (1999).

baselines.[112] Sandra Greiner and Axel Michaelowa (2003) discussed possible criteria for evaluating whether an investment meets the requirement of additionality.[113] Jusen Asuka and Kenji Takeuchi's (2004) quantitative study shows that the creation of non-additional offset credits will ultimately affect developing countries in a negative way because relaxed additionality can damage "environmental integrity," "market development," and the "meaningful participation of developing countries in the future post-Kyoto framework based on the mutual trust."[114]

After the launch of the CDM, scholars began to evaluate the additionality of CDM projects. Lambert Schneider (2007) studied 93 randomly chosen registered CDM projects, concluding that "it is very likely that a significant amount of registered projects are not additional."[115] He indicated that because of poor design, some of the additionality tools cannot adequately assess whether a project meets the requirement of additionality, and that in many instances, project participants have not used the tools correctly.[116] Axel Michaelowa and Pallav Purohit (2007) investigated a sample of 52 Indian CDM projects and found that validators are not able to or willing to thoroughly evaluate barriers in a transparent way.[117] Through two case studies of two projects, they concluded that if the

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[112] Leif Gustavsson et al. , *Project-based greenhouse-gas accounting: guiding principles with a focus on baselines and additionality*, Energy Policy 28(13): 935-946 (2000).
[113] Greiner, S. and A. Michaelowa, *Defining Investment Additionality for CDM projects--practical approaches*, Energy Policy 31(10): 1007-1015 (2003)
[114] Asuka, J. and K. Takeuchi, *Additionality reconsidered: lax criteria may not benefit developing countries*, Climate Policy 4: 177-192 (2004).
[115] Schneider, L., *Is the CDM fulfilling its environmental and sustainable development objectives? An evaluation of the CDM and options for improvement*, Berlin, Öko-Institut (2007).
[116] *Id.*
[117] Michaelowa, A., & Purohit, P., *Additionality determination of Indian CDM projects: Can Indian*

project developer packages information in a way that conceals the attractiveness of the project, it is more likely to pass the additionality test.[118] Based on over 80 interviews with practitioners involved in CDM project development in India, study of a CDM project database, and an analysis of the documents for 70 CDM projects registered in Indian and China, Barbara Haya (2009) claimed that "the majority of CDM projects are 'non-additional.'"[119]

In addition, some researchers turned their attention to the investment analysis used to demonstrate additionality under the CDM. Hoi Wen Au Yong (2009) analyzed a sample of 222 registered CDM projects, using the change in internal rate of return (IRR) resulting from CDM revenues as a measure of degrees of additionality.[120] She found that different project types show different degrees of additionality. In addition, she pointed out that 26% of the projects have a change in IRR lower than the 2% that she adopted as a threshold of questionable additionality. Christoph Sutter and Juan Carlos Parreño (2007)[121] and Johannes Alexeew et al. (2010)[122] also evaluated the possibility of additionality through assessing how offset credit revenues affect the IRR of individual

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CDM project developers outwit the CDM Executive Board? Switzerland: University of Zurich (2007).

[118] *Id.*

[119] Barbara Haya, *Measuring Emissions against an Alternative Future: Fundamental Flaws in the Structure of the Kyoto Protocol's Clean Development Mechanism*, Energy and Resources Group Working Paper ERG09-001, University of California, Berkeley (2009).

[120] Au Yong, H. W., *Investment Additionality in the CDM*, Technical Paper. Edinburgh, Ecometrica Press (2009).

[121] Sutter, C. and J. Parreño, *Does the current Clean Development Mechanism (CDM) deliver its sustainable development claim? An analysis of officially registered CDM projects*, Climatic Change 84(1): 75-90 (2007).

[122] Alexeew, J. et al., *An analysis of the relationship between the additionality of CDM projects and their contribution to sustainable development*, International Environmental Agreements: Politics, Law and Economics 10(3): 233-248 (2010).

CDM projects, concluding that the type of project greatly determines the probability of it being additional.

Later, Gang He and Richard Morse (2013) analyzed 143 Chinese wind CDM projects and found that domestic regulation affects the additionality of offset projects.[123] In investigating a co-generation CDM project in Uganda from 2008-2014, Mark Purdon (2014) pointed out that CDM projects are not intrinsically either additional or non-additional, since a project can be additional upon registration but become non-additional at some later point, often because of variations in financial incentives and background economic conditions.[124] He found that the Ugandan project had obtained considerable financing from the World Bank and other donors before and during the crediting period but that the CDM had not counted this money in the project's baseline.[125] Mark Purdon (2015) drew a similar conclusion in another field study, based on a systematic empirical investigation of seven afforestation/reforestation and bioenergy carbon finance projects across Tanzania, Uganda, and Moldova.[126] Moreover, he claimed that carbon finance projects are highly additional when they are implemented by NGOs or state agencies.[127]

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[123] Gang He, Richard Morse, *Addressing carbon Offsetters' Paradox: Lessons from Chinese wind CDM*, Energy Policy Volume 63, 1051-1055 (2013).
[124] Mark Purdon, *Ex-post Evaluation of the Additionality of a Clean Development Mechanism Cogeneration Project in Uganda: the significance of changes in project financing and background economic conditions*, Centre for Climate Change Economics and Policy Working Paper No. 170, Grantham Research Institute on Climate Change and the Environment Working Paper No. 152 (2014).
[125] *Id.*
[126] Mark Purdon, *Opening the Black Box of Carbon Finance "Additionality": The Political Economy of Carbon Finance Effectiveness across Tanzania, Uganda, and Moldova*, 74 WORLD DEVELOPMENT 462 (2015).
[127] *Id.*

So far, most studies have looked at the additionality of general CDM projects, but no research has focused specifically on the additionality of forest projects under the CDM. Meanwhile, due to the short history of the California Cap and Trade Program, few examinations of the additionality of its carbon offset program are available. However, there is one recent research that assessed the additionality of California's forest offset program, which is a significant component in the California Cap and Trade Program, generating more than half of the total offset credits of the program. Christa Anderson et al. (2017) collected and analyzed ownership, risk rating, forest inventory, and logging data, and found that through multiple mechanisms, the program as a whole has realized additional emission reductions.[128]

3.4 CDM

3.4.1 CDM's Approach to Demonstrating Additionality

The CDM requires carbon reductions to be additional. Article 12.5 of the Kyoto Protocol stipulates that emission reductions must be "additional to any that would occur in the absence of the certified project activity."[129] The CDM has established a project

[128] Christa M. Anderson et al., *Forest Offsets Partner Climate-Change Mitigation with Conservation*, 15 FRONTIERS IN ECOLOGY AND THE ENVIRONMENT 359 (2017).
[129] Kyoto Protocol, *supra* note 28, Article 12(5)(c).

registration process for evaluating additionality.[130] To begin with, the project developer prepares a Project Design Document (PDD) that describes the project and demonstrates its additionality. The developer then submits the PDD to a Designated National Authority (DNA)[131] for evaluation.[132] After the DNA decides that the PDD meets the CDM requirements, including additionality, the DNA transmits the document to the CDM Executive Board (CDM EB)[133] for review.[134] Finally, the EB decides whether to register the project.[135]

The CDM employes a project-based additionality test. The project-based approach examines the unique location and circumstances of the project to determine whether the project developer would undertake the project activity absent the funding of an offset program.[136] For this test, each project provides documents to demonstrate that the project is additional, and then the CDM evaluates each project on a case by case basis. The CDM has developed tools by which each forest project can demonstrate additionality, and it imposes different requirements for large-scale and small-scale forest projects. Large-scale

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[130] Antoine Dechezleprêtre, Jonathan Colmer, Caterina Gennaioli, Matthieu Glachant, Anna Schröder, *Assessing the Additionality of the Clean Development Mechanism: Quasi-Experimental Evidence from India*, Grantham Research Institute on Climate Change and the Environment working paper, 5-6 (2014).
[131] A DNA is "the organization granted responsibility by a Party to authorise and approve participation in CDM projects." The DNA's primary responsibility is "to assess potential CDM projects to determine whether they will assist the host country in achieving its sustainable development goals, and to provide a letter of approval to project participants in CDM projects." *See Designated National Authorities (DNA)*, CDM, https://cdm.unfccc.int/DNA/index.html.
[132] Antoine Dechezleprêtre et al., *supra* note 130, at 6.
[133] The CDM EB "supervises the Kyoto Protocol's clean development mechanism under the authority and guidance of the Conference of the Parties serving as the Meeting of the Parties to the Kyoto Protocol (CMP)" and is "the ultimate point of contact for CDM Project Participants for the registration of projects and the issuance of CERs." *See* CDM, Executive Board (EB), https://cdm.unfccc.int/EB/index.html.
[134] Antoine Dechezleprêtre et al., *supra* note 130, at 6.
[135] *Id.*
[136] Derik Broekhoff, *supra* note 57, at 5-6.

projects must conduct either a barrier analysis or an investment analysis.[137] A barrier analysis requires project applicants to prove that existing barriers prevent the project's implementation and that the funding from the CDM will overcome these barriers. An investment analysis demands that an applicant demonstrates that the project is less financially attractive than at least one other alternative. In addition, each project must provide a common practice analysis in which the applicant cites evidence to prove that the planed afforestation or reforestation practices are not common in the project area. Small-scale projects only need to present one barrier to prove that the project is additional (although they may show more than one).

A designated operational entity (DOE) is involved in this process in order to ensure that the project meets CDM criteria. A DOE is "an independent auditor accredited by the CDM Executive Board (CDM EB) to validate project proposals or verify whether implemented projects have achieved planned greenhouse gas emission reductions."[138] As the definition indicates, the CDM EB accredits the DOE; the CDM's modalities and procedures prescribe accreditation standards for accrediting operational entities.[139] The EB also conducts performance assessments and spot checks to make sure that each DOE continuously complies with accreditation standards.[140]

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[137] In practice, some projects have conducted both analyses.
[138] *Designated Operational Entities (DOE)*, CDM, https://cdm.unfccc.int/DOE/index.html.
[139] UNFCCC Decision 17/CP.7, Section D (2001).
[140] *Id.*

These designated operational entities can be domestic legal entities or international organizations and are usually private companies such as auditing and accounting firms, consulting companies, or law firms. To ensure independence, a DOE must demonstrate that it has no real or potential conflict of interest with the participants for which it is conducting validation, verification, or certification functions.[141] A DOE performs two different tasks, validating a project proposal before its approval, and verifying emission reductions periodically after the project's registration. Normally, separate DOEs carry out the validation and the verification for each large scale project.[142]

3.4.2 Research Method

Many scholars have examined the additionality of CDM projects. As I indicated in the literature review, Lambert Schneider carried out one prominent piece of research. He assessed the additionality of 93 CDM projects randomly drawn from 768 ones registered as of July 18, 2007.[143] He based his analysis mainly on official CDM documents, including Project Design Documents (PDDs) and the validation reports of the Designated Operational Entities (DOEs), and focused on barrier analysis, investment analysis, common practice analysis, and consideration of the CDM as it decided whether to proceed with the projects. Schneider concluded that in its first three years of operation, the CDM had not been "very effective in ensuring that emission reductions are actually

[141] UNFCCC Decision 3/CMP.1(2005).
[142] CDM, *supra* note 138.
[143] Lambert Schneider, *supra* note 97.

additional,"[144] and that "additionality seems unlikely or questionable for a significant number of projects that were registered in the first 3 years." [145] Therefore, "tools for demonstrating additionality are in need of substantial improvement."[146] He indicated that the barrier analysis that these projects used was highly subjective and difficult to verify objectively and transparently.[147] He further determined that these projects failed to provide credible documented evidence to support the adoption of key assumptions to demonstrate additionality.[148]

Lambert Schneider is an expert in this area. When he published his research in the journal *Climate Policy* in 2009, Schneider was a member of the CDM Executive Board's Methodologies Panel, and he now serves as a member of the Executive Board of the Clean Development Mechanism. Based on his insights about how the CDM works, Schneider came up with an idea that assesses the additionality of CDM projects by evaluating whether each project has provided documents that meet requirements set by the CDM's additionality tools. If a project's documents fail to fulfill the requirements, it means that the additionality of the project is doubtful. Schneider's research evaluated additionality at the project level,[149] and is one of only a few good pieces of research on

[144] *Id.*
[145] *Id.*
[146] *Id.*
[147] *Id.*
[148] *Id.*
[149] Nicholas Tatrallyay & Martin Stadelmann, *Climate Change Mitigation and International Finance: The Effectiveness of the Clean Development Mechanism and the Global Environment Facility in India and Brazil*, 18 MITIG ADAPT STRATEG GLOB CHANGE 903, 904 (2013).

this subject.[150] The literature generally acknowledges his research, using his results to question the additionality of CDM projects or indicate that problems existed in the CDM's method of addressing additionality.[151] Moreover, the court in *Our Children's Earth Foundation v. State Air Resources Board* cited Schneider's report and endorsed his opinion.

In my research, I use a method that is similar to Schneider's to evaluate the additionality of all 66 CDM forest projects. It would have been helpful had I also been able to investigate projects that the CDM rejected, however the CDM has never rejected a forest project.[152] These 66 registered projects consist of 35 large-scale projects and 31 small-scale ones. The CDM treats large-scale projects and small-scale projects differently. It imposes a relatively rigorous obligation for demonstrating additionality on the former but a nuch lighter burden on the latter. The CDM provides tools by which large-scale afforestation or reforestation projects can demonstrate additionality, tools that have evolved since the beginning of the forest offset program. The current version is the *combined tool to identify the baseline scenario and demonstrate additionality in A/R CDM project activities (version 1)*. The simplified rule for small-scale projects only requires the proponent to demonstrate a single barrier for additionality (although it may choose to present more than one).

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[150] Robert Hahn & Kenneth Richards, *Understanding the Effectiveness of Environmental Offset Policies*, 44 J REGUL ECON 103, 110 (2013).
[151] Based on Web of Science's data, as of February 21, 2020, Schneider's article had generated 78 citations, a considerable number in this narrow area of additionality.
[152] UNFCCC secretariat stated that "there is no forest CDM project rejected as of now" in reply to my inquiry. (Dec 16, 2015).

For this research, I collected project information from the CDM's official website, focusing on PPDs and the DOEs' validation reports. My assessment includes a barrier analysis, investment analysis, common practice analysis, and retroactive crediting. I analyzed the content of these PPDs and validation reports to determine whether they adequately demonstrated additionality. Specifically, I assessed the quality of the documents, with regard to their barrier analysis, investment analysis, common practice analysis, and retroactive crediting, and sorted the descriptions that they contained into a range of categories, from a general statement to detailed explanation with evidence. After that, I produced graphs of the results and drew various conclusions from them.

3.4.3 Assessing the Additionality of CDM Forest Projects

3.4.3.1 Barrier Analysis

Developers of forest projects use barrier analysis much more frequently than they do investment analysis. Notably, 63 out of the 66 forest projects adopted barrier analysis in their Project Design Documents (PDDs); of these 63, 12 employed both the barrier analysis and the investment analysis to demonstrate additionality. All of the small-scale forest projects and 89% of the large-scale forest projects used barrier analysis. The most commonly used barriers are the investment barrier and the technical barrier.

3.4.3.1.1 General Explanations of Barriers

According to the additionality tool, project applicants who use barrier analysis to demonstrate additionality should describe the relevant barriers in their PPDs. However, my study determined that PDDs tend to provide only general information about the barriers that their projects encounter. More than half of the 63 forest projects that adopted barrier analysis (56%) provided only a general explanation of barriers. The most common explanation is that the proposed forest project is located in a poor rural area, lacking investment and technology. Notably, three projects (5%) gave extremely simple explanations, and one project (2%) did not offer any explanation at all. About 14% of the projects provided substantial explanations of key barriers, while 24% provided substantial explanations of all barriers. Figure 3.1 reveals the results of my assessment with regard to explanations of barriers in PDDs of these projects.

3.4.3.1.2 Evidence for Barriers

In addition to explaining barriers, the additionality tool requires project applicants to cite evidence to support their declared barriers. While some projects only asserted one barrier and cited evidence for it, others claimed several barriers and provided evidence for one or two of them. The additionality tool does not specify how many barriers are required to establish an adequate demonstration of additionality and allows project developers to use a number of the potential barriers prescribed in the tool, as well as other barriers that it does not mention. In practice, some projects provided evidence for one or two barriers and listed others without evidence, with the goal of making their cases more convincing. It might not be appropriate to consider those that projets failed to comply fully with the requirement of citing evidence. Therefore, I considered whether a project has cited evidence or not. The statistics show that 86% of the projects provided or referred to evidence for the barriers they listed, and that the rest of the projects (14%) did not present any evidence.

3.4.3.1.3 Explanation of How the CDM Helps to Overcome Barriers

The CDM requires each project to provide evidence showing how the CDM helps project developers to overcome or alleviate barriers. However, 97% of small-scale forest projects and 46% of large-scale forest projects did not do this. Most projects only offered a general explanation in their PDDs. For example, one wrote that the funding from the CDM would help to overcome the investment barrier. Only six large-scale forest projects, accounting for about 16% of all large-scale forest projects, provided detailed explanations.

3.4.3.1.4 Validation Reports on the Barrier Analysis

The CDM requires that a DOE validate a project proposal before a developer may register a project. The CDM's official website posts the validation reports of all registered projects. My study focused on the barrier analysis in the reports for forest projects. Figure 3.2 shows my assessment of the validation reports on the barrier analysis. Most of them offer the generality that they have checked the information or that the barriers are real. 32% of validation reports provide short statements attesting that they have checked the information in the PDD, 14% of reports confirm that key barriers are real, and 37% affirm that all barriers are real. Detailed information does not follow these short statements. Notably, 5% of reports only repeat the information in the PDD, while 2% of them do not provide any information on barrier analysis. In fact, of every project that employs barrier analysis, only about 5% provide detailed assessments of parts of barriers, and only 6% provide detailed assessments of all barriers. (Here, the detailed assessment of all barriers does not include the detailed assessment of parts of barriers so that the total of the seven categories amounts to 100%.)

3.4.3.1.5 Conclusion Regarding the Barrier Analysis

Overall, the PDDs and validation reports have not sufficiently demonstrated the additionality of these forest projects. A majority of projects provided general explanations for barriers, and not all projects provided evidence for asserted barriers. Most projects failed to explain how the CDM would help them to overcome the barriers. Moreover, the validation reports generally do no more than restate the information in the PDDs; only a limited number provided detailed assessments.

3.4.3.2 Investment Analysis

Under the CDM, the project can choose to provide investment analysis alone, or together with barrier analysis, to demonstrate additionality. The purpose of investment analysis is to show that the proposed project activity does not generate the greatest economic return. The rationale behind the investment analysis is that without funding from the CDM, a more financially attractive alternative would have taken the place of the proposed project activity. Using investment analysis to demonstrate additionality, project applicants need to adopt one of three analytic approaches – simple cost analysis, investment comparison analysis, or benchmark analysis. The project applicant can select the simple cost analysis if the project generates no financial benefits other than the revenue from the sale of offset credit. The simple cost analysis merely requires the applicant to present the costs of the project. If a project generates revenues in addition to the carbon credit, then the applicant must choose either the investment comparison analysis or the benchmark analysis. The investment comparison analysis uses financial indicators such as Internal Rate of Return (IRR) or Net Present Value (NPV) to compare the project with alternatives. The benchmark analysis employs a financial indicator to compare it with a benchmark indicator that represents standard returns by market.

Small-scale forest projects are not required to conduct investment analysis, and investment analysis is less popular than barrier analysis among large-scale forest projects. Of all 37 large-scale forest projects, 15 provided investment analysis, while 12 out of these 15 also used barrier analysis to demonstrate additionality. In other words, of all large-scale forest projects, 15 presented investment analysis and 34 offered barrier analysis.

3.4.3.2.1 Information that PDDs Provide

The additionality tool for the forest project does not specify requirements for the investment analysis. Most developers choose different parameters and different methods to show that their proposed projects are less profitable than other alternatives. Often, when the same organization or company carried out several projects, it employed exactly the same parameters and methods for each. The problem of this freedom for project developers to choose parameters and assumptions when conducting investment analysis is that the input parameters and assumptions of an investment analysis can profoundly influence the result.[153] In other words, adding or omitting certain parameters and assumptions can affect the result of the investment analysis.

My assessment of the information regarding the investment analysis in the PDDs shows that about 7% of all projects only provided the result of the calculation, 27% offered investment costs and the result of the calculation, and another 27% offered investment costs, annual costs, and revenues, as well as the result of the calculation. Fewer than half of the projects (40%) provided detailed data on costs and revenues, and only some of

[153] Personal communication with Lambert Schneider, Research Coordinator for International Climate Policy, Öko-Institut (April 2017).

these included explanations for their chosen assumptions. Figure 3.3 reveals the level of information regarding the investment analysis in PDDs.

3.4.3.2.2 Analysis Methods

The benchmark analysis is the most frequently used investment analysis method, with 12 out of 15 of the projects employing it. Only two projects chose the investment comparison analysis, and only one offered a simple cost analysis. Most of the projects adopting benchmark analysis took the IRR as their benchmark. The IRR in those projects ranged from 8% to 25%. One project[154] derived an IRR of 25% as the benchmark by using internal company information, which seems questionable. This kind of information might not be the standard returns by the market as the tool requires.

Regarding the single project that used the simple cost analysis,[155] I found the choice of that analysis questionable. As I mentioned above, the condition for using this option is that a project does not obtain any financial benefits except the revenue from the sale of offset credits. The project document explains that the company would not benefit from the project. Nevertheless, it also discloses that the company had agreed to purchase the harvested timber at harvest time. Clearly, the farmers as landowners could gain financially by selling the harvested timber, which seems to contravene the prerequisite

[154] *See* the Niassa Reforestation Project, https://cdm.unfccc.int/Projects/DB/DNV-CUK1380279225.53/view.
[155] *See* the project of Reforestation of Degraded Land by MTPL in India, https://cdm.unfccc.int/Projects/DB/TUEV-SUED1310638384.3/view.

for the adoption of the simple cost analysis. In fact, this project is similar to most of the forest projects that employed benchmark or investment comparison analysis in their investment analysis to demonstrate additionality, in that outside companies or organizations sought to develop a forest project on a site owned by local landowners.

3.4.3.2.3 Sensitivity Analysis

When developers adopt either the investment comparison analysis or the benchmark analysis, the additionality tool requires the project applicant to apply a sensitivity analysis that will assess the robustness of the financial attractiveness against reasonable variations of parameters. However, the additionality tool does not provide guidance for the choice of parameters and the range of variations. Each project applicant has the discretion to choose parameters, scenarios, and variations. Not surprisingly, the number of parameters that all projects that conducted the sensitivity analysis selected ranges from 1 to 13, and the scenarios they considered, between 1 and 4. Most projects conducted the sensitivity analysis with a 10% variation of parameters, although one project used both a 10% and a 50% variation, and one, a 20% variation.

3.4.3.2.4 Information in Validation Reports

The quality of the validation reports on investment analysis in PDDs varies. While about half of these reports (53%) issued a detailed assessment of the information embodied in the PDDs, approximately 27% of the reports merely provided a short statement that the DOE had checked the information and 13% of the reports confirmed only that the DOE had checked parts of the investment analysis. One project validation report, accounting for 7% of all projects, simply repeated the information in the PDD. Figure 3.4 shows my assessment of validation reports on investment analysis.

3.4.3.2.5 Conclusion Regarding the Investment Analysis

The investment analysis does not prescribe in detail what kinds of parameters apply to each project. Thus, project applicants have the discretion to choose parameters in ways that will achieve a satisfactory result. My assessment of all projects that conducted an investment analysis shows that more than half of them provided financial information without a detailed explanation. Most projects employed the benchmark method and chose the IRR as the benchmark, with ranges from 8% to 25%. The sensitivity analysis seems problematic, giving too much discretion to project developers. For all forest projects that conducted sensitivity analyses, the number of parameters that developers used in projects with the investment analysis ranged from 1 to 13, and the number of scenarios was between 1 and 4. Moreover, about half of the validation reports did not provide detailed assessments of the information in the PDDs.

3.4.3.3 Common Practice Analysis

The additionality tool requires each large-scale forest project to provide a common practice analysis, as a way to demonstrate that the proposed project is not standard practice in its geographical area. All large-scale forest projects provided this common analysis, other than three early projects that were not required to do so according to the rule of that time. Moreover, the additionality tool requires the applicant to provide relevant quantitative information. Of the 34 large-scale projects that provided the common analysis, 23 projects (68%) provided this quantitative data.

The CDM accepts forest projects that are similar to common practice on the condition that the distinctions between the proposed project and the common practice are essential. My assessment of the 34 large-scale projects with the common analysis assessment showed that about 35% of forest projects that provided the common practice analysis stated that their forestation activities are common practice with essential distinctions.

The assessment of explanations of common practice in PDDs demonstrates that among those large-scale projects that included the common practice analysis, 56% of them provided a substantial explanation, 35% gave a general explanation, and 9% offered almost no explanation at all (Figure 3.5). The more recently registered projects tended to deliver better explanations of common practice than did older projects.

The common practice analysis also needs DOE validation. When it finishes the validating process, the DOE produces a validation report that discloses relevant information. All large-scale forest projects that conducted the common practice analysis include corresponding validation reports. My evaluation of these validation reports found that few of them provided a detailed assessment of the information contained in PDDs. As the following graph illustrates, merely 12% of the reports provided a detailed assessment of the information in PDDs, whereas 50% of them offered short statements that they had checked the information, 32% repeated the information in the PDDs, and 6% did not mention the common practice analysis at all. Figure 3.6 shows the result of my analysis of validation reports concerning common practice analysis.

In conclusion, a number of forest projects submitted PDDs that do not meet the requirements of the additionality tool. Specifically, only about 68% of the projects provided quantitative data in the PDDs as required, and only 56% of projects offered a substantial explanation. Only 12% of the validation reports for these forest projects provided a detailed assessment of the information in their PDDs.

3.4.3.4 Retroactive Crediting

The CDM allows retroactive crediting, which enables projects to apply for credits after they have begun, as long as the applicants can prove that they seriously considered the CDM requirements before starting. It is true that some project developers might start projects before approval when there is a high likelihood that approval will be forthcoming. However, it is also possible that some projects would go forward with or without the CDM's carbon credits. In this circumstance, these projects are not additional. Thus, the CDM's approach fails to rule out projects that are not additional. My assessment of all CDM forest projects reveals that the CDM registered 86% of them through retroactive crediting, which means that they were already running when they were approved. Moreover, not all projects that sought retroactive crediting provided relevant information in their PDDs; only about 82% of them did so. Of these projects, 98% provided supporting evidence. Only 19% of the validation reports confirmed with evidence the claim that their developers considered the CDM before the start of the projects. These figures raise a reasonable doubt that without funding from the CDM, the projects that received retroactive crediting would not exist.

3.4.3.5 Conclusion Regarding the CDM

Schneider indicated in his study on projects registered during the CDM's first three years of operation that "additionality seems unlikely or questionable for a significant number of projects,"[156] and that the CDM had not been "very effective in ensuring that emission reductions are actually additional."[157] My assessment of all registered forest projects since the inception of the program is consistent with Schneider's conclusion. According to the assessment, many forest projects failed to demonstrate additionality in their project documents. The CDM did not enforce its requirement for objective and verifiable criteria that constrain the barrier analysis that these projects used. A majority of the projects

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[156] Lambert Schneider, *supra* note 97.
[157] *Id.*

provided general explanations for barriers, but not all of them presented evidence for the asserted barriers. Further, it is difficult to verify the barrier analysis objectively. The validation reports tend to corroborate the information in the PDDs on a general level, and only a few of them offered a detailed assessment.

The main problem with the investment analysis is that it lacks a uniform rule on the choice of parameters. Project applicants have the discretion to choose parameters in a way that will achieve a satisfactory result. Most projects failed to explain their reasons for adopting certain key parameters. My assessment shows that more than half of the projects provided data without detailed explanations. Most projects employed the benchmark method and chose the IRR as the benchmark, applying ranges from 8% to 25%. In particular, the sensitivity analysis is troubling, because the additionality tool does not offer specific guidance on the choice of parameters. My assessment reveals that the number of parameters appearing in projects with the investment analysis ranges from 1 to 13, while the number of scenarios is between 1 and 4. It is possible that project applicants only chose parameters that produce results that met the requirements and avoided unsatisfactory parameters.

The common practice analysis is also a problem because only 12% of the validation reports provided a detailed assessment of the information that the PDDs contained. Moreover, it is dubious whether the acceptance of retroactive crediting meets the condition that without CDM funding, the project would not have happened. In fact, 86% of the projects obtained offset credits through retroactive crediting.

Therefore, my analysis of all of the forest projects under the CDM reveals that some projects have not demonstrated additionality. Some projects did not provide documents that sufficiently demonstrated the additionality of the project. Moreover, the lack of objective and verifiable criteria gave project developers room to present only information that would reflect to their benefit. In the end, they were able to obtain validation for their projects without actually meeting the stated requirements.

3.5 California Cap and Trade Program

3.5.1 Definition of Additionality in the California Cap and Trade Program

Additionality is also a vital criterion for the offset program under the California Cap and Trade Program.[158] The California program requires that the offset be "real, additional, quantifiable, permanent, verifiable, and enforceable."[159] It defines additionality as "greenhouse gas emission reductions or removals that exceed any greenhouse gas reduction or removals otherwise required by law, regulation or legally binding mandate, and that exceed any greenhouse gas reductions or removals that would otherwise occur in

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[158] Tatyana Ruseva et al., *Additionality and Permanence Standards in California's Forest Offset Protocol: A Review of Project and Program Level Implications*, 198 JOURNAL OF ENVIRONMENTAL MANAGEMENT 277, 279–80 (2017).
[159] 17 Cal. Code Regs. § 95802(a)(12).

a conservative business-as-usual scenario."[160] California's additionality focuses on whether greenhouse gas reductions or removals exceed an established project baseline.

The California cap and trade regulation has further defined the "conservative business-as-usual scenario." The "business-as-usual scenario" means "the set of conditions reasonably expected to occur within the offset project boundary in the absence of the financial incentives provided by offset credits, taking into account all current laws and regulations, as well as current economic and technological trends."[161] "Conservative" means "utilizing project baseline assumptions, emission factors, and methodologies that are more likely than not to understate net GHG reductions or GHG removal enhancements for an offset project to address uncertainties affecting the calculation or measurement of GHG reductions or GHG removal enhancements."[162] The California program is restrained in its issuance of offset credits for each project as a way of coping with the inherent uncertainty of additionality.

3.5.2 California Program's Approach to Address Additionality

Under the California Cap and Trade Program, each project must use an ARB-approved Compliance Offset Protocol in order to receive offset credits.[163] According to the California Cap-and-Trade Regulation, the Compliance Offset Protocol must establish a

[160] *Id.* §95802 (a)(4).
[161] *Id.* §95802 (a)(43).
[162] *Id.* §95802 (a)(58).
[163] *Id.* §95970 (a) (2); *see* also *Id.* §95970 (b).

conservative business-as-usual baseline,[164] as well as standard criteria to evaluate the additionality of projects.[165] Currently, the California Air Resource Board has developed six offset protocols, covering forest, urban forest, livestock, ozone depleting substances, mine methane capture, and rice cultivation.[166] The credits that the forest projects generate are the major component of the offset program.[167]

The baseline is the key to determining whether a project is additional. A forest project is additional if it sequestrates more greenhouse gases than the business-as-usual baseline. A developer establishes a baseline by modeling the amount of sequestrated carbon from onsite stocks and harvest wood products in the absence of the forest project over a 100-year period.[168] The California program derives the data for establishing the project baseline from the Forest Inventory and Analysis (FIA) Program, which the U.S. Forest Service manages, providing continuous censuses of America's forests and projections of trends in the growth of forests.[169]

The California Cap and Trade Program adopted a standardized approach for dealing with additionality. This approach focuses on general information about the forest sector, establishing general criteria for assessing whether a specific project meets the

[164] *Id.* § 95972 (a) (3).
[165] *Id.* § 95972 (a) (9).
[166] *Compliance Offset Program*, California Air Resources Board, https://ww3.arb.ca.gov/cc/capandtrade/offsets/offsets.htm.
[167] As of March 2017, the Forest Offset Protocol had generated two-thirds of the offset credits. *See* Tatyana Ruseva et al., *supra* note 158, at 279.
[168] California Air Resources Board, Compliance Offset Protocol U.S. Forest Offset Projects (2015), https://ww3.arb.ca.gov/cc/capandtrade/protocols/usforest/forestprotocol2015.pdf.
[169] *Forest Inventory and Analysis National Program,* USDA Forest Service, https://www.fia.fs.fed.us/.

additionality requirement.[170] The California program is not concerned with what a particular project would do without the credits from the program. Instead, it imposes baselines based on similar forests and evaluates whether each project sequestrates greenhouse gases in amounts exceeding its baseline. The essence of the standardized approach is "to minimize the subjective judgment required in evaluating whether a project should receive credit for emission reductions, and how much credit it should receive."[171]

The Forest Offset Protocol provides two tests for additionality – the legal requirement test and the performance test. If a project passes both tests, the program automatically deems it additional. In contrast, if a project does not pass both tests, it fails to meet the requirements for an offset project under the California program and cannot earn offset credits.[172] Section 3.4.1 of the Forest Offset Protocol describes the legal requirement test, stipulating that the offset project should not be "required by any law, regulation, or other legally binding mandate."[173] The other legally binding mandates include "management plans … that are required for government agency approval of harvest activities" and "conservation easements or deed restrictions."[174] This legal requirement test is highly reliant on existent laws and regulations. Federal laws — such as the Endangered Species Act, the Clean Water Act, the Multiple-Use Sustained Yield Act of 1960, the National

[170] Derik Broekhoff, *supra* note 57, at 8.
[171] *Id.* at 3.
[172] 17 Cal. Code Regs. §95970; §95973.
[173] California Air Resources Board, *supra* note 168, Section 3.4.1 (a).
[174] *Id.* Section 3.4.1 (b).

Forest Management Act, the Resources Planning Act, and the Wilderness Act — have established a system of forest protection.[175] Any aspects of a project that these laws require do not qualify it as additional.

Section 3.4.2 of the Forest Offset Protocol explains the performance test in detail. To meet the requirement for additionality, a forest project must sequestrate more greenhouse gases than would occur in a "conservative business-as-usual scenario."[176] The forest offset program recognizes three types of projects – reforestation projects, improved forest management projects, and avoided conversion projects. The protocol sets forth the specific requirements for each of these. A reforestation project automatically passes the performance test if the land has had "less than 10 percent tree canopy cover for at least 10 years."[177] Any improved forest management project automatically passes the performance test.[178] Avoided conversion projects have a few more requirements.[179] Specifically, the project developer must provide a real estate appraisal showing that "the project area is suitable for conversion" and "alternative land use for the project area has a higher market value than forestland,"[180] which is "at least 40 percent greater than the value of the current forested land use."[181]

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[175] Regele indicated that these environmental laws would be adequate and cost-effective for screening projects, as long as they are fully implemented. *See* Adam Regele, *Forest Offsets and AB32: Ensuring Flexible Mechanisms Are Firm*, 19 Hastings W.-Nw. J. Envt'l L. & Pol'y 163, 182 (2013).
[176] California Air Resources Board, *supra* note 168, Section 3.4.2 (a).
[177] *Id.* Section 3.4.2 (b) (1) (A).
[178] *Id.* Section 3.4.2 (b) (2) (A).
[179] *Id.* Section 3.4.2 (b) (3) (A).
[180] *Id.*
[181] *Id.*

3.5.3 The Process of Adopting the Forest Protocol

The California Program based its forest protocol on the Climate Action Reserve's (CAR) forest protocol.[182] The CAR is one of three carbon offset registries in the California program, encouraging actions to reduce GHG emissions and developing protocols for carbon offset projects. The CAR started to create a set of forest protocols in April 2003,[183] and released the first one in September 2005.[184] The protocol has continued to evolve since then.[185] Stakeholders, forest experts, environmental organizations, and government agencies have all participated in the development of the forest protocol.[186]

Assembly Bill 32 required the California Air Resources Board to adopt CAR's forest protocol, with minor revisions, in its cap and trade program.[187] The Cap and Trade Program launched on January 1, 2012, and the compliance obligation began on January 1, 2013.[188] The ARB adopted the cap and trade program together with four compliance offset protocols – the forest protocol, the urban forest protocol, the livestock protocol,

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[182] California Air Resources Board, Compliance Offset Protocol U.S. Forest Offset Projects (2011), Section 1, https://ww3.arb.ca.gov/regact/2010/capandtrade10/copusforest.pdf.
California Air Resources Board, Compliance Offset Protocol U.S. Forest Offset Projects (2014), Section 1, https://ww3.arb.ca.gov/regact/2014/capandtrade14/ctusforestprojectsprotocol.pdf.
[183] *Forest Project Protocol*, Climate Action Reserve, http://www.climateactionreserve.org/how/protocols/forest/.
[184] *Id.*
[185] *Id.*
[186] *Id.*
[187] *Cap-and-Trade Program,* California Air Resources Board, https://ww3.arb.ca.gov/cc/capandtrade/capandtrade.htm.
[188] *Id.*

and the ozone depleting substances protocol.[189] The adoption of the regulation to implement the Cap and Trade Program and these initial four compliance offset protocols required a lengthy and thorough rulemaking process.

The ARB initiated this rulemaking as early as October 28, 2010,[190] making the proposal accessible for public review and comment on the same day, and scheduled a public hearing on December 16, 2010. [191] The comment period started on November 1, 2010, and lasted until December 15, 2010. [192] The ARB received 800 separate written comments and many form letters during this period. [193] On December 16, 2010, the ARB conducted the public hearing to consider the proposed rulemaking.[194] At the hearing, the ARB heard oral testimonies from 150 people and received 35 additional written statements and other submissions.[195]

After the hearing, the ARB made modifications to the original proposal. It made this modified proposal available for a supplemental 15-day comment period that ran from July 25 to August 11, 2011.[196] When this supplemental period was over, the ARB considered the additional comments that it had received and decided to allow a second

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[189] California Air Resources Board, California's Cap-and-Trade Program Final Statement of Reasons, 5 (2011).
[190] *Id.* at 2.
[191] *Id.*
[192] *Id.*
[193] *Id.*
[194] *Id.*
[195] *Id.*
[196] *Id.*

15-day comment period. [197] It presented a further modified proposal to the public for review and comment from September 12, 2011, to September 27, 2011.[198] By September 27, 2011, the ARB had received another 114 additional written comments. Finally, after considering these new comments, the ARB issued a final statement of reasons for this cap and trade regulation (which ran to about 2,400 pages), and on October 20, 2011, adopted the Cap and Trade Program.[199]

The forest protocol went through the same extensive public review and comment process before the ARB adopted it on October 20, 2011.[200] Later, the ARB further amended the forest protocol, adopting the second version on November 14, 2014,[201] and a third on June 25, 2015.[202]

3.5.4 Legal Challenges to the California Program

The California Cap and Trade Program had been under attack even before the regulation's final adoption. In 2009, several nonprofit organizations and individuals challenged the Scoping Plan. The AB 32 mandates the ARB to adopt a Scoping Plan that depicts the approach to reducing greenhouse gas emissions in order to achieve

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[197] *Id.* at3.
[198] *Id.*
[199] *Id.*
[200] California Air Resources Board, *supra* note 182.
[201] *Id.*
[202] California Air Resources Board, *supra* note 168.

California's emission-reducing goal. [203] The ARB did so in 2008.[204] Six months later, on June 10, 2009, the Association of Irritated Residents, several other nonprofit organizations, and several individuals brought suit against the ARB in *Association of Irritated Residents v. California Air Resources Board*, arguing that the Scoping Plan did not comply with Assembly Bill 32 and that the ARB's Functional Equivalent Document (FED) failed to comply with California's Environmental Quality Act.[205] The District Court found the FED failed to analyze alternatives adequately, but after the ARB provided a supplement to the FED, the court ruled that it was adequate.[206] The District Court rejected the plaintiffs' challenge to the Scoping Plan, and the Court of Appeals affirmed this decision.[207]

In March 2012, two environmental organizations, Our Children's Earth Foundation and Citizens Climate Lobby filed a joint lawsuit against the ARB, challenging its compliance offset protocols' methodology for evaluating additionality.[208] The District Court ruled against the environmental organizations. Our Children's Earth Foundation appealed the judgment but upon review, the Court of Appeals affirmed the District Court's decision.

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[203] *AB 32 Scoping Plan*, California Air Resources Board, https://ww3.arb.ca.gov/cc/scopingplan/scopingplan.htm.
[204] *Id.*
[205] Association of Irritated Residents v. State Air Resources Bd., 206 Cal.App.4th 1487, 1492 (2012).
[206] *Id.* at 1493–94.
[207] Association of Irritated Residents v. State Air Resources Bd., 206 Cal.App.4th 1487.

[208] Our Children's Earth Foundation v. State Air Resources Bd., 234 Cal.App.4th 870 (2015).

The Our Children's Earth Foundation alleged that the mechanism for evaluating additionality should be "perfect" so that it can "precisely delineate between additional and non-additional reductions."[209] The ARB contended that it is impossible to design such a perfect mechanism because "additionality is inherently uncertain."[210] The Court of Appeals recognized that "it is virtually impossible to know what otherwise would have occurred in most cases,"[211] which "is hypothetical and counter-factual — it can never be proven with absolute certainty."[212] The court further stated that the Legislature had delegated to the ARB the rule-making authority to design "a workable method" to ensure additionality,[213] and that the ARB had invoked an extensive regulatory process, considering opinions from the public, pertinent industries, and relevant experts, before adopting the Cap and Trade Program regulation and deciding to include offset credits in the program.[214] The court opined that the administrative record that the ARB's regulatory proceedings generated substantially supported "the many policy decisions the Board had to make in order to formulate protocols which complied with the requirements of the 2006 Act by, among other things, implementing and enforcing the Board's interpretation of the additionality requirement."[215] The court ruled that Our Children's Earth Found had failed to demonstrate that the ARB's action was arbitrary or capricious.[216]

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[209] *Id.* at 884.
[210] *Id.*
[211] *Id.* at 889.
[212] *Id.*
[213] *Id.*
[214] *Id.* at 892.
[215] *Id.*
[216] *Id.*

3.5.5 The Effectiveness of the California Forest Offset program

Whether a given forest offset project has adequately addressed additionality is crucial to the integrity of the California Cap and Trade Program. As I mentioned earlier, the California forest offset program uses a standardized approach by which to address additionality, employing objective criteria to evaluate whether each project satisfies the additionality requirement. For the additionality of the whole forest offset program, the key is how to set the baseline. If the projected baseline is lower than the actual baseline, the whole program is not additional, because this situation would count more than the actual reductions.

In fact, uncertainty exists in the projection of the baseline. The California forest offset program uses the U.S. Forest Service's methods and FIA data to establish baselines for forest projects. However, research by Thomas Buchholz et al. (2014) suggests that uncertainty exists in U.S. Forest Service projections regarding forest resources.[217] Since 1965, the U.S. Forest Service has conducted timber trend assessments every decade. These assessments predict trends in growth, harvests, and inventory of forests within U.S. territory. Thomas Buchholz et al. compared these predictions with later-measured data to determine whether the projected baseline correctly anticipated reality. He and his team found that in fact, the predicted business-as-usual baselines were lower than ensuing

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[217] Thomas Buchholz et al., *Uncertainty in Projecting GHG Emissions from Bioenergy*, 4 NATURE CLIMATE CHANGE 1045 (2014).

reality.[218] From this, they concluded that it is difficult to make an accurate prediction about "the complex dynamics of forest growth, wood use, harvest, land-use change, management intensity, forest policy, disturbance, and other factors influencing surplus growth."[219] They surmised that policy influence or intentional bias might also be involved, because "over-projection of biomass supply could have more negative socioeconomic consequences than under-projecting supply," so can lead to the adoption of assumptions and parameters that result in over-projecting removals and under-projecting growth.[220]

To address the uncertainties in forest projects, the California Cap and Trade Regulation specifically requires the establishment of a conservative business-as-usual baseline,[221] which demands that the estimation be "more likely than not to understate net GHG reductions or GHG removal enhancements."[222] The forest project protocol adopted this conservative method in its quantitative approaches, discounting credits issued for projects to cope with uncertainties.

Christa Anderson, Christopher Field, and Katharine Mach have assessed the additionality of forest projects under California's offset program.[223] The researchers collected data from project documents regarding the project area, year initiated, carbon stock, and other

[218] *Id.*
[219] *Id.* at 1047.
[220] *Id.*
[221] 17 Cal. Code Regs. § 95802 (a) (4).
[222] *Id.* § 95802 (a) (58).
[223] Christa M. Anderson et al., *Forest Offsets Partner Climate-Change Mitigation with Conservation*, 15 FRONTIERS IN ECOLOGY AND THE ENVIRONMENT 359 (2017).

voluntarily reported information. They looked at ownership, risk rating, forest inventory, and logging data, and focused on the additionality of the overall program. They concluded that “multiple lines of evidence suggest that California’s forest offset program results in additional emissions reductions, beyond reductions that would have occurred in the absence of the program,” although “some projects may be under-credited because of strict project discounting, and others may be over- credited by having non-additional credits.”[224]

The authors based their conclusion on four factors. First, they assume that forests that conservation nonprofits do not own are more likely to be additional, as conservation nonprofits tend to be not interested in logging for profit and they might already have undertaken forest carbon sequestration.[225] This assumption is consistent with common sense because in practice few private companies engage in conservation activities but many nonprofits are dedicated to protecting the environment. Their study shows that conservation nonprofits own only 26% of the projects, which suggests overall program additionality.[226] Secondly, they assume that a forest with active logging at or prior to project inception would be more likely to change practice to further sequestrate carbon dioxide after joining the forest offset program.[227] Again, this assumption matches common sense. Most of the improved forest management projects (64% of all 21 projects) have active logging at or before project inception, which demonstrates overall program

[224] *Id.* at 361.
[225] *Id.*
[226] *Id.*
[227] *Id.* at 361-62.

additionality.[228] Thirdly, the California forest offset program adopted three measures of risk – reversal risk, a buffer pool, and leakage – which discounted about 20% of the offset credits that it issued for projects on average, and ensured that the remaining credits were "insured."[229] Fourth, the California forest offset program requires improved forest management projects to be financially feasible.[230] To be more specific, the projected baseline containing logging should be financially feasible. If logging is not profitable, it is likely that the business-as-usual activities do not include logging. Also, the program requires projects to discount legally protected carbon, mainly excluding carbon from pre-existing conservation easements, endangered species activity centers, and stream management zones.[231]

The California forest offset program recognizes that uncertainty exists in forest projects. Instead of achieving additionality with each project, through its conservative design the program ensures that, as a whole, they are additional. Although this approach is not perfect, in that some projects are under-credited and some are not even additional, overall the program meets the requirement of additionality.

3.5.6 Implementation of the California Program

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[228] *Id.* at 362.
[229] *Id.*
[230] *Id.*
[231] *Id.*

The California Cap and Trade Regulation and the forest protocol impose detailed requirements for verification in order to ensure that a project implements the Cap and Trade Program accurately.[232] The ARB demands that an ARB-accredited third-party verification body verify all emission reductions.[233] The ARB sets strict rotation requirements for verification bodies, maintaining that the same verification body or offset verification team members cannot verify an offset project in more than any six out of nine consecutive reporting periods.[234] It requires the verification statement to disclose general project information and final total GHG reductions. The verification statement also adopts a standardized approach, requesting each project to respond to three questions: (1) whether the submitted offset project data report is reasonably assured of being free of offset material misstatement; (2) whether the submitted offset project data report is reasonably assured of being in conformance with the quantification, monitoring, and metering requirements of the Cap and Trade Regulation, and (3) whether the submitted offset project is reasonably assured of being in conformance with all of the other requirements of the Cap and Trade Regulation and in compliance with all local, regional, and national regulatory requirements. If all the answers are "yes," then the result is "positive," and the project is qualified for the issuance of credits. If one or more answers to these questions is "no," then the result is "adverse." In this case, the verifier has to submit a qualifying statement explaining what requirements the project did not meet and why, and the project will not receive credits.

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[232] California Air Resources Board, *supra* note 168, Section 8.
[233] *Id.* Section 8 (b).
[234] 17 Cal. Code Regs. §95977.1 (a).

Moreover, to make sure that the verifications are not biased, the ARB carries out a conflict of interest evaluation process. It requires that all verification bodies submit a conflict of interest form for each project, indicating the degree to which verifiers might have a vested interest in the project.[235] Further, the offset project registries must audit at least 10% of the annual full offset verifications in order to ensure that the verification bodies are conducting them correctly and objectively.[236]

3.5.7 Conclusion Regarding the California Cap and Trade Program

The California Cap and Trade Program adopts a standardized approach to dealing with additionality. The California Program does not address what a particular project would do without the credits from the Program. Instead, its strategy addressing additionality focuses on whether greenhouse gas reductions or removals exceed an established project baseline. The ARB adopted the forest protocol only after a thorough public review and comment process. It has withstood a number of challenges, all of which the courts have rejected. Research indicates that California's forest offset program has effectively addressed uncertainty inherent in additionality, and has achieved additionality in the program as a whole. Moreover, the California Program carries out strict verification measures to ensure that each project implements Program's rules accurately. Therefore, California's forest offset program has effectively addressed the additionality issue.

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[235] *Id.* §95979.
[236] *Id.* §95987 (e).

3.6 Conclusion

Additionality is critical to a forest carbon offset program. While the CDM adopts a project-based approach to address additionality, the California Program embraces a standardized method. The comparison between the two programs reveals that the California Program's approach is more effective than the CDM's at addressing additionality.

The CDM's project-based approach is precise in theory for it takes into account specific project conditions and factors, but it is difficult to apply such an approach in practice. In fact, some forest projects under the CDM failed to demonstrate additionality. The barrier analysis that these projects used is highly subjective, and a majority of the projects provided only vague explanations of the barriers. Also, it is difficult to verify this kind of analysis objectively. Validation reports tend to verify the information in PDDs generally, but only a few of them offered a detailed assessment. The rules regarding the investment analysis are loose, allowing each project to offer only the kind of data that will achieve a satisfactory result. More than half of the projects provided data without detailed explanations. The common practice analysis is also troublesome; only 12% of the validation reports offered a thorough assessment of the information contained in their PDDs. Moreover, the acceptance of retroactive crediting raises a reasonable doubt about the claim that without the funds from the CDM, the project would not have occurred. Nonetheless, 86% of projects obtained offset credits through retroactive crediting.

In contrast, California's forest offset program's standardized approach has successfully addressed additionality. Although California's method lacks precision for each project, it ensures the additionality of the whole program by discounting the credits that each forest project generates. The development of a forest protocol with a standardized approach required a long and arduous process. After that, the application is easy, the review process is simple and transparent, and the transaction costs are low. Research shows that California's forest offset program has achieved additional emissions reductions. Furthermore, the California Program imposes several measures to ensure that participants implement its rules correctly.

Chapter 4

Permanence

4.1 Introduction

After analyzing additionality in the previous chapter, this chapter examines the permanence issue in forest projects. Trees, like other organisms, have limited lifespans, but forests can last forever. In theory, to meet the requirement of offset, carbon removals should be permanent. The CDM and the California Program use different approaches to address the issue of permanence. While the CDM issues temporary credits that are valid for a limited time for forest projects, the California program issues regular credits for forest projects and requires the maintenance of each project for 100 years.

I have organized this chapter as follows: Section 4.2 introduces the concept of permanence. Section 4.3 provides a literature review. Section 4.4 evaluates the CDM forest carbon offset program, analyzing how the CDM addresses the permanence issue and describing its consequences. Section 4.5 assesses the California forest carbon offset program. Section 4.6 presents the conclusion.

4.2 Concept of Permanence

In the context of carbon offset, permanence generally means, "that GHG reductions or removals cannot be reversed, and that carbon once sequestered cannot be emitted back into the atmosphere."[237] Based on their study of carbon sequestration, Murray and Kasibhatia (2013) defined permanence in a slightly different way. They asserted that permanence refers to, "the point in time at which stored carbon has essentially fulfilled its role as offsetting the global warming potential of the original emission."[238] They pointed out that permanence does not necessarily mean forever, because the original emission for which the offset compensates decays over time and does not remain in the atmosphere forever.[239]

Permanence is a vital issue for forest projects. A carbon offset credit represents a reduction in emissions of greenhouse gases and can be used to compensate for an emission made elsewhere. Releasing the sequestrated carbon back into the atmosphere would undercut the goal of emission control. However, the carbon dioxide that trees absorb is not permanently sequestrated. A tree might release its carbon store into the atmosphere at any point. The carbon is stored in above-ground biomass (including trees, litter, and woody debris), below-ground biomass (including roots and soil carbon) and harvested material.[240] Trees sequestrate carbon when they are growing, and stop doing so

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[237] Tatyana Ruseva et al., *supra* note 158, at 280.
[238] Brian C. Murray & Prasad Kasibhatla, *Equating Permanence of Emission Reductions and Carbon Sequestration: Scientific and Economic Foundations for Policy Options*, Duke Environmental and Energy Economics Working Paper EE 13-08, 3 (2013).
[239] *Id.*
[240] Organisation for Economic Co-operation and Development, International Energy Agency, *Forestry Projects: Permanence, Credit Accounting and Lifetime*, Information Paper, 8 (2001).

when they are mature.[241] A forest can take anywhere from 25 to more than 150 years to reach maturity.[242] The specific maturity time depends on the climate and the species of trees.[243] Notably, both natural and human activities can destroy forests, leading to the release of sequestrated carbon.[244] Naturally occurring events such as fires, pest or fungal attacks, floods, droughts, hurricanes, volcanoes, earthquakes, and landslides can affect the carbon stored in a forest with varying severity.[245] Human-induced events such as fires and logging also lead to deforestation.[246]

Admittedly, trees, like other organisms, have a finite lifetime. No matter how long the life span of a tree, it eventually dies. Fire and disease can lead to the death of trees. In addition, some trees are harvested before they die. However, when trees within a forest vanish, for whatever reason, they leave room for new trees to sprout and grow. Before long, the new trees take the place of the previous ones. In this way, it is possible for a forest to exist forever. Correlatively, it is also possible that a forest sequestration project could be permanent. Therefore, it is of vital importance that each forest carbon offset program take measures to ensure that its forest projects are permanent.

4.3 Literature Review

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241 *Id.* at 8-9.
242 *Id.* at 9.
243 *Id.*
244 *Id.* at 11.
245 *Id.*
246 Carlos A. Peres , Jos Barlow and William F. Laurance, *Detecting anthropogenic disturbance in tropical forests,* TRENDS in Ecology and Evolution Vol.21 No.5 (2006).

The permanence of emission reductions is one of the major concerns for forest carbon offset projects, which often have difficulty maintaining carbon storage. Natural factors, such as droughts, storms, diseases, insect attacks, and changes in climate, affect forests in ways that cause the release of CO_2. Bernhard Schlamadinger et al. (2007) determined that these factors are beyond humans' control, although land management techniques such as choice of species, planting density, thinning regime, pest and fire control, and fertilizer addition can modify their effects on tree growth.[247] This uncertainty is inherent in forest offset projects. Michael Dutschke and Arild Angelsen (2008) argued that continuous monitoring and maintaining forestlands are imperative to guarantee the permanent existence of trees in the project area.[248]

Thomas Rudel et al. (2005) suggested that forest transitions take place as the economy grows: First a significant reduction in forest cover happens; then the trend changes and steady growth in forest cover occurs.[249] Kenneth Chomitz (2000) claimed that some temporary forest carbon projects might finally become permanent carbon sequestration, because after the conclusion of a forest project, pressure for agricultural transformation might diminish and local demand for environmental services may expand, which could

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[247] B. Schlamadinger et al., *A Synopsis of Land Use, Land-Use Change and Forestry (LULUCF) under the Kyoto Protocol and Marrakech Accords*, 10 ENVIRONMENTAL SCIENCE & POLICY 271, 274–75 (2007).
[248] Dutschke Michael, Angelsen Arild, *How Do We Ensure Permanence and Assign Liability?* In MOVING AHEAD WITH REDD: ISSUES, OPTIONS AND IMPLICATIONS, ed. Arild Angelsen, 77–85. Bogor, Indonesia: CIFOR (2008).
[249] Thomas K. Rudel et al., *Forest Transitions: Towards a Global Understanding of Land Use Change*, 15 GLOBAL ENVIRONMENTAL CHANGE 23 (2005).

lead to indefinite preservation of the forest.[250] Again, Kenneth Chomitz et al. (2006) warned that temporary sequestration can turn into a permanent carbon sink.[251] They explained that due to rising wages and increased appreciation of biodiversity values, after 20 to 40 years of deforestation, the previous desire to transform forests for other usages may disappear.

Ian Noble and Robert Scholes (2001) argued that carbon sequestration can be carried out quickly at a moderate expense and that doing so gains time for the development of new energy technologies.[252] Franck Lecocq and Kenneth Chomitz (2001) assessed this argument through their research, confirming the statement that carbon sequestration is "a wooden bridge to a clean energy future."[253] Vincent Gitz (2006) pointed out that as a cost-effective way to mitigate the effects of climate change, carbon sequestration can serve as insurance against uncertain climate damages over the next one or two decades.[254]

Permanence is a crucial issue that forest carbon offset programs have to address. Michael Dutschke and Arild Angelsen (2008) identified specific risks that threaten the permanence of carbon storage, including natural/ecological risk, climate change-related

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[250] Kenneth M. Chomitz, *Evaluating Carbon Offsets from Forestry and Energy Projects : How Do They Compare?*, Policy Research Working Paper No. 2357, World Bank, Washington, DC. (2000).
[251] Kenneth M. Chomitz et al., *At Loggerheads? Agricultural Expansion, Poverty Reduction, and Environment in the Tropical Forests*, The World Bank, Report No. 36789, 201 (2006).
[252] Ian Noble & R.J. Scholes, *Sinks and the Kyoto Protocol*, 1 CLIMATE POLICY 5 (2001).
[253] Franck Lecocq, Kenneth M. Chomitz, *Optimal Use of Carbon Sequestration in a Global Climate Change Strategy: Is There a Wooden Bridge to a Clean Energy Future?*, World Bank Policy Research Working Paper No. 2635 (2001).
[254] Vincent Gitz et al., *The Timing of Biological Carbon Sequestration and Carbon Abatement in the Energy Sector Under Optimal Strategies Against Climate Risks*, 27 EJ (2006).

risk, demand-side risk, failure of project partners, and political risk.[255] They offered several suggestions on how to deal with each of these, including temporary crediting, ton-year approach, project credit buffers, risk pooling, insurance, and shared liability or forest compliance partnership. They discussed the merits and drawbacks of these solutions.[256] Charles Palmer (2011) also suggested most of these solutions for carbon reversal and stressed the necessity of defining carbon property rights.[257]

4.4 CDM Forest Projects

4.4.1 CDM's Approach to Addressing Permanence

As I mentioned in Chapter 2, the CDM initially did not accept forest projects. One reason for this was its concern that a forest project comes with the inherent risk of non-permanence, because the carbon that a forest sequestrates can be released unpredictably, due to human activities or natural events.[258] Later, parties to the UNFCCC agreed to include forest projects in the CDM but imposed certain limits on them.[259] In order to address the issue of permanence, the CDM created two types of temporary credits exclusively for forest projects.

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[255] Dutschke Michael et al., *supra* note 248.
[256] *Id.*
[257] Charles Palmer, *Property Rights and Liability for Deforestation under REDD+: Implications for 'Permanence' in Policy Design*, 70 ECOLOGICAL ECONOMICS 571 (2011).
[258] Charlotte Streck, Toby Janson-Smith, Joachim Schnurr, Key Technical Issues Relevant to CDM Forestry Projects 1 (2006) (unpublished report)(on file with the Climate Focus).
[259] UNFCCC Decision 19/CP.9 (2003).

Under the CDM, forest projects cannot earn permanent credits, such as Certified Emission Reductions (CERs). Instead, the CDM issues them temporary credits, including temporary Certified Emission Reductions (tCERs) and long-term Certified Emission Reductions (lCERs).[260] The number of tCERs is equal to a project's verified net anthropogenic greenhouse gas removal since its inception,[261] and they expire at the end of the commitment period following the one during which they were issued.[262] In contrast, the CDM issues lCERs for the quantity of verified net anthropogenic greenhouse gas that the project has removed since last verification,[263] and these expire at the end of the crediting period of the project.[264] In short, tCERs and lCERs use different methods to account for greenhouse gas removal, and tCERs remain valid for a shorter period than do lCERs. Figure 4.1 illustrates the differences between tCERs and lCERs. The project developer has to choose one of these two types of credits, and cannot change the choice during the crediting period.[265] The crediting period is either 20 years, which the developer can choose to extend to 40 or 60 years, or 30 years with no extension.[266] Unlike permanent credits, which do not expire and never require any replacement, buyers of both tCERs and lCERs must replace them with permanent credits before their expiration.[267]

[260] *Id.*
[261] *Id*., section 36.
[262] *Id*., section 1 (g).
[263] *Id*., section 36.
[264] *Id*., section 1 (h).
[265] UNFCCC Decision 19/CP.9. (2003).
[266] *Id*., section 23.
[267] UNFCCC Decision 19/CP.9. (2003).

4.4.2 Assessment of CDM's Approach

The use of temporary credits for forest projects has some drawbacks. Temporary credits have lower market prices than do permanent credits.[268] They are only valid for a limited period of time, and must be replaced before expiration. These temporary credits are traded privately, and their prices are not public. Bird et al. asserted that the price of tCERs or lCERs should be less than the current price of CERs minus the net present value of the replacement cost.[269] This is because replacing the credits has transaction costs. Bird estimated that the tCERs stand at approximately 10% of the price of CERs, and that the lCERs, with 30-year crediting period, at 60% of the price of CERs.[270]

Meanwhile, the costs of developing a forest project under the CDM are high. Every step, from validating, through registering, monitoring, verifying, and engaging the market has its costs. Under the CDM's rules, some forest projects need to provide environmental services.[271] The World Bank's report based on the BioCarbon Fund's experience indicates that the costs of developing a CDM forest project are the highest among projects in all sectors, at about \$1.0 per tCO_2e, or \$0.5 higher than the second highest, the wind sector.[272] Figure 4.2 shows the development costs for each type of project.

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[268] GURMIT SINGH, UNDERSTANDING CARBON CREDITS 383 (2009).
[269] *Id.*
[270] *Id.*
[271] Zenia Salinas & Ellysar Baroudy, *BioCarbon Fund Experience : Insights from Afforestation and Reforestation Clean Development Mechanism Projects*, the World Bank, Report No. 76566, 52 (2011).
[272] *Id.* at 98.

In addition, the low prices of temporary credits might not cover the total costs of developing a forest project under the CDM. This was the BioCarbon Fund's experience.[273] Some projects generate additional revenues from timber or other products, which might cover the difference for a project.[274] A compelling example is a rubber-based agroforestry project, Lao PDR,[275] which meets the requirement of additionality according to my assessment in Chapter 3. The project developer, Lao Thai Hua Rubber Co. Ltd, collects rubber periodically and manufactures wood-based furniture from harvested rubberwood in order to compensate for part of the cost of the project. However, the number of this kind of project under the CDM is limited, as not many projects offer a way to generate additional income.

4.4.3 The Unattractiveness of the CDM Forest Projects

From its beginning in 2005 to July 31, 2016, the CDM registered 7,733 projects.[276] These projects fall into 15 different sectors – the energy industries, energy distribution, energy demand, manufacturing industries, chemical industries, construction, transport, mining/mineral production, metal production, fugitive emissions from fuels, fugitive emissions from production and consumption of halocarbons and sulphur hexafluoride, solvent use, waste handling and disposal, afforestation and reforestation, and agriculture.

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[273] *Id.* at 52.
[274] *Id.*
[275] *See* the project Mitigation of GHG: Rubber Based Agro-Forestry System for Sustainable Development and Poverty Reduction in Pakkading, Bolikhamsay Province, Lao PDR, https://cdm.unfccc.int/Projects/DB/TUEV-SUED1424864873.61/view.
[276] UNFCCC, *supra* note 71.

Markedly, only 66 of these CDM projects are afforestation or reforestation projects, accounting for only 0.8% of the total registered number.[277] For each forest project, the project developer had to choose between tCERs or lCERs. While 9% of them opted for lCERs, 91% of forest project developers picked tCERs.[278] Unlike lCERs, tCERs enable developers to avoid long-term liability for maintaining the project. Also, tCERs allow buyers to circumvent the uncertainty arising from long-term project risk and the hardly predictable or even unpredictable future prices of carbon credits.[279]

The small number of registered forest projects under the CDM seems to suggest that forest projects are unattractive to most prospective project developers. The sources of funding might offer one explanation for this. Generally, private entities invest in a forest project out of economic incentive, whereas governments and NGOs support these projects for other purposes, such as protecting the environment, conducting research, and subsidizing rural communities.

I examined information about sources of funding in the project documents of all 66 forest projects and divided them into four categories – government, non-governmental organization (NGO), private entity, and combination (which includes at least two of these three groups). I found that 44% of the projects receive government financing, and that NGOs fund 11% of them. The combination of government, NGO, and private funding

[277] *Distribution of Registered Projects by Scope*, UNFCCC, http://cdm.unfccc.int/Statistics/Public/files/201607/proj_reg_byScope.pdf.
[278] I obtained these figures through counting tCERs and lCERs in all forest projects.
[279] Salinas & Baroudy, *supra* note 271, at 50.

represents 21% of all projects. Private entities alone support only 24% of projects. The graph below shows the sources of financing for all the forest projects under the CDM. Figure 4.3 discloses sources of funding for them.

Notably, the projects that governments, NGOs, and combinations of parties finance account for 76% of forest projects. As every combination of parties includes at least one government or one NGO, we see that these support 76% of CDM's forest projects financially. Governments or NGOs might fund forest projects even without economic return as they may have other concerns.

Some private entities might have additional incentives to engage in this activity. The above-mentioned projects in India and Lao PDR are such examples. The project developer in the Indian project obtains timber from the project, and the project developer in Lao PDR's project collects rubber and acquires rubberwood from it. However, the number of such enterprises is limited, which explains why there are so few private entities financing forest projects. Overall, the forest project under the CDM fails to offer an economic incentive for project developers who do not need the lumber or another product that the forest provides.

It is notable that the actual number of forest projects, 66, is small, compared to the nearly 8,000 other registered CDM projects. This number, together with the low proportion of private investors, indicate that the forest projects under the CDM are economically unattractive to project developers.

4.4.4 Conclusion Regarding the CDM

To cope with the risk of non-permanence, the CDM created two types of temporary credits — tCERs and lCERs — for forest projects. This approach, however, has not proved economically compelling. These temporary credits remain valid for a limited time and project developers must replace them with permanent credits before they expire. This means that the prices of temporary credits are lower than those of permanent credits. However, the average cost of developing a forest project is higher than the cost of any other kind of project under the CDM. The low income from these temporary credits and the high cost for developing forest projects combine to render CDM forest projects financially unattractive to project developers. CDM's small number of forest projects indicates that they are unattractive — 66 registered forest projects in stark contrast to almost 8,000 projects in all sectors. My assessment of financial sources of all forest projects under the CDM further confirms the unattractiveness of CDM forest projects. Theoretically, governments and NGOs are more likely to give financial support to forest projects for purposes such as environmental conservation, while private entities are more concerned with economic returns. My assessment shows that 76% of forest projects obtained funding, in full or in part, from governments or NGOs and that only a small portion of projects was financed solely by private entities.

4.5 Forest Projects in the California Program

4.5.1 California Program's Approach to Permanence

The California program takes a different approach when addressing the issue of permanence in forest projects. In order to comply with California's Cap and Trade regulations that demand that the carbon sequestration be permanent,[280] California's forest protocol requires each forest project to store carbon for 100 years after the issuance of any offset credits.[281] Viewing 100 years as permanence is consistent with Murray and Kasibhatia's study, which suggests that storing carbon for that amount of time is sufficient to compensate for the atmospheric effects of the corresponding emission that the offset allows, because the greenhouse gas in the atmosphere decays over time.[282] The California program addresses the permanence issue through three mechanisms.

First, it requires that all offset projects monitor onsite carbon stocks, submit annual offset project data reports, and have third-party verifiers verify those reports with site visits at least every six years during the project life, from its commencement to 100 years after

[280] California Air Resource Board, *supra* note 168, section 3.5 (a).
[281] *Id.*
[282] Brian C. Murray & Prasad Kasibhatla, *Equating Permanence of Emission Reductions and Carbon Sequestration: Scientific and Economic Foundations for Policy Options*, Duke Environmental and Energy Economics Working Paper EE 13-08, 5 (2013).

any issuance of offset credits.[283] An ARB-accredited offset verification body must conduct the verification.[284] The California Cap and Trade regulation and the forest protocol all include detailed requirements for verification.[285]

Second, the offset project must compensate for intentional reversals of carbon sequestration through the retirement of other compliance instruments.[286] Intentional reversal means "any reversal … caused by a forest owner's negligence, gross negligence, or willful intent, including harvesting, development, and harm to the area within the offset project boundary, or caused by approved growth models overestimating carbon stocks."[287] If an intentional reversal occurs, the offset project must give written notice, provide a description and explanation, and compensate for the reversal.[288]

Third, the ARB establishes a forest buffer account to provide insurance against unintentional reversals.[289] Unintentional reversal refers to "any reversal, including wildfires or disease, that is not the result of the forest owner's negligence, gross negligence, or willful intent."[290] Each forest project must contribute a proportion of the offset credits that it generates to the forest buffer account. The proportion of a project's contribution is determined by its reversal risk rating. The forest protocol divides the

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[283] California Air Resource Board, *supra* note 168, section 3.5 (a)(1).
[284] *Id.*, section 3.1 (c)(5).
[285] *Id.*
[286] *Id.*, section 3.5 (a)(2).
[287] 17 Cal. Code Regs. § 95802.
[288] *Id.* § 95983.
[289] California Air Resource Board, *supra* note 168, section 3.5 (a)(3).
[290] 17 Cal. Code Regs. § 95802.

reversal risks into four risk categories — financial, management, social, and natural disturbance. The forest protocol assigns a certain value to each risk type in these four risk categories. Each project must identify its own risk and calculate its reversal risk rating.

4.5.2 Assessment of the California Program's Approach

I have assessed the way that the California forest offset program addresses the issue of permanence. The results are as follows. First, in order to ensure the permanence of forest projects, it requires that 100 years of monitoring follow any issuance of credits. The crediting period for forest projects is 25 years, but developers can renew this any number of times. When a project developer renews the project after a 25-year crediting period has expired, the 100-year monitoring period extends as well. The project will continue to exist as long as the developer renews the crediting periods. Even if the developer does not renew the crediting period, the project must still monitor carbon sequestration for the next 100 years. As I mentioned earlier, Murray and Kasibhatia's study suggests that 100 years of carbon storage meets the requirement of permanence.[291] The carbon dioxide that trees release into the atmosphere decays over time, although a fraction of the emitted carbon dioxide remains there indefinitely. At the same time, due to fires, insects, diseases, and other factors, carbon stored in forests gradually returns to the atmosphere. Murray and Kasibhatia's study indicates that keeping the carbon intact for 100 years is sufficient to

[291] Murray & Kasibhatla, *supra* note 282.

compensate for the atmospheric effects of the corresponding emissions that the offset allows.[292]

However, uncertainties exist in long-term contracts. Robert Solow indicates that there is a concern that long-term contracts might not be reliable, since political intervention could make contracts unenforceable.[293] Furthermore, if a participating landowner goes bankrupt and cannot maintain the forest project, the ARB will probably be unable to force the landowner to continue to perform the long-term contract. In this situation, ARB might work with the bank or relevant court to come up with a compromise solution.

It is true that the 125-year contract (100 years plus the 25-year crediting period) is a lengthy contract that involves uncertainty. Nevertheless, as the above literature review revealed, forest carbon sequestration is an inexpensive way to reduce greenhouse emissions quickly, buying time for future technology advancement that will allow real emission abatement at a low cost. This long-term contract appears to be a workable solution to the complicated and uncertain issue of permanence.

Second, calculating the reversal risk rating by the forest protocol's method creates a result that exceeds the real risk. This is deliberate; the CAR intentionally designed the calculation to contribute to the buffer account so that each project far outweighs its risk

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[292] *Id.*
[293] Robert M. Solow, *The Economics of Resources or the Resources of Economics*, 64 THE AMERICAN ECONOMIC REVIEW 1, 80 (1974).

of reversal.[294] One example is the fire risk rating, which is based on fire risk in California.[295] The risk of wildfire in California is far higher than the average fire risk across the United States. The ARB has registered 13 compliant forest projects. The average reversal risk rating of these projects is 18.25%, with the lowest rating at 14.08% and the highest at 20.90%. All of these projects started in or after 2012. As of the end of 2017, only one reversal had occurred. It happened in the Trinity Timberlands University Hill Improved Forest Management Project, where a lighting-initiated wildfire caused an unintentional reversal.[296] The numbers make it clear that the actual reversal risk is lower than the reversal rate that the California Program sets. According to the calculation based on actual data, with an average reversal risk of 18.25% for these 13 forest projects, 2.37 reversals should occur each year; thus in a period of five years, we might see 11.85 reversals. The actual number of reversals is lower than that because some projects started after 2012, and there were not 13 projects during early years. However, it is certain that the actual number is far greater than one, since according to the California Program's calculations, unintentional reversals reached 2.37 for 13 projects in only one year. Although five years is a short term that might not correctly reflect the situation over a long period, this five-year sampling of projects in the California forest offset program seems to suggest that the calculations about the reversal rate are conservative. So far, the

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[294] Memorandum from the Climate Action Reserve on Forest Project Buffer Pool (on file with the Climate Action Reserve).
[295] *Id.*
[296] *See* Trinity Timberlands University Hill Improved Forest Management Project, available at https://thereserve2.apx.com/mymodule/reg/TabDocuments.asp?r=111&ad=Prpt&act=update&type=PRO&aProj=pub&tablename=doc&id1=1046.

buffer account has sufficiently covered any potentially unintentional reversals, and supports the permanence of the whole forest program.

Third, the issuance of regular offset credits does not discourage the development of forest projects. Unlike the CDM, the California Program issues regular offset credits for forest projects. As of December 11, 2019, the ARB had issued 167,740,508 metric tons of CO2 equivalent (MTCO2e) offset credits, which consist of 24,187,917 MTCO2e early action offset credits and 143,552,591 MTCO2e compliance credits.[297] Notably, the forestry project is the most important part of the compliance offset program under the California Cap and Trade Program. Forest projects have generated more offset credits than any other type of project,[298] with credits of 133,924,967 MTCO2e, near 80% of the total credits of 167,740,508 MTCO2e.[299] Clearly, the forest is the most popular type of project under the California Program.

4.5.3 Conclusion Regarding the California Program

In order to address the issue of permanence, California's forest protocol requires forest projects to store carbon for 100 years after the issuance of any offset credits. During these 100 years, each project must monitor its onsite carbon stocks, submit annual offset project data reports, and have a third-party verifier verify those reports with site visits at

[297] California Air Resources Board, *supra* note 74.
[298] *Id.*
[299] *Id.*

least every six years. Although the 100 years of monitoring is not perfect, due to uncertainty inherent in such a long-term contract, it appears to be a workable solution to ensure the permanence of the forest project. Also, the California Program requires each project to compensate for intentional reversals of carbon sequestration and establishes a forest buffer account to provide insurance against unintentional reversals. California deliberately designed the method of calculating reversal risk rating to over-count reversal risk, which ensures that the buffer account is large enough to cover any potentially unintentional reversals. In addition, by issuing permanent offset credits, the California program does not weaken developers' enthusiasm for the development of the forest projects.

4.6 Conclusion

Permanence is an essential issue that each forest carbon offset program must address. The CDM and the California Program handle the risk of reversal for forest projects in different ways. While the CDM issues temporary credits for forest projects, the California Program gives them regular ones, setting aside a certain percentage for potential reversal risks. The comparison of the two programs suggests that California's approach is more effective in producing sound projects than the CDM's.

The CDM attempts to use the temporary credits to resolve the issue of permanence, but the unattractiveness of the temporary credits discourages potential investors and paralyzes the forest offset program. The CDM issues two types of temporary credits for forest projects. Project developers must replace these temporary credits before the credits expire. Temporary credit prices are lower than the price of permanent credits, which discourages the development of the forest project under the CDM, particularly for private entities. The sources of funding indicate the unattractiveness of the CDM forest projects.

In contrast, the California Program employs a different approach to address permanence, while also making the development of forest projects attractive to investors. The California Program requires forest projects to store carbon for 100 years after the issuance of any offset credits, specifically in order to keep carbon sequestration permanent. The ARB imposes on each project the obligations of monitoring and verification throughout the 100-year period. Also, the California Program establishes a forest buffer account to provide insurance against unintentional reversals, with conservative settings of reversal risks. Although the long-term contract is not perfect, it seems a workable solution to cope with the issue of permanence that embraces different kinds of uncertainties. Thus far, the buffer account has sufficiently covered all unintentional reversals since the inception of the program.

Chapter 5

Leakage

5.1 Introduction

Leakage is the third crucial issue for forest projects. Leakage occurs when planting trees in one place causes the displacement of grazing or agricultural activities that destroy forests in other places, or when preserving one forest shifts logging to another forest. This chapter analyzes how the CDM and the California Program address leakage from forest projects. The CDM only accepts afforestation or reforestation projects, estimating leakage from the displacement of agricultural or grazing activities. The California Program recognizes reforestation, improved forest management, and avoided conversion projects, applying different generic leakage risk rates to different situations.

I have organized this chapter as follows: Section 5.2 introduces the concept of leakage. Section 5.3 provides a literature review, presenting the disagreement among scholars regarding the range of leakage rates for forest projects. Section 5.4 describes the CDM's and the California Program's approaches to addressing leakage. Section 5.5 evaluates these approaches. Section 5.6 presents Henders et al.'s research analyzing quantitative methods for leakage estimation from several major offset programs worldwide. Section

5.7 uses Henders et al.'s approach to assess the CDM and the California program. Section 5.8 presents the conclusion.

5.2 Concept of Leakage

Leakage, also called "emission displacement," is the third vital issue for forest carbon offset programs. It means that emissions outside a project's boundary displace emissions within it. The Intergovernmental Panel on Climate Change (IPCC) defines leakage in the context of land use activity as "the indirect impact that a targeted land use, land-use change, and forestry activity in a certain place at a certain time has on carbon storage at another place or time."[300] The IPCC further explains that leakage is the "unanticipated decrease or increase in GHG benefits outside of the project's accounting boundary as a result of the project activities."[301] To illustrate, suppose an avoided deforestation project successfully prevents clear cutting of the trees in the project site. However, to meet the demand for the lumber that still exists, loggers fell trees on another location, outside of the project boundary. This shifts emissions from this project site to another, without reducing them. Leakage is likely to occur in forest projects. Some forest projects are successful in sequestering carbon within the project boundary, but even so, the project activities can lead to increased emissions elsewhere.

[300] Special Report on Land Use, Land-Use Change, and Forestry, IPCC 2000, section 2.3.5.2.
[301] *Id.*, section 5.3.3.

We can divide leakage into two categories. The first is primary leakage, also called "activity-shifting leakage," which refers to the "direct leakage effects caused by displacement of
baseline activities or agents from one area to the next."[302] This primary leakage occurs when activities that produce emissions directly shift to other locations. An example would be when preserving one forest for the purpose of avoiding emissions leads to the deforestation of another. The second kind is secondary leakage, or "market leakage," meaning that "forest conservation in one place indirectly creates incentives to deforest in other places."[303] Put another way, secondary leakage occurs when conservation practices in one location drive up the prices of forest-related commodities, and the resulting high prices galvanize more intensive harvesting activities in other areas.

5.3 Literature Review

Estimating leakage is technically challenging. In practice, it is almost impossible to measure leakage for a specific forest project, because leakage could be everywhere except at the project site. Currently established forest projects usually calculate leakage through a variety of models. Each model involves different variables and each generates different results. The result of this is that there is little agreement among scholars as to the appropriate range by which to establish the leakage rate.

[302] Sabine Henders & Madelene Ostwald, *Forest Carbon Leakage Quantification Methods and Their Suitability for Assessing Leakage in REDD*, 3 FORESTS 33, 36 (2012).
[303] *Id.* at 37.

Sedjo and Sohngen (2000) used a global timber market model to analyze the relationships between newly created sequestration forests and timber markets, and found that the leakage that occurred in carbon plantations is modest, less than 16%.[304] They determined that 50 million ha of carbon plantations produce leakage from 0.2 to 7.8 million ha over a 100-year period.[305] When Murray et al. (2004) combined analytic, econometric, and sector-level optimization models to estimate leakage from forest-sector climate mitigation projects in the U.S., their results indicated leakage ranges from less than 10% to more than 90%.[306] The leakage effect varies among different activities and regions.[307] Sohngen and Brown (2004) conducted research to estimate the leakage arising from a carbon project in a developing country, Bolivia. They developed a dynamic optimization model of Bolivian timber markets and assumed Bolivia to be a price taker on the global market. Their model suggested that leakage could range from 5% to 42%, and from 2% to 38% when discounting carbon.[308] Gan and McCarl (2007) adopted a multiple-country model, finding that the estimated global leakage rate ranged from 42% to 95%.[309] Sun

[304] Roger A. Sedjo & Brent Sohngen, *Forestry Sequestration of CO2 and Markets for Timber*, Resources for the Future, Discussion Paper 00–35, 36 (2000).
[305] *Id.*
[306] Brian C. Murray et al., *Estimating Leakage from Forest Carbon Sequestration Programs*, 80 LAND ECONOMICS 109 (2004).
[307] *Id.*
[308] B. Sohngen and S. Brown, *Measuring Leakage From Carbon Projects in Open Economies: A Stop Timber Harvesting Project in Bolivia as a Case Study*, CANADIAN JOURNAL OF FOREST RESEARCH 34: 829-839 (2004).
[309] Jianbang Gan & Bruce McCarl, *Measuring Transnational Leakage of Forest Conservation*, 64 ECOLOGICAL ECONOMICS 423 (2007).

and Sohngen (2009) used a global land use and forestry model to estimate leakage worldwide. Their results indicated that the global leakage ranges from 47% to 52%.[310]

5.4 Approaches to Addressing Leakage

The CDM and California programs use different approaches to addressing leakage. While the CDM provides a leakage estimation tool with a step-by-step guide to calculating leakage for each project, the California program adopts a standardized approach to discount emission reductions. The following is the introduction to these two different approaches.

5.4.1 CDM's Approach

Given the special nature of the forest project, the UNFCCC specifically defines leakage under the CDM for afforestation or reforestation projects as "the increase in greenhouse gas emissions by sources which occurs outside the boundary of an afforestation or reforestation project activity under the CDM which is measurable and attributable to the afforestation or reforestation project activity."[311] Notably, the CDM confines its

[310] Bin Sun & Brent Sohngen, *Set-Asides for Carbon Sequestration: Implications for Permanence and Leakage*, 96 CLIMATIC CHANGE 409 (2009).
[311] UNFCCC Decision 19/CP.9 (2004).

calculation of leakage to primary leakage, excluding secondary leakage with the claim that the secondary effects of the project activity are insignificant.[312]

The CDM has established a step-by-step approach to estimating leakage for forest projects. This approach only applies to afforestation or reforestation projects, because the CDM does not accept avoided deforestation projects, which it considers likely to involve a high leakage risk.[313] Its leakage estimation tool provides detailed guidance, as well as formulas for estimating the leakage stemming from pre-project activities that result in increased emissions in the land that is receiving the displaced activities.[314] Usually, leakage stems from the displacement of grazing animals or agricultural activities. A typical example is the "Restoration of Degraded Lands through Reforestation," a CDM forest project in the Aberdare Forest Complex & National Park area, Kenya.[315] This is a reforestation project that involves the planting of 1,694 hectares of unstocked land within the Aberdare Forest Range in the Republic of Kenya. Before the implementation of project activities, elephants fed on grasses at the project site. The project activity shifted these elephants from that area to a new patch of land, which resulted in deforestation in the new location. Thus, leakage occurred, in that the project activity caused deforestation in an area outside of the project site.

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[312] CDM, A/R Methodological tool — Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity.

[313] Charlotte Streck et al., *supra* note 258, at 2; *see* also B. Schlamadinger et al., *A Synopsis of Land Use, Land-Use Change and Forestry (LULUCF) under the Kyoto Protocol and Marrakech Accords*, 10 ENVIRONMENTAL SCIENCE & POLICY 271, 278 (2007).

[314] CDM, *supra* note 312.

[315] *See* the project Restoration of Degraded Lands through Reforestation in Aberdare Forest Complex & National Park area, Kenya, https://cdm.unfccc.int/Projects/DB/DNV-CUK1384937677.31/view.

5.4.2 California Program's Approach

The California Program uses a different approach to addressing leakage, taking it into account when determining total net greenhouse gas reductions and removals. According to its protocol, the forest owner first presents the project's primary effect, which is its "intended changes in carbon stocks, greenhouse gas emissions, or greenhouse gas removals." [316] Second, the forest owner quantifies the project's secondary effects, which are the "unintended changes in carbon stocks, greenhouse gas emissions, or greenhouse gas removals caused by the forest project."[317] Secondary effects usually contain increases in mobile combustion emissions produced by site preparation and additional emissions due to leakage (when harvesting activities shift to places outside the project site). Therefore, secondary effects are always negative, reflecting a negative consequence of the primary effect. Finally, the forest owner calculates the total net greenhouse gas reductions and removals by summing the primary and secondary effects.

The California Program employs a standardized approach to account for secondary effects. The Program treats each type of project differently, providing a separate formula with which to calculate secondary effects for each type of project. The secondary effects of reforestation projects are the mobile combustion emissions associated with machinery used in site preparation and the shifting of cropland or grazing activities to forestland

[316] California Air Resource Board, *supra* note 168.
[317] *Id.*

outside the project area.[318] The Program uses standard factors to estimate the emissions arising from mobile combustion and the shifting of activities. It calculates the secondary effects of improved forest management projects through the application of a standard 20% market leakage factor.[319] For avoided conversion projects, it takes account of primary leakage, using a standard conversion factor of 3.6%.[320]

5.5 Assessment of the CDM and the California Program

This section assesses the CDM and California programs respectively. For the CDM, I evaluated its leakage estimation tool and all of the registered forest projects that apply it. Since these projects used the project-based approach, in which each project provided documents and evidence to support its specific claim, it is worth examining how each one applied the tool. For the California Program, I assessed the approaches that all three types of projects under the program used. I did not investigate the project documents of registered forest projects under the California Program, because the use of a standardized approach results in simple and similar project documents.

5.5.1 CDM

5.5.1.1 Assessment of Leakage Estimation Tool

[318] California Air Resource Board, *supra* note 168, section 5.1.5.
[319] *Id.*, section 5.2.6.
[320] *Id.*, section 5.3.5.

The methodologies under the CDM have been evolving. The CDM once made more than ten methodologies available for forest projects. Gradually, newer versions of the methodologies have replaced some of these. Currently, the number of valid methodologies has dropped to four, two for large-scale projects and two for small-scale ones. All the four methodologies employ the same tool to estimate the leakage, called *estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity*, which is simpler than previous versions.

This leakage estimation tool provides a step-by-step approach to calculating the leakage that arises from the displacement of pre-project agricultural activities. The tool makes clear that its estimates do not take secondary leakage into account. Moreover, it considers displaced activities insignificant and counts them as zero leakage as long as they meet one of the following five conditions: "(a) Animals are displaced to existing grazing land and the total number of animals in the receiving grazing land (displaced and existing) does not exceed the carrying capacity of the grazing land; (b) Animals are displaced to existing non-grazing grassland and the total number of animals displaced does not exceed the carrying capacity of the receiving grassland; (c) Animals are displaced to cropland that has been abandoned within the last five years; (d) Animals are displaced to forested lands, and no clearance of trees, or decrease in crown cover of trees and shrubs, occurs due to the displaced animals; (e) Animals are displaced to zero-grazing system."[321]

For projects that should account for leakage, this estimation tool provides equations to calculate that leakage. Basically, it determines leakage by multiplying the sum of the decrease in carbon stock and the change in soil organic carbon stock in the land receiving the displaced activity by a factor of 44/12, which is the ratio of the molecular weights of carbon dioxide and carbon (CO2 and C).[322] Notably, it applies a factor of 1.1 in the calculation of the decrease in carbon stock in order to account for deadwood and litter pools. In addition, it uses some default values for calculating the decrease in both carbon stock and soil organic carbon stock, if the use of other values is not justified.

5.5.1.2 Assessment of Registered Forest Projects

After looking at the leakage estimation tool itself, I investigated how forest projects actually apply it. Out of all forest projects, I selected those that employ one of the four methodologies I mentioned above, all of which use the current version of the leakage estimation tool. There are 17 such forest projects. I examined the project documents of each to see how they treat leakage. I found that only two projects accounted for leakage,

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[321] CDM, Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity, https://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-15-v2.0.pdf/history_view.
[322] The leakage estimation tool does not explicitly express the meaning of the factor 44/22. The CDM Secretariat explained that the fraction 44/12 represents the ratio of the molecular weights of carbon dioxide and carbon in October 2018.

one from the displacement of agricultural activities and the second from the displacement of grazing activities. Among the remaining 15 projects that claimed no expected leakage, three stated that leakage due to the displacement of pre-project grazing or agricultural activity was insignificant and therefore counted as zero according to CDM's leakage estimating tool, and 12 asserted that there was no pre-project grazing or agricultural activity. This assessment assumed that substantial leakage was not likely to occur in afforestation or reforestation projects. This seems of a piece with the way that the CDM addresses leakage, by only accepting the projects that have a low leakage risk.

5.5.2 California Program

Projects registered under the California Program all used standardized approaches to calculating leakage. All projects submitted similar documents for the estimation of leakage, except for the variances in values. It is difficult to distill useful information from these documents. Instead, my assessment focuses mainly on the methods of addressing leakage that the forest protocol specifically described. The California program addresses leakage in each of the three types of projects differently. I assess each type of project in the following sections.

5.5.2.1 Reforestation Projects

Like the CDM, the California Program accounts for primary leakage in reforestation projects. However, the California Program employs a different method to calculate primary leakage. The Air Resource Board requires each reforestation project to take into account mobile combustion emissions and the shifting of cropland or grazing activities in its calculation of leakage. The forest protocol provides equations and standard factors for estimating leakage related to reforestation. When the CAR designed the forest protocol, a stakeholder workgroup determined these quantitative methods and factors based on the research available at the time.[323] The stakeholder workgroup consisted of industry representatives, federal agency personnel, environmental organizations, verifiers, and expert consultants.[324] As new information becomes available, the ARB will go through a regulatory rulemaking process to update the forest project protocol.

The estimation of leakage from machinery used in site preparation depends on the conditions of the project area. The program applies a mobile combustion emission factor of 0.090 metric tons CO2e per acre to a project area with 0 - 25% brush cover; 0.202 metric tons CO2e per acre to > 25 - 50% dense brush cover; and 0.429 metric tons CO2e per acre to > 50% brush cover or stump removal.

The forest protocol also provides equations to quantify leakage from shifting cropland and grazing activities, which are the two main sources of leakage from reforestation

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[323] Personal communication with Sarah J. Wescott, Senior Forest Program Manager, Climate Action Reserve (March 2018).
[324] *Forest Project Protocol Development*, Climate Action Reserve, https://www.climateactionreserve.org/how/protocols/forest/dev/.

projects. It offers a decision tree for determining the leakage risk percentage, which, once identified at the beginning of the project, remains unchanged through the end of the project's life. The decision tree assigns reforestation projects on commercially viable cropland a leakage risk of 24% for crop displacement. This risk rate derives from the EPA's estimation of leakage from afforestation in the United States.[325] According to the EPA, this 24% of national afforestation leakage falls in the range of 18.3% to 42.5% for regional leakage across the U.S. that Murray et al.[326] found. Table 5.1 shows specific values of leakage for the five regions in the U.S. that they studied.[327]

The Program does not consider project sites without commercially viable grazing activities or project sites with commercially viable grazing activities but with less than 30% canopy cover to be leakage risks. For project sites with commercially viable grazing activities and more than 30% canopy cover, the Program expects leakage risk to go up as the canopy cover increases. The leakage risk for grazing displacement is 10% for reforestation with 30 – 39% canopy cover; 20% leakage risk for 40 – 49% canopy cover; 30% leakage risk for 50 – 59% canopy cover; 40% leakage risk for 60 – 69% canopy cover; and 50% leakage risk for ≥70% canopy cover. These leakage rates for grazing displacement initially appeared in Version 3.0 of CAR's Forest Project Protocol, and CAR's responses to public comments indicate that the workgroup initially incorporated these leakage rates for grazing displacement, as they were based on the then "most up-to-

[325] U.S. EPA, Greenhouse Gas Mitigation Potential in U.S. Forestry and Agriculture, EPA 430-R-05-006 (2005).
[326] Murray et al., *supra* note 306.
[327] *Id.*, at 34.

date, peer-reviewed estimates of leakage from reforestation projects.[328] The CAR pointed out that it will approve changed leakage estimates as more data becomes available and as further research addresses this issue.[329]

5.5.2.2 Improved Forest Management Projects

In accordance with the forest protocol, improved forest management projects account for secondary leakage. This approach adopts a standard market leakage factor of 20%, which "was essentially a compromise recommended by the stakeholder working group, as a way to streamline application of the protocol."[330] This means that the Program counts leakage as 20% of the net emission reductions that a project realizes. The 20% market leakage factor stems originally from Murray et al.'s research.[331]

Murray et al.'s research suggested that secondary leakage from forest preservation projects varies in two regions of the U.S., with 16.2% for the west side of the Pacific Northwest (PNWW) and 68.3% for South-central (SC) region.[332] They adopted a FASOM forest and agricultural sector model to produce empirical leakage

[328] Climate Action Reserve, Summary of Comments and Responses on the Draft Forest Project Protocol, 68-9 (2009).
[329] *Id.*
[330] Personal communication with Derik Broekhoff, Senior Scientist, Stockholm Environment Institute (Septempber 2017).
[331] Personal communication with Sarah J. Wescott, Senior Forest Program Manager, Climate Action Reserve (February 2017).
[332] Murray et al., *supra* note 306, at 23.

consequences.[333] They simulated a scenario that sets aside 100,000 old-growth forests in the PNWW that would otherwise have been harvested, and another scenario that reserves 660,000 acres in the SC region. After running the two scenarios independently, they found leakage of 16.2% for PNWW and 68.3% for SC. They explained that the difference in these two outcomes is based partly on the relative carbon densities in the two regions; the old-growth forest in the PNWW has a higher carbon density than SC's tropical young forest does. Thus, harvests shifting from PNWW to SC render fewer carbon losses than harvests moving from SC to PNWW. The 20% leakage rate that the California program adopts, falls between 16.2% and 68.3%, the plausible range of estimates that the study produced.

It is worth noting that the United States is a net importer of wood, buying it mainly from Canada, China, Brazil, Mexico, and Germany,[334] and that net imports make up less than 20% of its total wood consumption.[335] California purchases large quantities of lumber from other U.S. states and Canada; about two-thirds of its lumber consumption depends on importation.[336] Given the importance of importation in the California market, the

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[333] They explained: "FASOM is an intertemporal, price-endogenous, spatial equilibrium model simulating temporal activities in and land transfers between the agricultural and forestry sectors. FASOM uses mathematical programming methods to maximize the present value of aggregate consumers' and producers' surplus in both sectors, subject to resource constraints. The results from FASOM simulate prices, productions, management, and consumption." *See Id.* at 19.

[334] *United States Wood Imports By Country and Region 2015,*World Integrated Trade Solution, https://wits.worldbank.org/CountryProfile/en/Country/USA/Year/2015/TradeFlow/Import/Partner/All/Product/44-49_Wood.

[335] Robert L. Deal, *Integrated Restoration of Forested Ecosystems to Achieve Multiresource Benefits: Proceedings of the 2007 National Silviculture Workshop*, U.S. DEPARTMENT OF AGRICULTURE, FOREST SERVICE, PACIFIC NORTHWEST RESEARCH STATION, 40 (2008).

[336] Susanna Laaksonen-Craig et al., *Forestry, Forest Industry, and Forest Products Consumption in California,* University of California, Division of Agriculture and Natural Resources (2003).

forest carbon offset program is unlikely to have much effect (if any) on the state's wood consumption. To avoid leakage, there must be a reduction in consumption somewhere, but it is not clear where the final reduction would occur. It is possible that lumber prices in exporting countries would increase slightly, leading people in those countries to consume less lumber. Therefore, it is difficult to determine whether 20% is a reasonable leakage goal or not. This important question requires further research.

5.5.2.3 Avoided Conversion Projects

The California Program requires the estimation of primary leakage in avoided conversion projects. The forest protocol recognizes that for avoided conversion projects, leakage is likely to shift to other forest lands. Therefore, it has assigned a standard conversion factor of 3.6% with which to estimate leakage for avoided conversion projects.

Again, this factor of 3.6% is based on Murray et al.'s research. Their study found that that leakage from avoided deforestation projects ranges from 8.9% to 92.2%.[337] When the project allows harvesting, this activity reduces the leakage range to –4.4% to 73.4%.[338] They used the FASOM forest and agricultural sector model to estimate leakage from avoided deforestation. They based their projection on the scenario of transferring forest land to agricultural land. They ran their model separately for each area without harvest and with harvest (which involves a perpetual harvest-reforestation cycle) to obtain these

[337] Murray et al., *supra* note 306, at 22, 33.
[338] *Id.*

results. Table 5.2 exhibits the results that their model generated. Notably, the leakage declines when the project allows harvesting on project lands.

It is important to note that avoided conversion projects allow harvesting. According to Murray, McCarl, and Lee's research, leakage from avoided deforestation projects that allow harvesting ranges from -4.4% to 73.4%. Henders et al. believed that this generic leakage rate of 3.6% was "remarkably small" and not "substantiated."[339] However, they did not explain why the 3.6% rate is so small. In fact, it is based on Murray et al.'s research. Although within plausible limits, the factor of 3.6% is close to the floor of the suggested leakage range for avoided deforestation projects. As I mentioned above, a stakeholder work group determined this 3.6% rate. However, the decision making process was not transparent. The CAR has not disclosed why the group chose this specific figure. Later, when it adopted this 3.6% leakage rate in its forest project protocol, the ARB directly incorporated the figure without any explanation of it in its rulemaking documents. It is worth noting that except in several early action projects, the ARB has not registered any avoided conversion project since the launch of the California Program. Maybe this is because avoided conversion projects are less flexible than improved forest management projects, as they require an appraisal and a conservation easement.[340] Clearly, the program needs to find a solution that will make avoided conversion projects work for landowners. It seems that the low leakage rate that the Califronia Program sets for

[339] Henders & Ostwald, *supra* note 302, at 49.
[340] Personal communication with Sarah J. Wescott, Senior Forest Program Manager, Climate Action Reserve (September 2018).

avoided conversion projects has not caused leakage problems yet. However, further research is necessary to evaluate the reasonableness of the 3.6% target.

5.5.3 Conclusion Regarding the Assessment

The main approach that the CDM employs to address leakage is only to accept afforestation or reforestation projects, ruling out forest management and avoided deforestation projects that have a high risk of leakage. For these afforestation or reforestation projects, the CDM does not take into account secondary leakage and considers five specific animal displacement activities as insignificant, counting them as zero leakage. For projects that do not include these five activities, the CDM offers a leakage estimation tool that provides a step-by-step approach to calculating leakage. My review of all 17 projects that have used the current version of this tool shows that only two of them accounted for leakage, one from the displacement of agricultural activities and the other from the displacement of grazing activities. This suggests that substantial leakage is not likely to occur in afforestation or reforestation projects, and confirms the CDM's rationale for only accepting afforestation or reforestation projects.

Notably, the California Program has recognized three types of forest projects, including reforestation, improved forest management, and avoided conversion projects. This broader scope means that the California Program's approach to leakage is more complicated in design. For reforestation projects, the California Program, like the CDM, only takes primary leakage into account. Like the CDM, the California Program prescribes conditions that it considers to offer no leakage risk — project sites without commercially viable grazing activities or with commercially viable grazing activities but with less than 30% canopy cover. For other grazing displacement activities that should take leakage into account, the risk rates range from 10% to 50%. The Program bases these risk rates on peer-reviewed estimates of leakage from reforestation projects and can be updated when more data and research are available. The California Program assigns a leakage risk of 24% for crop displacement, which it derived from the EPA's estimates and which falls into what Murray et al. claim is the plausible range of leakage in the United States.

The California Program's generic leakage risk rate of 20% for improved forest management projects also stems originally from Murray et al.'s research. That research suggested that preserving forests in PNWW generates secondary leakage of 16.2% and in SC produces leakage of 68.3%. The California Program picked a leakage risk of 20% because it lies in between these two values. Given that the United States is a net importer of wood and that California relies on imported lumber, further research is necessary to determine whether 20% is a reasonable goal for market leakage. The California Program assigns a risk rate of 3.6% for avoided conversion projects, to cope with primary leakage. This figure is also within the plausible limits that Murray et al.'s research suggests, as it indicated that leakage from avoided deforestation projects that allow harvesting ranges from -4.4% to 73.4%. Since no one has registered an avoided conversion project under the California Program since 2012, when the ARB lauched the California Program, this low leakage rate has not led to the occurrence of leakage. However, it would be worth doing further research to assess whether it is rational to set the rate at 3.6%.

5.6 Henders et al.'s Relevant Research

Sabine Henders and Madelene Ostwald conducted research that assessed 34 forest carbon leakage quantification methods from the Clean Development Mechanism (CDM), the Verified Carbon Standard (VCS)[341], the Climate Action Reserve (CAR)[342](which is similar to the California Cap and Trade Program), and the CarbonFix Standard (CFS), as well as from scientific literature. The Verified Carbon Standard, which the nonprofit organization Verra maintains, is a standard for certifying carbon emission reductions. In 2009, the VCS incorporated as a non-profit organization in Washington D.C. and in 2018 changed its name to Verra. The Climate Action Reserve is a nonprofit organization based in California, which served as a carbon offset registry specializing in carbon accounting. The CarbonFix Standard is a forest carbon standard that CarbonFix, a non-profit association based in Germany, administers. The CFS now has become part of the Gold Standard, the carbon standard that the Gold Standard Foundation, a non-profit foundation based in Switzerland, maintains. Henders and Ostwald grouped the quantification methods from these sources into nine main methodological approaches and assessed them

[341] Verified Carbon Standard (VCS) is now named Verra.
[342] California Cap and Trade Program's forest protocol is based on the Climate Action Reserve's Forest Project Protocol.

in the light of leakage type, the tools used for quantification and the geographical scale covered. Table 5.3 shows their assessment results.

The authors also summarized these approaches from another perspective, looking at how each program addresses the three basic leakage characteristics. They produced Table 5.4, which assesses the four programs – CDM, VCS, CAR, and CFS – in terms of leakage type, quantification tool, and leakage scale.[343]

The authors concluded that the VCS best accounted for carbon leakage.[344] The VCS requires accounting for both primary and secondary sources of leakage, and its methodologies cover all five quantification tools that can be used to estimate leakage.[345] They ranked the CAR as second best in this area.[346] The CAR addresses both primary and secondary leakage through generic discount factors.[347] They considered the generic factor of 3.6% that the CAR applies to avoided conversion projects to be small and not very appropriate.[348] The CDM ranks below the VCS and the CAR, because it does not address secondary leakage and only partially fulfills their recognized requirements for leakage accounting, which according to Henders et al. include "addressing all relevant types of

[343] Henders & Ostwald, *supra* note 302, at 50.
[344] *Id.* at 53.
[345] *Id.* at 49.
[346] *Id.* at 54.
[347] *Id.* at 49.
[348] *Id.*

leakage," "covering a range of appropriate assessment tools," and "capturing leakage effects on at least national scale."[349]

5.7 Using Henders et al.'s Approach to Assess the CDM and the California Program

Henders et al. have assessed various quantitative methods to estimate leakage for forest projects under the CDM and the CAR. The literature reflects other scholars' approval of Henders et al.'s research. Many articles[350] have cited Henders et al.'s research, finished in 2012, to support their own claims, and it has not generated criticism. Since then, the CDM's methodologies for forest projects have evolved. Currently, the CDM makes only four methodologies for forest projects available, all of which use the same leakage estimation tool. In 2012, when California launched its Cap and Trade Program, it based its forest protocol on CAR's forest protocol, and incorporated most of its features. This section presents an extension and update of Henders et al.'s analysis, reflecting changes in the CDM's methodologies, and including the California Program. I will use Henders et al.'s approach to assess the CDM's currently available leakage estimation tools and California's quantitative methods for estimating leakage.

The following is my research method: I will assess the CDM's leakage estimation tool and the California Program's methods of calculating leakage for reforestation, improved forest management, and avoided conversion projects. Specifically, my assessment will

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[349] Henders & Ostwald, *supra* note 302, at 41,49.
[350] According to Web of Science, as of February 21, 2020, the article had been cited 29 times.

focus on three aspects — leakage type, tools for quantification, and geographical scale. For the leakage type, I will look at whether each method addresses primary and secondary leakage. For the tool for quantification, I will analyze each method to find out which tool or tools it uses to quantify leakage; potential quantitation tools include direct monitoring, area measurements, interviews, leakage factors, and modeling. For the geographical scale, I will evaluate the scope each method covers, including the local, regional, national, and global scale. Finally, I will present all the results in a table.

My assessment obtained the unsurprising results that the differences between the CDM and the California Program are similar to the differences between the CDM and the CAR, which appear in Table 5.5. To be more specific, while the CDM only addresses primary leakage, the California Program takes into account both primary and secondary leakage. Whereas the CDM's tools for quantification contain direct monitoring, area measurements, and interviews, the California Program applies generic discount factors to projects, in addition to area measurements. Moreover, the CDM limits the scope of leakage to a local geographical scale; in contrast, the California Program extends its scope nationally. The California Program is more comprehensive than the CDM's, covering both types of leakage and using a larger geographic scale.

5.8 Conclusion

Leakage is a critical concern for forest offset programs. The integrity of a forest offset program relies partly on whether it can deal with leakage effectively. Without the ability to account fully for leakage, forest projects cannot offset the emissions that regulated entities release. This chapter compares the approaches that the CDM and the California programs use to address leakage. While the CDM provides a tool with a step-by-step guide to calculating leakage for each project, the California program adopts a standardized approach, counting a certain percentage of emission reductions as leakage.

The primary approach that the CDM employed to address leakage is that it only accepts afforestation or reforestation projects, ruling out forest management and avoided deforestation projects because of their high risks of leakage. The CDM does not take secondary leakage for afforestation or reforestation projects into account and considers five animal displacement activities as having zero leakage. My assessment of all 17 projects that have used the current version of this tool shows that only two projects accounted for leakage, suggesting that substantial leakage is not likely to occur in afforestation or reforestation projects, and supporting the CDM’s reasons for limiting its acceptance only to them.

Unlike the CDM, the California Program has recognized three types of forest projects, including reforestation, improved forest management, and avoided conversion projects. For reforestation projects, the California Program accounts for leakage on project sites that have commercially viable grazing activities and more than a 30% canopy cover;

these leakage risk rates range from 10% to 50%. These risk rates are based on peer-reviewed estimates of leakage from reforestation projects and the program can update them when more data and research become available. The California Program assigns a leakage risk of 24% for crop displacement, which is the result of the EPA's estimate for leakage and falls within the probable range of leakage that Murray et al. suggested. The California program set a generic leakage risk rate of 20% for improved forest management projects, which it also based on Murray et al.'s research. The program assigns avoided conversion projects a risk rate of 3.6%, again from Murray et al.'s research. Although the rates of 20% and 3.6% fall within plausible limits, they are close to the floor of the suggested leakage range for each type of project. It is unclear why the California Program adopted these leakage rates, since the ARB and CAR's decision-making processes are not transparent. To evaluate the reasonableness of these leakage rates, further research is necessary.

Sabine Henders and Madelene Ostwald's research showed that the CAR outweighs the CDM in dealing with leakage from forest projects. In fact, California's forest project protocol is based on the CAR's forest project protocol and incorporates its quantitative methods for leakage estimation. Giving the evolution of the CDM methodologies, I used Henders et al.'s approach to compare the CDM leakage estimation tool directly with California's quantitative methods. I found that the California Program is more comprehensive than the CDM, covering both primary and secondary leakage and using a larger geographic scale.

Overall, the California Program is better than the CDM at addressing the issue of leakage. It seems that the CDM has addressed leakage by only accepting afforestation or reforestation projects. In fact, leakage is more likely to occur in forest management and avoided deforestation projects. To resolve the problem, the CDM just avoids it. It is true that the California Program contains uncertainties. Nevertheless, it offers a comprehensive solution covering reforestation, forest management, and avoided deforestation projects, and creating workable approach to make the Program run smoothly. Certainly, further research could justify or improve its quantitative methods.

Chapter 6

Environmental Credit Markets

6.1 Introduction

After analyzing the additionality, permanence, and leakage of forest carbon offset programs, this chapter focuses on the co-benefits of forest projects and environmental credit markets. In addition to carbon sequestration, forest projects generate other co-benefits such as soil and water protection and biodiversity, as well as other social benefits. In fact, current environmental credit markets exist in the United States, including funding activities that benefit the soil, water, and wetlands. Credit stacking in the last few years has allowed one project to generate two or more types of environmental credit. However, credit stacking is still in its nascent stage, and there are no federal guidelines relating to it. Credit stacking has benefits as well as potential problems. Since carbon credits have the potential to be stacked, the design of forest offset programs might wish to incorporate this possibility, but should be cautious about potential problems.

I have organized this chapter as follows. Section 6.2 describes the co-benefits of forest projects, explaining the benefits to the soil, to water, and for biodiversity in detail. Section 6.3 introduces environmental credit markets, elaborating on wetlands mitigation banking, conservation banking for the protection of biodiversity resources, and water quality trading. Section 6.4 discusses credit stacking, depicting the current situation, and analyzing its benefits, potential problems, and implications. Section 6.5 presents the conclusion.

6.2 Co-benefits of Forest Projects

In addition to the direct benefit of increasing carbon storage, forest projects generate indirect benefits, usually called co-benefits. These co-benefits have positive effects not only on the environment but also for society. In 2016, Forest Trends, a non-profit organization based in Washington, DC, presented a report that provides information for ecosystem services, and identifies the many co-benefits of forest projects, including community involvement, climate adaptation, water benefits, biodiversity, jobs, benefits to vulnerable groups, benefits to women, and more.[351] In fact, some buyers purchase offsets from forest carbon projects primarily because of these co-benefits.[352] In the following sections, I will focus on the benefits to the environment, elaborating on co-benefits to the soil, to water, and for biodiversity.

6.2.1 Soil

[351] Allie Goldstein, *Not So Niche: Co-benefits at the Intersection of Forest Carbon and Sustainable Development*, Forest Trends (2016).
[352] *Id.*

Trees improve soil quality in a number of ways. First, they add organic matter to the soil. In a forest, leaves, twigs, and branches fall to the ground and decay gradually. These then become organic matter, released into the soil itself. With more organic matter, soil fertility increases. The organic matter also enhances the soil's capacity to absorb and retain water. Second, trees draw nutrients from deep soil. Because tree roots generally extend far into the ground, they are able to absorb nutrients in the deep soil, such as potassium, phosphorus, and other micronutrients. These nutrients are essential for plant growth. Third, trees help the soil absorb nutrients from the atmosphere. Trees reduce wind speed, allowing dust that contains nutrients to fall more easily to the ground.

Moreover, one essential role of forests is to retain topsoil and control erosion. Deep tree roots hold the soil in place and retain water. In contrast, deforestation leads to soil erosion. After trees are removed, there are no roots to hold the soil in place, making it easy for heavy rains to wash it away. The logging and clear-cutting of forests has lead to soil erosion across the globe. The Rainforest Conservation Fund's data show that deforestation is a direct cause of soil erosion in tropical rain forests.[353]

6.2.2 Water

Water is a crucial resource that all organisms need to live. Forests play a significant role in maintaining water quality. They work as filters to purify the water that runs through

[353] *Soil Erosion Due to Rainforest Deforestation*, Sciencing, https://sciencing.com/soil-erosion-due-rainforest-deforestation-23042.html.

woodlands, removing the sediment and pollutants that impair water quality. Tree roots stabilize the soil, preventing soil erosion, and also help to absorb sediment and pollutants. When deforestation occurs, it releases still more sediment into the streams, increasing water pollution.

Forests can also mitigate the effects of floods and droughts. Tree roots make soil porous, expediting the seepage of rainwater into soil and allowing woodlands to absorb the water more quickly. In the event of heavy rain, the faster the water can seep into the soil, the sooner the volume of water left on the ground will decrease. This, in turn, reduces the amount of water that will pour into streams and rivers. In this way, forests mitigate the risks of flood. Research shows that forests might substantially relieve the negative effects of even moderate rainfall.[354] Moreover, forests retain water during the rainy season and release water during the dry season. This release of water counters the effects of droughts.

6.2.3 Biodiversity

Biodiversity refers to the variety of life on earth. It is the basic system that supports human life. Ecosystems influence climate and provide people with natural resources. Forests are diverse ecosystems, containing various species, and providing habitats for animals. Animals can live on or in trees on the forest floor or in ground conditioned by the roots and life processes of trees. Forests offer plenty of material for nest building,

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[354] James C. Bathurst et al., *Forest Impact on Floods Due to Extreme Rainfall and Snowmelt in Four Latin American Environments 1: Field Data Analysis*, 400 JOURNAL OF HYDROLOGY 281 (2011).

improve water quality for aquatic animals, and supply food so that the species that live in them can flourish. Insects and micro-organisms thrive on the leaves, bark, and ground litter, and themselves become food resources for birds and other animals. Moreover, biodiversity affects economic and social development. "At least 40 percent of the world's economy and 80 percent of the needs of the poor are derived from biological resources. In addition, the richer the diversity of life, the greater the opportunity for medical discoveries, economic development, and adaptive responses to such new challenges as climate change."[355]

Biodiversity and forests are ineluctably interrelated, both for better and for worse. On the negative side, deforestation can cause biodiversity loss because it eliminates tree species and destroys animal habitats. This, for example, has occurred in the Amazon, where loggers have clear cut rain forests for agriculture use, causing plant and animal species to disappear. On the positive side, biodiversity affects forest productivity, which is the rate of biomass production in an ecosystem.[356] Jingjing Liang et al. established a biodiversity-productivity relationship (BPR) on a global scale, collecting data from 777,126 sample plots across 44 countries and territories and 13 ecoregions, covering 30 million trees across 8,737 species. Their assessment suggests that a 10% decrease in biodiversity (as

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[355] Convention on Biological Biodiversity (2011).
[356] Jingjing Liang et al., *Positive Biodiversity-Productivity Relationship Predominant in Global Forests*, 354 SCIENCE (2016).

measured by species richness) leads to a 2 to 3% decline in forest productivity on a global scale.[357]

6.3 Environmental Credit Markets

Acknowledging the benefits of forests, U.S. government agencies have recognized various measures to encourage afforestation and the maintenance of existing forests throughout the country. Federal and state governments have offered tax deductions to forestland owners, and have granted tax deductions for the donation of conservation easements. In order to channel more funding into this area, government agencies have established environmental credit markets to support forest projects financially. In addition to carbon credits, a forest project can earn credits related to wetlands, habitat, and water quality. The following is an introduction to these credit markets. Table 6.1 summarizes the environmental credits markets in the United States.[358]

6.3.1 Wetlands Mitigation Banking

A wetland generally is an ecosystem inundated with water. Both the U.S. Army Corps of Engineers (Corps) and the U.S. Environmental Protection Agency (EPA) define wetlands as "areas that are inundated or saturated by surface or groundwater at a frequency and

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[357] *Id.*
[358] Jessica Fox, Royal C. Gardner, and Todd Maki, *Stacking Opportunities and Risks in Environmental Credit Markets*, 41 ELR 10122 (2012).

duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions," including "swamps, marshes, bogs, and similar areas."[359] The wetland and the forest are related because of the existence of the forested wetlands.

Wetlands fall under the protection of the federal Clean Water Act (CWA). Section 404 of the CWA requires a permit before one may discharge dredged or fill materials into waters of the United States, including wetlands.[360] The EPA promulgates regulations that set requirements for the permit.[361] The Corps reviews permit applications and issues permits that meet the EPA's regulations.[362] To qualify for a permit, applicants must meet three requirements. First, they must demonstrate that the damage to the wetland is unavoidable, which means that there is no other practicable alternative with less impact on wetlands to the proposed discharge.[363] Second, applicants must take steps to minimize the potential adverse impact of the proposed project.[364] Third, applicants must compensate for the remaining unavoidable impact.[365]

Wetlands mitigation banking helps to meet the requirement for compensation. This is a market-based system conserving or creating wetlands to offset wetland loss due to

[359] *How Wetlands are Defined and Identified under CWA Section 404*, EPA, https://www.epa.gov/cwa-404/section-404-clean-water-act-how-wetlands-are-defined-and-identified.
[360] 33 U.S. Code § 1344 (2000).
[361] *Permit Program under CWA Section 404*, EPA, https://www.epa.gov/cwa-404/section-404-permit-program.
[362] *Id.*
[363] 40 C.F.R. § 230.10(a) (2000).
[364] *Id.* § 230.10(d).
[365] *Id.* § 230.75(d).

development elsewhere. The federal government describes mitigation banking as “the restoration, creation, enhancement and, in exceptional circumstances, preservation of wetlands and/or other aquatic resources expressly for the purpose of providing compensatory mitigation in advance of authorized impacts to similar resources.”[366] Mitigation banking can also be used to counter wetland loss caused by agriculture.[367] President George H.W. Bush established the goal of achieving “no net loss of wetlands” as a national policy in 1989, and Presidents Bill Clinton, George W. Bush, and Barack Obama endorsed it. To date, President Donald Trump has not confirmed this national policy.

A mitigation bank is a piece of land that a bank sponsor develops for the purpose of compensating for unavoidable wetland loss in other places. The EPA defines a wetlands mitigation bank as “a wetland area that has been restored, established, enhanced or preserved, which is then set aside to compensate for future conversions of wetlands for development activities.”[368] A mitigation banker is a person who or entity that conducts the restoration work that will turn the mitigation bank site into a wetland. A mitigation bank earns mitigation credits after conserving or creating work that the regulatory agencies have approved. Bank owners can sell these mitigation credits to individuals or entities that intend to conduct a development project that will cause wetland loss. In this

[366] Federal Guidance for the Establishment, Use and Operation of Mitigation Banks, Federal Register: November 28, 1995 (Volume 60, Number 228), Page 58605-58614, https://www.epa.gov/cwa-404/federal-guidance-establishment-use-and-operation-mitigation-banks-0.

[367] *Conservation Compliance and Wetland Mitigation Banking,* USDA Natural Resources Consevation Service, https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/farmbill/?cid=nrcseprd362686.

[368] *Wetlands Compensatory Mitigation*, US EPA, https://www.epa.gov/sites/production/files/2015-08/documents/compensatory_mitigation_factsheet.pdf.

way, the developers fund the restoration and conservation of wetlands, helping to achieve the goal of no net loss of wetlands.

The number of mitigation banks has increased dramatically in recent decades. The first 46 mitigation banks appeared in 1992, but none of these was an entrepreneurial bank, which sells credits to permit holders; they were publicly sponsored single-user banks.[369] The concept of entrepreneurial banks developed between 1991 and 1994.[370] In 2005, there were 405 approved mitigation banks, of which 72% were entrepreneurial banks.[371] As of August 2013, the Regulatory In-lieu fee and Bank Information Tracking System (RIBITS) database showed more than 1,800 bank sites.[372]

6.3.2 Conservation Banking

The purpose of conservation banking is the conservation of biodiversity resources. Like wetlands mitigation banking, conservation banking is a market-based method that provides credits to offset unavoidable damage to endangered or threatened species. The United States Fish and Wildlife Service (the FWS) defines a conservation bank as "a parcel of land containing natural resource values that are conserved and managed in perpetuity, through a conservation easement held by an entity responsible for enforcing

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[369] *Mitigation Banks under CWA Section 404*, US EPA (Jun. 16, 2015), https://www.epa.gov/cwa-404/mitigation-banks-under-cwa-section-404.
[370] *Id.*
[371] Jessica Wilkinson & Jared Thompson, *2005 Status Report on Compensatory Mitigation in the United States*, Environmental Law Institute (April, 2006).
[372] US EPA, *supra* note 369.

the terms of the easement, for specified listed species and used to offset impacts occurring elsewhere to the same resource values on non-bank lands."[373]

The federal Endangered Species Act (ESA) provides protection for endangered and threatened species. The FWS and the National Marine Fisheries Service (NMFS) are responsible for the ESA's implementation. The ESA proscribes the "taking" of species that are federally listed as endangered or threatened species.[374] The term "take" has a wide range of meanings under the ESA, including "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct."[375] The Department of Interior has defined "take" to include habitat modification that "actually kills or injures wildlife by significantly impairing essential behavioral patterns."[376] However, the ESA also sets forth exceptions that might allow a take. Under section 7 of the ESA, a consulting agency (FWS or NMFS) that prepares biological opinions stating no jeopardy to listed species or habitat, can issue an "incidental take statement" to the action agency.[377] The incidental take statement grants an exemption to the ESA's take prohibitions, but in return, it requires the action agency to undertake conservation mitigation measures that will minimize unavoidable impacts to listed species.[378] Section 10 of the ESA authorizes agencies to issue incidental take permits for non-federal entities,

[373] Memorandum from the Director of Fish and Wildlife Service on Guidance for the Establishment, Use, and Operation of Conservation Banks (May 2, 2003) (on file with Fish and Wildlife Service), https://www.fws.gov/endangered/esa-library/pdf/Conservation_Banking_Guidance.pdf.
[374] 16 U.S.C. § 1538(a)(1) (2006).
[375] *Id.* § 1532(19).
[376] 50 C.F.R. § 17.3 (2001).
[377] 16 U.S.C. § 1536 (2006).
[378] *Id.*

which must present a habitat conservation plan that adequately minimizes and mitigates any adverse impact.[379] One recognized mitigation measure for both federal agencies and non-federal entities is the purchase of credits from a conservation bank.[380]

The first conservation bank was in California, which promulgated its official policy on conservation banks in 1995. The policy prescribes how to use conservation banks to maintain natural resources.[381] Habitat lands serve as conservation banks, earning credits by managing their natural resources and can sell these credits to project developers, allowing them to offset damage to resources elsewhere.[382] In 2003, the federal government issued the FWS's "Guidance for the Establishment, Use, and Operation of Conservation Banks."[383] These are still the primary federal rules directing conservation banks.[384]

As of March, 2013, the FWS had approved 105 conservation banks.[385] These banks protect nearly 75,000 acres of habitat.[386] The size of the conservation banks varies, ranging from 8 to 4,009 acres, with an average of 741 acres.[387]

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[379] *Id.* § 1539.
[380] The Director of Fish and Wildlife Service, *supra* note 373, at 3, 4.
[381] California Resources Agency, California Environmental Protection Agency, *Official Policy on Conservation Banks* (1995), https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=110849.
[382] *Id.*
[383] The Director of Fish and Wildlife Service, *supra* note 373.
[384] Royal C. Gardner & Jessica Fox, *The Legal Status of Environmental Credit Stacking*, 40 ECOLOGY LAW QUARTERLY 46, 722 (2013).
[385] DOI Office of Policy Analysis, *Conservation Banking Overview and Suggested Areas for Future Analysis*, U.S. Fish and Wildlife Service (2013).
[386] *Id.*
[387] *Id.*

6.3.3 Water Quality Trading

Water is indispensable for human life. In response to public concern over widespread water pollution, Congress enacted the Clean Water Act (CWA) in 1972, aiming to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters."[388] The goal was to eliminate "the discharge of pollutants into the navigable waters."[389] Section 402 of the CWA establishes the National Pollutant Discharge Elimination System (NPDES) to regulate point sources discharging pollutants into waters of the United States.[390] This discharge is unlawful unless done in accordance with an EPA NPDES.[391] The EPA can devolve the responsibility for implementing the NPDES permit program onto the states, which makes the state government the permitting authority.[392] Most states have received authorization to enforce the NPDES permit program.[393]

To facilitate the achievement of the CWA's water quality goal, the EPA issued its Water Quality Trading Policy in 2003. The policy encourages the development of water quality

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[388] 33 U.S.C § 1251 (a) (2006).
[389] *Id.* The statute states that "it is the national goal that the discharge of pollutants into the navigable waters be eliminated by 1985," and "it is the national goal that wherever attainable, an interim goal of water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water be achieved by July 1, 1983."
[390] 33 U.S. Code § 1342 (2006).
[391] *Id.*
[392] *Id.*
[393] *NPDES State Program Information*, US EPA (Sept. 25, 2015), https://www.epa.gov/npdes/npdes-state-program-information.

trading programs for pollutants.[394] In the policy, the EPA explains that water quality trading, as a market-based approach, can reduce the cost of improving water quality, thus providing greater flexibility than traditional regulatory approaches.[395] The EPA also provides funding to promote the implementation of trading programs.[396] As of 2016, the states had established 20 water quality trading programs.[397]

Water quality trading is similar to other market-based schemes that aim to reduce pollutants, such as carbon emission trading. Each point source must meet requirements of the NPDES permit, either by controlling its own pollutant discharge or by purchasing the credits that other point sources or nonpoint sources have generated. A point source can earn credits by reducing its discharge to a level below that which the NPDES permit sets, while a nonpoint source can acquire credits by installing best management practices (BMPs) beyond its baseline. Facilities with high pollution-abatement costs can purchase these credits to meet their obligations. This achieves the goal of improving water quality with lower total costs.

6.4 Credit Stacking

[394] US EPA, Water Quality Trading Policy (January 13, 2003), https://archive.epa.gov/ncer/events/calendar/archive/web/pdf/finalpolicy2003.pdf.
[395] *Id.*
[396] US EPA, Water Quality Trading Evaluation Final Report (2008), https://www.epa.gov/sites/production/files/2015-09/documents/epa-water-quality-trading-evaluation.pdf.
[397] *Water Quality Trading*, US EPA (Apr. 12, 2016), https://www.epa.gov/npdes/water-quality-trading.

The environmental credit markets exist separately, but they sometimes interact with each other. For instance, an afforestation project might have a positive impact on an endangered species, water quality, wetlands, or carbon storage. Theoretically, it could even generate wetland, endangered species, water quality, and carbon sequestration credits from the same activity. This raises the essential question of whether the project is eligible to receive different credits from different programs. This practice is known as "stacking," which generally means that a single activity generates several types of credits. A consensus definition of credit stacking among environmental credit market practitioners, and stemming from Jessica Fox, Royal C. Gardner, and Todd Maki's 2010 national survey, is "establishing more than one credit type on spatially overlapping areas."[398]

6.4.1 Current Situation

Currently, there are no general federal guidelines regarding the issue of environmental credit stacking. In fact, different federal agencies' rules regarding environmental credits occasionally conflict. The United States Department of Agriculture (USDA) appears to be an advocate of credit stacking. Some USDA programs, including the Conservation Reserve Program (CRP), the Environmental Quality Incentive Program (EQIP), and the

[398] They surveyed about 1,500 environmental credit market practitioners, and obtained 309 valid responses. According to their self-identification, these respondents fell into the following categories: credit sellers (117), researchers (89), policy makers (82), credit buyers (17), and credit exchanges (4). The survey provided the definition of "establishing more than one credit type on spatially overlapping areas, i.e., in the same acre," and other four choices. 83.5% of respondents chose this description as the best definition for credit stacking. *See* Jessica Fox et al., *supra* note 358.

Wetlands Reserve Program (WRP), provide financial support for conservation purposes. The CRP, which the Farm Service Agency (FSA) administers, offers long-term rental payments to farmers who establish a permanent vegetative cover over environmentally sensitive cropland, in order to improve the land, soil, and water quality.[399] The USDA Natural Resources Conservation Service (NRCS) provides financial and technical support to agricultural producers who want to implement environmental conservation practices through the EQIP,[400] and to landowners seeking to restore wetland through the WRP.[401] The USDA has indicated that it allows environmental credit trading programs to complement these financial assistance programs.[402] The CRP permits "the sale of carbon, water quality, or environmental credits" to the extent that "they are consistent with the conservation purposes" of the program.[403] The WRP and the EQIP treat these environmental credits similarly,[404] with the WRP indicating that "environmental credits may be gained,"[405] and the EQIP asserting that "a participant in EQIP may achieve environmental benefits that may qualify for environmental credits."[406]

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[399] Farm Service Agency, Conservation Reserve Program –Continuous Enrollment Period (2019), https://www.fsa.usda.gov/Assets/USDA-FSA-Public/usdafiles/FactSheets/2019/crp_continuous_enrollment_period-fact_sheet.pdf.
[400] *Environmental Quality Incentives Program*, USDA Natural Resources Conservation Service, https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip/.
[401] *Wetlands Reserve Program*, USDA Natural Resources Conservation Service, https://www.nrcs.usda.gov/wps/portal/nrcs/detail/null/?cid=nrcs143_008419.
[402] *Natural Resources Credit Trading Reference*, USDA Natural Resources Conservation Service, https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/technical/econ/?cid=stelprdb1068479.
[403] 7 C.F.R. § 1410.63 (d) (2016).
[404] Jessica Fox et al., *supra* note 358.
[405] 7 C.F.R. §1467.20 (2016).
[406] *Id.* §1466 .36.

In contrast, other federal agencies do not allow credit stacking. The Corps and the EPA, the two federal agencies that administer wetland mitigation, explicitly indicate through their regulations that CRP- or WRP-funded projects are not eligible for wetland credits.[407] These agencies view the fact that CRP- and WRP-funded projects generate wetland credits as double counting because the same project activity gains funding from both the CRP and the WRP, and by selling wetland credits. It is possible that some parts of any given CRP or WRP project create wetland credits but do not receive CRP or WRP funding. In these cases, those parts should be eligible for credit stacking. However, the Corps and the EPA's regulations rule out this possibility. Moreover, the FWS involves in credit approval for conservation banking, and its "Guidance for Conservation Banking" generally excludes issuing species credits for lands that other federal programs have already funded.[408]

Despite this uncertainty in environmental credit markets, some projects are moving forward to establish frameworks for the trade of stacked credits.[409] For example, in 2009, the Electric Power Research Institute (EPRI), an American independent nonprofit organization that is closely identified with the U.S. power industry, launched a pilot project called the "Ohio River Basin Water Quality and Greenhouse Gas Trading Project," examining the possibility of stacking multiple environmental credits, with an initial focus

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[407] Jessica Fox et al., *supra* note 358.
[408] Jessica Fox et al., *supra* note 358 (citing FWS, Guidance for the Establishment, Use, and Operation of Conservation Banks (2003)).
[409] *Id.*

on water quality and carbon credits.[410] But overall, relatively few credit stacking projects have been developed.

6.4.2 Benefits of Credit Stacking

In theory, stacking can channel money into environmental credit markets because stacking makes more credits available for sale. There are several advantages to this inflow of funds. For one, stacking payments can provide an incentive for landowners to manage their lands with an eye toward multiple ecosystem services.[411] If a project only issues carbon credit, a landowner might consider the carbon sequestration aspect of the project, but not pay much attention to its negative effect on water quality. But if a project earns both carbon credits and water quality credits, the landowner has reason to take care of the carbon stock and water quality. Lankoski et al. (2015) showed that stacking promotes the employment of more environmentally effective activities.[412]

Stacking might also give landowners an incentive to participate in ecosystem services programs, resulting in an increase in the overall provision of ecosystem services.[413] Financial support from a single market might not be enough to cover the cost of environmental conservation activities in some projects. With funding from multiple

[410] *Ohio River Basin Trading Project*, EPRI, https://wqt.epri.com/credit-stacking.html.
[411] David Cooley and Lydia Olander, *Stacking Ecosystem Services Payments: Risks and Solutions,* 42 ELR 10150 (2012).
[412] Lankoski, J. et al., *Environmental Co-benefits and Stacking in Environmental Markets*, OECD Food, Agriculture and Fisheries Papers, No. 72, OECD Publishing, Paris (2015), https://doi.org/10.1787/5js6g5khdvhj-en.
[413] David Cooley et al., *supra* note 411.

programs, environmental practices in these projects are becoming profitable. As David Cooley and Lydia Olander have indicated, multiple payment streams from multiple programs could cover landowners' opportunity costs of conducting conservation activities.[414] Furthermore, when Lankoski et al. examined a case involving carbon offset and water quality credit markets,[415] they found that allowing the stacking of water quality credits increased the profit from carbon sequestration practices, which in turn increased the participation of farmers in carbon offset markets.[416]

6.4.3 Concerns about Credit Stacking

Despite the benefits of stacking, however, the practice also raises new concerns. An increase in the supply of credits could flood the market. Stacking might give rise to the problem of double accounting, which would complicate the issue of additionality.

6.4.3.1 Flooding the Credit Market

It is evident that credit stacking would increase the supply of environmental credits in the market. This is because without stacking, some projects that produce several environmental benefits only generate one type of credit, while with stacking they could create several. According to the law of supply and demand, if the demand for these

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[414] *Id.*
[415] Lankoski, J. et al., *supra* note 412.
[416] *Id.*

credits, which comes mainly from some regulated entities and voluntary buyers, is stable, their price would drop. Lankoski et al.'s research (2015) supports this scenario, finding that in small environmental markets with limited local demand for credits, stacking might cause an oversupply of credits, which would lead to a drop in equilibrium credit prices.[417] However, it is worth noting that regulators can address lower credit prices by setting stricter caps, so that entities can achieve their more ambitious goals at lower than anticipated cost.

6.4.3.2 Double Counting

Notably, credit stacking might give rise to double counting, or counting the same environmental benefit two times or more. Double counting is most likely to occur when bundled ecosystem service credits overlap with single ecosystem service credits.[418] A project developer can generate bundled credits by collecting several environmental benefits into a group and selling them as a single unit. As Cooley and Olander have mentioned, an example of bundled ecosystem service credits is wetland mitigation, where a project can earn credits for multiple ecosystem services, including water quality improvements, biodiversity habitat, and hydrologic functioning.[419] Double counting would occur if the project developer sells the bundled wetland mitigation credits to one buyer and sells water quality credits, generated from water quality improvements already

[417] *Id.*
[418] David Cooley et al., *supra* note 411.
[419] *Id.*

included in the bundled ecosystem services, to another buyer.[420] This would lead to counting the same ecosystem service — water quality improvements — twice. Double counting causes a net negative ecosystem service outcome.[421] Double counting inflates the number of ecosystem service credits issued for a preservation activity, generating some credits that do not account for any environmental benefit. After these credits flow into the market, they give their owners the right to discharge pollutants that have not been offset by real environmental benefits. In this way, double counting leads to negative effects on the environment.

The problem of double counting actually happened in a project located in the Neuse River watershed of North Carolina.[422] In 2000 a private company, Environmental Banc & Exchange (EBX), developed this project and sold wetland credits, which as bundled wetland credits encompassing water quality benefits, to the North Carolina Department of Transportation to compensate for impact to wetlands resulting from road construction.[423] In 2009, EBX sold the water quality credits generated from the same project without any additional activities to the North Carolina Department of Environment and Natural Resources in compensation for nitrogen impact to the Neuse River Basin. [424] This transaction stimulated heated public debate. In response, North Carolina placed a

420 *Id.*
421 *Id.*
422 *Id.*
423 *Id.*
424 *Id.*

moratorium on certifying water quality credits from projects that have already earned wetland credits.[425]

6.4.3.3 Additionality

Stacking further complicates the intricate concept of additionality. As I discussed earlier, additionality means an activity would not otherwise have happened.[426] "A proposed activity is additional if the recognized policy interventions are deemed to be causing the activity to take place."[427] "The occurrence of additionality is determined by assessing whether a proposed activity is distinct from its baseline."[428] Like the carbon offset program, additionality is a vital issue when it comes to stacking. In the context of a carbon offset project, additionality looks at whether the project's funding has caused the project to exist. Here, when credits are stacked, additionality should focus on whether funding from these different sources together will make the project feasible.

Cooley and Olander put forth an example that illustrates the issue of additionality in projects with stacked credits.[429] Suppose an afforestation project both sequesters carbon dioxide and improves water quality. If the water quality credits sufficiently cover the

[425] North Carolina General Assembly, Program Evaluation Division, *Department of Environment and Natural Resources Mitigation Credit Determinations: Special Report to the General Assembly*, Report Number 2009-04 (2009).
[426] Michael Gillenwater, *What Is Additionality? Part 3: Implications for stacking and unbundling*, GHG Management Institute, Discussion paper No. 003 (2011).
[427] *Id.*
[428] *Id.*
[429] David Cooley et al., *supra* note 411.

expense of the project, then the project does not need funding from carbon credits. The payment from carbon credits would not create any additional carbon sequestration; the project would have come to existence without the financing from carbon credits.

Although assessing additionality is complicated in projects with stacked credits, Cooley and Olander have proposed two tests by which to determine whether a project is additional or not.[430] The first is a timing test, which specifies that a project is eligible for funding upon the condition that it has not yet been implemented.[431] If a project has already started, it probably did not need the extra funding. For the same reason, in the case of crediting, once a developer has carried out a project, it should not be eligible for additional environmental credits. If a project has been completed with financial support from wetland credits, it should not be eligible for carbon credits, even if it sequestrates carbon as well.

Another test is the financial additionality test, which assesses whether financial support makes a project viable.[432] When a project stacks credits, this test requires that their combined payments provide sufficient funding for the project. Further, it requires that without payment from any one particular credit there would not be sufficient funding. An example would be a project that qualifies for both wetland credits and carbon credits, but if the wetland credits are sufficient to cover the cost of the project, then the project will

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[430] *Id.*
[431] *Id.*
[432] *Id.*

fail to pass the test because funding from carbon credits will not generate any additional carbon storage.

6.4.4 Implications

The option of stacking environmental credits is promising. It would probably channel more funding into protected areas, which could promote land management with more ecosystem services and increase the participation of landowners in ecosystem services programs. Credit stacking is relevant to the current carbon market. The California Program covers forest projects in the United States, and therefore carbon offset credits that forest projects under the California Program generate might be involved with the issue of credit stacking. In contrast, the credit stacking that I have discussed in this chapter is limited to the United States, so it is not related to the CDM, which only funds carbon offset projects in developing countries (see Chapter 2).

Currently, there is no unified federal rule governing credit stacking. Although there are a few pilot projects exploring the feasibility of stacking, there is still uncertainty involved in developing credit stacking projects. I highly recommend that the federal government establish guidelines with regard to this matter. Doing so would make it easier for landowners to comply with the rule and would reduce transaction costs.

Meanwhile, there are three critical issues of concern to developers who wish to stack credits. The first is the market impact of credit stacking. Although stacking would provide more funding for ecosystem services, research shows that stacking credits leads to the depreciation of credit prices. With the creation of a large number of credits, it is hard to tell how much funding landowners could ultimately obtain. Currently, there is not enough data to project the exact effect on existing environmental markets. As more projects generate stacked credits, it will be important to do further research to assess their effect on the market.

Second, double counting severely affects the integrity of the environmental market, and therefore it is important to pay attention to this when stacking credits. Some scholars suggest that bundled credits should not be stacked, because these are the most likely to generate double counting. I agree that it would be better to limit stacking to unbundled ecosystem services only. This restriction would avoid the kinds of instances of double counting that I have discussed.

Third, as with carbon offset projects, additionality is a critical concern when considering projects that stack credits. Even though the issue of additionality is complicated, the two tests that I described could address it adequately. Moreover, I recommend developing standard methods for determining whether a project meets the requirements of both tests. The advantage of standard methods is that generally once they are established, subsequent applications should be easy and efficient.

6.5 Conclusion

Forest projects not only store carbon but also produce co-benefits. Forests improve soil quality, purify water, and promote biodiversity. Carbon markets can be involved in larger environmental credit markets. Currently, environmental law and policy use market-based instruments to promote environmental protection, and governments have established a variety of environmental markets to support conservation activities financially. Thus, a forest project might be eligible for the issuance of carbon, wetlands, habitat, and water quality credits. Generally, a number of federal agencies are responsible for issuing these different kinds of credits.

The fact that one project activity can qualify for several types of credits gives rise to the hotly debated issue of credit stacking. Currently, there is no unified federal guidance on stacking, and the various federal agencies have different attitudes on the matter. It is probable that credit stacking would create incentives for landowners to manage their lands in a more eco-friendly manner and would spur landowner participation in environmental markets. However, because an increased supply of credits leads to the decline in the prices of these credits, it is hard to predict exactly how much more funding landowners could acquire. Also, it is imperative to avoid double accounting and to address the additionality concerns that affect the integrity of the environmental market.

Chapter 7

Conclusion

Climate change is an increasingly urgent problem. As a major component of the world carbon cycle, forests play a significant role in climate change mitigation, releasing as well as absorbing greenhouse gases. The forest carbon offset, a market-based scheme that has the potential to lower the cost of reducing greenhouse gas emissions dramatically, has become an economical way to tackle climate change. For this dissertation, I have compared two forest carbon offset programs, looking at the CDM, which uses a project-based approach, and the California Cap and Trade Program, which has adopted a standardized approach. My comparison mainly focuses on the three essential criteria for every forest carbon offset program — additionality, permanence, and leakage. Through an assessment of these criteria, I intended to determine which of the two is more effective at addressing these crucial issues and producing sound forest projects. The results of my research indicate that the forest carbon offset program under the California Program surpasses its counterpart under the CDM with regard to all the three pivotal issues.

For additionality, I found that the California Program's approach has assured that, as a whole, the forest projects that it funds are additional, while CDM's approach raised some concern. The CDM's project-based approach is precise in theory, since it considers specific project conditions and factors, but it does not obtain the expected results in practice. My assessment of the project documents for all of the registered forest projects under the CDM indicates that some projects failed to demonstrate additionality adequately. Nonetheless, the CDM issued offset credits for them. My evaluation demonstrates that the barrier analysis that these forest projects used is highly subjective, and that a majority of them provided only general (vague) explanations for the barriers that they chose. Further, it proved difficult to verify the barrier analysis objectively. By way of verification, most validation reports did no more than repeating the information in PDDs, while only a few of them offered a detailed assessment. The rules of the investment analysis are lax; when a project may choose its own data, it is likely to pick that which will present a satisfactory result, which has led to a situation in which more than half of the projects provided data without detailed explanations. The common practice analysis is also questionable, with only 12% of the validation reports offering a thorough assessment of the information contained in their PDDs. The CDM's acceptance of retroactive crediting is also troubling, as it seems doubtful that without CDM funding, the project would not have happened; notably 86% of projects obtained offset credits through retroactive crediting.

In contrast, the California Program's standardized approach has successfully addressed additionality. Although California's method lacks precision for each project, it ensures the additionality of the whole program by discounting the credits that it issues for each forest project. For the standardized approach, the key is the efficacy of the quantitative methods it employs, because once the methods have been developed, their subsequent application is simple, easy, and economical. To assure the efficacy of the forest protocol's standardized approach, the California Air Resource Board underwent a long and thorough process. The fact that the California Cap and Trade Program and its protocols survived several legal challenges indicates the soundness of the program. Also, research shows that California's forest offset program has achieved additional emissions reductions. Last but not least, the California Program carries out strict verification measures to ensure that its funded projects implement its rules accurately.

With regard to permanence, the CDM and the California Program control the risk of reversals in forest projects in different ways. While the CDM issues special offset — or temporary — credits for forest projects, the California Program discounts the credits that it issues for each such project. A comparison of the two programs suggests that California's approach is more effective at producing sound projects than is the CDM's. The CDM believes that the use of temporary credits for forest projects would resolve the issue of permanence. To this end, it issues two types of temporary credits, both of which must be replaced before expiration. Because of this, the prices of temporary credits are lower than those of permanent credits. However, the costs of developing forest projects are higher than they are for other types of projects. This makes these temporary credits unattractive to project developers, discouraging potential investors and paralyzing the CDM's forest offset program. My survey of the financial sources of all forest projects under the CDM reveals that the funding for 76% of them comes partly or entirely from governments or NGOs. This suggests that due to their financial unattractiveness, the CDM is not able to produce sound forest projects.

In contrast, California's approach has addressed the issue of permanence, although not perfectly. Significantly, it also makes the development of forest projects appealing to investors. The California Program considers 100 years as permanent for forest projects. Thus, it imposes compulsory maintenance of carbon sequestration for 100 years after it issues offset credits for forest projects, requiring each project to monitor and verify its outcomes for the duration of this period. Murray and Kasibhatia's research supports California's definition of permanence. Although this 100-year commitment might be interrupted at some point due to the uncertainty of such a long-term contract, currently this is a workable solution for dealing with the urgent and uncertain situation of climate change. The California Program has also established a forest buffer account to provide insurance against unintentional reversals, deliberately designing its calculation of reversal risk rating to overcount this risk. So far, the buffer account has sufficiently covered all unintentional reversals. Unlike the CDM, the California Program issues regular offset credits for forest projects. These do not dissuade potential developers of forest projects. In fact, we know that forest projects are popular under the California Program, since the credits that the Program issues for them account for approximately 80% of the total amount of credits for all types of projects registered with the California program.

The CDM mainly addresses the third issue, leakage, by accepting only afforestation or reforestation projects, ruling out forest management and avoided deforestation projects that have a high risk of leakage. Except for five animal displacement activities that it counts as having zero leakage, the CDM offers a leakage estimation tool that provides a step-by-step approach to calculating leakage. My assessment of all 17 projects that used the current version of this tool shows that only two actually needed to account for leakage. This suggests that substantial leakage probably does not occur in afforestation or reforestation projects.

Unlike the CDM, the California Program recognizes three types of forest projects, including reforestation, improved forest management, and avoided conversion projects. For reforestation projects, the California Program accounts for leakage on those project sites that have commercially viable grazing activities and more than 30% canopy cover, with leakage risk rates that range from 10% to 50%. It bases these risk rates on peer-reviewed estimates of leakage from reforestation projects and is prepared to update them when more data and research become available. The California Program assigns a leakage risk of 24% for crop displacement, which it derives from the EPA's study and which falls in Murray at al.'s estimated leakage range. The California Program sets a generic leakage risk rate of 20% for improved forest management projects, again using Murray et al.'s research. Using the same source, it assigns a risk rate of 3.6% for avoided conversion projects. Although the rates of 20% and 3.6% are within the plausible limits, they are close to the bottom of the suggested leakage range for each type of project.

Given that United States and California depend on the importation of wood and that ARB and CAR's decision-making processes that determined these leakage rates were not transparent, further research would be useful, to justify or improve these rates.

Furthermore, Henders and Ostwald's research showed that the CAR surpasses the CDM when dealing with leakage from forest projects. In fact, the California Program bases its forest project protocol on CAR's forest project protocol, utilizing its quantitative methods for leakage estimation. In view of the evolution of the CDM's methodologies, I used Henders et al.'s approach, which allowed me to compare the CDM's leakage estimation tool and California's quantitative methods directly. I found that the California Program is more comprehensive than the CDM's, covering both primary and secondary leakage and using a larger geographic scale.

By and large, the California Program outperforms the CDM's with regard to all the three criteria. This raises a new question: Is it possible to apply California's approach to other countries, especially developing ones? Notably, the CDM applies to projects in developing countries, while the California Program only covers projects located in the United States. The California Program bases its quantitative methods on powerful data that the government provides. It is notable that most developing countries do not have such data, which might make it impossible to implement California's methods there. Further substantive research on this subject will be necessary in order to determine whether California's model can apply to countries other than the United States.

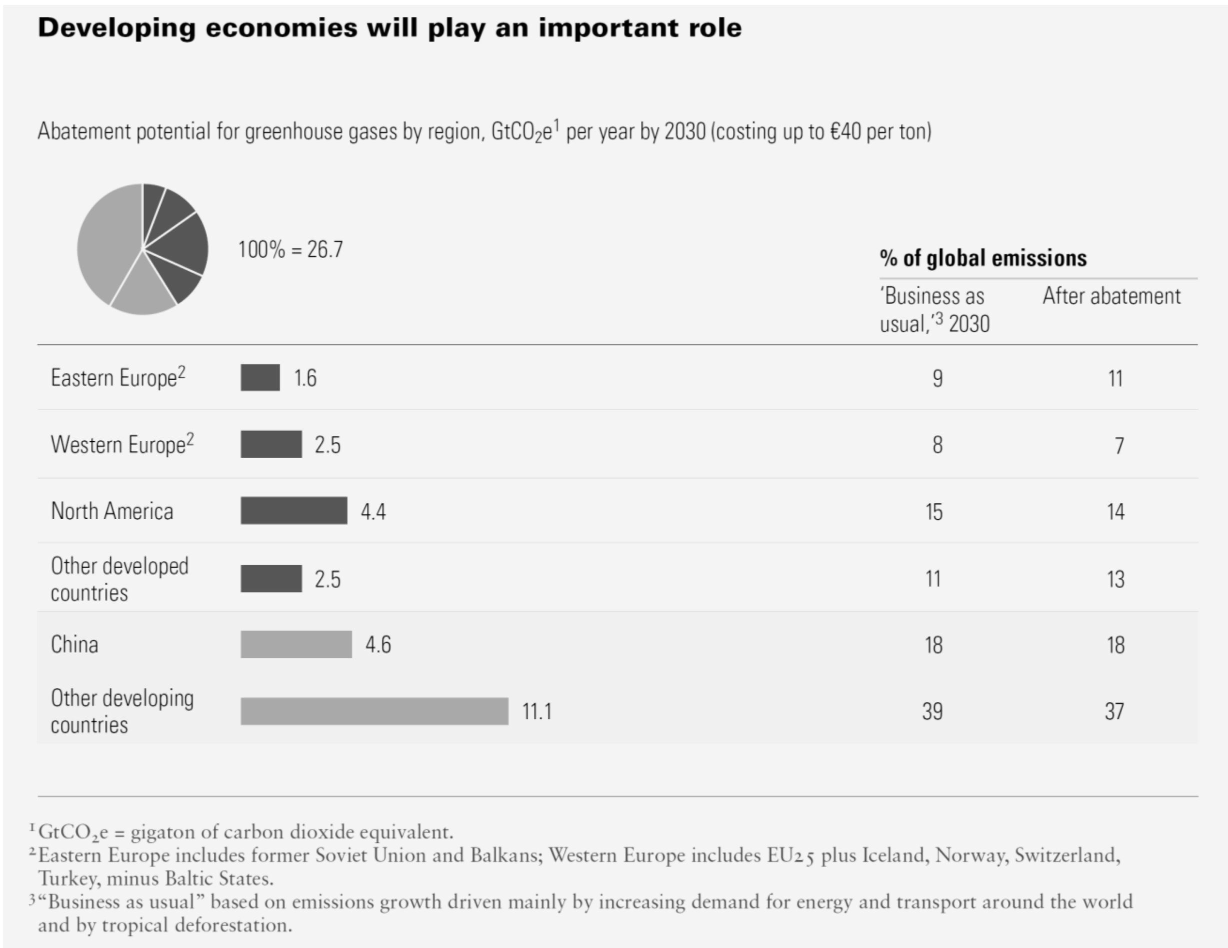
Besides comparing the two forest carbon offset programs, this dissertation has paid attention to larger environmental credit markets. Forest projects not only store carbon but also produce co-benefits. Forests can improve soil quality, purify water, and promote biodiversity. Currently, environmental law and policymakers use market-based instruments to promote environmental protection, and governments have established a variety of environmental markets to support conservation activities financially. Thus, a forest project might be eligible for the issuance of carbon, wetlands, habitat, and water quality credits. Generally, a number of federal agencies are responsible for issuing these different kinds of credits.

The fact that one project activity can qualify for several types of credits has given rise to the contentious issue of credit stacking. There is currently no unified federal guidance regarding stacking, and the various federal agencies have differing attitudes towards it. Credit stacking could create incentives for landowners to manage their lands in a more eco-friendly manner and could spur landowner participation in environmental markets. However, because an increase in the supply of credits is likely to lead to a decline in the prices of these credits, it is hard to predict exactly how much more funding landowners could acquire. Also, it is imperative to avoid double accounting and to address the additionality questions that affect the integrity of the whole environmental market. In short, credit stacking is promising, but we must approach it with caution. Further research is necessary in this nascent area.

Figures

Figure 2.1: Potential for Greenhouse Gas Reduction

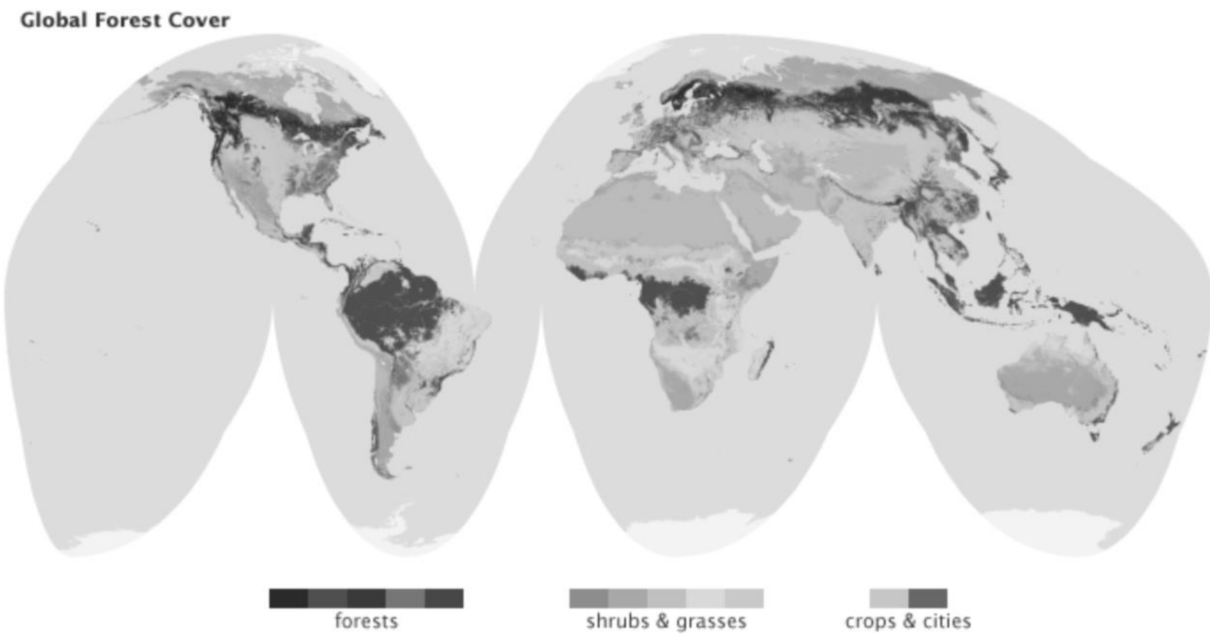
Source: McKinsey[433]



[433] Per-Anders Enkvist et al., *supra* note 33.

Figure 2.2: Forests Cover About 30% of Earth's Land Surface

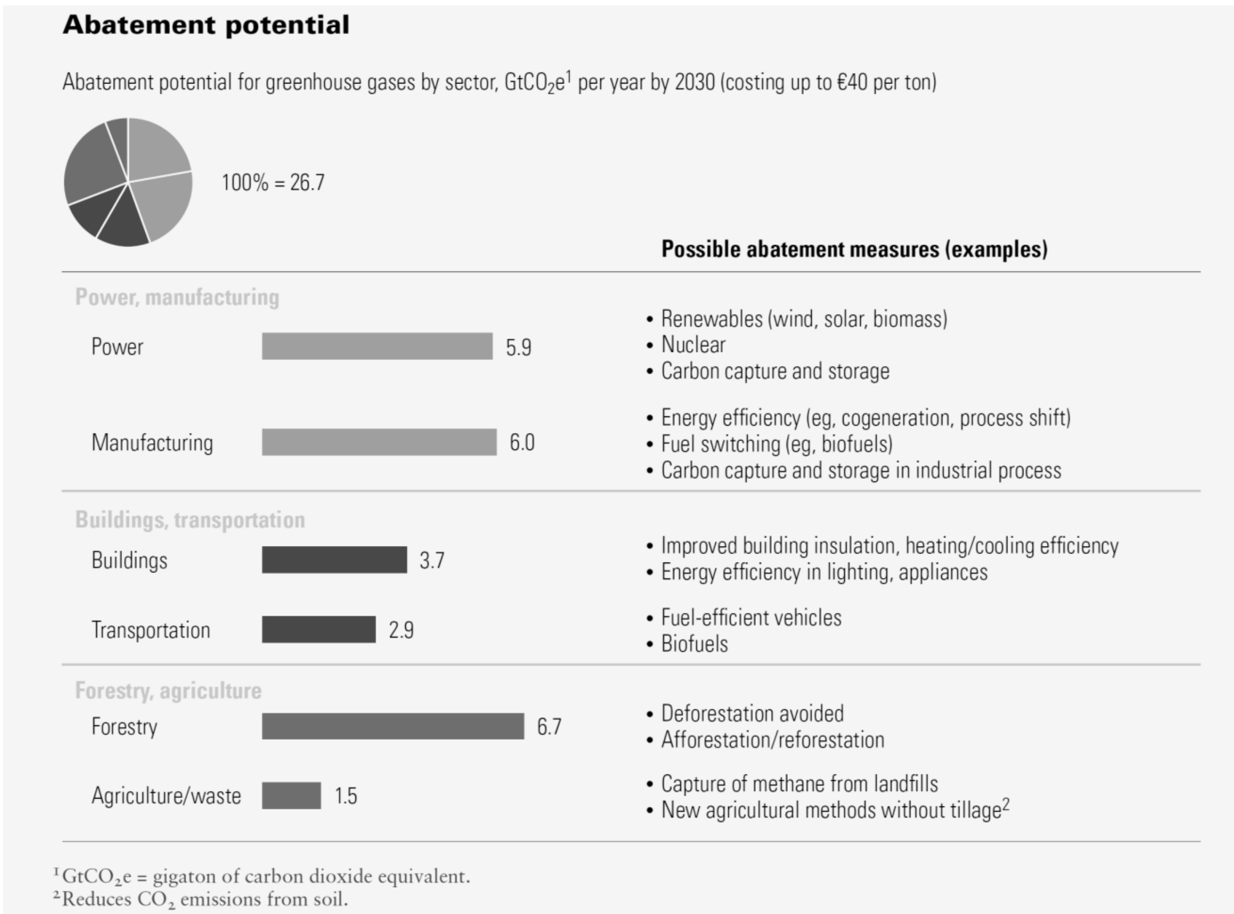
Source: NASA[434]



[434] The map created by Robert Simmon, based on data from the MODIS Land Cover Group, Boston University. *See* https://earthobservatory.nasa.gov/features/ForestCarbon.

Figure 2.3: Abatement Potential by Sector

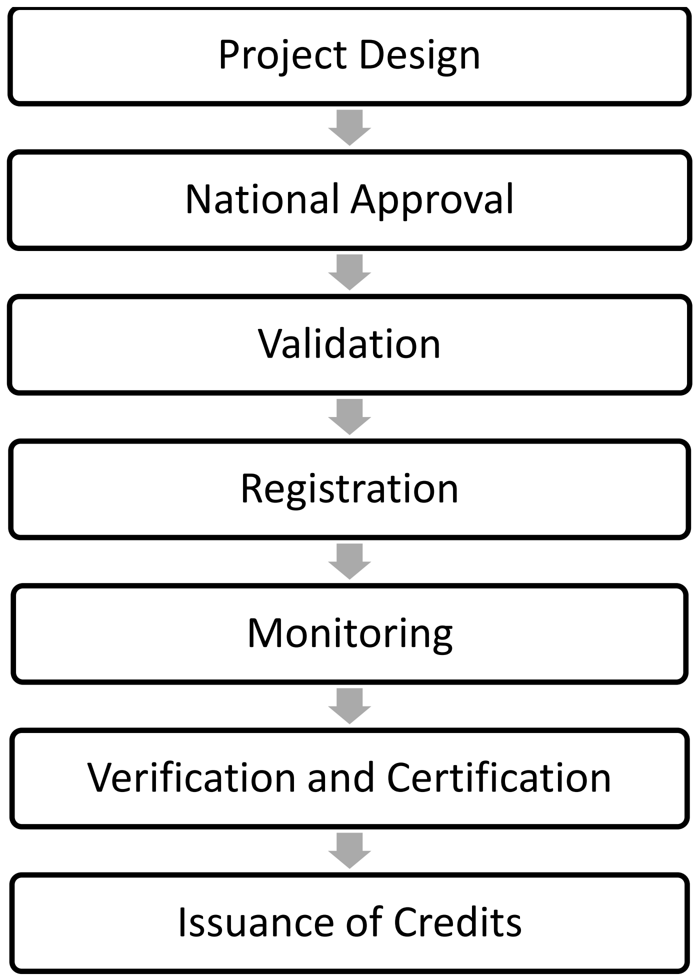
Source: McKinsey[435]



[435] Per-Anders Enkvist et al., *supra* note 33.

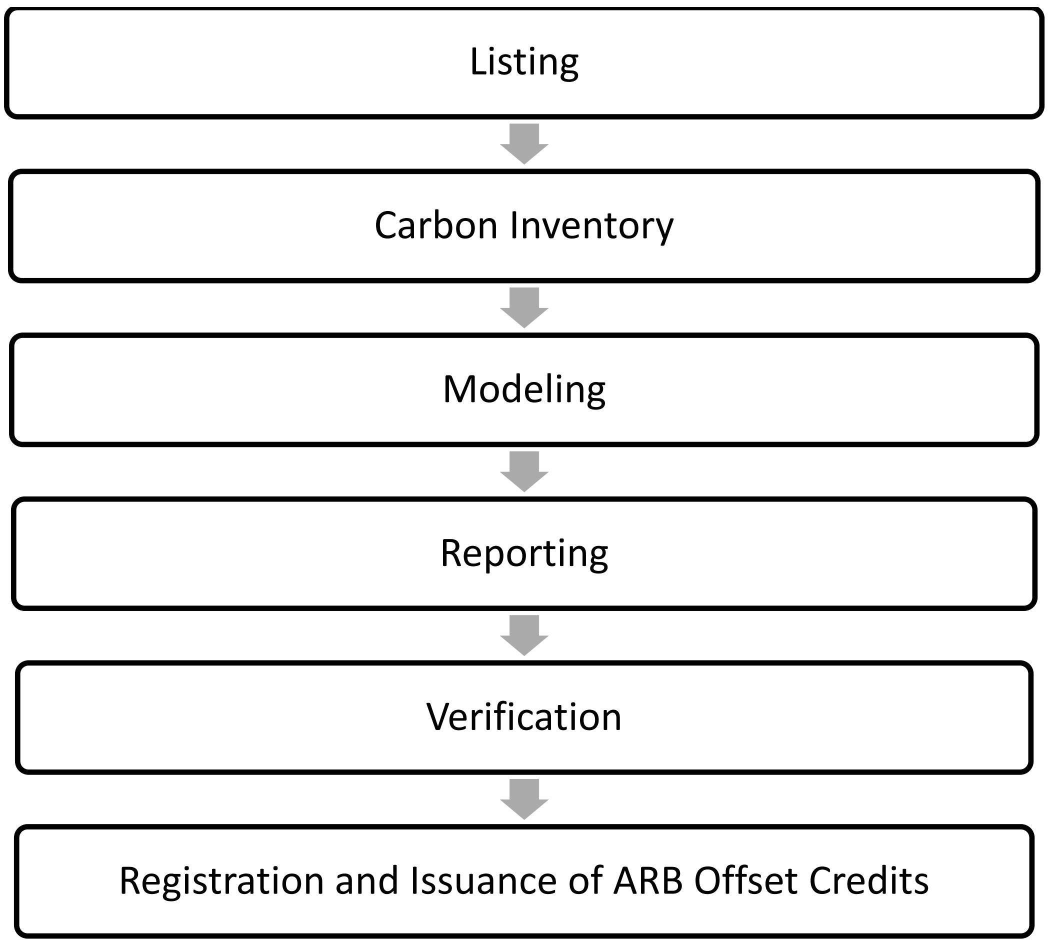
Figure 2.4: The Process for the Issuance of Carbon Offset Credits under the CDM

Source: UNFCCC[436]



[436] UNFCCC, Afforestation and Reforestation Projects under the Clean Development Mechanism: A Reference Manual, 14 (2013).

Figure 2.5: The Process for the Issuance of Carbon Offset Credits under the California Cap and Trade Program[437]



[437] 17 Cal. Code Regs. §95801-96022; *see* California Air Resource Board, *supra* note 168.

Figure 3.1 Level of Explanation of Barriers in PDDs

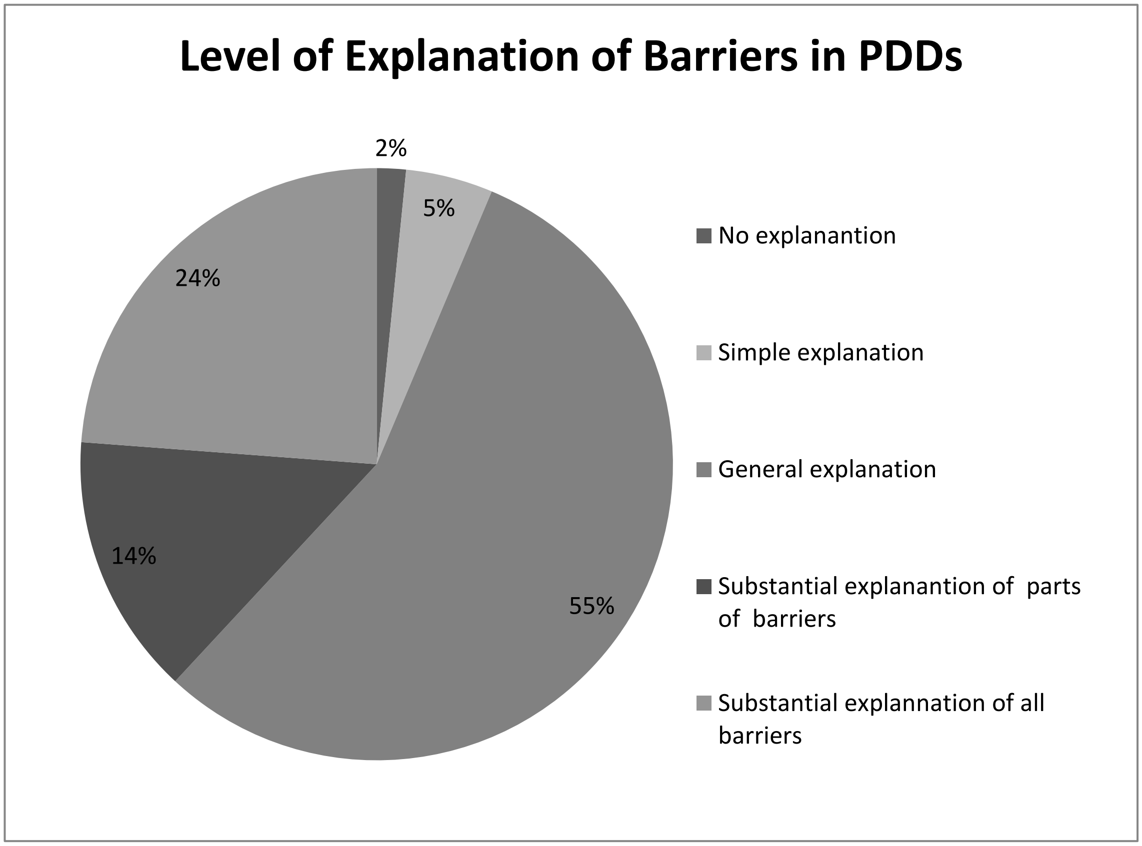


Figure 3.2 Assessment of Information in Validation Reports on Barrier Analysis

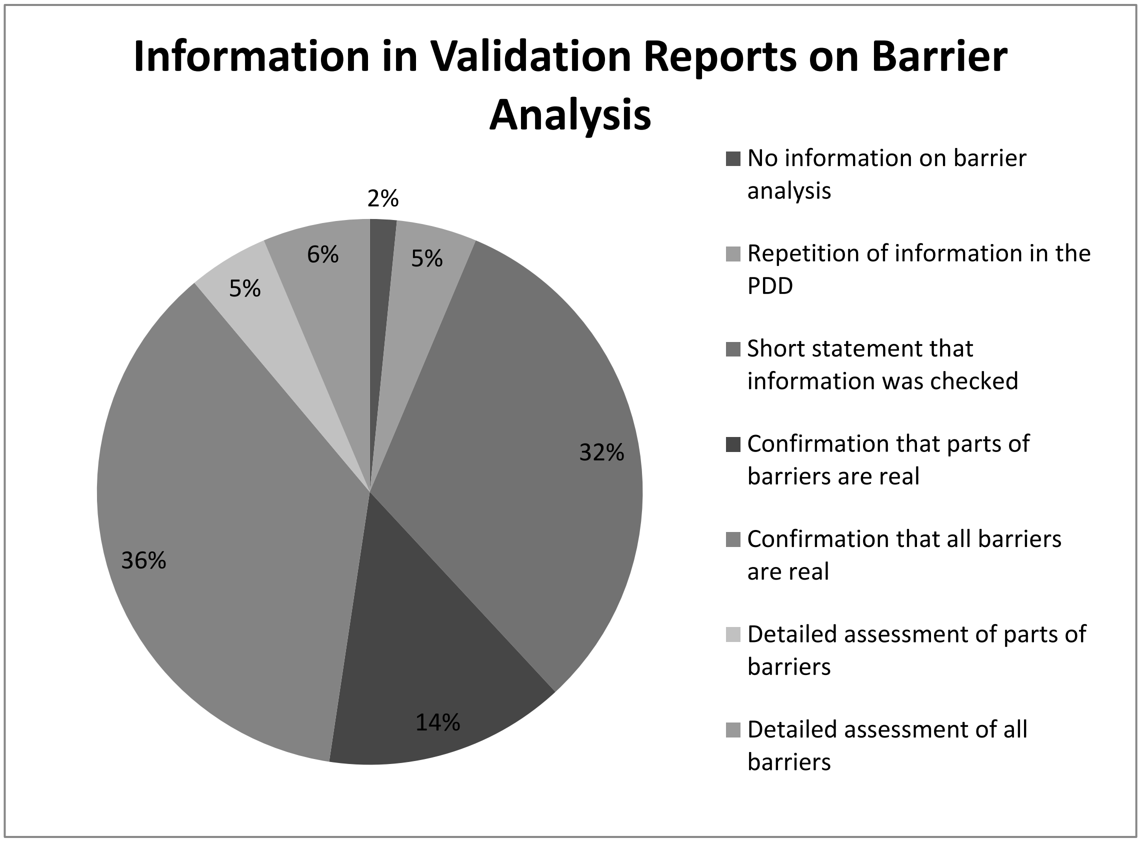


Figure 3.3 Level of Information Regarding the Investment Analysis in PDDs

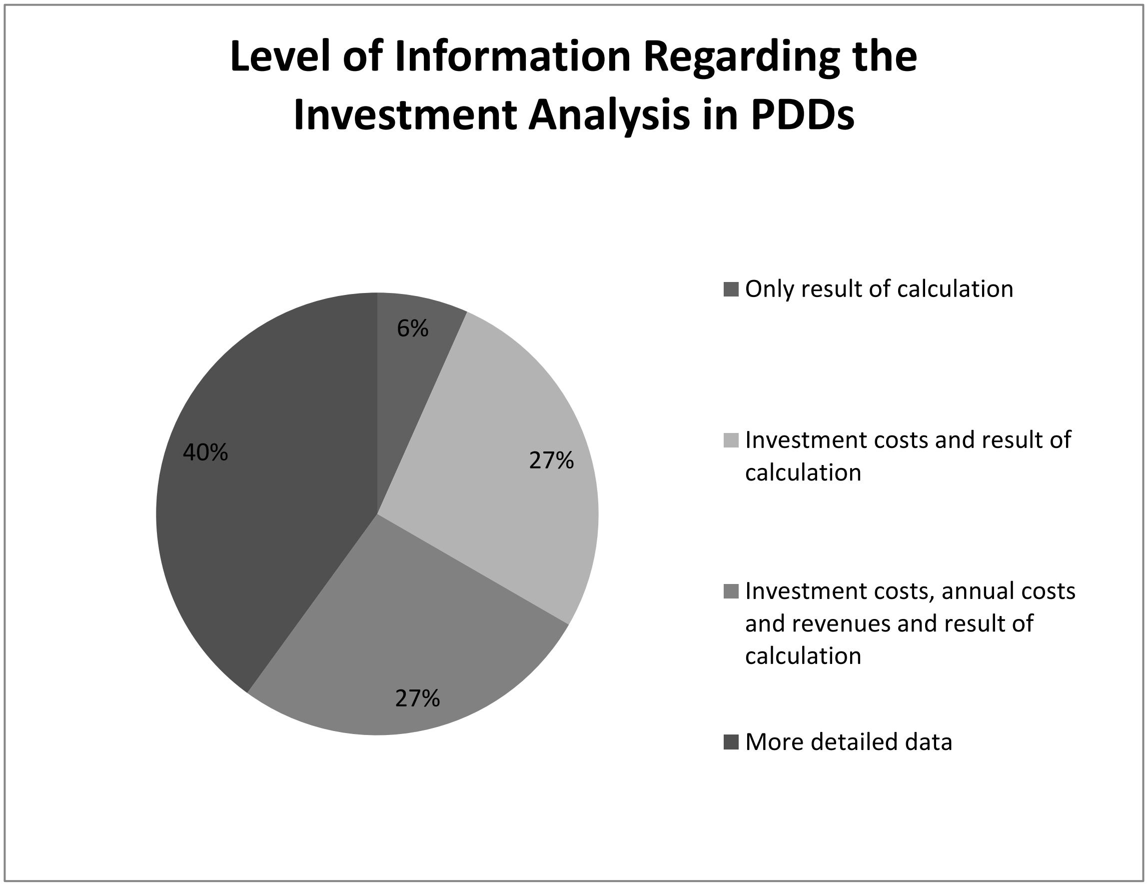


Figure 3.4 Information in Validation Reports Regarding Investment Analysis

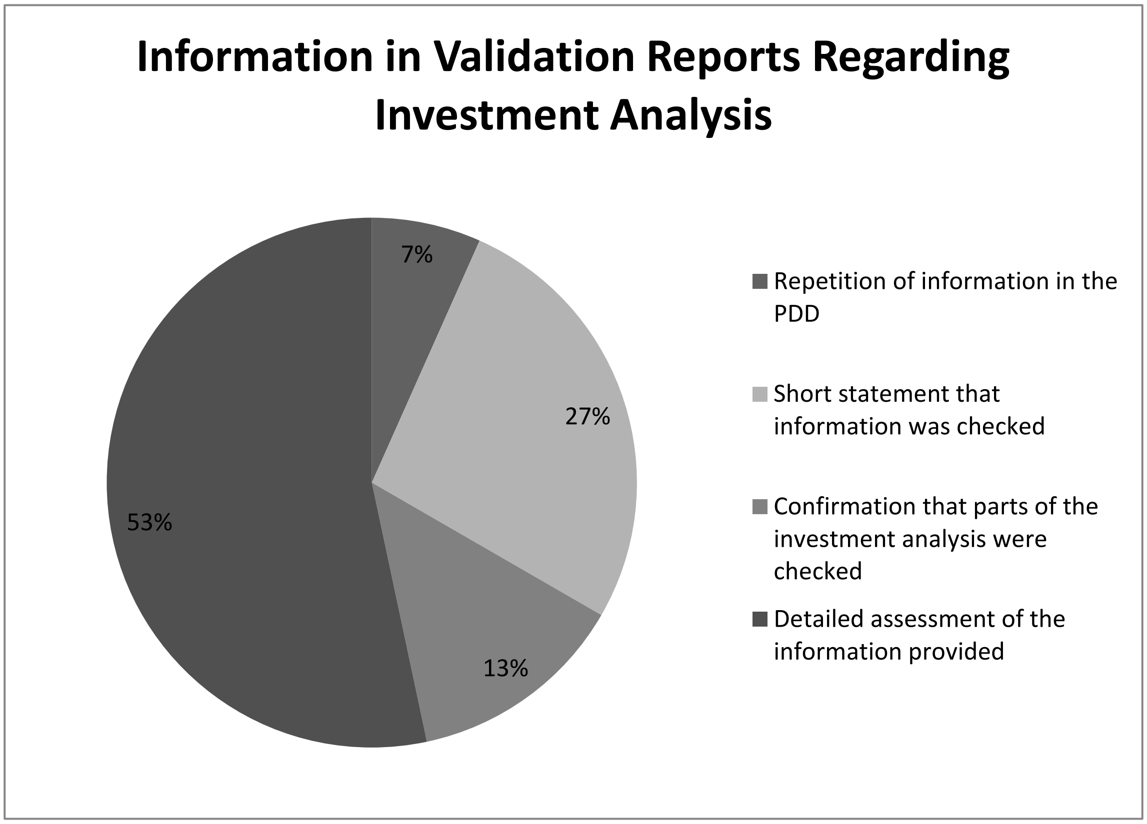


Figure 3.5 Level of Explanation of Common Practice Analysis in PDDs

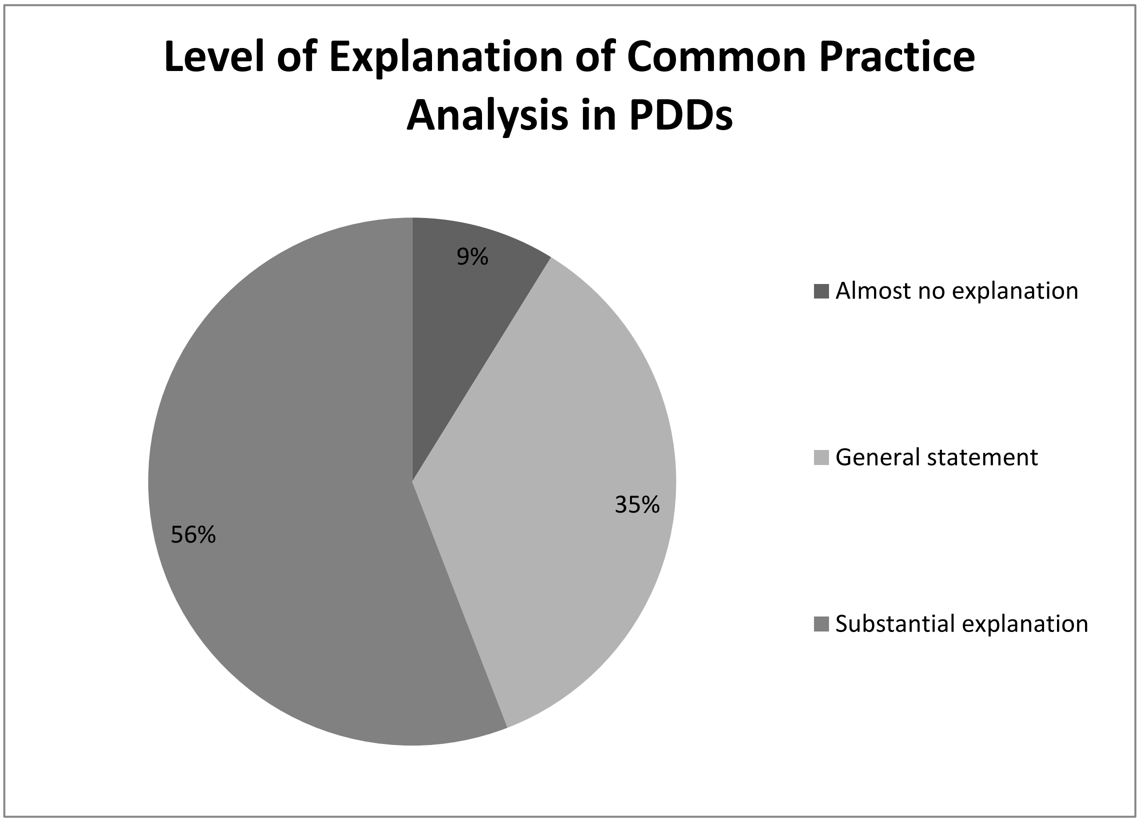


Figure 3.6 Information in Validation Reports Regarding Common Practice Analysis

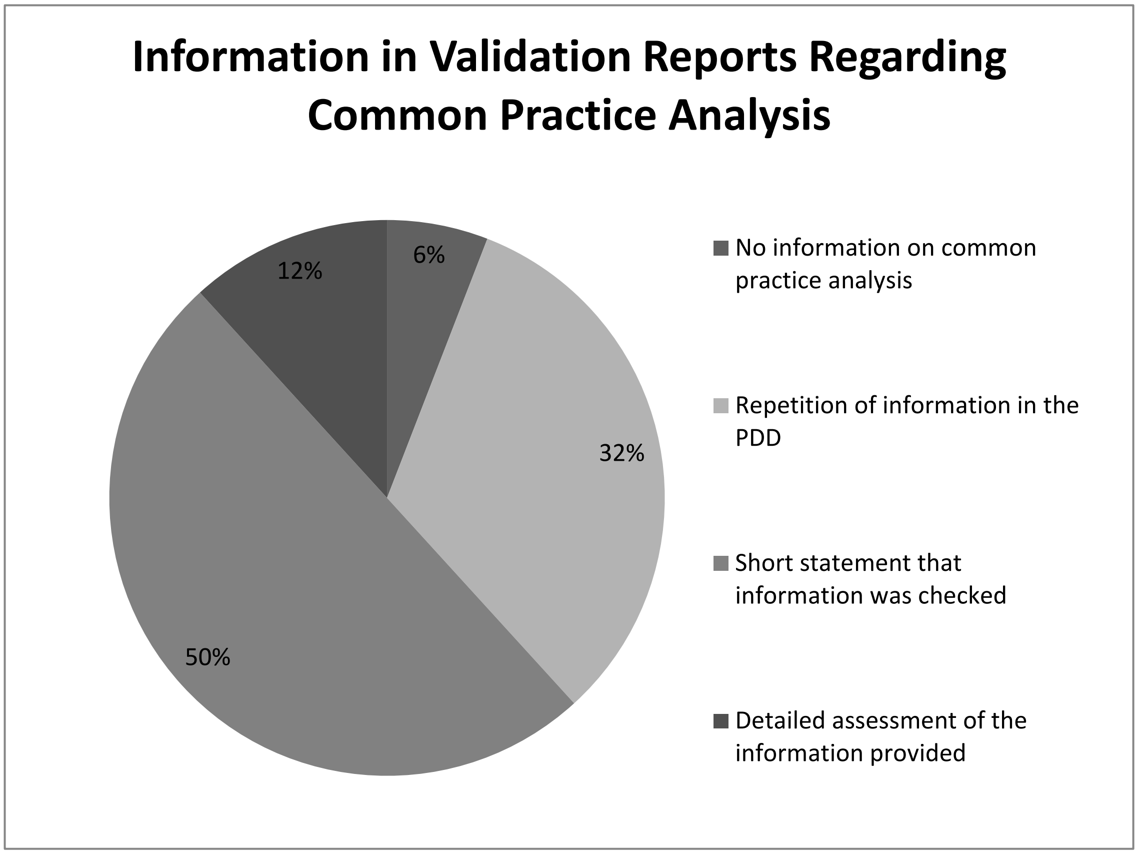
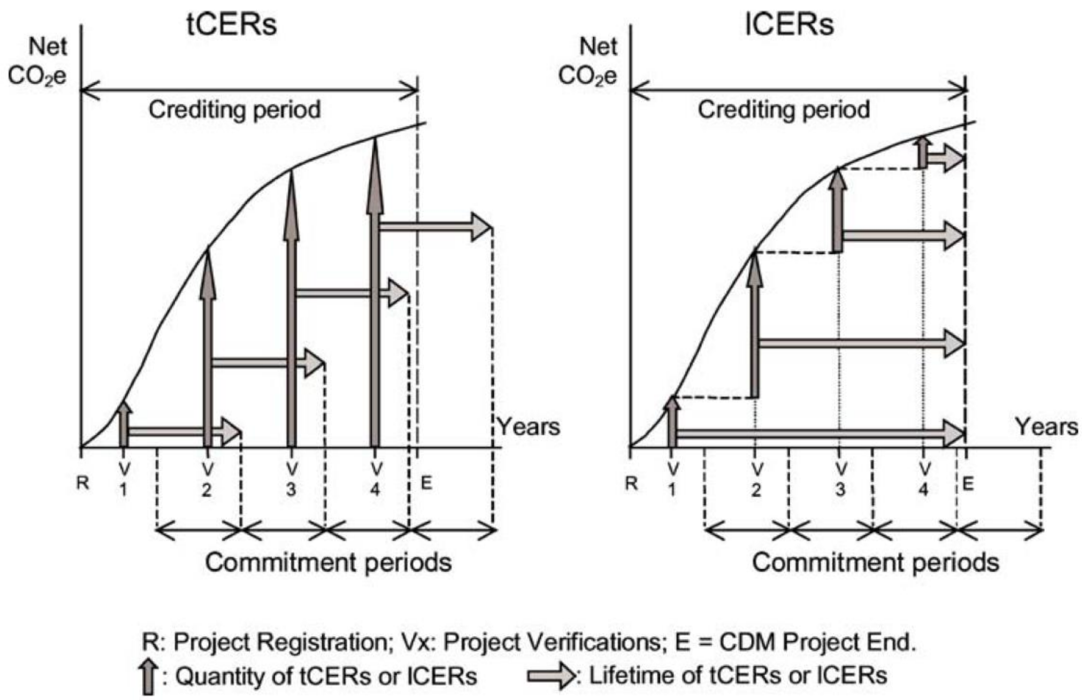


Figure 4.1: Differences between tCERs and lCERs

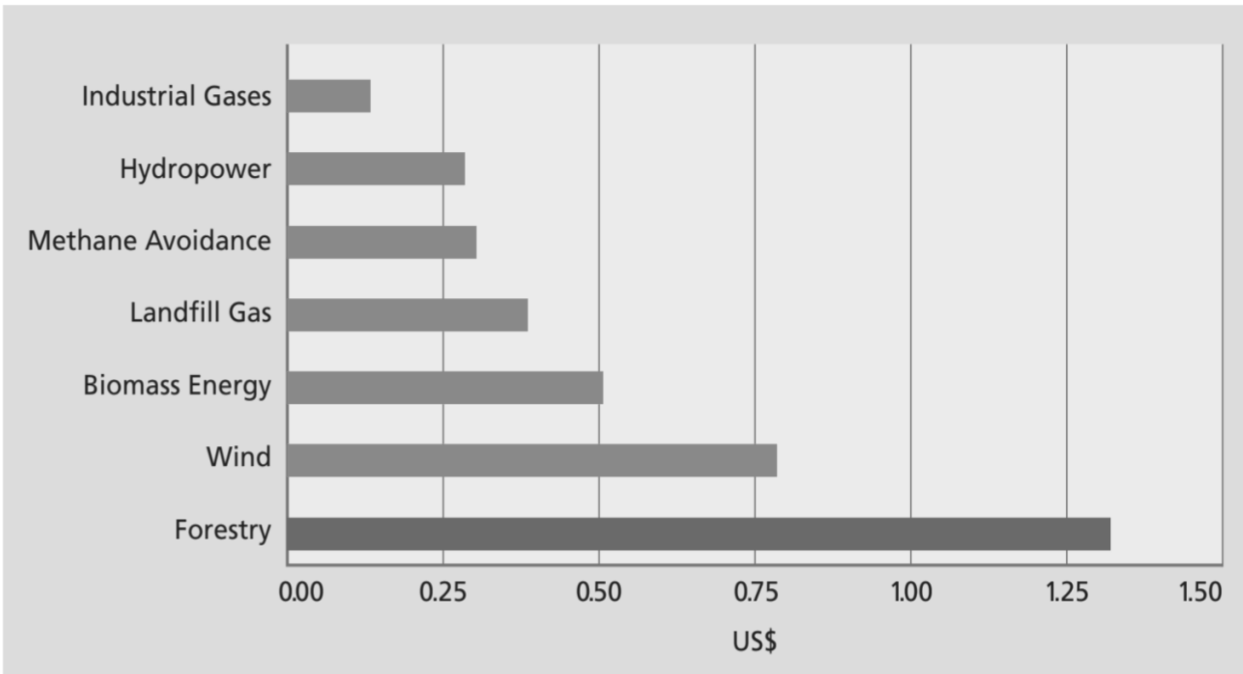
Source: Bruno Locatelli and Lucio Pedroni (2006)[438]



[438] Bruno Locatelli & Lucio Pedroni, *Will Simplified Modalities and Procedures Make More Small-Scale Forestry Projects Viable Under the Clean Development Mechanism?*, 11 MITIGATION AND ADAPTATION STRATEGIES FOR GLOBAL CHANGE 621, 628 (2006).

Figure 4.2: Project Development Cost by Technology ($/tCO2e) — Weighted Average

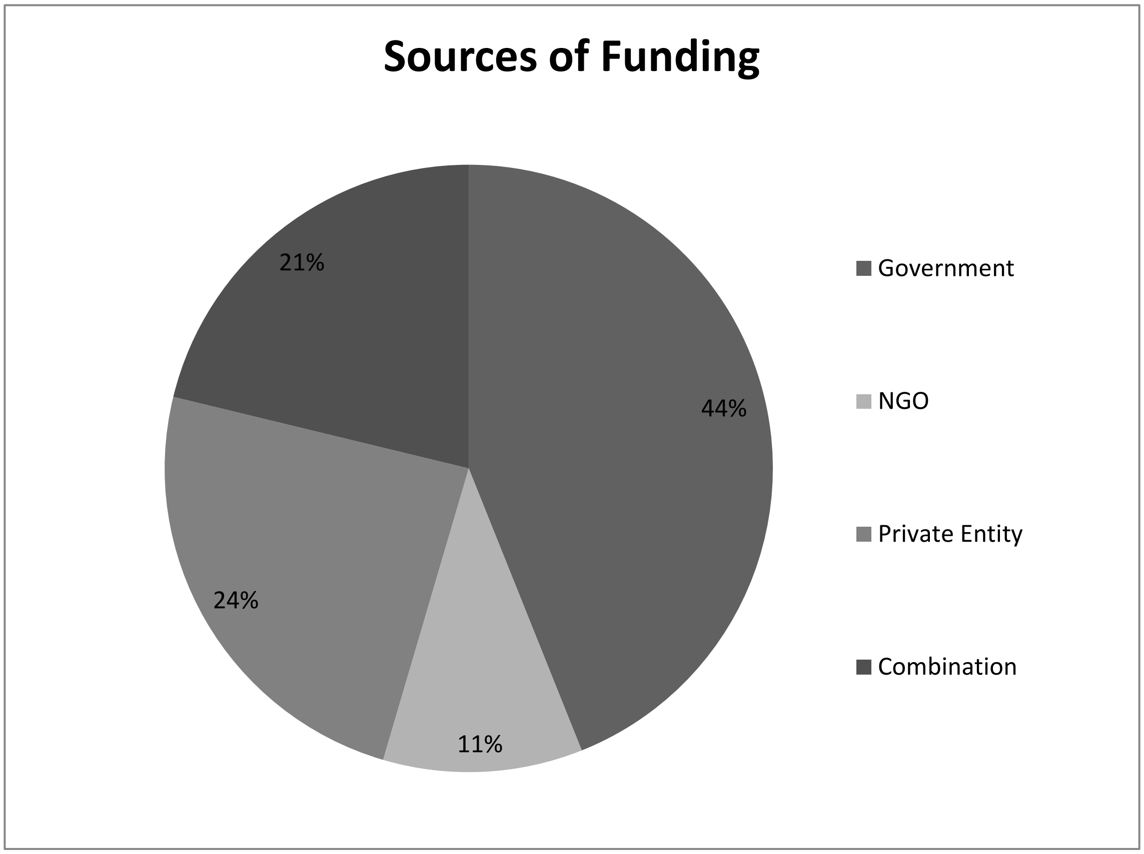
Source: World Bank[439]



Note: Transaction costs included in this figure are project preparation, validation, and monitoring costs up to July 2011. The figure does not include methodology preparation costs, and it only reflects World Bank costs—excluding other transaction costs incurred by the project entity.

[439] Zenia Salinas & Ellysar Baroudy, *BioCarbon Fund Experience : Insights from Afforestation and Reforestation Clean Development Mechanism Projects*, the World Bank (2011).

Figure 4.3: Sources of Funding for CDM Forest Projects



Tables

Table 5.1: Afforestation Regional Leakage Estimates

Source: Murray et al. (2004)[440]

Region	Leakage Estimate (%)
Northeast	23.2
Lake states	18.3
Corn Belt	30.2
Southeast	40.6
South-Central	42.5

[440] Brian C. Murray et al., *supra* note 306.

Table 5.2: Avoided Deforestation Regional Leakage Results

Source: Murray et al. (2004)[441]

Region	No Harvesting Allowed	Harvesting Allowed
Pacific Northwest—east side	8.9	7.9
Northeast	43.1	41.4
Lake states	92.2	73.4
Corn Belt	31.5	-4.4
South-Central	28.8	21.3

[441] *Id.*

Table 5.3: Results of Screening the Methodological Approaches for Basic Leakage Characteristics 1-3. PLA—Primary Leakage Approaches, SLA—Secondary Leakage Approaches
Source: Henders and Ostwald (2012) [442]

		Leakage type		**Tool for quantification**					**Geographical scale**			
Metho-dological approach	**Methods using the approach**	Primary	Secondary	Direct monitoring	Area measurements	PRA, Interviews	Leakage factor	Modeling	Global	National	Regional	Local
PLA 1	***VCS:*** VM0003, VM0004, VM0010; VM0011, VM0012, VMD009	x		x						x	x	x
PLA 2	***CDM:*** AR-AM0005; AR-AM0011, AR-AM0013, AR-CM 0001, CDM LK tool for Agriculture*;* Ewers & Rodrigues [26]	x		x	x	x						x
PLA 3	***CDM:*** Leakage tool for non-renewable biomass, ***VCS:*** VMD0012	x			x	x						x
PLA 4	***CDM***: AR-AM0004 ***VCS***: VM0006, VMD0010; ***Carbon Fix***; Dutschke *et al.* [27]	x		x	x	x	(x)			x	x	x
PLA 5	***CDM***: AR-AMS 0001 AR-AMS 0002, AR-AMS 0003, AR-AM 0014; ***CAR*** Forest Protocol	x			(x)		x			x	x	x
PLA 6	***VCS***: VM0009 Boer *et al.* [28] Lasco *et al.* [29]	x			(x)			x			x	x
SLA 1	***VCS:*** VM0003,VM0004; VM0005; VM0010; VM0011; VM0012; VMD0011; ***CAR***		x				x			x	x	x
SLA 2	***VCS:*** VM0012		x				x		(x) *	x	x	x
SLA 3	Gan & McCarl [18] Sun & Sohngen [23] Sohngen & Brown [24] Murray *et al.* [25]		x					x	x	x		

* Method has been developed to cover the national scale, but can potentially address the international scale as well.

[442] Henders & Ostwald, *supra* note 302.

Table 5.4: Carbon Standards Addressing Basic Leakage Characteristics: Leakage type, Quantification tool, Geographical scale. CDM—Clean Development Mechanism, VCS—Verified Carbon Standard, CAR—Climate Action Reserve, CFS-Carbon Fix Standard.

Source: Henders and Ostwald (2012) [443]

	CDM	**VCS**	**CAR**	**CFS**
Leakage type	x			
Primary		x	x	x
Secondary		x	x	
Quantification tool				
Direct monitoring		x		
Area measurements	x	x		x
PRA, Interviews, Surveys	x	x		x
Leakage factor	x	x	x	
Modeling		x		
Leakage scale				
Global				
National	x	x	x	x
Regional	x	x	x	x
Local	x	x	x	x

443 *Id.*

Table 5.5: Assessment of the CDM and the California Program

	CDM	California Program		
	Leakage Estimation Tool	Reforestation	Improved Forest Management	Avoided Conversion
Leakage type				
Primary	x	x		x
Secondary			x	
Quantification tool				
Direct monitoring	x			
Area measurements	x			x
PRA, Interviews, Surveys	x			
Leakage factor		x	x	x
Modeling				
Leakage scale				
Global				
National		x	x	x
Regional		x	x	x
Local	x	x	x	x

Table 6.1: Summary of Environmental Credit Markets in the United States

Source: Jessica Fox et al. (2011)[444]

	Wetlands	**Endangered Species**	**Water Quality**	**Carbon**
Underlying U.S. Federal Laws Driving Markets	Clean Water Act (§404)	Endangered Species Act (§7, §10)	Clean Water Act (§303)	Currently none. (Possibly in the future under the Clean Air Act, if green-house gas trading is allowed.)
Federal Laws, Regula-tions, Policies, and Guid-ance for Environmental Credit Markets	Compensatory Mitiga-tion for Loss of Aquatic Resources[1]	Federal Guidance for the Establishment, Use, and Operation of Con-servation Banks[2]	U.S. EPA Water Quality Trading Policy[3]	Currently none.
State Laws, Regulations, Policies, and Guidance for Environmental Credit Markets	At least 31 states have wetland mitigation laws, regulations, and/ or policies[4]	California Official Policy on Conservation Banks[5]	Seven statewide trad-ing frameworks in place (CO, ID, MI, OH, OR, PA, VT) with an additional four in development (FL, MD, MN, WV)[6]	Regional Greenhouse Gas Initiative; Western Cli-mate Initiative (program in development); Midwestern Regional Greenhouse Gas Reduction Accord (program in development); Oregon Carbon Dioxide Standard of 1997 (H.B. 3283); California Global Warming Solutions Act of 2006 (AB-32); Wash-ington SB6001 Mitigating the Impacts of Climate Change, 2007.
Commodity (Credit Currency)	A functional or areal measure (such as **acres** of wetlands) repre-senting the accrual or attainment of aquatic functions at a compen-satory mitigation site.	**Acres** of habitat and/or numbers of **breeding pairs** representing the quantification of species or habitat conservation values within a conser-vation bank.	**Pounds** of nutrient reductions (e.g., total phosphorus and total nitrogen) or sediment loads. Other pollut-ants on a case-by-case basis.	Offset credits typically repre-sent **short tons** or **metric tons (tonnes)** of carbon dioxide equivalent (tCO_2e) reductions.
Government Agen-cies Involved in Credit Approval	Interagency Review Team for federal Clean Water Act credits. Army Corps is chair; other members can be EPA, the FWS, the NRCS, NOAA (specifi-cally, National Marine Fisheries Service), and other federal, tribal, state, and/or local agency representatives.	Conservation Bank Review Team. The FWS or NOAA (specifically, National Marine Fisher-ies Service) is chair; other members can be other federal, state, tribal, and/or local agency representatives.	EPA and various state agencies.	Various state agencies. (For voluntary carbon mar-kets, nongovernmental offset standards organizations, including Climate Action Reserve, Voluntary Carbon Standard Association, Ameri-can Carbon Registry, and Chicago Climate Exchange.)

1. 33 C.F.R. pt. 332 (2010).
2. FWS, *Guidance for the Establishment, Use, and Operation of Conservation Banks* (2003), http://endangered.fws.gov/policies/conservation-banking.pdf.
3. U.S. EPA, *Final Water Quality Trading Policy* (Jan. 13, 2003), http://water.epa.gov/type/watersheds/trading/finalpolicy2003.cfm.
4. Environmental Law Institute, Banks and Fees: The Status of Offsite Wetland Mitigation in the United States (2002).
5. The Resources Agency and California Environmental Protection Agency, *Official Policy on Conservation Banks* (1995), http://ceres.ca.gov/wetlands/policies/mitbank.html.
6. U.S. EPA, *State and Individual Water Quality Trading Programs* (February 2010), http://water.epa.gov/type/watersheds/trading/tradingmap.cfm.

[444] Jessica Fox et al., *supra* note 358.

Appendix

Definition of Key Terms for the Assessment of CDM Forest Projects in Chapter 3

For the purposes of the assessment of CDM Forest Projects, the following definitions apply:

(1) “General” means showing the chief aspects without giving details and appearing to be not precise;

(2) “Detailed” means containing or including abundant facts, specific points or descriptions;

(3) “Substantial” means containing evidence or data.

Bibliography

Eric T. Sundquist & Ralph F. Keeling, *The Mauna Loa Carbon Dioxide Record: Lessons for Long-Term Earth Observations*, *in* 183 GEOPHYSICAL MONOGRAPH SERIES 27 (Brian J. McPherson & Eric T. Sundquist eds., 2009).

Tatsutani, Marika and Pizer, William A., *Managing Costs in a U.S. Greenhouse Gas Trading Program: A Workshop Summary,* RFF Discussion Paper No. 08-23 (2008).

Raphael Trotignon, *Combining Cap-and-Trade with Offsets: Lessons from the EU-ETS*, 12 CLIMATE POLICY 273 (2012).

Michael Gillenwater & Stephen Seres, *The Clean Development Mechanism: Review of the First International Offset Program,* Pew Center on Global Climate Change (2011).

Anja Kollmuss, Helge Zink, Clifford Polycarp, *Making Sense of the Voluntary Carbon Market: A Comparison of Carbon Offset Standards*, WWF Germany (2008).

Bernhard Schlamadinger, Gregg Marland, *Land Use and Global Climate Change: Forests, Land Management, and the Kyoto Protocol,* Pew Center on Global Climate Change (2000).

Goldemberg, J. et al., *Introduction: scope of the assessment*. In: Climate Change 1995: Economic and Social Dimensions of Climate Change. Contribution of Working Group III to the Second Assessment Report of the Intergovernmental Panel on Climate Change (J.P. Bruce et al. Eds.), Cambridge University Press (1996).

Noah S. Diffenbaugh & Marshall Burke, *Global Warming Has Increased Global Economic Inequality*, 116 PROC. NATL. ACAD. SCI. U.S.A. 9808 (2019).

Valentin Bellassen & Sebastiaan Luyssaert, *Carbon Sequestration: Managing Forests in Uncertain Times*, 506 NATURE NEWS 153, 153 (2014)

CLIMATE CHANGE 2007 SYNTHESIS REPORT: SUMMARY FOR POLICYMAKERS 5 (Report, 2007).

Jean-Francois Bastin et al., *The Global Tree Restoration Potential*, 365 SCIENCE 76 (2019).

Steven Ruddell et al., *Forest Carbon Trading and Marketing in the United States*, Report to the North Carolina Division of the Society of American Foresters (2006).

Derik Broekhoff, *Expanding Global Emissions Trading: Prospects for Standardized Carbon Offset Crediting*, World Resources Institute (2007).

The World Bank, *Overview of Carbon Offset Programs: Similarities and Differences*, Partnership for Market Readiness technical papers; no. 6. Washington, DC: World Bank Group, 10 (2015).

Afforestation and Reforestation Projects under the Clean Development Mechanism: A Reference, UNFCCC (2013).

Keeping Maine’s Forests, *Adoption of Carbon Credit Programs among SFI Participants in Maine—Keeping Maine’s Forests*, Center for Research on Sustainable Forests (2017).

Lambert Schneider, *Assessing the Additionality of CDM Projects: Practical Experiences and Lessons Learned*, 9 CLIMATE POLICY 242 (2009).

Wu Yunna, Chen Quanzhi, *The Demonstration of Additionality in Small-Scale Hydropower CDM Project*, Renewable Energy 36, 2663-2666 (2011).

Trexler, Mark C., Derik J. Broekhoff and Laura H. Kosloff, *A Statistically-driven Approach to Offset-based GHG Additionality Determinations: What Can We Learn?*, Sustainable Development Law & Policy, Winter 2006, 30-40 (2006).

Leigh Raymond, *Beyond Additionality in Cap-and-Trade Offset Policy,* Issues in Governance Studies, Number 36 (2010).

Michael Gillenwater, *What is Additionality? Part 1: A long standing problem*, Greenhouse Gas Management Institute Discussion Paper No. 001 (version 03) (2012).

Kenneth Chomitz, *Baselines for Greenhouse Gas Reductions: Problems, Precedents, Solutions*, Washington, DC, Development Research Group, World Bank, Draft for discussion (rev. 1.4) (1998).

Leif Gustavsson et al. , *Project-based greenhouse-gas accounting: guiding principles with a focus on baselines and additionality*, Energy Policy 28(13): 935-946 (2000).

Greiner, S. and A. Michaelowa, *Defining Investment Additionality for CDM projects--practical approaches,* Energy Policy 31(10): 1007-1015 (2003).

Asuka, J. and K. Takeuchi, *Additionality reconsidered: lax criteria may not benefit developing countries*, Climate Policy 4: 177-192 (2004).

Schneider, L., *Is the CDM fulfilling its environmental and sustainable development objectives? An evaluation of the CDM and options for improvement*, Berlin, Öko-Institut (2007).

Michaelowa, A., & Purohit, P., *Additionality determination of Indian CDM projects: Can Indian CDM project developers outwit the CDM Executive Board?* Switzerland: University of Zurich (2007).

Barbara Haya, *Measuring Emissions against an Alternative Future: Fundamental Flaws in the Structure of the Kyoto Protocol's Clean Development Mechanism*, Energy and Resources Group Working Paper ERG09-001, University of California, Berkeley (2009).

Au Yong, H. W., *Investment Additionality in the CDM*, Technical Paper, Edinburgh, Ecometrica Press (2009).

Sutter, C. and J. Parreño, *Does the current Clean Development Mechanism (CDM) deliver its sustainable development claim? An analysis of officially registered CDM projects*, Climatic Change 84(1): 75-90 (2007).

Alexeew, J. et al., *An analysis of the relationship between the additionality of CDM projects and their contribution to sustainable development*, International Environmental Agreements: Politics, Law and Economics 10(3): 233-248 (2010).

Gang He, Richard Morse, *Addressing carbon Offsetters' Paradox: Lessons from Chinese wind CDM*, Energy Policy Volume 63, 1051-1055 (2013).

Mark Purdon, *Ex-post Evaluation of the Additionality of a Clean Development Mechanism Cogeneration Project in Uganda: the significance of changes in project financing and background economic conditions*, Centre for Climate Change Economics and Policy Working Paper No. 170, Grantham Research Institute on Climate Change and the Environment Working Paper No. 152 (2014).

Mark Purdon, *Opening the Black Box of Carbon Finance "Additionality": The Political Economy of Carbon Finance Effectiveness across Tanzania, Uganda, and Moldova*, 74 WORLD DEVELOPMENT 462 (2015).

Christa M. Anderson et al., *Forest Offsets Partner Climate-Change Mitigation with Conservation*, 15 FRONTIERS IN ECOLOGY AND THE ENVIRONMENT 359 (2017).

Antoine Dechezleprêtre, Jonathan Colmer, Caterina Gennaioli, Matthieu Glachant, Anna Schröder, *Assessing the Additionality of the Clean Development Mechanism: Quasi-Experimental Evidence from India*, Grantham Research Institute on Climate Change and the Environment working paper, 5-6 (2014).

Nicholas Tatrallyay & Martin Stadelmann, *Climate Change Mitigation and International Finance: The Effectiveness of the Clean Development Mechanism and the Global Environment Facility in India and Brazil*, 18 MITIG ADAPT STRATEG GLOB CHANGE 903 (2013).

Robert Hahn & Kenneth Richards, *Understanding the Effectiveness of Environmental Offset Policies*, 44 J REGUL ECON 103 (2013).

Tatyana Ruseva et al., *Additionality and Permanence Standards in California's Forest Offset Protocol: A Review of Project and Program Level Implications*, 198 JOURNAL OF ENVIRONMENTAL MANAGEMENT 277 (2017).

Adam Regele, *Forest Offsets and AB32: Ensuring Flexible Mechanisms Are Firm*, 19 Hastings W.-Nw. J. Envt'l L. & Pol'y 163 (2013).

Thomas Buchholz et al., *Uncertainty in Projecting GHG Emissions from Bioenergy*, 4 NATURE CLIMATE CHANGE 1045 (2014).

Christa M. Anderson et al., *Forest Offsets Partner Climate-Change Mitigation with Conservation*, 15 FRONTIERS IN ECOLOGY AND THE ENVIRONMENT 359 (2017).

Brian C. Murray & Prasad Kasibhatla, *Equating Permanence of Emission Reductions and Carbon Sequestration: Scientific and Economic Foundations for Policy Options*, Duke Environmental and Energy Economics Working Paper EE 13-08 (2013).

Organisation for Economic Co-operation and Development, International Energy Agency, *Forestry Projects: Permanence, Credit Accounting and Lifetime*, Information Paper, 8 (2001).

Carlos A. Peres , Jos Barlow and William F. Laurance, *Detecting anthropogenic disturbance in tropical forests*, TRENDS in Ecology and Evolution Vol.21 No.5 (2006).

B. Schlamadinger et al., *A Synopsis of Land Use, Land-Use Change and Forestry (LULUCF) under the Kyoto Protocol and Marrakech Accords*, 10 ENVIRONMENTAL SCIENCE & POLICY 271 (2007).

Dutschke Michael, Angelsen Arild, *How Do We Ensure Permanence and Assign Liability?* In MOVING AHEAD WITH REDD: ISSUES, OPTIONS AND IMPLICATIONS, ed. Arild Angelsen, 77–85. Bogor, Indonesia: CIFOR (2008).

Thomas K. Rudel et al., *Forest Transitions: Towards a Global Understanding of Land Use Change*, 15 GLOBAL ENVIRONMENTAL CHANGE 23 (2005).

Kenneth M. Chomitz, *Evaluating Carbon Offsets from Forestry and Energy Projects : How Do They Compare?*, Policy Research Working Paper No. 2357, World Bank, Washington, DC. (2000).

Kenneth M. Chomitz et al., *At Loggerheads? Agricultural Expansion, Poverty Reduction, and Environment in the Tropical Forests*, The World Bank, Report No. 36789 (2006).

Ian Noble & R.J. Scholes, *Sinks and the Kyoto Protocol*, 1 CLIMATE POLICY 5 (2001).

Franck Lecocq, Kenneth M. Chomitz, *Optimal Use of Carbon Sequestration in a Global Climate Change Strategy: Is There a Wooden Bridge to a Clean Energy Future?*, World Bank Policy Research Working Paper No. 2635 (2001).

Vincent Gitz et al., *The Timing of Biological Carbon Sequestration and Carbon Abatement in the Energy Sector Under Optimal Strategies Against Climate Risks*, 27 EJ (2006).

Charles Palmer, *Property Rights and Liability for Deforestation under REDD+: Implications for 'Permanence' in Policy Design*, 70 ECOLOGICAL ECONOMICS 571 (2011).

GURMIT SINGH, UNDERSTANDING CARBON CREDITS (2009).

Zenia Salinas & Ellysar Baroudy, *BioCarbon Fund Experience : Insights from Afforestation and Reforestation Clean Development Mechanism Projects*, the World Bank, Report No. 76566 (2011).

Brian C. Murray & Prasad Kasibhatla, *Equating Permanence of Emission Reductions and Carbon Sequestration: Scientific and Economic Foundations for Policy Options*, Duke Environmental and Energy Economics Working Paper EE 13-08 (2013).

Robert M. Solow, *The Economics of Resources or the Resources of Economics*, 64 THE AMERICAN ECONOMIC REVIEW 1 (1974).

Sabine Henders & Madelene Ostwald, *Forest Carbon Leakage Quantification Methods and Their Suitability for Assessing Leakage in REDD*, 3 FORESTS 33 (2012).

Roger A. Sedjo & Brent Sohngen, *Forestry Sequestration of CO2 and Markets for Timber*, Resources for the Future, Discussion Paper 00–35 (2000).

Brian C. Murray et al., *Estimating Leakage from Forest Carbon Sequestration Programs*, 80 LAND ECONOMICS 109 (2004).

B. Sohngen and S. Brown, *Measuring Leakage From Carbon Projects in Open Economies: A Stop Timber Harvesting Project in Bolivia as a Case Study*, CANADIAN JOURNAL OF FOREST RESEARCH 34: 829-839 (2004).

Jianbang Gan & Bruce McCarl, *Measuring Transnational Leakage of Forest Conservation*, 64 ECOLOGICAL ECONOMICS 423 (2007).

Bin Sun & Brent Sohngen, *Set-Asides for Carbon Sequestration: Implications for Permanence and Leakage*, 96 CLIMATIC CHANGE 409 (2009).

B. Schlamadinger et al., *A Synopsis of Land Use, Land-Use Change and Forestry (LULUCF) under the Kyoto Protocol and Marrakech Accords*, 10 ENVIRONMENTAL SCIENCE & POLICY 271 (2007).

U.S. EPA, Greenhouse Gas Mitigation Potential in U.S. Forestry and Agriculture, EPA 430-R-05-006 (2005).

Robert L. Deal, *Integrated Restoration of Forested Ecosystems to Achieve Multiresource Benefits: Proceedings of the 2007 National Silviculture Workshop*, U.S. DEPARTMENT OF AGRICULTURE, FOREST SERVICE, PACIFIC NORTHWEST RESEARCH STATION, 40 (2008).

Susanna Laaksonen-Craig et al., *Forestry, Forest Industry, and Forest Products Consumption in California*, University of California, Division of Agriculture and Natural Resources (2003).

Allie Goldstein, *Not So Niche: Co-benefits at the Intersection of Forest Carbon and Sustainable Development*, Forest Trends (2016).

James C. Bathurst et al., *Forest Impact on Floods Due to Extreme Rainfall and Snowmelt in Four Latin American Environments 1: Field Data Analysis*, 400 JOURNAL OF HYDROLOGY 281 (2011).

Jingjing Liang et al., *Positive Biodiversity-Productivity Relationship Predominant in Global Forests*, 354 SCIENCE (2016).

Jessica Fox, Royal C. Gardner, and Todd Maki, *Stacking Opportunities and Risks in Environmental Credit Markets*, 41 ELR 10122 (2012).

Jessica Wilkinson & Jared Thompson, *2005 Status Report on Compensatory Mitigation in the United States*, Environmental Law Institute (April, 2006).

Royal C. Gardner & Jessica Fox, *The Legal Status of Environmental Credit Stacking*, 40 ECOLOGY LAW QUARTERLY 46, 722 (2013).

DOI Office of Policy Analysis, *Conservation Banking Overview and Suggested Areas for Future Analysis*, U.S. Fish and Wildlife Service (2013).

David Cooley and Lydia Olander, *Stacking Ecosystem Services Payments: Risks and Solutions,* 42 ELR 10150 (2012).

Lankoski, J. et al., *Environmental Co-benefits and Stacking in Environmental Markets*, OECD Food, Agriculture and Fisheries Papers, No. 72, OECD Publishing, Paris (2015).

Michael Gillenwater, *What Is Additionality? Part 3: Implications for stacking and unbundling*, GHG Management Institute, Discussion paper No. 003 (2011).

Zenia Salinas & Ellysar Baroudy, *BioCarbon Fund Experience : Insights from Afforestation and Reforestation Clean Development Mechanism Projects*, the World Bank (2011).