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Financing the agrarian transition? The Clean Development Mechanism and agricultural change in Latin America

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Abstract. The food crisis of 2007–08 generated widespread global concerns about land consolidation and agricultural transition, with renewed attention on foreign land investments and growing global markets for meat and biofuels. As part of and alongside this process, agriculture and land-use projects registered in the Kyoto Protocol's Clean Development Mechanism (CDM) continued to rise, representing almost a third of global projects and almost 50% of projects in Latin America. In this paper we conduct an analysis of the sustainable development claims of Latin American CDM projects, focusing particularly on their implications for land consolidation, regional food security, and agrarian justice. Our analysis suggests that in Latin America those benefiting most from the development and sale of carbon-offset projects have, to date, been large-scale corporations investing in industrial carbon projects such as large tree plantations, sugarcane, and large-scale, export-oriented livestock production. As such, we argue that the carbonization of agriculture through the CDM serves as a driver of 'global green grabbing' and that the scope and financialization of CDM projects in the agriculture and forestry sectors in Latin America may contribute to the maintenance of an agrarian system of 'climate injustice' rather than foster sustainable development across the region.

Keywords: carbon offsets, land use, agriculture, Clean Development Mechanism, land grabbing

1 Introduction

As stalled negotiations for a post-Kyoto agreement under the United Nations Framework Convention on Climate Change (UNFCCC) clearly indicate, climate change negotiations are now firmly established as a process of climate 'exchange' in what is increasingly referred to as the 'new' carbon economy (eg, Boyd et al, 2011; Boykoff et al, 2009). The institutional management of climate change via technology and policy, the social, political, and economic costs of mitigation, and the winners and losers associated with particular mitigation initiatives have thus become both new sources of global contention and drivers of global landscape transformation (Bumpus and Liverman, 2008; Lohmann, 2010a; Wittman and Caron, 2009). The novel features of the carbon economy—in terms of its ongoing constitution, governance, and effects on specific landscapes and societies—require exploration and ground-truthing

of their "unpredictable effects on a variety of other political and economic issues" (Boykoff et al, 2009, page 2301). This paper considers how the carbon economy is inscribed on Latin American agrarian landscapes through the implementation of agriculture-related carbon-offsetting projects through the Clean Development Mechanism (CDM). We explore the extent to which the increasing carbonization of agriculture may result in land dispossession and subsidize a new phase of the agrarian transition, contributing to a 'growth logic' that is incompatible with climate mitigation and sustainable development (Bailey, 2007).

We assess the role of carbonization and climate financialization through an analysis of the sustainable development claims articulated in CDM Project Design Documents (PDDs) registered in Latin America between 2005 and July 2012. Agriculture and agriculture-related land-use change (eg, land clearing, deforestation) is estimated to be responsible for almost a quarter of total global greenhouse gas (GHG) emissions in 2010 (Tubiello et al, 2013) (see table 1). As a result, discussions around the role of agriculture in climate mitigation and adaptation are also increasingly imperative, with twenty-one of the fifty-five countries that have submitted Nationally Appropriate Mitigation Action plans to the UNFCCC, proposing mitigation actions in the agriculture sector (Wilkes et al, 2013). A work program on agricultural adaptation and mitigation was designated for the UNFCCC's Subsidiary Body for Scientific and Technological Advice (SBSTA) and agriculture was included for the first time as a formal topic of discussion in the ad hoc Working Group on Long-term Cooperative Action at COP-17 in Durban, which proposed language around agriculture for discussion at COP-18 in Qatar (Beddington et al, 2012). By 2013, at COP-19 in Warsaw, the SBSTA put agriculture firmly on the agenda, and hosted discussions on how to "enhance the adaptation of agriculture to climate change impacts, while promoting rural development, sustainable development and productivity of agricultural systems and food security in all countries, particularly developing countries", which should "take into account the diversity of agricultural systems and the difference in scale as well as possible adaptation co-benefits" (FAO, 2013 page 1).

Volatility in both carbon-offset pricing and global resource commodity chains (particularly in food and biofuel markets) has complicated the relation between ecologically sustainable and socially just land use and agricultural development and a possible 'climate-friendly' agriculture. In this context, our analysis offers an opportunity to evaluate the potential of

Table 1. Global greenhouse gas emissions for agriculture, deforestation, and fossil fuel use, 1990–2010 (source: adapted from FAOSTAT Agriculture, Forestry and Other Land Use emissions data; Tubiello et al, 2013).

	Million tonnes CO_2e		Percentage change 1990–2010
	1990	2010	
Agriculture			
enteric fermentation	1 875	2 018	7.6
manure left on pasture	578	764	32.2
synthetic fertilizer	434	683	57.4
rice cultivation	466	499	7.1
manure management	319	353	10.7
crop residues	124	151	21.8
manure applied to soils	88	116	31.8
Net deforestation	3 883	3 374	−13.1
Fossil fuel and cement	22 554	33 509	48.6

further integration of agriculture into climate markets in relation to sustainable development and climate mitigation.

The CDM was created as part of the Kyoto Protocol in 2001 (coming into effect in 2005) to promote green technology and improved land-use practices in developing countries, while allowing carbon producers in industrialized countries to offset their emissions in a less costly manner (Boyd, 2009; Paulsson, 2009). A range of assessments of the CDM have shown that projects have been influential in reducing emissions in developing countries, but that offset performance has been uneven across CDM sectors and geographic regions (Bond, 2011; Boyd, 2009; Corbera and Brown, 2010; Ellis et al, 2007; Olsen, 2007). By July 2014 the number of registered projects exceeded 7500, with 2553 of these successfully achieving credit issuance (for a total of 1.5 billion Certified Emission Reductions—CERs) (UNFCCC, 2014). The CDM, as the market-based mechanism involving the greatest number of countries, has been responsible for US$28 billion worth of pre-2013 CERs and has prompted US$130 billion investment in GHG-reducing activities (World Bank, 2014). Globally, about one third of offset projects currently registered in the CDM take place in the agriculture and forestry sectors, including renewable energy projects in agroindustry (Tubiello et al, 2009). These include methane capture from livestock and manure/waste management, renewable energy from agricultural wastes, including bagasse (sugar cane residue), rice husks, and food processing wastes, energy from woody biomass, mainly from tree plantations, and afforestation and reforestation projects.

In Latin America 46% of the 610 projects registered in the CDM between 2005 and 2012 fall into the agricultural and land-use sectors (see table 2), representing a total potential carbon mitigation contribution of 151.3 million tonnes of carbon dioxide equivalent (CO_2e), about

Table 2. Clean Development Mechanism (CDM) projects in Latin America (Source: CDM Project Design Documents, UNFCCC CDM Project Registry, and UNEP Risø Centre CDM Pipeline Registry, July 2012).

	Number of projects	CERs[a] expected (kilotonnes CO_2e) to 2020	Projects with CERs issuance	CERs target (%)	Average months delay
Agriculture-related projects					
Afforestation/reforestation	15	11 226	0	0	21.0
Biofuels					
bagasse	37	14 869	26	102	18.1
tree plantations	26	34 189	13	121	24.8
other agricultural wastes and biodiesel	48	29 562	17	91	25.2
Livestock waste management/methane capture	156	61 490	73	49	41.1
Agriculture subtotals	282	151 336	129		
Non-agriculture-related projects					
Hydro	137	108 413	64	119	23.7
Landfill (flaring/power)	92	224 480	48	54	28.5
Wind	37	54 390	11	76	20.6
Other (industrial, chemical, transportation)	62	212 695	29	82	21.6
Totals	610	750 596	281		25.0

[a] CERs—Certified Emissions Reductions.

20% of expected offsets by 2020. Latin America is the second-largest regional producer of emissions from agriculture after Asia, at 17% of total global agricultural emissions. Emissions have risen sharply in the region, from 388 million tonnes CO_2e in 1961 to more than 900 million tonnes CO_2e in 2010. Enteric fermentation is the largest source (60%), followed by manure left on pasture (25%), synthetic fertilizer use (5%), manure applied to soils (2%), manure management (3%), and crop residues (2%) (FAO, 2014a). Industrial agricultural expansion is one of the main drivers of such increasing GHG emissions, mainly attributable to deforestation and habitat degradation, soil erosion, and water pollution (Gutiérrez-Vélez et al, 2011).

We focus our analysis on the relationship between the ongoing carbonization of the agriculture sector in Latin America and the phenomenon of 'land grabbing', or the large-scale acquisition of land-related rights and resources by corporate, and often international, entities (Borras and Franco, 2012). In the Americas, Borras et al (2012a; 2012b) identify several trends for increased momentum in land grabbing that affect the agricultural landscape in this region. These include global concerns for food insecurity and increased meat consumption that drive foreign investment in the expanded production of food and feedcrops (Godfray et al, 2010; Jarosz, 2009); the expansion of the biofuels complex (Borras and Franco, 2012; McMichael, 2010); and the increased use of financial instruments by transnational actors within the global food regime (Clapp, 2014; Fairbairn, 2014). Thus, our analysis also sheds light on the potential role of CDM funding in fostering land acquisitions and land use shifting towards biofuel activities in Latin America, with implications for global food security and land-use change in host country environments. We discuss the extent to which industrial agriculture in this region, already a major driver of climate change, stands to benefit from carbon markets. The analysis indicates that supporting the agricultural sector further through carbon offsetting in the CDM may exacerbate the role of industrial agriculture, biofuel monocultures, and industrial tree plantations in land dispossession, thus deepening the region's agrarian transition, and displacing diversified, family-based, and agroecological productive activities.

2 The agrarian transition and the CDM in Latin America

The agrarian transition (ie, the transformation of agricultural landscapes from a focus on domestic food economies to their integration into a global export-oriented food regime) in Latin America, and the role of carbon finance within that transition, should be understood within its historical context (McMichael, 2008; 2012). Economic development in Latin America has long been underpinned by the promotion of an agricultural export regime involving the insertion of international capital into rapidly transforming agricultural landscapes (Akram-Lodhi and Kay, 2008; Otero et al, 2013). Agricultural foreign investment strategies have involved widespread reconcentration of land and capital, but detailed analysis of the scale of this capital investment in different sectors, the differential effects on agrarian populations, and the transformation of material landscapes is lacking (Borras et al, 2012b). For example, foreign direct investment (FDI) in agriculture and agroindustry in Latin America's ten largest economies amounted to $52 billion (out of almost $500 billion) between 2005 and 2010 (ECLAC, 2013). This has largely been focused in export-oriented agriculture and agribusinesses, including large-scale soybean production, livestock production, and biofuels production.

In contrast, family farming in Latin America comprises 84% of agricultural landholdings but holds only 20% of agricultural land. This sector, however, is responsible for between 36% (Central America) to 59% (South America) of national 'average dietary energy requirements', as a measure of their contribution to local food security (FAO, 2014b). This sector includes subsistence-level farms, as well as farms which are classified as small-scale or family farms,

but which are integrated into domestic agricultural markets focused on regional food security (Berdegué and Fuentealba, 2011). The reduction of socioeconomic support for small-scale, diversified agriculture under neoliberal policies has made it more difficult for such systems to thrive, despite the fact that they provide higher levels of public goods (eg, biodiversity, ecosystem services including climate mitigation, biocultural conservation) as well as contributing substantially to food security and local economic development (de Schutter, 2011; Vorley et al, 2012). In fact, privatization in land and agricultural services and the growth in scale and industrialization of Latin American agriculture have contributed to the creation of the most unequal rural sector in the world, with the highest inequalities in land access, and has led to increasing emissions and greater levels of biodiversity loss (Chappell et al, 2013)

Proponents of the inclusion of agricultural projects in carbon-offset initiatives suggest that the negative social and environmental impacts of the sector could be ameliorated through job creation, increased productivity, reduced energy intensity, and improvements to local air and water quality (Anderson and Zerriffi, 2012; FAO, 2009). The FAO has also argued that almost 90% of agriculture's climate change mitigation potential could be realized through soil carbon sequestration, and that carbon markets that provide strong incentives for public and private carbon funds in developed countries to buy agriculture-related emissions reductions from developing countries could provide important investments to spur rural development and sustainable agriculture in developing countries (FAO, 2009).

While the mandate for CDM projects and the form and structure for PDDs dictates that they include explanations of the projects' contributions to sustainable development, generically conceptualized by the CDM as having positive environmental, economic, and social impacts, project design must be examined more closely to determine to what extent specific project activities could contribute to these goals, and what additional impacts the projects may have on surrounding landscapes and the agrarian sector more broadly. Our research thus analyzes the PDDs of the 610 Latin American CDM projects registered from 2005 to July 2012 to examine the design, form, and intent of the projects regarding sustainable development benefits, especially as they relate to the agriculture and land-use sector. We consider the extent to which these PDDs claim to promote different forms of sustainable development, and the extent to which these claims are generic in terms of their implementation (that is, not specifically adapted to the local context) and nonspecific (both in terms of how they will provide the sustainable development benefits claimed and who will benefit from them). This analysis enables us to estimate the extent to which these projects are providing on-the-ground benefits to local populations, and the extent to which they are directly/indirectly supporting an already unsustainable agrarian transition.

As a region, Latin America and the Caribbean hosted 610 CDM projects, or about 14% of all CDM projects registered in July 2012. Brazil (207 projects, 4.79% of worldwide CDM projects) and Mexico (141 projects, 3.26% of total) are the largest Latin American hosts of CDM projects. Over half of the projects in the CDM-defined agriculture sector are hosted in Latin America [152 CDM projects globally and eighty-one in Latin America, constituting 3.04% of all registered projects at the global level in July 2012 (UNFCCC, 2012)]. However, projects related to agriculture and land-use change can be found not only in the agriculture sector, but also in the afforestation and reforestation, waste handling and disposal, manufacturing industries, and energy industries sectors. Offset projects are divided into 'large-scale' and 'small-scale' categories, with the latter defined as those for which the yearly emissions reductions do not exceed 60 kilotonnes CO_2e (16 kilotonnes for afforestation and reforestation project activities) (CDM Rulebook, 2013). Small-scale projects are also allowed to use simplified methodologies, monitoring, and verification procedures.

For this paper, we first accounted for all 610 CDM projects registered in Latin America and developed an Excel database, building on the CDM Pipeline chart initially prepared by the United Nations Environment Programme Risø Centre (Fenhann, 2012) and adding six missing projects that we found in the online UNFCCC CDM project search database. We assessed the projects by 'sectoral scope' according to CDM classification, and then recategorized them as related to agriculture and land use according to our analysis of the specific project methodologies as indicated in the PDDs, which resulted in an increase to the CDM agriculture-related projects from eighty-one projects in Latin America officially listed in the UNFCCC agriculture sector to the 282 projects that we eventually included in this analysis. For example, the CDM Reforestation and Afforestation category contained fifteen projects in Latin America, primarily comprised of watershed management and carbon sink projects. Other tree plantation projects (twenty-six in Latin America) destined for use as biofuel in industrial applications were registered in the manufacturing industries, fugitive emissions, and renewable energy CDM categories. Similarly designed renewable energy projects and fuel-switching projects using fuel stock from tree plantations and agricultural wastes were also found in the energy, manufacturing, and agriculture categories. Our analysis resulted in a recategorization of the PDDs into three revised thematic areas—*afforestation and reforestation*, *biofuels*, and *livestock waste management*, each further analyzed below (see table 3).

We then utilized an open coding scheme to identify all claims in the PDDs related to sustainable development, agriculture, and land-use change, including their contribution to emission reductions, discussion, and handling of potential environmental impacts, social and economic impacts and/or benefits, processes used in soliciting stakeholder feedback, and recipients of CER revenue. Considering all projects with agricultural and land-use implications (excluding hydro projects), the rapidly growing number of agricultural CDM projects in Latin America comprises a larger portion of total CDM projects (46% in July 2012) in comparison with other world regions and thus offers a substantial framework for evaluation in terms of the ability of offsetting-supported agriculture to meet combined goals of emissions reductions, food and climate security, and sustainable development. In what follows we present and discuss the results of our analysis and draw out the implications of such findings for agrarian transition in Latin America.

3 Sustainable development claims in the CDM portfolio

As stated in Kyoto Protocol Article 12.2, "The purpose of the clean development mechanism shall be to assist Parties not included in Annex I in achieving sustainable development." Considered as a whole, PDDs in all three thematic areas related to agriculture highlight the potential for significant influence on sustainable agrarian development in Latin America. Table 3 lists the range of sustainable development claims made among the 282 PDDs. Not surprisingly, 278 of the 282 Latin American agriculture-related PDDs make explicit claims about how the project will contribute to the sustainable development of the geographic area in which the project is located. We enumerated the most commonly stated claims across PDDs, which fell into three broad categories aligned with the economic, environmental, and social 'pillars of sustainability.' Beyond the expected requirement of mitigating climate change and/or reducing GHG emissions, PDD claims related to environmental benefits included improving local air or water quality, improving biodiversity, and avoiding open piles of waste biomass. While 134 projects, primarily in the biofuels category, claimed the reduction in the consumption of fossil fuels and/or increased use of sources of renewable energy as the primary environment-related sustainable development claim, another 116 lay the groundwork for this as an optional addition to or later expansion of the project, primarily in the form of potential cogeneration of electricity in the livestock manure methane avoidance projects.

Table 3. Sustainable development claims in agriculture-related Clean Development Mechanism projects in Latin America.

	Project sector			
	afforestation and reforestation	biofuels	livestock waste management	total
Number	15	111	156	282
Any social development claims	15	109	156	280
Environmental social development claims				
Improves local air or water quality	4	36	152	192
Improves biodiversity	5	0	0	5
Avoids uncontrolled solid waste	0	30	0	30
Reduces fossil fuel use/increases renewable use	1	101	32	134
Positive model	2	56	137	195
Economic social development claims				
Formal technological transfer	4	22	33	59
Promotes growth in industry	3	25	38	66
Creates jobs	13	88	144	245
Social social development claims				
Community cobenefits	6	45	17	68
Improves employee working conditions	0	5	6	11

Claims about economic development benefits were also widely present in the PDDs, and included benefits both to industries and to communities in the project impact area. The phrase "serves as a model" or "demonstration" of the use of an innovative technology was listed by 195 projects as a benefit to sustainable development, although only fifty-nine explicitly used the language of technology transfer or training in technical skills where knowledge is acquired from another (developed, usually European) country via the project implementation strategy. For example, 137 of the 156 livestock projects mention establishing a positive model for better environmental management and financial viability through a reduction in energy costs, and/or sale of cogenerated electricity from livestock operations. For these projects, CDM financing is articulated in the PDDs as providing an essential input to demonstrating options for changing industrial operations to more environmentally or economically sustainable models. Claims promoting growth of an industry were made in sixty-six PDDs. For example, the utilization of bagasse for electricity cogeneration was suggested in twenty-one PDDs as "creating a sustainable competitive advantage" for the sugarcane industry (eg, PDDs, #485, #216, and #203), and methane avoidance projects were described as "supporting continued pork production" in thirty-seven PDDs (eg, #3456, #650, and #636).

Social sustainable development claims included contributions to the general quality of life in communities surrounding the projects, including healthcare, poverty alleviation, and education (sixty-eight PDDs), and improved working conditions for laborers either involved in the CDM project or the industrial site to which it was attached to (eleven PDDs). For example, for the Cerradinho Bagasse Cogeneration Project in Brazil (PDD #203), it is stated that, by benefitting the company, the project will benefit the programs it supports, including providing sports facilities, a library, and medical care to any children in the surrounding communities. A project mitigating methane emissions in charcoal production in Brazil

(PDD #4262) notes that, in addition to reducing methane emissions, the new process initiated as part of the CDM project will improve environmental conditions that directly affect workers' health and safety. Job creation was listed as an economic benefit in 245 PDDs, falling into three broad categories: (i) PDDs which claimed job creation was a contribution to sustainable development but gave no clear path to the creation of these jobs or information about them (forty-nine projects); (ii) PDDs which did not give a clear path to job creation, but gave some unspecific indications of what kind or how many jobs might be created (172 projects); and (iii) PDDs which gave a clear path to job creation, including titles, duties, and numbers of jobs to be created (twenty-four projects).

With the sale of CERs to finance project development as the keystone of the entire CDM project system, we also looked at who was directly benefitting from the sale of the carbon credits. In ten of the 282 PDDs it was unclear who would control the carbon credits; the remainder gave at least some indication. In 107 (38%) of the projects a private company, most frequently a major national or international corporation, received full control of the CERs and revenue from their sale. In twenty-one of the projects (7.4%) a private company received full control of the CERs and revenue, but gave an explicit indication of how the revenues would be used to directly support the community: for example, as in the case of a palm oil mill effluent biogas recovery and heat generation project in Peru, which dedicates 1% of CER sales going to a program to feed, clothe, and educate five to six needy children over the duration of the project (PDD #1249). In 135 of the projects, all in the livestock waste management category, the PDDs indicate that individual farms are receiving the CER revenue to support the construction of the manure digesters and other facilities; however, nearly all of these farms have large numbers of animals, and ownership of the farms is either unclear or clearly indicated as corporate. Three of the PDDs indicate that a nonprofit or government agency will control the CERs, but use them to directly benefit the local community surrounding the project. In only seven of the PDDs it is indicated that individual landowners with small to medium-sized operations will directly receive at least a percentage of the CER revenue. These numbers indicate that CER revenues from the agricultural CDM projects are to a large extent financing large-scale, corporate, and export-oriented agricultural endeavors in Latin America, rather than resource-poor farmers or small-scale and diversified farming enterprises.

The fifteen projects classified under the afforestation/reforestation sector, according to their PDDs, are expected to offset 11.2 million tonnes of CO_2e by 2020, although to date no CERs from these projects have been issued. In the biofuels sector the 111 projects examined are expected to offset around 78.6 million tonnes of CO_2e by 2020, with the 156 projects in the livestock management category expected to offset a total 61.5 million tonnes CO_2e by 2020. Across the three sectors the total agriculture-related CDM project contribution to offsetting emissions averages about 12 million tonnes/year—just 1.3% of all emissions related to agriculture in Latin America based on the 2010 baseline (FAO, 2014a). Given the relatively low impact on total emissions reduction, it is important to analyze the additional implications of new carbon finance mechanisms like the CDM for land-use change, sustainable development, and agricultural livelihoods in the region.

3.1 Afforestation and reforestation

Sequestration of carbon in forested environments has been the longest tested offset strategy since its first use in Guatemala in the late 1980s (Wittman and Caron, 2009). Forestry projects are among the top-three most popular project types in the voluntary carbon market, yet only fifteen officially designated afforestation and reforestation projects were registered in the CDM in Latin America between 2005 and 2012, over a combined area of 70 237 ha. Afforestation and reforestation projects got off to a slow start in CDM project registrations, in part due to uncertainties over how to measure baseline and additionality concerns (Thomas et al, 2010).

Registered projects include large-scale timber plantations for pencils (Faber-Castell) and furniture (Precious Woods), where international investors purchased grazing land areas for conversion to timber plantations specifically based on the assumed future financial benefit of access to sales of carbon offsets (PDD #3970, Nicaragua; and #4861, Colombia) and as a strategy against "possible future obligations" in post-2012 climate treaties (PDD #3845, Uruguay, land purchased by Posco Korea). Another teak reforestation project in this category (PDD #3233) on land seized by paramilitaries during Colombia's civil war has been criticized for contributing to the ongoing displacement of small-scale farmers and indigenous peoples (eg, Bargent, 2011). These projects, involving both international investment in land acquisition and carbon sales to buyers located in Canada, Europe, Japan, and the UK, with little evidence in project verification documents of sustainable development outcomes, are examples of 'green grabbing'.

Small-scale projects involving reforestation with native species on grazing lands with extensive community involvement include CDM Project #2694 in Paraguay, approved in 2009 and developed by the Japan International Research Center for Agricultural Sciences (JIRCAS) to implement plantations of exotic *Eucalyptus* and *Gravillea* species to sequester 1523 tonnes CO_2e per year. According to the project document, "local farmers will provide the parcels of land and labor … JIRCAS and INFONA (the Paraguayan Ministry of Forests) will have the right to the income from CER resulting from the project activity and the farmers will have the right to the net income from forest products."

Evaluations of carbon forestry offset programs have raised concerns about not only the accuracy and permanence of carbon offset calculations, but also concerns around ownership and benefit sharing, environmental externalities, and loss of biodiversity caused by landscape carbon management (Dauvergne and Neville, 2010; Kosoy and Corbera, 2010; McAfee and Shapiro, 2010). In small-scale agroforestry and reforestation projects, as in the Paraguayan case above and others examined in the literature, smallholder farmers are typically not directly compensated for the carbon credits derived by their activities, and other economic benefits may be distributed unequally (Corbera and Brown, 2010; Tschakert et al, 2007; Wittman and Caron, 2009). In the case of the fifteen total afforestation and reforestation projects we examined, six projects were designed so that individual or indigenous (noncorporate) farmer-landowners directly receive either a percentage or all of the CER revenue. In five cases corporations receive control of the CERs, and in three cases a nonprofit organization either receives the CER revenue or oversees how it is invested in the local community. Afforestation projects often involve the encouragement of plantation forestry (Sasaki and Putz, 2009), which can lead to losses of biodiversity, changes in the hydrological cycle, and a shift in local food production systems. In the projects examined here eleven result in the displacement and/or intensification of grazing, and four result in the displacement of crop production.

3.2 Biofuels: tree plantations, bagasse, and agricultural wastes

Offset forestry has had greater success in CDM project registrations when classified under manufacturing or fuel-switching categories, with twenty-six projects registered in Latin America between 2005 and 2012 involving more than 1.4 million ha of large-scale plantations of *Pinus* and *Eucalyptus*. These projects are also highly concentrated in South America, with fourteen projects in Brazil and eight in Chile, and the remainder in Argentina and Uruguay. This category includes Brazil's Plantar project in Brazil (PDD #1051, combined with PDD #2569, which is an afforestation/reforestation project), which received CDM registration in 2007 and 2010 for the sale of offsets from 11 700 ha of *Eucalyptus* planted in the year 2000 for conversion to charcoal as an energy source in pig-iron production, one of the first projects funded under the World Bank's Prototype Carbon Fund. The project involves more than 69 000 ha of plantations, funding improvements in the charcoal production process to

reduce methane emissions. Its PDD indicates that it contributes to sustainable development objectives by reducing GHG emissions, providing skilled employment, and improving workers' health and safety. The PDD also states that the CO_2 emissions from the establishment, management, and harvesting of its eucalyptus plantations are "not relevant" because they are "renewable" (PDD #1051, page 10).

Evaluations of the Plantar project, however, have identified serious concerns both about its additionality and about its role in fostering sustainable development:

> "The company's activities in the area of the project have illegally dispossessed many people of their land, destroyed jobs and livelihoods, dried up and polluted local water supplies, depleted soils and the biodiversity of the native cerrado savannah biome, threatened the health of local people, and exploited labour under appalling conditions" (Gilbertson and Reyes, 2009, page 80).

The twenty-seven bagasse cogeneration projects in Brazil support an industry that has been charged with widespread violations of labor rights and with competing directly with small-scale producers for food production (Dauvergne and Neville, 2010; McMichael, 2010). For example, the Itamarati sugar and ethanol mill in Mato Grosso, Brazil processes 6.5 million tonnes of sugarcane/year into sugar and ethanol fuel. It generates electricity by burning the sugar cane residues, and sells extra energy back to the state-owned electricity grid. In 2001 the Itamarati plant upgraded equipment to allow more efficient energy production and allow the sale of larger quantities of electricity to the grid. In 2006, based on a provision of the CDM guidelines that allow projects to 'bank' CERs starting in the year 2000, project developers successfully argued that the Itamarati upgrade was 'additional' and thus eligible for CDM project registration because in 2001 the plant had taken into account the potential of CER sales when designing the upgrade (PDD #0287). The PDD estimated the project would reduce emissions by 7990 tonnes of CO_2e per year over seven years, and the CDM Executive Board has since then approved the issuance of a total of 82 115 CERs from this project between 2006 and 2008. The offsets have been purchased by a Japanese power plant and a Brazilian carbon development fund. Of the total thirty-seven bagasse CDM projects in Latin America, twenty-three include among the sustainable development claims in the PDDs that the sale of electricity will create a "competitive advantage" or "sustainable competitive advantage" for the sugarcane industry. At least two of these projects involve significant increases in land area devoted to sugarcane production, generally replacing areas cultivated for domestic food consumption.

Despite indications that some of the biofuels-tree plantations, bagasse, and agricultural waste CDM projects may be part of problematic industrial operations, they do still hold the potential for addressing environmental concerns, at least according to their PDDs. Of the twenty-six Latin American biofuels-tree plantations projects studied, fourteen consume sawmill and/or forestry residues that would otherwise have been disposed of unsustainably, most frequently in large, open piles left to decay, resulting in methane emissions. Avoidance of these piles also benefits neighboring communities, as a reduction in waste wood residue reduces particulate air pollution from sawdust and fire risk. Similarly, of the forty-eight Latin American biofuels-waste biomass and biodiesel projects, twenty-three consume residues that would have either been left to decay or burned, thus avoiding methane release, unpleasant odors, bugs, fire hazards, and other issues associated with previous disposal methods. Also, twenty-one of the forty-eight projects avoid methane release from wastewater.

3.3 Livestock waste management

In order to meet growing global demands for animal-based foods, the livestock production system in Latin America is both growing rapidly and transforming from a small-scale and extensive (ie, grazing) model to large-scale, intensive, vertically integrated operations close

to large urban centers, especially for pig and poultry production. Confined animal feeding operations now comprise 40% of world meat production; within this almost 60% of pork production is carried out in industrial operations controlled by just a few global companies (Niernenberg, 2005; Robinson et al, 2011). These large-scale operations are a significant source of environmental effluents linked to water and air pollution, as well as a major contributor to methane emissions from manure holding ponds (Alexandratos and Bruinsma, 2012). In 2011, at a global scale, manure management comprised 7% of all agricultural GHG emissions, and Latin America was responsible for 22% of global manure management emissions, one third of these from swine production (Tubiello et al, 2014).

In our analysis we found that 55% of agriculture-related projects—and 25% of all CDM projects in the region—involve livestock waste management, representing 40% of total expected agricultural CERs and 8% of total CDM CERs. These are unequally distributed, with fifty-three projects located in Brazil and ninety-three projects in Mexico, and rapidly increasing in number (registered projects in this sector almost doubled between 2010 and 2012). These are mostly large-scale projects involving the installation of biogas digesters in concentrated animal feeding operations, which in turn are mostly owned by multinational corporations oriented towards agricultural production for the export market. In several cases, large projects were broken into several subprojects to meet the CDM 'small-scale' project guidelines, which allowed the projects to take advantage of less stringent monitoring and validation requirements. Of the 156 Latin American livestock waste management projects, 144 were part of thirteen different groups of projects. Within each group almost identical PDDs were submitted, indicating some glossing of details particular to each project site.

In one example, Granjas Carroll Mexico (GCM), a large-scale pork exporter and subsidiary of the US-owned Smithfield Farms, submitted a suite of twenty-eight small-scale anaerobic digestor/biogas energy generation projects to the CDM in 2006.[1] Project partners included Cargill (with CDM offset credits accruing to Switzerland through the EU-Emissions Trading System) and EcoSecurities, an offset project developer. In the PDDs, rationale for inclusion in the CDM included: improvements in air quality, odor, and worker safety, and an explicit consideration of the project's importance in subsidizing a growth in pork exports (PDD #608). CDM validation and verification documents for this project indicate that only six of the twenty-one sites were visited for verification; yet over 200 000 tonnes CO_2e have been estimated to have been offset. Corbera and Jover's (2012) field-based evaluation of the Procina La Bellota II project (PDD #509), a similarly designed methane avoidance project in Mexico, found that the project was unlikely to deliver the promised emissions reductions due to changes in market incentives (ie, lower than expected pork sales) and technology-related problems.

In Chile, Agrosuper (the world's eighth-largest pork producer) has cooperated with energy companies in Canada and Japan to implement methane capture and combustion activities on feeding operations containing over 100 000 pigs (PDDs #31, #32, #33, #458). In an analysis of the Agrosuper projects, Alarcón (2009) argues that the projects financed the expansion of the export pork industry, not climate change mitigation, suggesting that "as the export of pork increases, more methane is produced and more carbon credits can be generated" (page 77). The project also involved other environmental externalities, such as illegal water extraction leading to nine separate fines from the Chilean environmental ministry (COREMA) between 2005 and 2007.

[1] Twenty-one of the twenty-nine projects were validated and registered in the CDM. Projects were not considered as 'debundled' because GCM's individual 'farms', each with its own manure lagoon, were at least 1 km apart.

4 The carbonization of agriculture in Latin America: agrarian transition or sustainable development?

This review of CDM PDDs demonstrates that almost half of CDM projects in Latin America have brought agriculture, forestry, and land-use activities into a global carbon market, with significant implications for agrarian change under conditions that do not clearly provide a strong foundation for the achievement of sustainable development objectives. Global discussions around climate change have centered upon offset trading as an efficient and equitable way to reduce emissions while protecting economic growth. The PDDs reviewed were designed to generate a total of 73 979 kilotonnes CO_2e between 2005 and 2012 which, based on an average carbon market price for CERs between 2008 and 2012, could result in a total financial revenue of US$ 962 million—about 10% of the value of total agricultural FDI in Latin America between 2005 and 2010. However, we have shown that the carbonization of agricultural and land-use activities through the CDM in the region has involved both direct and indirect processes that transform both the terms of governance for agricultural land use and the directionality of land use. Our content analysis of PDDs, coupled with existing evidence from CDM project on-site analyses, critically demonstrates that CDM projects are at best modest in their provision of environmental and social benefits, insufficiently detailed in the mechanisms that should guarantee the realization of such benefits, and that they are becoming increasingly common as a driver of land consolidation by corporate actors—including some NGOs in the case of forestry initiatives—and the alienation of carbon and livelihood rights from local communities.

Within the reviewed PDDs, CDM financing support for the direct purchase or lease of land for tree plantations by multinational actors was found for fifteen projects. In these cases the role of carbon financing in changes in property rights and potential 'green grabbing' seems unquestionable. In many other cases, however, changes in land-tenure regimes or in property rights to carbon offsets were abstracted and layered, with the rights to land and forest usage remaining in theory with communities or local landowners or companies, but the rights to sales of a carbon offset accruing to a foreign investor or project developer [see Bumpus and Liverman (2008), Corbera and Brown (2010), and Corbera and Friedli (2012) for a discussion of the distribution of benefits from offset projects]. Our review highlights the prominent role played by external and often international project developers, carbon aggregators, and other middlemen in mediating these benefits. Field-based verification and monitoring of agricultural and land-use change, sustainable development outcomes, and carbon offsets themselves were either not discussed or not described in detail in most PDDs. Our review of the PDDs seems to support previous estimations that up to three quarters of CDM projects were completed before being registered by the CDM Executive Board (eg, the Itamarati case) (Davies, 2007).

Additionally, the reviewed PDDs reveal the indirect financial drivers of land-use change and land dispossession as 'flex crops' like sugarcane (eg, McMichael, 2010) benefit from CDM-funded improvements in ethanol processing, which enables increases in global consumption. This increase in global consumption can then lead to expanded land use in sugar cane. For example, in central Mato Grosso, Brazil, the location of CDM-funded ethanol plant Itamarati, acreage in sugarcane has quadrupled between 1991 and 2011, to more than 250 000 ha. Similarly, CDM support for methane and waste management in the livestock sector may further support the expansion of these industries to meet global increases in demand for meat consumption, with subsequent increased land-use demand for soy as feed (cf Zaks et al, 2009). CDM finance has thus contributed to a deepening of the region's agrarian transition, supporting the expansion of mostly large-scale, and technologically driven agricultural activities which aim to serve urban and distant global consumers. It has ignored

other farmer-led, small-scale agricultural enterprises that could have also benefited from incentives to improve land management and increase the climate and ecological benefits of their activities.

Given the role of agricultural activities in contributing to climate change, as well as the potential of agriculture to mitigate the effects of global warming, negotiations are increasingly focused on how agriculture can "feed the world and cool the planet" while enabling sustainable development. This is the slogan of La Via Campesina, an international coalition of peasant movements in sixty-nine countries that advocates a food sovereignty framework for enabling equitable land-use dynamics (Patel, 2009; Wittman, 2011). This framework promotes agroecological intensification, a form of increasing productivity through the incorporation of natural biodiversity patterns and processes (Tscharntke et al, 2012) within the small-scale farming sector. This sector, globally comprising 500 million farms and employing approximately 2 billion people, has been shown to produce food and maintain ecological services more efficiently than conventional monocropping systems such as those favored by the CDM (Badgley et al, 2007; de Schutter, 2011; Godfray et al, 2010; IAASTD, 2009). La Via Campesina and other small-scale farming organizations argue that, without significantly addressing issues of governance, transparency, and cobenefits, the further expansion of the agricultural carbon market through land-use and land-cover change offsets may prevent alternative and diversified forms of agriculture in developing countries, while failing to effectively reduce global GHG emissions. Our analysis suggests that in Latin America those benefiting most from the development and sale of carbon-offset projects have, to date, been large-scale corporations who invest in industrial carbon projects such as large tree plantations, sugarcane, and large-scale, export-oriented livestock management. As such, CDM projects in the agriculture and forestry sectors in Latin America may contribute to the maintenance of a global system of 'climate injustice' (Roberts and Parks, 2007) by supporting what an indigenous peoples' network calls "potentially the biggest land grab in history" (Lohmann, 2010b), as carbon markets place new claims on forested and agricultural territories.

Proponents of a 'climate justice' model argue that, if the CDM is to achieve its aims in supporting sustainable development, better measures of accountability, additionality, and compensation need to be developed, particularly in the areas of land-tenure protection and access to rights over carbon-offset funds to adequately protect the interests of indigenous peoples and diversified small-scale and family-oriented farming population in the Global South (Bohm et al, 2012; Bond, 2011). Overall, our analysis of agricultural CDM projects has provided insights on the role of carbon finance in fostering Latin America's agrarian transition, with increasing cross-scale and cross-national relationships between governments, businesses, NGOs, social movements, and other actors, as well as increasing synergies and trade-offs across policy mechanisms and markets which transform land value in different ways (Li, 2014; Sikor et al, 2013). The CDM market is just one avenue through which climate change negotiations are reaching into daily land-use practices in Latin America and worldwide. It has indirectly revalorized land-use activities by placing an economic value on any emission reduction activities developed by the sector, and it has therefore acted as one but not the only process contributing to the expansion of industrial agriculture over small-scale and/or subsistence agriculture (Sikor et al, 2013, page 523). This was either a deliberate or unintended outcome of carbon markets, given that elite actors already integrated into the global market economy have more capacity to respond quickly to changing incentives and new market opportunities, such as the CDM.

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