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Offsetting benefits? Analyzing access to forest carbon

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Abstract. Emissions trading has created new forms of exchangeable property which become commodities when traded in markets designed to reduce greenhouse-gas emissions and mitigate climate change. This paper analyzes a set of social processes which influence who benefits from reductions in emissions generated by primary production from forest ecosystems. Informed by commodification literature, and property and access theory, we suggest that farmers and rural communities cannot derive full benefits from carbon sequestration because they lack key structural and relational mechanisms, such as capital, knowledge, expertise, technology, and, in some cases, even labour. We illustrate this argument by examining three ongoing carbon-forestry projects in China, Ecuador, and Mexico and we highlight its implications for future forestry mitigation projects and programmes.

1 Introduction

Since the adoption of the Kyoto Protocol by the UN Framework Convention on Climate Change in 1997, emissions trading has become a global blueprint to deal with rising greenhouse gas (GHG) emissions. The Kyoto Protocol established three market-based instruments to reduce the cost of meeting reduction targets, namely: International Emissions Trading (IET), Joint Implementation (JI), and the Clean Development Mechanism (CDM). Whereas in IET, countries and large emitters buy or sell Emissions Allowances (EUAs) under a cap-and-trade framework, JI and CDM are project-based institutions that allow for investment in emission-reduction projects in developing countries. JI and CDM projects generate Emission Reduction Units and Certified Emissions Reductions (CERs), respectively, and they are based on the assumption that the geographical location of a mitigation measure is irrelevant to its effect on global warming.

A variety of other GHG-emissions markets have also been established in Canada, New Zealand, some regions of the United States, and Australia. A new bill is being discussed in the US to establish a federal cap-and-trade carbon market (Corbera and Broderick, 2009). These systems involve trading of emissions allowances, often combined with national and international project-based emission reductions to reduce compliance costs (Tuerk et al, 2008). In addition to these legally binding markets, there are also voluntary carbon markets, for the exchange of more or less standardized Verified Emissions Reductions (VERs), where individuals and companies reduce emissions over and above the mitigation goals set by regulations, with an interest in becoming more environmentally friendly; these include the Chicago Climate Exchange and the Over the Counter markets (Corbera et al, 2009a).

Critical geographers have warned against the illusion of solving environmental problems through monetary valuation and markets alone. They have emphasized that ecological ills can be caused by both missing and existing markets and that nature's commodification[1] has many methodological and moral pitfalls (Harvey, 1996; O'Neill, 2001; 2007; Vatn, 2000). McCarthy and Prudham (2004), for example, criticize the way in which a market approach is used to imagine and legitimate particular social orders which involve increasing privatization and the emergence of the state as a guarantor of private property rights. In the particular context of carbon markets, Backstrand and Lövbrand (2006, page 70) argue that carbon markets epitomize "continued neoliberal governance building on a capitalist compact between business and government elites in industrialised and developing countries" and, similarly, Bumpus and Liverman (2008, page 127) suggest that "carbon offsets represent capital-accumulation strategies that devolve governance over the atmosphere to supranational and nonstate actors and to the market." They also argue that project-based offsets represent a process of "accumulation by decarbonisation" because they facilitate capital achieving higher rates of accumulation as it needs to invest less in domestic emission reductions. From an accounting perspective, Lohmann (2008) emphasizes that carbon markets treat emissions allowances and emission reductions as essentially the same thing, which allows the comparison of offsets across cultural and geographical distances and the linking of "traders' conceptual, largely electronic universe of 'abstract', simplified, fungible carbon credit numbers" with "the universe of the 'concrete', diverse, particular, highly complex, often obscure local projects that produced them" (page 506).

This paper looks critically into the commodification of primary production by forest ecosystems—hereafter referred to as 'forest-carbon sequestration'—from an unexplored angle. We use Ribot and Peluso's "theory of access" (2003) to examine the social processes influencing who benefits from forest-carbon offsets, thus overcoming a more restrictive analysis focused on property alone.[2] A carbon-forestry project consists of states, companies, NGOs, communities, and/or farmers in the developing world selling emission reductions from tree plantations and forests to companies, governments, and/or citizens in developed countries. These buyers can include those who aim to become environmentally friendly, those who purchase offsets and then resell them to other organizations and citizens to make profit (ie carbon funds, retailers, and brokers), and those who purchase offsets to meet policy regulations.

To date, carbon-forestry studies have concentrated on examining project design and outcomes, including transaction costs, permanence, and monitoring procedures, and their welfare implications, particularly for the poor (Corbera et al, 2007a; Wunder and Albán, 2008). However, there has not been any systematic attempt to describe and analyze how land tenure and other means and social relations influence who benefits from carbon-forestry projects, who becomes entitled to tradable offsets, and how these means and

[1] In this paper we adopt Prudham's (2008) definition of commodification, which is understood as "interlinked processes whereby: production for use is systematically displaced by production for exchange; social consumption and reproduction increasingly relies on purchased commodities; new classes of goods and services are made available in the commodity-form; and money plays an increasing role in mediating exchange as a common currency of value" (page 125). Given this, Prudham also considers two distinct moments in commodification: "the development of relations of exchange spanning across greater distances of space and time (market expansion) or stretching", and "the systemic provisioning of more and more types of things (goods and services) in the commodity-form, or deepening" (page 125).

[2] Property can be defined as "the organisation and legitimisation of rights and obligations with respect to resources and services that are regarded as valuable" (von Benda-Beckman et al, 2006, page 1), which in turn structure the ways in which wealth can be acquired, used, and transferred. Property is thus a multidimensional concept, which can be accessed and legitimized through different means, and which constructs social identities and shapes the political organization of society.

relations relate to the overarching process of commodification. We acknowledge that carbon-forestry projects represent a very modest share of carbon trade under the CDM. In February 2010 there were only thirteen afforestation and reforestation projects out of 2029 CDM registered projects, and these will provide 0.1% of all carbon credits potentially tradable through this market by 2012 (UNEP-Riso Centre, 2010). In contrast, land-use and forestry projects provided 22% and 11% of emission reductions in the Chicago Climate Exchange and the OTC markets in 2008, respectively (Hamilton et al, 2009). Nonetheless, we believe that the study of carbon forestry is and will continue to be important in the light of the current entrenching of a political economy of forest carbon in climate-mitigation policy. The current efforts towards accounting, valuing, and trading forest carbon through the World Bank and the UN frameworks for Reduced Emissions from Deforestation and Forest Degradation will complement ongoing and newly designed projects under the CDM and voluntary markets, the number of which will increase if the US carbon market takes off with provisions for domestic and international forestry offsets (Corbera and Broderick, 2009).

Forest-carbon projects are thought to provide economic benefits to the rural poor and to preserve biodiversity in the developing world (Bailis, 2006; Smith and Scherr, 2002). Nonetheless, we argue that holding property rights over land and trees is not a sufficient guarantee for rural communities and landowners to derive economic benefits from the commodification of forest-carbon sequestration. This is because benefits may result from combining landowners and communities' property rights and labour with other factors such as capital, expertise, and technology, which can only be provided by carbon buyers and project developers. Therefore, an access-based analysis can help to elucidate who owns the land and trees providing the carbon offsets, the interplay of land-tenure regimes with project design and implementation, and how these regimes are shaped by actors' entitlements; and it can highlight who benefits most from tradable forestry offsets and why.

We recognize that the factors outlined above exist and evolve within wider complex and cultural contexts, where other issues like gender, class, race, and politics also determine who participates in and benefits from forest-carbon trading. Baldwin (2009), for example, argues that, underlying the discourse around boreal forest-carbon management in Canada, there is a "hierarchy of racial difference" (page 245), where aboriginal tribes are both invisible and active subjects of forest protection and carbon valuation. Aboriginal groups' rights and agency are ignored in the construction of the public discourse around the ecological and economic value of boreal forests; although related policy documents recognize such groups as future forest stewards and potential recipients of carbon revenues. According to Baldwin, the latter propositions contribute to reproducing aboriginality "as an abstract universal thus negating the deep diversity that characterizes the lived experience of aboriginality" (page 244), contribute to retraining aboriginal subjects "in a form of economic agency consistent with the broader exigencies of an ecologically modern future" (page 247), and also cast doubt on the future allocation of carbon rights between the state and aboriginal right holders (pages 249, 250). Baldwin's work situates forest-carbon management in the context of a national territory, racial contests, and historical constructions of forest management, political rights, and cultural (mis)interpretations.

This broader contextualization of forest carbon echoes Callon's recent reflections on the nature of nascent carbon markets (2009), considered as ongoing experiments where a series of economic, political, and technical issues are problematized and continuously negotiated, and where a large number of actors beyond pure economic agents, such as scientists, NGOs, indigenous groups, political organizations, and even the general public, establish or request procedures to influence these markets in different ways. Put into the Canadian context, this means that markets for forest carbon evolve haphazardly, alongside public and policy claims regarding wilderness, aboriginality, rural development, and conservation, but also alongside scientific constructions of boreal forests' ecological, economic (including carbon), and cultural values. This makes philanthropists, NGOs, policy makers, logging companies, and aboriginal groups potential subjects to be included in or excluded from these markets.

In the next section we relate the process of forest-carbon commodification to broader commodification processes and highlight the relevance that land tenure and other social relationships have in such processes. Section 3 outlines the case studies used to build the argument and analyze their tenure arrangements and how these influence project design and operation, in terms of the types of carbon contracts established, the presence of conflict, and the distribution of economic benefits. In section 4 we discuss the role of capital, labour, expertise, and technology in determining the nature of benefit-sharing arrangements related to carbon offsets. In section 5 we summarize, and conclude the paper.

2 Understanding access to forest-carbon offsets

2.1 The commodification of forest-carbon offsets as context

The commodification of forest-carbon sequestration is part of a "new carbon economy" that relies on an exchange of carbon emissions through cap-and-trade and project-based markets (Brown and Corbera, 2003, page 41). It is a particular case of carbon commodification in which tradable carbon emissions are generated through tree planting, and forest management and/or conservation, rather than through allocated emission rights (allowances) or changes in emission levels through efficiency measures and technological change. For some scholars, carbon commodification opens up a new space for nonstate actors to participate actively in climate governance (Betsill, 2009; Lovell et al, 2009; Newell and Paterson, 2009), while for others it creates new spaces for profit, colonialism, and accumulation (Bachram, 2004; Bumpus and Liverman, 2008; Lohmann, 2005). Carbon commodification can thus be situated within a larger market environmentalism doctrine (Anderson and Leal, 2001), current trends in marketized environmental governance (Kosoy and Corbera, 2009; Liverman, 2004), and the construction of a 'neoliberal nature' (Bakker, 2005; 2009; Castree, 2003; 2008; 2009; McCarthy and Prudham, 2004).

Forest-carbon offsets involve the sale of the atmospheric benefits provided by the forest separately from the forest and the land itself (Binkley et al, 2002; Duraiappah, 2006; Peskett and Harkin, 2007). However, such exchange may or may not result from a process of privatization—"a change of ownership, or a handover of management, from the public to the private sector" (Bakker, 2005, page 544)—which may depend exclusively on the project's underlying land-tenure regime and its implementation arrangements. For example, the state could retain the property rights over carbon offsets generated by a project developed on public forestlands, but it could also transfer all or some of these rights to the project developer or to the communities living de facto in the forest. Following Bakker's (2005) understanding of commodification, we therefore suggest that forest carbon becomes a commodity only when property rights over forest offsets are defined and the results are economically valuable and tradable through an institutional market-based framework, as well as alienable from its ecological context as a standardized good.

In this regard, the attribution of property rights over carbon offsets, so that an individual, group, organization, or the state can dispose of such offsets as they wish and exchange them freely or for money (Castree, 2003), only takes place after the corresponding tonnes of carbon dioxide sequestered have been accounted for, verified, and issued by external organization(s). These organizations act as legitimizing authorities in the operating market and grant such rights to one or various participants, as specified in project design arrangements (eg the Designated Operational Entities and the Executive Board in the CDM case, or some consultancies, foundations, and banks in the voluntary market). This process of "individuation" (Castree, 2003, page 280) separates the ecological function of the photosynthesis from its supporting biological and social context, and it involves putting legal and material boundaries around this biological function so that it can be bought, sold, and used by equally 'bounded' individuals, groups, or institutions.

The process of individuation is thus accompanied by 'functional and spatial abstraction', which consist of assimilating the qualitative specificity of any individualized thing to the qualitative homogeneity of a broader type of process (Castree, 2003; Robertson, 2000; 2004). In the commodification of forest carbon, 'functional abstraction' results from making interchangeable VERs or temporary CERs (tCERs)(3) within and across projects, regardless of the type of tree and forests where carbon dioxide has been sequestered. 'Spatial abstraction', in turn, occurs when, in the event of a carbon loss, project developers are able to compensate buyers for the property loss by transferring another offset from another tree-planting or conservation site, as if each were equal in socioecological terms. Both 'individuation' and 'abstraction' are sustained by expertise and technology, which in turn allow scientists, intermediaries, and traders to accrue benefits from forest-carbon trading, as is shown below.

The commodification of forest-carbon sequestration also entails the economic valuation of carbon offsets. Prices that consumers pay or farmers receive for forest-carbon offsets are influenced by the wider carbon-market principle that one unit of emission reductions has the same functional value for buyers regardless of where it has taken place. As a result, buyers have a diversity of offsets choices and they may occasionally be willing to pay more for forest-carbon offsets than for other types of emission reductions (Neeff et al, 2009). As for any other commodity, then, the economic value of carbon offsets is not defined through bottom-up participatory processes where producers propose a fair price in relation to their costs of production and desired profits but, rather, through the marginal costs of overall GHG abatement. This further decontextualizes the economic value of carbon offsets from social and ecological diversity at the project level (Kosoy and Corbera, 2010). For example, the World Bank Biocarbon Fund set up a price range of US\$ 3–6/tCO_2e in its early funded projects in order to match the cost of energy-related offsets from the Bank's Prototype Carbon Fund (World Bank, 2003).

Forest-carbon commodification is also characterized by processes of 'displacement' (Castree, 2003). This relates to Marx's concept of 'commodity fetishism', which essentially referred to the invisibility of exploitative labour relations at the site of production, as well as to Hartwick's (1998) geographical, temporal, and phenomenal separations existing between commodity producers and buyers. These can hide not only unjust labour relations, but also environmentally degrading and socially destructive outcomes. In carbon forestry, buyers can be persuaded by elaborated narratives of a project's contribution to biodiversity conservation and poverty alleviation (Lovell et al, 2009), and in reality purchase offsets grounded on conflicting labour arrangements and negative impacts on local ecosystems, as is described below.

(3) Afforestation and reforestation projects under the CDM generate temporary Certified Emission Reductions (tCERs), which expire at the end of the commitment period after the one during which they have been issued, and have then to be replaced by permanent reductions. tCERs cannot be traded under the European Union Emissions Trading Scheme, and are not fungible with other CERs or EUAs.

Overall, the processes underlying forest-carbon sequestration are made up of social processes and relations which connect actors across different material realities and geographical scales through new constructed markets (Lohmann, 2009). These processes and relations translate into local environmental change and define who is entitled to forest-carbon offsets, how much offsets are worth, which benefits accrue across these actors, and so on. In the remaining parts of this section, we highlight the extent to which local land-tenure regimes can shape forest-carbon project design and implementation, by determining who can plant trees or protect forests, and where. Then we show that understanding land tenure is not sufficient to explain who derives benefits from selling carbon offsets because this last is constrained by landowners' limited access to other "structural and relational means, processes and relations" (Ribot and Peluso, 2003, page 160), such as capital, knowledge, expertise, technology, and labour, which impede them deriving full benefits from this environmental service.

2.2 Land tenure as a departure point of commodification

Understanding and identifying who owns the land where trees are to be planted, or forest protected, is a prerequisite for an effective design and implementation of carbon-forestry projects. Nonetheless, this may not be an easy task, as rural property is characterised by nuanced social relationships which, in turn, confer complex property arrangements. The existence of overlapping layers of rights and competing claims of land ownership, legitimised by the state or other institutions such as customary law, community-based governing bodies, or religious authorities, is the common rule in developing and postsocialist countries (Ostrom and Schlager, 1996; Sikor and Lund, 2009). It may be easy to identify who holds formal property rights over land and its resources in statutory terms, but it may be extremely difficult to identify who holds full ownership or access rights over land and forests, as legitimized by other customary institutions. These considerations suggest that involving all those with claims over environmental services will be difficult, costly, and potentially conflictual (Humphreys, 2006; McKean, 2000). Even when all actors are identified and involved, land use may further complicate the distribution of project-management responsibilities and the negotiation of benefit-sharing arrangements. As Roncoli et al suggest, for a carbon project in Mali, "it will be hard to allocate carbon sequestration benefits among the multiple resource users given that sequestration will result from management decisions and practices that take place at the same time or influence each other in a relay pattern" (2007, page 101).

Unruh (2008) argues that the complexities of land-tenure regimes and natural resource management in Africa reduce the chances of carrying out a large number of carbon-forestry projects across the continent. He recognizes that "Most African populations conduct their lives with the idea that 'ownership' of land and trees is based on occupancy, use, lineage, and other inborn rights" (page 701), which differ significantly from a liberal and Westernized notion of property. These customary, complex systems are often ignored by governments, which regard forests as a public domain, even if they do not have resources to enforce public property or to resolve the conflicts that such a claim often produces. Unruh also suggests that the most suitable areas for carbon forestry will be located in regions with a pronounced temporal and spatial "legal pluralism", which will produce a wide "variety of understandings about what law applies to whom, when, and how" (page 702). Furthermore, once trees are planted, a number of social actors may have rights over different parts of the tree at different times, with distinct use, ownership, and inheritance attributions among others (Bruce and Fortmann, 1999; Saunders et al, 2002). In some cases, tree planting may be used to legitimize tenure and to exclude people like tenants, migrants, and women where property is contested (Corbera et al, 2007b; Unruh, 1995). These multiple claims over land, forests, and trees are also continuously shifting due to demographic and migration trends, which bring new tenurial ideas and legitimizing institutions.

There is already evidence from ongoing carbon-forestry projects suggesting that complex or ill-defined land-tenure regimes can make project design and implementation difficult. For example, Eraker (2000) highlights the case of a carbon project in Uganda, where a Norwegian logging company and its Ugandan subsidiary acquired a fifty-year lease over 5000 ha in a forest reserve to develop plantations and claim carbon offsets. Nonetheless, the companies soon realised that the lands were populated by farmers who had held customary tenure for generations. This translated into conflict as the farmers were threatened with eviction. Brown et al (2004) also depict the case of a conservation-based carbon project in Belize, which prohibited surrounding communities from exercising their customary rights to log some tree species and collect nontimber forest products from within the area. This exacerbated conflict and increased the costs of enforcing the project rules and patrolling the boundaries of the reserve. Boyd et al (2007) showed that unclear property rights resulted in a carbon project in Bolivia conducting a process of land-tenure clarification and attribution, which inevitably resulted in conflicts and local resistance.

2.3 Conceptualizing access to forest-carbon offsets

There has not been a detailed account of how such relations and processes influence the extent to which other actors along the commodification chain also benefit from offsets. For example, what are the means which allow project developers, buyers, and intermediaries to benefit from forest-carbon sequestration if, in principle, they do not hold any property rights over land and trees? How can forest-carbon ownership be granted to a project developer or an investor if they do not hold any rights over the land which provides such an environmental service?

To address these questions, Ribot and Peluso's "theory of access" (2003) provides a useful analytical framework because it differentiates between property and access. These scholars define access as "the ability to derive benefits from things", in contrast to the classical definition of property, as "the right to benefit from things" (page 153). Access analysis allows us to understand why some people or institutions benefit from resources whether or not they have rights to them, and through what processes they are able to do so (page 154). Access is thus more akin to 'a bundle of powers' than to a 'bundle of rights'. Access is constituted by a "constellation of means, processes and relations", which Ribot and Peluso refer to as "mechanisms", by which actors are enabled to gain, control, and maintain access to resources (pages 159 – 160). We use this term throughout this paper. These mechanisms can be rights based (ie sanctioned by law, custom, or convention), including illegal access (ie when benefits are obtained through illegal means), and structural and relational, including assets and processes, such as technology, capital, markets, labour, knowledge, authority, identities, and social relations. Ribot and Peluso (2003) recognize that this is just one possible classification and acknowledge that these mechanisms will be mediated "by constraints established by the specific political-economic and cultural frames within which access to resources is sought" (page 164). This approach is similar to that proposed by Leach et al (1999), which recognizes that access to the benefits from natural resources is mediated by the rights and resources one has, including land, labour, and skills, as well as by existing institutions.

We thus suggest that landowners—in the broadest sense of the term—cannot obtain benefits from carbon offsets without engaging with other social actors, such as project managers and carbon buyers, who provide the necessary capital, expertise and technology to commodify carbon sequestration and participate in global carbon markets. The commodification of forest-carbon sequestration through regulated and voluntary markets results, then, from the coexistence of different access mechanisms which allow geographically and culturally distant actors to participate in projects and to benefit from offsets in a variety of ways (Lohmann, 2009). Such commodification and its constitutive projects rely upon an expertise-based process which simplifies and isolates forest-carbon sequestration, thus rendering offsets tradable in markets. In the next two sections we build on three ongoing carbon-forestry projects to analyze how existing tenure arrangements and access mechanisms operate and how they influence the procedural and distributional outcomes of the projects.

3 Analyzing access: three case studies

3.1 Carbon-forestry projects

We analyze access to benefits of forest-carbon offsets by examining the operations of three projects, located in China, Ecuador, and Mexico, respectively. These projects reflect the range and diversity of existing forest-carbon projects operating under distinct carbon markets and property regimes as of May 2009. The description and analysis relies on project documents, monitoring reports, independent research,

Table 1. Case-study key features (source: own elaboration from Granda, 2005; Pearl River Basin Project, 2006; Wunder and Albán, 2008).

Project name	Carbon market	Activities	Expected sequestered carbon
Facilitating Reforestation for Guangxi Watershed Management (China) Start date 2006	CDM (registered in 2006)	Reforestation of 4000 ha on 80 different sites with fast-growing species (*Eucalyptus sp, Pinus massoniana*)	773 842 tCO_2e over 30 years
PROFAFOR – FACE (Ecuador) Start date 1994	Voluntary market	Reforestation of >24 000 ha of private and community lands with local and fast-growing species (*Pinus sp.*, *Eucalyptus sp.*)	>8 million tCO_2e over 20 years[a]
Scolel Té (Mexico) Start date 1997	Voluntary market (Plan Vivo system)[c]	Agroforestry, reforestation, and conservation with native and fast-growing species (eg *Pinus chiapensis*, *Poocarpa*, *Cedrela adorata*, *Swietenia macrophylla*)	395 923 tCO_2e over 30 years (154 195 tonnes had been sold and 241 728 are committed for sale)

[a] The project estimates that the sequestration potential ranges between 11 and 36 tCO_2e/ha, depending on physical, geographic, and climatic factors, as well as potential incidences.
[b] FACE—Forest Absorbing Carbon dioxide Emissions.
[c] The Plan Vivo system consists of a set of standards, processes, and tools used to develop and register payments for ecosystem-services projects in developing countries (http://www.planvivo.org).

including academic literature, additional information obtained from project managers primarily through electronic communications, as well as on primary data collected by the authors during a two-year period in the Mexican project. Project details are summarized in table 1 and further elaborated in the text below. In the following sections we analyze existing tenure arrangements and how they relate to project design and operation, in terms of contracts established, the presence of conflict, and the distribution of economic benefits.

3.2 Land tenure and contract design

In China the CDM carbon project has been implemented both in individually managed (1100 ha) and communal (2900 ha) lands, with the communal lands being termed as 'abandoned barren land' (Pearl River Basin Project, 2006). Rural land in China is mostly owned by villages or cooperatives, whilst single families hold all but alienation rights over individual landholdings. Families hold an agricultural plot on lease for a 30-year period, but they can be subject to periodical land reallocations as a result of population growth. The village authority, in turn, ensures that common resources are adequately managed and allocated across households (James, 2007; Kung, 2000). This tenurial context has translated into the development of two contractual models for

Table 1 (continued).

Carbon buyers	Developers and verifiers	Sellers	Tenure system
World Bank BioCarbon Fund on behalf of the Spain and Italy (US $4 / tCO_2e)	Four logging companies (project developer); independent third party (verification)	27 rural communities from Cangwu and Huanjiang counties, southern China	Community 'barren lands, farmers' private plots
FACE[b] Foundation and The Climate Neutral Group	PROFAFOR (project developer) Triodos Bank Climate Clearing House (offsets issuance and registration)	72 private landowners, 43 indigenous communities, 1 NGO	Community lands, private properties
Various World Bank, Tetra Pak, IAF)	AMBIO (project development), independent third party (periodical verification), Plan Vivo Foundation (verification and technical assistance), BioClimate Research and Development (offsets issuance and registration)	674 farmers from more than 30 rural communities in the states of Chiapas and Oaxaca, 3 communal planting programmes	Farmers' private plots, community forests

project implementation which define actors' roles and responsibilities, as well as the terms for offsets benefit-sharing.

On the one hand, individual farmers sign a 50-year contract with the project developer to undertake project activities on their agricultural/grazing plots—which are ultimately owned by the village—including site and soil preparation, planting, and stand management. They are supervised by forestry agencies which provide technical assistance. In turn, the project developer negotiates and sells tCERs to the World Bank on the farmers' behalf. Farmers will retain all benefits from future tCERs and it is thus unclear what the project developer gets from this arrangement. In contrast, the second contractual model consists of an agreement between farmers, village authorities, and the forest companies, in which farmers contribute land and labour while forest companies invest in planting, provide technical knowledge, manage plantations, and pay farmers' labour to ensure their access to short-term income. In this model, farmers will obtain approximately a 60% share of future tCERs revenue (approximately US $4/tCER, as indicated in table 1) and 40% of the income obtained from forest products, including future harvested trees and resin.

The PROFAFOR project in Ecuador also operates in a diversity of land-tenure contexts, including private, single-owner, small and large holdings; communal property; rural cooperatives' landholdings; and state public land. Private contracts encompass plantations ranging from 10 to 300 ha, except for two cases in which plantations are over 1500 ha. All but three of these landholders have opted for 15–20-year, rather than 99-year, carbon contracts. In all cases, landowners and communities receive initial payments of US $100–$150 per ha for seedlings production and plantation, representing 80% of the estimated plantation and management costs (ie labour, tools, and transportation). The remaining share of the payment accrues after three years, provided a minimum survival rate of 75% can be demonstrated. Participants also receive in-kind benefits from all by-products (eg thinning and pruning) and they will receive a minimum of 70% of the revenues from the sale of harvested trees at the end of the cycle (15–20 years). If they reforest the area, as is the case in the 99-year contracts, they will receive the full revenue. In contrast with the Chinese case, the proceeds from selling VERs accrue 100% to PROFAFOR.

Land in Mexican rural communities is mostly held in common, although most households hold usufruct rights over their land plots, with full rights of withdrawal, management, and exclusion, but not alienation. Similarly to the other two examples, the project develops two types of Plan Vivo contracts with individual farmers and rural communities. Individual farmers' planted plots range between 0.25 and 5 ha, with a mean average of 1.2 ha/participant. Each contract lasts for 25–30 years and beneficiaries will receive 60% of their Plan Vivo carbon value, while AMBIO dedicates the remaining 40% to cover management costs. Of their 60% share, farmers receive 80% in cash during the first 10 years—split into several payments—thus serving as initial up-front capital for establishing plantations and setting up management activities. Farmers and communities receive the remaining 20% at the end of the contract, adjusted according to the actual amount of emission reductions achieved. The price paid per tCO_2e varies according to the carbon volume purchased by the retailer or the end-consumer and the acquisition date—with relatively higher prices for larger quantities in recent years due to an increase in global carbon prices. Overall, carbon prices have oscillated between US $2.7/$tCO_2e$ and US $10.38/$tCO_2e$ (AMBIO, 2008). Timber and nontimber forest-product benefits will accrue wholly to participants.

3.3 Tenure-related conflicts

In all three projects, conflicts between project managers and individual farmers have been minimal due to the voluntary character of the projects and the relatively soft enforcement measures in cases of noncompliance, as we discuss below. However, implementation may prove more contentious in the case of collective contracts, which could marginalize the interests of some resource users. In China, for example, the project is not expected to impact negatively on villagers when it involves 'barren' lands, as villagers only collect shrubs and grasses for fuelwood and no grazing activities take place. Yet this statement is only supported by a survey covering 121 out of 14724 households in participating villages, and recent research shows that project implementation is currently withheld in 400 ha of communal lands, due to ongoing tenure and resource disputes with surrounding villages (Gong et al, 2010). This conflict echoes other cases where 'barren' lands are subject to ownership claims by tribes, chiefdoms, lineages, and clans, and are often used for occasional grazing (Unruh, 2008).

Similarly, Granda (2005) and Lohmann (2006) analyzed four out of the forty-three communities involved in PROFAFOR, and suggested that the project has displaced grazing activities and contributed to the degradation of soil and vegetation of the Ecuadorian *páramo*.[4] In Lohmann's words:

> "there's a long global history to the kind of claim that PROFAFOR is making, that a certain set of common lands are 'waste', 'degraded' or 'unused', and are idly waiting to be brought into the commodity market before they can become 'productive'. It's a claim that was used in the Americas during the colonial era to seize indigenous peoples' cropland and hunting and gathering grounds and transform them into the private property of Europeans" (2006, pages 229–230).

Furthermore, it is argued that the expected economic benefits from the project at community level do not compensate households' new investments required for renting alternative grazing areas, purchasing fodder, or reducing their herds. In contrast, two other studies (Albán and Argüello, 2004; Wunder and Albán, 2008) analyze another five communities and indicate that only a few people, in one of these communities, were opposed because they had lost their grazing grounds.

In Mexico no explicit conflicts have been documented in those villages working on communal lands. Nonetheless, we have shown elsewhere how a collective contract in Scolel Té was influenced by local political structures and marginalized women in decision making (Corbera et al, 2007b). Indigenous women in southeast Mexico often accompany men in agricultural activities, including planting and harvesting, and they are in charge of sheep herding, fuelwood collection, and the maintenance of home gardens and the borders of community paths. However, they are not involved in decisions regarding the forest commons, which are made through a men-dominated community assembly. This situation, which represents a classic productive and social organization of indigenous groups inhabiting the central and northern area of the state in which Scolel Té operates (Collier, 1976), limits the project's ability to incorporate a range of preferences regarding tree planting. While men prioritise fast-growing species, women prefer slow-growing trees which are more suitable for fuelwood, fodder, and fencing (Silva, 2002).

[4] The 'páramo' is a mountainous wetland ecosystem covering the upper Andes region of Venezuela, Colombia, Ecuador, and northern Peru. The ecosystem extends between the continuous natural forest border (about 3500 m altitude) and the permanent snow (about 5000 m). It consists of accidented, mostly glacier-formed valleys and plains with a large variety of lakes, peat bogs, and wet grasslands intermingled with shrubs and low-stature forest patches. Its vegetation consists mainly of tussock grasses, ground rosettes, dwarf shrubs, cushion plants, and conspicuous giant rosettes and their soils have a complex particulate structure that enable them to retain water and organic matter during winter and keep moisture in the soils during dry seasons (Buytaert et al, 2005; Lohmann, 2006).

3.4 Land tenure and the distribution of economic benefits

The Chinese CDM project expects to bring benefits to approximately 20 000 people in twenty-seven participating villages, of whom 1600 people belong to local ethnic minorities in fourteen villages. Individual farmers planting on their holdings will benefit from future tCERs and timber revenues, while farmers planting in communal areas will benefit from employment in planting, weeding, harvesting, and collecting resin over the project lifetime. Over thirty years the net average increase in annual income per capita is estimated at US $34, and in some villages this net gain may quadruple average annual income. If one considers this figure over the project lifetime and accounts for the days employed in planting, weeding and tending, harvesting, and collecting resin (252 days), one comes up with the figure of US $4/working day. Mean annual income per capita in the project areas has been estimated at US $145, and even under US $100 in some remote villages.

In the PROFAFOR initiative, private farmers' net benefits over the project lifetime have not been reported, and these can vary significantly due to the range of plot size covered by the contracts (10 – 300 ha). The existence of large-area contracts demonstrates that PROFAFOR has been inclined to support large properties, even if it has also involved forty-three communities from the Ecuadorian highlands. In the five communities analyzed, Wunder and Albán (2008, page 693) highlighted that the project's fees range between US $60 and $635 per household, depending on the extent of the plantation and population size. This figure represents 6% to 50% of household expenditure per year, while tree-harvest benefits at the end of the project can range between US $7 and $2481 per household. These authors recognize that communities invest most of these benefits in collective goods like schools, family orchards, or buying tools and machinery. Again, however, Lohmann (2006) provides a different picture. He argues that in at least one out of four communities the costs of planting, monitoring, and maintaining the plantation over the first three years exceeded the payment offered by PROFAFOR. Furthermore, the final payment never happened because the plantation did not meet PROFAFOR's required survival rate of 75%. According to community members, this was because the plantation species were ill suited for the páramo and also they were repeatedly damaged by natural fires.

The range of 0.25 – 5.0 ha for individual contracts in Scolel Té suggests that poorly endowed households participate in project activities. Unfortunately, there are no detailed studies documenting net income gains from community contracts for participating farmers and households. A study commissioned by the UK Department for International Development estimates the farmers' net benefits in the range of US $109 to $1687 per ha, depending on the forestry system, its sequestration rates, the cost of establishing and maintaining the forestry system (mainly labour costs) and the foregone benefits of other land-use benefits (DTZ Pieda Consulting, 2000). Project managers published an estimate of the likely establishment, management, and opportunity costs associated with different forestry systems present in the project at that time, and they highlighted that farmers would only find incentives to change their land use when payments oscillated between US $5 and 15/t$CO_2$e and activities focused on forest-management or conservation options (de Jong et al, 2000). Both studies suggest that average carbon income per family, hectare, and year can be extremely variable and that the contribution of such income to cover opportunity and maintenance costs is highly context specific. Corbera (2005) analyzed farmer income gains in one of the participating communities and came up with a figure of US $280/ha, excluding future timber revenues. For the case of a collective Plan Vivo, he noted that the community received US $18 000, split in three payments between 2000 and 2003, and that it would receive another US $29 600 for the expected carbon sequestered through ongoing reforestation activities over the next few years. He emphasized that the community spread the annual payment among households only once—translating into less than US $10 per household; in the other two years income was invested in collective goods, as in the Ecuadorian highlands.

The evidence presented so far shows that carbon-forestry projects create new social relationships around land tenure and forest-resource management by binding together existing and new social actors through land-use management and labour contracts. These contracts are established either with individual landowners or with communities, depending on the type of land-tenure arrangements existing where plantations and forest-conservation activities develop. These contracts establish participants' rights, responsibilities, and benefit-sharing streams, indirectly defining short-term and mid-term income for participants. Mid-term income varies across individuals and communities, depending on the terms proposed by project developers, land available for planting, and population size when participant communities decide to distribute payments. In the next section, we examine four mechanisms underlying the design and development of the contracts and making the commodification of forest-carbon sequestration possible: capital, labour, expertise, and technology.

4 Mechanisms of access to forest-carbon offsets

4.1 Capital

Capital has always been seen as a central factor influencing who is able to benefit from resources by controlling or maintaining access to them, and is generally thought of as "access to wealth in the form of finances and equipment... that can be put into the service of extraction, production, conversion, labor mobilization, and other processes associated with deriving benefits from things and people" (Ribot and Peluso, 2003, page 165). In all three case studies, landowners, communities, and project developers benefit from selling carbon insofar as there is someone who is able to mobilize funds to develop forest plantations and/or willing to pay for such activities. Such willingness to pay is in turn founded on the existence of regulated or voluntary carbon markets and, jointly with tenure, capital can be considered the starting point for the commodification of forest-carbon sequestration.

Sellers require capital to develop plantations or to protect standing forests effectively, and buyers provide all or a share of this capital in order to benefit from emission reductions. Project developers can be seen either as intermediaries in the flow of capital from buyers to sellers, or as buyers who aim to access the benefit streams derived from the future use of planted trees and nontimber forest products. In Mexico AMBIO is an intermediary organization which manages carbon capital on behalf of farmers and, in turn, helps them to generate credible offsets for buyers. In contrast, the CDM and PROFAFOR project intermediaries act as a bridge between farmers and carbon buyers, but they are also able to capture additional funds through grants or commercial loans to develop plantations, with future carbon assets acting as an additional guarantee.

Proving a project's financial additionality[5] is a prerequisite to register a project under the Kyoto Protocol's CDM. The Chinese project shows that its investment rate of return (IRR) increases from 8.53% to 15.02% when future tCERs sales are

[5] There are two types of additionality criteria that a project must fulfil to be registered under the CDM. First, it must be environmentally incremental and show that emission reductions would not take place without project activities. Second, it must prove that it would not be economically viable without carbon revenues.

taken into account in financial projections. The IRR then exceeds the Chinese benchmark of a 12% IRR for agriculture and forestry investment projects, thus making the project financially sound for commercial banks. Such additionality is further demonstrated by showing that Chinese national reforestation and forest-management programmes have traditionally been underfunded and unsuccessful in tackling remote lands or involving ethnic minorities (Pearl River Basin Project, 2006). Similarly, the project developer of another CDM project in the state of Andhra Pradesh, a large Indian company with a paper-production division, demonstrates the project's additionality by arguing that poverty conditions and the economic unattractiveness of the tribal groups' 'barren' lands where plantations will be developed make it difficult for farmers to access commercial loans for such purposes. In this context, the project developer becomes the only company willing to support tribal groups in plantations development, funding them up front and against future carbon revenues and preferential access to timber resources (Khamman District of Andhra Pradesh Project, 2009).

Access to carbon finance has also been used by intermediary organizations to gain expertise and reputation in the field of carbon forestry. PROFAFOR, for example, has redefined its mission since it started the project in 1994, evolving from a technical organization which supported FACE's (Forest Absorbing Carbon dioxide Emissions) funded plantations to become a consulting and advisory firm in logging and forestry. AMBIO members have increasingly provided technical advice to other carbon-forestry projects in the country and have shared their knowledge in several national and international forums. Access to carbon finance has also been used by existing NGOs to support their own forest-management and conservation activities. For instance, well-established conservation organizations are now selling forest-carbon offsets from existing and new conservation projects and the Planting Trees and Improving Agriculture for Better Lives Programme, which has been supporting tree planting in Kenya, Uganda, and Tanzania since 1999, recently started to monitor its carbon offsets and sell them on ebay.

Finally, it is worth noting that access to other financial instruments, like mortgages, can be used by buyers and intermediaries to secure the permanence of carbon-sequestration services over time. In PROFAFOR individual landowners' are obliged to sign a lien for their land as a guarantee that they will meet the contract commitments over time. This allows project developers and buyers to increase their leverage over carbon providers and secure access to emission reductions. This strategy has not been pursued with rural communities in the páramo because communal lands cannot be mortgaged. This differential treatment has consequences on enforcement procedures. As Wunder and Albán remark,

> "PROFAFOR has legally pursued severe infractions of individual contracts with some success, but it has proved more difficult to monitor and sanction minor infractions (moderate grazing, inadequate silvicultural management), and impossible to get defaulting communities to reimburse payments. In some cases, PROFAFOR was able to persuade communities to repeat planting; in others the contract area was reduced ex post" (2008, page 693).

Project managers have thus not been able to get defaulting communities to reimburse payments and "permanence on participating lands will depend on long-run socioeconomic changes (eg population pressure or prices of timber and agricultural products). From a carbon sequestration viewpoint, the longer contract duration is desirable for permanence, but its de facto social viability is questionable" (Wunder and Albán, 2008, page 693).

In Mexico, the semiprivate nature of participants' landholdings does not allow mortgages on land either, and such is also the case for China's household and communal lands. Farmers and communities' withdrawal or noncompliance with their Plan Vivo have been addressed by temporarily cancelling payments or keeping a carbon buffer fund which compensates for carbon losses (Corbera, 2005). In fact, in most existing carbon-forestry projects, rural communities and participants may be able to withdraw from project activities because project managers may rarely prosecute them, as this would be a too sensitive and costly process, as observed in other PES (Payments for Environmental Services) initiatives (Wunder et al, 2008).

4.2 Labour

Access to labour opportunities includes the ability to labour for oneself and to maintain access to employment with others. In the case of carbon forestry, households' ability to plant trees and manage plantations while attending to their conventional livelihood activities is critical and thus contingent on the household's family structure, its land endowment, and the overall livelihood portfolio. Nonetheless, none of the projects discussed in this paper describes the extent to which their activities increase or reduce community groups' and farmers' workloads. This is in fact a question which deserves more attention in carbon-forestry research. In the case of another Plan Vivo project in Mozambique, Jindal (2010) highlights that women now spend more time performing agricultural activities and looking after newly planted trees because their husbands are employed by the project's microenterprises and do not dedicate as much time as before to their cultivated plots.

The examined cases show that participants sometimes employ external labourers in order to access the benefits associated with carbon offsets. Some of the Ecuadorian communities, for instance, hired labour for planting activities because they did not have enough community members available at the time of planting (Albán and Argüello, 2004). Several Mexican farmers employed other participants or nonparticipants in planting activities and paid them a daily fee (Corbera, 2005). In China some villages also lacked enough labour to develop plantations because many household heads had temporally migrated to urban areas. This created tensions within the villages as some perceived that bringing neighbouring labourers would lead these labourers to claim property rights on the planted trees and associated revenues (Gong et al, 2009). All this evidence suggests that carbon revenues can also benefit project outsiders through labour relationships.

These relationships, however, can also be a source of conflict within participating communities. In another carbon-forestry project operating on communal lands in Mexico, formal and informal right holders(6) got differential economic rewards from their tree-planting tasks, thus leading to local mistrust (Corbera et al, 2009b). This suggests that social identity—being a 'migrant', 'an informal right holder' or a 'newcomer from a neighbouring village'—can constrain the benefits from environmental services, even if one has de facto access to communal lands for other activities, such as grazing and fuelwood collection.

(6) In Mexican communities, the formal right holders are known as *ejidatarios* or *comuneros* and they hold formal property rights over family landholdings and common forests. Informal right holders are known as *avecindados'* and have de facto access to communal environmental resources. They often own a piece of land as well, but they do not have voting rights in the community assembly. There are other individuals and social groups who have access to land and resources owned by formal or informal right holders, such as the landless, or the household head's partner and children.

4.3 Expertise and technology

By expertise, we mean theoretical and practical knowledge about climate change, carbon markets, project design and operational principles, carbon monitoring, accounting and certification procedures, while technology encompasses the electronic means used to measure and exchange carbon offsets, such as computers, satellite imagery and positioning systems, and trading platforms and databases. Both mechanisms combine to permit the design of carbon-forestry projects, the measurement of carbon stocks and flows in tonnes of carbon across carbon pools, and legitimize offsets property rights through accounting, monitoring, verification, and issuance procedures (Lohmann, 2009).

As for capital, farmers lack the necessary expertise and technology to commercialize their offsets through carbon markets and thus require the assistance of project developers and third parties to show that offsets meet market standards. Therefore, project developers use their expertise to identify potential project activities, define their operational principles, including accounting, monitoring, and payment rules, and to search for buyers. It is thus not surprising that most CDM afforestation and reforestation projects to date have relied on the technical expertise of international NGOs and logging companies for their design and to meet the requirements of the validation and registration process (Thomas et al, 2009).

During project design and implementation, project developers may transfer part of this expertise to carbon sellers, who become familiar with concepts like climate change, carbon sequestration, and GHG emissions, and learn how to monitor tree growth through technological means. However, this transfer is often limited to local and community leaders, who also tend to have preferential participation in forest-management courses or other project-related workshops. This indirectly strengthens the reputation and political status of these leaders and establishes hierarchies across management and implementation levels (Corbera, 2005; Wunder and Albán, 2008).

Independent third-party organizations act as legitimizing institutions in carbon markets because they verify the environmental value of offsets, although recently their credibility has been increasingly contested (Lohmann, 2009; Sutter and Parreño, 2007). Offset verification has become a profitable niche in regulated Kyoto carbon markets. Ahonen and Hämekoski estimate the cost of verification CDM at around US \$4300 – \$25 850 or US \$0.06 – \$1.18/tCO_2e, and the World Bank has estimated this cost between US \$7000 and \$70 000, depending on the project size. For illustrative purposes, we can estimate the benefits of an organisation which would verify the emission reductions expected in the Chinese CDM project: taking an average cost of US \$0.62/tCO_2e, the organization would get US \$479 782, which represents 38% of the overall tCERs value; this is strikingly more than the likely financial benefits of a single farmer over the course of the project (US \$1020).

In voluntary markets the verification process often works somewhat differently than in regulated markets, with project managers relying only occasionally on independent verifiers, but somehow adhering to standards, which incorporate project-development guidelines, accounting methodologies, verification firms, and offsets registries (Corbera et al, 2009a). In Scolel Té, for example, AMBIO conducts periodic verification of tree growth, mortality rates, and carbon losses on randomly selected plots. The Plan Vivo Foundation oversees monitoring reports and the Bioclimate Research and Development Foundation issues the corresponding offsets. More recently, the monitoring protocol has been revised and improved, to incorporate a larger set of monitoring indicators and technologies like satellite positioning in response to suggestions made by another external company and an international NGO. PROFAFOR has also developed a monitoring methodology, and a third party verifies the results while the Triodos Bank issues the emission reductions.

Table 2. The main mechanisms used by project participants to derive benefits from forest-carbon trading.

	Capital	Property rights	Labour	Expertise and technology
Considerations	Critical mechanisms for buyers to access offsets and mobilize project developers and farmers (through paid labour) and for project developers to design and implement projects.	Farmers and communities can only participate in forest-carbon trading if they hold formal rights over project areas. The type of tenure (individual or communal) will in turn influence how project and benefit-sharing arrangements are established.	Critical mechanism for farmers and communities to participate in carbon-forestry activities; external labour may be critical for some households and communities.	Critical mechanisms to design and implement carbon projects (project developers) and to monitor, account for, and certify carbon offsets (project verifiers).
CDM reforestation project (China)	Forest companies act as an intermediary between World Bank payments and farmers, but they use potential carbon revenue as a guarantee to access commercial loans and develop plantations.	Project implemented on individual and collectively managed lands. Communities will obtain 100% of projected carbon revenues, but farmers planting on their landholdings will only get 60% (with the rest accruing to forest companies). Conflict with neighbouring villages and community households over access to ‘barren’ lands.	Urban migration in some communities leads to reliance on external labour to meet contractual project arrangements (leading to conflict).	Forest companies have the necessary expertise to prepare the technical and financial aspects of the project. Verification and certification conducted by third parties. It is unclear whether such knowledge will be transferred to local communities over time.

Table 2 (continued)

	Capital	Property rights	Labour	Expertise and technology
Voluntary reforestation project (Ecuador)	PROFAFOR acts as an intermediary for capital flows between buyers and sellers, but also uses carbon revenue as a guarantee to access grants. Access to carbon finance provides reputation to PROFAFOR. Financial instruments like liens are used to guarantee compliance with project activities.	Project implemented on individual and communal lands, and on rural cooperatives' landholdings. Participants are not paid according to the potential value of carbon offsets, but through payment per hectare related to labour costs (carbon revenues accrue 100% to PROFAFOR). Conflicts reported over the use of community 'degraded' lands for plantation development.	Reliance on external labour to develop plantations in some rural communities of the highlands.	PROFAFOR is in charge of plantation design and monitoring (with occasional overseeing by a third party). Nonexistent transfer of knowledge and technology to farmers and rural communities.
Voluntary reforestation and conservation project (Mexico)	AMBIO acts as an intermediary for capital flows between buyers and farmers. Access to carbon finance provides reputation to AMBIO.	Project implemented on individual and communal lands. Farmers and communities receive 60% of expected carbon revenues during a 10-year period; AMBIO uses the remaining 40% to cover management costs. Project activities on communal lands reproduce existing inequalities in collective decision making around forest resources.	Some farmers rely on other community members to develop plantations.	AMBIO develops Plan Vivo in collaboration with farmers and communities. Monitoring skills have been transferred to a great extent to some community leaders and participants. Verification is conducted by AMBIO and occasionally contracted externally.

Uneven levels of knowledge and expertise also explain why sellers are ignorant about the likely value of timber or the future markup practice of carbon retailers. In Ecuador, for example, Albán and Argüello (2004) note that PROFAFOR did not show its projections about the future economic revenues of plantations to participants, so that they would not create expectations which could not be fulfilled. A similar transparency problem occurs in Scolel Té, where farmers do not know how much the retail organizations sell their carbon for. Two of these organizations' websites show that certificates are sold to end consumers for US $13 and US $16, which represent a markup range of 39% and 50% if we assume that offsets have been purchased from Scolel Té at the average price of US $7.9/t$CO_2$e. These markups coincide with the average 50% for carbon retailers found in recent market surveys, justified by the greater percentage of transaction costs in the final cost of a credit, including website development and taxation (Hamilton et al, 2007; Neeff et al, 2009).

Table 2 summarizes the main mechanisms used by project participants to derive benefits from forest-carbon trading.

5 Conclusion

Carbon trading results from a broader process of market environmentalism pursuing the commodification of environmental services. The growing number of carbon-trading frameworks will continue to increase the demand for forestry offsets as a source of tradable emission reductions over the next decades, unless there is a significant turn in current policy trends and marketized climate-change governance is suddenly rejected. Such a shift is unlikely in the light of the growing popularity of offsetting among governments, industry, and the increasingly larger involvement of civil society through trading services, consultancy activities, and educational training in carbon markets, among others (Lovell et al, 2009). Current negotiations on how to halt deforestation through the United Nations Framework Convention on Climate Change, the continuous expansion of the CDM, and the future US market will likely expand the commodification of carbon-sequestration services (Campbell, 2009; Neeff et al, 2009).

In this paper we have taken a new perspective on the commodification of forest-carbon sequestration by analyzing who has access to forest-carbon offsets and why. We have provided insights into the social processes which result from commodifying carbon-sequestration services and defining the type and nature of the benefit streams associated with the sale of tradable emission reductions. Informed by three carbon-forestry projects, in China, Ecuador, and Mexico, and supported by secondary literature, we have shown that the ability to benefit from carbon-forestry offsets depends on existing land-tenure regimes which determine who owns the land and resources where project activities develop, as well as on structural and relational mechanisms, such as capital, labour, expertise, and technology.

The commodification of forest-carbon sequestration is made up of a web of access relations in which formal and informal tenure rights and sellers' access to labour is combined with buyers and project managers' access to capital, expertise, and technology. This web influences the ways in which property over forest-carbon offsets is established: for example, through the provision of short-term employment and up-front investment for tree plantations or negotiating shares over future timber and carbon revenues. For buyers and project managers, securing the benefits from forest-carbon offsets can be a conflictual process, difficult to maintain and enforce, due to rural populations' changing social needs and economic priorities, and the likely ineffectiveness of sanctioning rules. For rural landholders, obtaining a flow of benefits from carbon sequestration will depend on their own entitlements, including land and labour, and their ability to exercise their social and political rights and identities in the project context.

The future of access-based research in carbon markets requires diligent attention to issues such as power distribution in the design and negotiation of carbon contracts, how social identities shape access to carbon markets within participating resource-user groups, and emerging conflicts in the process of verifying offsets and distributing benefits along the commodity chain. Ultimately, this will inform ongoing discussions on the geography of production, distribution, consumption, and degradation of environmental services.

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