Property rights to carbon in the context of climate change

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"…if property involves a bundle of rights, it is not at all clear that all the sticks in the bundle fit comfortably together." (Singer 2000: 3)

ABSTRACT

In this paper we review the pools, flows and fluxes of carbon at a global level and the markets that have emerged since the Kyoto Protocol as a means of identifying the characteristics of carbon and the context behind the need for defining carbon property rights. We examine who has rights and interests in forest carbon emphasizing the extent of community rights. We recognize that a new set of property rights can be conceptualized in a number of different ways and to that end we discuss different lenses for viewing a property right to carbon. Finally, we consider the basic property information that would be required to support these property rights in some form of carbon cadastre. In this discussion we draw on field experience and the de jure situation in the Amazon areas of Bolivia, Peru and Brazil.

Keywords: Carbon, REDD, carbon markets, property rights, land tenure, carbon cadastre, extractive reserves, campesino communities

1. Introduction

Several years ago we were interviewing a rubber tapper (Jose) in the Brazilian Amazon state of Acre as part of a project to analyze the dynamics of communal land tenure (Ankersen and Barnes 2004). While wandering down one of Jose's rubber trails, we came across a magnificent cedar tree that must have been well over 100 years old. Jose informed us that a timber company had recently offered him $500 for the tree and, given the poor market prices for rubber, he was seriously considering selling the tree to make ends meet.

On the drive back to town we contemplated raising the $500 ourselves to purchase the timber rights to Jose's cedar tree in order preserve it. At first glance this appeared to be a simple transaction, but on further reflection we began to ask several searching questions:

- What rights did Jose have to the tree given that the state owned the land?
- How could the transaction be legally formalized?
- What would prevent Jose from selling the development rights to a number of other unsuspecting gringos?
- How could our rights be enforced if Jose turned around and logged the tree for its timber value?
- Is $500 a fair market price for the tree given its ecological function as a carbon sink?

All of these questions point to the fundamental property rights – in this case the rights to a single tree. The recognition of the role of forests in addressing climate change has raised these same questions, but on a much larger scale – instead of a single tree we are now dealing with an entire forest. And the success or failure of attempts to reduce carbon emissions has impacts at the local as well as the global level.

Land tenure, and more specifically property rights to carbon stocks, is increasingly recognized as an integral part of the climate change debate. Property rights issues have been raised with respect to: communally held land (Randrianarisoa et al 2008) including indigenous lands (Griffiths 2007); insecure tenure leading to deforestation (Porrua and Garcia-Guerrero 2008; OCC 2008; Parker et al 2008); legal conceptions of a carbon property right (Allen and Baylis 2005; Boydell, Sheehan and Prior 2008; Basnet-Parasai 2007); and the need to clarify who will be the beneficiaries of carbon payments through mechanisms such as REDD (Forests Dialogue 2008). Property rights to forests and/or carbon have been recognized as a key issue in almost all the major climate change reports, such as the Eliasch (OCC 2008) and Stern Reports (Stern et al 2007) and the various IPCC reports (IPCC 2001, IPCC 2003, IPCC 2007).

Where is carbon currently located? The short answer to this question is "almost everywhere."[1] However, beyond the ocean and earth's crust (where most carbon is stored), scientists usually point to the carbon pools discussed in the next section, namely tree biomass, vegetation, roots, forest litter, dead wood and soil (Pearson, Walker and Brown 2008: 139). For the purposes of this paper we will focus primarily on tree biomass and the property rights to forest carbon.

We begin the paper with a review of carbon dynamics and the markets and other mechanisms that have emerged since climate change rose to prominence as an international policy issue. These sections clarify both the object (carbon) to which property rights pertain as well as the broader climate change context that is driving the need to clarify carbon property rights. We then link to the major stakeholders – those who control or own forest resources at the global level with emphasis given to the Amazon. We recognize that a new set of property rights can be conceptualized in a number of different ways and to that end we discuss different lenses for viewing a property right to carbon. Finally, we consider the basic property information that would be required to support these property rights in some form of carbon cadastre. In this discussion we draw on field experience and the de jure situation in the Amazon areas of Bolivia, Peru and Brazil.

2. The Life and Times of a Carbon Molecule

Understanding the nature and characteristics of the resource – in this case carbon – is a necessary first step in examining carbon within a property framework. Carbon dioxide is most commonly emitted to the atmosphere by the combustion of coal for electrical power; the burning of petroleum products for transportation; the removal of carbon during the production of cement; and the clearing of forests typically for agricultural expansion. Once combusted, oxidized carbon enters the atmosphere where it is sequestered by plants, via photosynthesis, or by the oceans where it resides as a carbonate

[1] Almost 20% of the human body is comprised of carbon.

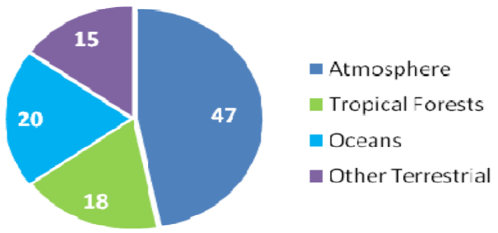
or bicarbonate ion. Should the molecule be sequestered by a tree through a leaf stomata, it will be incorporated into a growing stem and exploited to fuel the synthesis of energy molecules to carry out various cellular functions.

Should this tropical tree be set on fire to clear land for a bio-fuels farm, the carbon in the stem will be immediately liberated and will re-enter atmospheric circulation. If the tree is harvested for timber, the wood will decay and return its carbon to the atmosphere at a slow, steady rate. The root mass left below ground will decompose and the resulting carbon will eventually migrate to rivers and oceans. Most importantly, the growing tree will no longer exist to grow leaves and biomass to sequester carbon. Aged leaves will no longer fall to the ground to form soil carbon. In summary, unless the carbon is locked in forest biomass over the long term, it will contribute to the growing greenhouse gases in the atmosphere with long-term climate change consequences.

Terrestrial biomass and the oceans are transient reservoirs for CO_2 and serve as stopping points before a carbon molecule reaches its final destination in carbonate rocks. The amount of time a molecule resides in a particular reservoir before transferring to the next varies for CO_2. After roughly 300 years 70-85% of CO_2 will have entered the oceans or terrestrial biomass, and even after 100,000 years, a small amount of (3-7%) of fossil fuel carbon may remain in the atmosphere (Archer, 2005).

The IPCC (2007) currently estimates anthropogenic CO_2 emissions at 32 billion tones per year; 47% of this remains in the atmosphere until sequestered over longer periods of time; approximately 20% is sequestered by oceans; and 15% by terrestrial systems. A recent study has found that tropical forests alone sequester 18% of anthropogenic carbon, representing one-half of the terrestrial carbon pool (Lewis et al, 2009).

Figure 1. Global Anthropogenic Carbon Sinks (%)



With growing evidence of anthropogenic climate change, it is important to identify the sources of emissions, as well as sinks. There are two approaches to accomplish this: the 'top down' method utilizes atmospheric data and transport models; the 'bottom up' method draws from forest inventories and land use change models (Houghton, 2007). The largest source of carbon emissions has been from fossil fuels followed by land use change. In recent times, land use change has stemmed predominantly from the conversion of forests to agriculture.

Terrestrial models of carbon stocks and fluxes have been contentious with discrepancies between the ‘top down’ and ‘bottom up’ methods (see Houghton, 2007 for further discussion). Emissions due to land use change increased in the 1990s and slowed marginally in the period 2000-2005. The retention of existing forest stocks and reforestation are viewed as one of the more cost effective mitigation strategies to stem rising carbon emissions through mechanisms such as REDD (reduction of emissions through deforestation and forest degradation)

3. Climate Change Mitigation Strategies

It is often claimed that climate change is a market failure requiring a market solution. In terms of pollution, a market failure is described as a negative externality that is an underpriced by-product of human activity that does not fall under any ownership or regulatory regime. According to environmental economic theory, pollution to water and air often occur in open access systems where social restraint is absent and are not subject to private ownership (Goldstein 1995). Proponents of this theory suggest establishing property rights to carbon and using market mechanisms to internalize these externalities so that its price provides the incentive to reduce emissions.

Countries that ratified the Kyoto Agreement agreed to reduce emissions through the Clean Development Mechanism (CDM) in developing nations, and to a lesser extent through Joint Implementation (JI). Project development under the CDM is time consuming and can take one to two years to emerge from the development and approval pipeline.

The largest emissions trader, the EU ETS (European Union Emissions Trading System) began implementing its cap-and-trade scheme in 2005. Under a cap-and-trade system, a limit or allowance is set on the amount of carbon a company can emit. If the allowance is exceeded, the company then buys an allowance or credit elsewhere or faces heavy fines. The seller, in turn, is rewarded for having reduced emissions. Other emissions trading regimes under the formal markets include New South Wales and UK ETS. Since the U.S. has not yet ratified the Kyoto Agreement (although it is expected to in December in Copenhagen), it is not bound by these markets; however, the Chicago Climate Exchange (CCX) and the newly emerged Regional Greenhouse Gas Initiative (RGGI) are considered voluntary markets.

The value of the formal carbon markets have achieved momentous growth every year – rising steadily from $10 billion in 2005 to $128 billion in 2008 (World Bank 2008; Environmental Leader 2009). Of this, the voluntary CCX and Over the Counter (OTC) trades, which include companies that offset emissions for corporations and individuals, captured $97 million in 2006 and $331 million in 2007 (Ecosystem Marketplace 2008). Unfortunately, the fantastic growth in the carbon markets has been constrained by the global economic downturn and declining industrial production, causing the price of carbon to collapse. Nevertheless, the carbon market is predicted to rebound and voluntary markets to grow to $50 billion by 2012 (Phillips and Razzuk 2007).

Despite enormous sums of money transacted for emissions reductions, forests have captured very little of this. The EU ETS excludes carbon offset forestry projects at this time, and under the CDM (which only allows afforestation and reforestation (A/R) projects), only one project has thus far been implemented (UNFCC 2008). Stringent CDM project development guidelines raise transaction costs making these projects less financially viable. Additionally, because the permanence of forestry projects are at higher risk, they capture short-term emission credits worth less money, making these projects less attractive relative to the energy sector. As a result, forestry projects have been streamlined into the voluntary markets where, again, the price of carbon is less (Robiedo & Ok Ma 2008).

At the 2007 UN Climate Conference in Bali, REDD (reduced emissions from deforestation and degradation) was introduced as a mechanism to compensate countries for conserving tropical forests. While REDD has not been formalized due to numerous concerns over policy and technical hurdles, it is expected to be implemented by 2012. In preparation for REDD, the UN and World Bank devised various funds to assist with capacity building and project planning. The World Bank Biocarbon Fund, in conjunction with conservation groups and local NGOs, combines reforestation, agroforestry and forest conservation and has three REDD projects underway (Woods Hole Research Center, 2008). Projects that preserve biodiversity and address poverty alleviation are especially attractive and can capture a higher price for carbon. The World Bank's Forest Carbon Partnership Facility assists countries in REDD preparations and designing a large-scale system for incentive payments (World Bank 2009), In a similar vein, the UN-REDD Programme, in partnership with the FAO, UNDP, and UNEP established a multi-donor fund in 2008 to provide funding for REDD activities (UNDP n.d.).

4. Who controls the major forest C Pools

White and Martin (2002, 22),[2] in their global survey of forest tenure, revealed that 22% of forests worldwide are either reserved for (via usufruct rights) or owned by community and indigenous groups (see
Table I). They found that forests were home to approximately 60 million indigenous people. In the two decades preceding 2002 it was estimated that tenure rights to 149 million hectares were transferred to communities in just four countries, namely Brazil, Bolivia, Colombia and Peru.

A follow-up study in 2008 found a continuing shift from government ownership and administration to all other categories (Sunderlin, Hatcher and Liddle 2008). There are significant regional differences where almost all African forests (99.7%) are administered by government, while in Latin America this figure drops to 34.3%.

[2] Their findings are based on official tenure data from 24 countries which together represent about 93% of the world's natural forests.

CATEGORIES	EXPRESSED IN PERCENT OF TOTAL			
	PUBLIC		PRIVATE	
	Administered by Government	Reserved for Community & Indigenous Groups	Community/ Indigenous	Individual/ Firm
Global Forest Estate	77	4	7	12
Developing Countries	71	8	14	7
Developed Countries	81	1	2	16
Countries with Tropical Forests	71	6	13	10
Top 17 Megadiverse Countries	65	6	12	17
Top 5 Roundwood Producers	80	7	6	7

Table II. Global de jure Ownership of the World's Forest - 2002[3]

One important difference between the 'Public' and 'Private' categories is that the land in the former category is 'owned' by the government. Usufruct rights are usually granted to communities on this public land, but the government maintains the "entitlement to unilaterally extinguish local groups' rights." (White and Martin 2002:4). Legally, usufruct rights allow the holder to profit from the resources on the land without "altering the substance" of it (BLD 1979: 1384). On private land, government may still control the usufruct rights to the forest if it is used for commercial purposes (such as logging companies or local communities). As Monterroso and Barry (2008: 3) warn, government is "never out of the picture."

Both the 2002 and 2008 studies of forest ownership show that, despite the trend away from government control, governments still on the surface control the large majority of forest. Government departments that approve forest management plans and annual operational plans are often hard-pressed to keep up with the demand. Measured purely by the volume of management plans, governments would seem to be doing a good job of managing the forests. Unfortunately, without enforcement or engagement with local actors, management plans often remain merely words on a piece of paper. Behind the blur of plans, deforestation continues unabated much of it through illegal logging. This is a major challenge for carbon payment schemes like REDD.

Government should also not be viewed as a single homogeneous entity. Agencies that administer land are usually in completely different ministries than the government entities that manage resources on the land. In Latin America land is typically administered by a national institute of land and/or agrarian reform while resources fall under a ministry of natural resources. Over the past several decades, agrarian reform and land titling efforts have focused almost exclusively on the land (and disproportionately on

[3] Source: White and Martin (2002:7)

agricultural land). Similarly, forestry departments have been almost entirely concerned with the extraction of timber from the forest and have paid little attention to such resources as non-timber forest products (NTFPs) (Pacheco 2007).

Who controls the forest often depends on where one asks the question. In the capital cities you will usually be directed to the de jure situation as it appears in laws and policies. On the other hand, if you are in the forest the de facto situation is much more complex often with a range of local actors – communities, firms or communities – making use of forest resources with little government presence.

5. Property Rights to Carbon

The question of "Who owns the Carbon?" is particularly relevant to REDD initiatives as it identifies the major stakeholders and potential 'beneficiaries' of REDD payments. But, in addition, the answer to this question determines the required effort, resources and time to clarify and document carbon property rights.

Land tenure has been defined as the balance between public and private rights. How the issue of public versus private rights is addressed depends to a large extent on the analytical lens used. An individual's view of land tenure depends to a large extent on the abstract model that has been built up through his/her own experience and is therefore culturally biased. This 'tenure-view' acts as both lens and mirror. It provides us with a structure and analytical lens to analyze foreign land tenure systems, but what we see in such systems mirrors our own cultural 'tenure-view.' This tends to lead to a "jamming" of foreign tenure systems into our preconceived model, regardless of whether or not they fit, resulting in a distorted interpretation of the system being analyzed. This interpretation has also been called a "backward translation" because of the preconceptions that shape such an analysis (von Benda-Beckmann 2000: 151). It is therefore important to be aware of these culture-specific preconceptions when analyzing land tenure and, more specifically, carbon property rights.

Since western property concepts, particularly those perpetuated through Roman law, have heavily influenced the analysis of property worldwide, we begin this section with a summary of these foundations.

(a) Western Property Concepts

Our perspective on property rights have been shaped historically by a number of well-known western philosophers and legal theorists such as John Locke, William Blackstone, Jeremy Bentham and others. These scholars refined the argument that private property rights were the rational outcome of a modern society where the supply of land is limited. Locke, in particular, developed the idea of acquiring individual property through labor. This concept can still be seen today in most countries where private property (including titled land) can be acquired through adverse possession or prescription. In the 1950s, Garret Hardin's much-quoted article on the "tragedy of the commons" added to the argument for private individual property rights if societies were to avoid the degradation of natural resources through overuse (Hardin 1968). Today, economists like Hernando de

Soto (2000) continue to advance the private property rights agenda arguing that property should be treated as a fungible commodity in order to facilitate its role in economic development.

Since many of our western property concepts have emanated from Roman Law, one may well ask "How would the Romans have dealt with carbon property rights?" Traditionally, the Romans categorized property into four distinct classes – *res communes*, *res publicae*, *res universitatis* and *res in patrominium*. In Table II below we give a short definition and example of each of these property classes and link various carbon pools to these categories in an effort to begin to define a carbon property right. By going through the various stages of the carbon cycle, we can test if this framework is useful for the purposes of classifying property rights to carbon. This framework expands on the public-private dichotomy by introducing property held by the government in the public interest. It also reminds us that a resource like atmospheric CO_2 may not be divisible and is therefore not attachable to individuals or communities.

Tenure Regime	**Definition**	**Examples**
Res Communes	Things open to all by their inherent nature (CO_2 in the atmosphere)	Air, sea (open access)
Res Publicae	Things belonging to the public and open to the public by law (C in the lithosphere)	Roads, navigable rivers (public property)
Res Universitatis	Property belonging to a private or public group in its corporate capacity (Forest C?)	Private university, condominium (community property)
Res in Patrominium	Things that could be privately owned by an individual (Forest C on private land?)	Land under private ownership
Res Nullius	Things belonging to no-one (C in the ocean)	Unclaimed land, fish or game

Table III. Roman Conception of Property

(b) Common Property Resources

The common property resources (CPR) and commons literature has significantly broadened the property debate and provided a useful counter to the private property school of property theorists. In fact most of the earlier works on CPR use Hardin's tragedy of the commons as an initial point of departure and then through case studies demonstrate that most of what Hardin referred to as open access 'commons' were in fact resources subject to a complex set of formal or informal rules (Ostrom 1990; McCay and Acheson 1987, Agrawal 2001). Ostrom et al (1999) and Ostrom (2002) identify 'subtractability' and 'measurability' as primary attributes of common pool resources. Is carbon subtractable – in other words, does the use by one individual reduce the common resource pool available to others? In the case of forest carbon, logging reduces both the stock of carbon and the forest's capacity to absorb carbon out of the atmosphere. The measurability (the ability to quantify the resource over time) of forests, particularly the level of deforestation and degradation, has been a debatable issue, but with the advent of higher resolution satellite imaging systems is no longer viewed as a major obstacle. Once again, whether or not forest carbon is a CPR – for example, forest located on privately owned land – depends on local circumstances (see discussion of two local cases in section in section 6).

(c) Bundle of Rights Paradigm

The most common approach for reaching beyond CPR or the broader Roman law property regimes has been to conceive of property as a bundle of rights. Typically this bundle is divided into public and private rights. The public part of the bundle (rights of the state as opposed to the Roman *res publicae*) generally includes eminent domain (aka expropriation), the right to tax landholders, and the right to regulate land use (also referred to as 'police power'). The last right is particularly relevant to the question of carbon property rights as it can convey significant power to the government over the control of the use of resources such as forests. The private part of the bundle of rights may include the following rights: access, inheritance, alienation (through sale or donation), use, develop/improve, mortgage, subdivision, exclusion, etc. Usually these rights are limited to land rights as opposed to resource rights such as water or timber rights. As pressure mounts to better manage resources on the land (such as forest carbon), there is an increasing emphasis not just on the definition of land rights, but of individual and communal rights to resources such as trees, animals, water, etc. Although the bundle of rights conception of property is uni-dimensional and does not capture the richness of property relationships (Singer 2000), it remains the most popular conception of property when it is 'unpacked' beyond general regimes such as communal, private and state (see for example the "tenure box" that has been developed by Barry and Meinzen-Dick (2008)).

(d) Web of Interests

Some property scholars have argued that the bundle of rights approach does not adequately deal with the relationship between the person and the object of ownership and is unduly skewed in the direction of rights thus ignoring, or at least hiding, the duties and restrictions attached to property (Arnold 2002). Instead property should be conceptualized as a "web of interests" defined as:

> … a set of interconnections among persons, groups, and entities each with some stake in an identifiable (but either tangible or intangible) object, which is at the center of the web. All of the interest holders are connected both to the object and to one another. (Arnold 2002: 333).

The web of interests metaphor is gaining support in struggles to define water rights (Zellmer and Harder 2008) and property rights to carbon (Boydell, Sheehan and Prior 2008: 20).

Interestingly, this web has many of the same basic relationships that were advanced by Bohannan (1963) when he was trying to develop a broad concept of property that included African tenure systems. Africa has always provided a counterpoint to this 'western' view of property. Africanists, like Paul Bohannan, showed that these Euro-centric concepts of property were inadequate for describing more complex customary tenure arrangements in many African societies. Instead Bohannan suggested viewing land tenure as a triad of relationships between an individual, society and the property object (e.g. land). What this approach emphasizes is the need to focus on social relationships that form the background structure to de facto property rights.

(e) Layers of Rights and Interests

Another approach to visualizing complex tenure systems is to examine the layers of rights and interests associated with above-ground natural resources, the land and sub-soil resources like minerals and oil. Distinct property regimes generally apply to these categories of resources and land cadastres almost never identify rights to above-ground or sub-soil resources on cadastral maps. This separation has been institutionalized by charging different government entities with the management of rights and interests pertaining to different resources. In Peru, for example, the mining cadastre is handled by the National Institution of Concessions and Mining Cadastre (INACC), while rural land titling was until recently carried out by the Ministry of Agriculture. Forestry concessions and resource information, on the other hand, are the responsibility of the National Institute of Natural Resources (INRENA), which manages a cadastre of protected natural areas.[4]

Almost all of the land titling that has taken place in Latin America has focused on land with little consideration given to what is growing on the land. This has led in some instances into the exclusion of primary resources (e.g. brazil nut trees in Pando, Bolivia) from the titled polygon of the community because these resources were not considered when the land boundaries were adjudicated (Cronkleton et al 2007).

The case of the eastern department (state) of Madre de Dios in Peru is used to illustrate this layered approach (see Figure 2 below). The three resource categories (natural resources, land, sub-soil) are crossed with the major classes of de jure property rights to illustrate how rights are packaged. The approximate distribution (%) between state, indigenous and private (individual) tenure is shown below each category. This layered approach integrates all possible land/resource tenure options with the three resource categories, while still maintaining a link to the major property regimes (state, indigenous and private individual/firm).

6. Towards a Carbon Cadastre

Conventional property rights are usually formalized in a cadastre and/or property registration system. While for some this conjures up visions of centralized bureaucratic systems, we believe that cadastral and registration systems can operate at various levels, including the local level. These formal systems strive to answer five fundamental questions about property rights: what rights? Whose rights? When were they acquired and what is their duration? How were they acquired? Where are their spatial dimensions – location, extent (area) and boundary dimensions? If carbon property rights are to support a global carbon market, then these five questions at the very least must be

[4] See http://www.inrena.gob.pe/ianp/ianp_catastro.htm

addressed. We do this via two case studies in the southwestern Amazon – campesino communities in Bolivia and extractive reserves in Brazil.

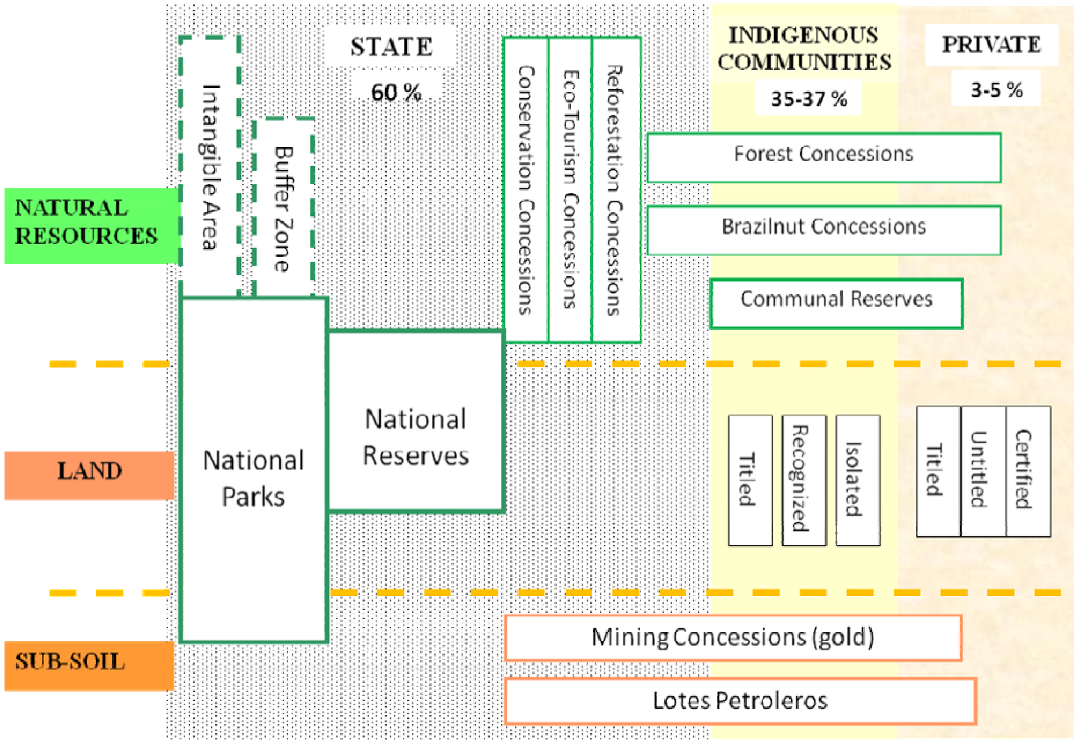


Figure 2. Layers of Rights and Interests (Peru)

(a) Campesino Communities in Pando, Bolivia

In 1996 a new land law (Ley INRA) was passed in Bolivia which established a new institutional structure and procedures for distributing and adjudicating land. The law defined six types of land tenure: family holdings; small properties; medium properties; agroindustrial holdings; indigenous territories; and communal properties designated for peasant farmers (campesinos).[5] We will focus only on the last category within the northern department (state) of Bolivia where 31% of the total area has been titled to campesino communities and where approximately 84% of the total area of the department was still forested in 2001.

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Although these communities have received a title and are regarded as private property they do not possess all the usual rights in the bundle of rights. Specifically, the property is inalienable, indivisible, not attachable (no mortgages), irreversible, immune from prescription (adverse possession), and must be held collectively. The 'ownership' of the trees is attached to the 'ownership' of the land in Bolivia and so these communities 'own' their trees. If a community wishes to commercially log their forest they are required to obtain a management plan and permission from the Forest Superintendency. Traditional

[5] Art. 41

and domestic use of the forest for subsistence purposes does not require authorization.[6] This part of Bolivia provides most of the world's brazil nuts and constitutes the main source of livelihood for community members.

Historically the forests in Pando were controlled by wealthy family-based rubber companies called *barracas*. Even though most *barracas* disappeared with the decline in the rubber market, they re-emerged in the struggle for access to land and brazil nut trees in Pando (de Jong et al 2006). With a mere 5% of Pando now titled to private individuals, it is clear that the *barraceros* have lost this round, although unassigned state land (called fiscal land) is still available and some have pursued land rights through the formation of a community with their previous employees. A 2004 presidential decree which gives peasant families the right to 500 hectares of land per family has also altered the land claim dynamic in Pando.

Within communities brazil nut trees are either harvested communally or the community divides them into family-specific groves. Although these fall under the Forest Law and therefore legally require management plans, this has not progressed beyond the formulation of technical norms and the initiation of communal mapping to inventory the trees (Cronkleton et al). What is clear in this case is that the trees are the property of the community and the state is attempting to extend its police power over NTFPs under the forest law.

The land titles issued by the national land reform agency (INRA) are registered in the property registry (registro de derechos reales) and the time of registration therefore determines when the land rights are conveyed to the community. Provided communities meet the social function of the land as required in the Bolivian constitution, their rights have no temporal limits.

Since very few formal rights existed prior to the titling efforts in Pando, most communities acquired their rights as first owners directly from the state. Community boundaries are determined through adjudication with neighboring communities, physical monumentation which is surveyed using GPS. These rectilinear boundaries are drawn on a cadastral plan (with a list of plane coordinates for all vertices) that is attached to the title. No internal boundaries, parcels or natural resources are shown on the plans and subsequent mapping of brazilnut trees has exposed overlaps between the titles boundary and the de facto resource rights to NTFPs (Cronkleton et al 2007).

(b) Extractive Reserves in Acre, Brazil

In response to the rubber boom in the late 1800s, rubber barons created expansive rubber estates (*seringais*) in the western Amazon and imported workers, mainly from Northeast Brazil, to carry out the labor-intensive job of extracting latex from the rubber trees. With the decline in the rubber market, and increased competition from Malaysia, the rubber barons lost interest in their estates and left the workers to their own devices. Many *seringueiros* stayed on the land and, in addition to continuing to extract latex, they began to harvest Brazil nuts and other forest products. Extractive reserves (ER) are built around

[6] Art. 32, Ley Forestal 1700 of 1996

these former rubber estates[7] and, although there has been out-migration, the *seringueiros* encountered in today's extractive reserves are largely the descendents of these earlier pioneers (Melone 1993).

The federal[8] or state government owns the land underlying extractive reserves (ERs), while the community acquires a 20 or 30 year concession[9] for joint usufruct rights over the entire extractive reserve. Use rights within the ER are transferable by inheritance. The government controls resource use through requiring a utilization plan as part of the concession (ELI 1995). Generally, deforestation is limited to 10% of the area.

Extractive reserves are composed of a complex distribution of de facto individual and community rights that are most often dictated by the spatial distribution pattern of the resource as opposed to a homogeneous geometric pattern typically used in other tenure regimes. Each family on the former rubber estates occupies an area known as a *colocação* which contains the rubber trails or *estradas de seringa*. An average family usually works three trails, each of which could contain as many as 150 rubber trees. The resource rights in this case are therefore defined initially by the location of the rubber trees and then by the trails that link them. The *seringueros* allow others to pass freely through their *colocação*, but the areas encompassed by the trails are regarded as relatively exclusive.

In addition, each family has a cleared area where they live, cultivate a few subsistence crops and raise small animals (Murrieta and Rueda 1995). Brazil nuts constitute the second most important extractive product and the trees are generally regarded as being the "property" of a particular colocação. The same is true for individual trees with value, such as cedar and mahogany. The *seringueros* also exercise hunting rights over particular areas of the forest.

Government ownership of the land means that the state has a much stronger claim to forest carbon within the ER than in the Bolivian case discussed above. Given the 10% deforestation limit, the state is explicitly withholding the use rights to the other 90% at least for use as timber. However, as our interaction with Jose (discussed at the start of the paper) indicated, members of the ER feel they have a strong claim to the trees in their family colocação and as de facto stewards of the forest they would have a strong claim to any benefits stemming from REDD and other mitigation schemes.

The spatial dimensions of ER challenge almost all of our conventional notions of property. Family-level use rights are anchored to the ground via the rubber trees and related trails which formed the original raison d'etre of the system. The length and shape of rubber trails varies widely, but on average a family will use three rubber trails. The rule of thumb that is used in Acre is that each trail is equivalent to 100 hectares, although the exact location of this area is not defined and likely overlaps with neighboring colocaçãos. Finally, as livelihood dependencies shift from rubber to brazil nut so the

[7] The Chico Mendes Extractive Reserve, for example, incorporates 19 former rubber estates.
[8] Either through INCRA, the agrarian reform agency, or IBAMA, the environmental agency.
[9] Concessão do Direito de Uso.

trails through the forest begin to change to facilitate access to the brazil nut trees. In the process the historical use right patterns begin to shift as well.

Table III. Summary of Property Rights Attributes

	Campesino Communities (Bolivia)	**Extractive Reserves (Brazil)**
What Rights?	Titled to the community with restrictions of inalienable, indivisible, not attachable (no mortgages), irreversible, immune from prescription (adverse possession), and must be held collectively.	Community holds usufruct rights which are transferable via inheritance. The state or federal government continues to own the land under the extractive reserve and controls the use through a utilization plan.
Whose Rights?	Community with de facto division of forest resources to household in some instances. State regulates use of forest resources for commercial purposes.	Government holds the land rights, while community has usufruct rights over land resources.
Time and Duration?	Initiated on registration of title and no restriction on duration.	Usufruct concession usually stipulates 20 or 30 years
How Acquired?	Communal Title from government.	Federal or state government grant a usufruct concession. No title issued.
Spatial Dimensions?	Field adjudicated rectilinear boundaries with physical monumentation. Cadastral plan shows dimensions of outside boundary.	Family-level use rights are tied to location of rubber trails and trails that link them.

7. Conclusion

Carbon is a highly dynamic resource which occurs predominantly in the atmosphere, ocean, earth and biomass. The open access problems associated with air and sea carbon pools (*res communes*), make it difficult to target this carbon. However, we have suggested that the initial focus should be on forest carbon which avoids this problem. Its market value has increased steadily since carbon markets emerged, but like most markets have been severely depressed by the global economic crisis. We highlight the need to recognize that many forests are home to indigenous and other forest people living as communities and suggest that they, not governments, may be the ultimate stewards of these forests. As such, they should be regarded as key stakeholders in the development of climate governance structures that try to link global carbon payments to national governments and ultimately to local users and rightholders in the forest.

Much of the property literature and efforts to formalize property rights have focused on land without much attention to the natural resources growing on the land. Carbon, and the demand to clarify these rights, has hastened the need to look beyond land titling to also mapping and documenting rights to resources. If mechanisms like REDD add market value to forests based on their carbon content, will this lead to benefits for local forest dwellers or will this lead to a widespread grab for forestland by wealthier and better positioned entrepreneurs? In short, can climate change mitigation schemes be designed to be pro-poor? We contend that poverty alleviation must accompany climate change policies and that a first step is documenting the carbon rights of those drawing a livelihood from the forest.

References

Agrawal, A. (2001). "Common Property Institutions and Sustainable Governance of Resources." *World Development*, 29 (10): 1649-1672

Allen, T. and K. Baylis (2005). Who Owns Carbon? Property Rights Issues in a Market for Green House Gases. Unpublished document, University of British Columbia, Canada, 22p.

Ankersen, T. and G. Barnes (2004). "Inside the Polygon: Emerging Community Tenure Systems and Forest Resource Extraction." *Working Forests in the Neotropics*, (eds: D. Zarin, R. Janaki, F. Putz and M. Schmink), Columbia University Press, N.Y. pp. 156-177.

Arnold, C. (2002). The Reconstitution of Property: Property as a Web of Interests. Harvard *Environmental Law Review*, 26 (2): 281-364

Archer, D. (2005). "Fate of fossil fuel CO2 in geologic time." *J. Geophysical Research*, 110(C09505).

Barry, D. and R. Meinzen-Dick (2008). The Invisible Map: Community Tenure Rights. *Proceedings of IASC*, Cheltenham, U.K. http://iasc2008.glos.ac.uk/conference%20papers/papers/B/Barry_138902.pdf

Basnet-Parasai, R. (2007). Who Owns Carbon in Community Managed Forest? Paper prepared for Amsterdam Summer School. http://www.2007amsterdamconference.org/Downloads/AC2007_Basnet.pdf (accessed 1 Sept, 2008)

BLD (1979). Black's Law Dictionary, West Publish Co, St. Paul, MN.

Bohannan, P. (1963). "'Land,' 'Tenure' and Land-Tenure." *African Agrarian Systems*, Oxford U Press, London, pp. 101-115

Bonan, G. (June 13, 2008). "Forests and climate change: forcings, feedbacks, and the climate benefits of forests." *Science*, 320(5882): 1444-49.

Boydell, S., J. Sheehan and J. Prior (2008). Carbon Property Rights in Context. Draft paper submitted to Environmental Practice.

Cronkleton, P., M. Albornoz, G. Barnes, K. Evans and W. de Jong (under review). Social Geomatics: Participatory Forest Mapping to Mediate Resource Conflict in the Bolivian Amazon. Submitted to *Human Ecology* Journal.

Cronkleton, P., C. Gönner, K. Evans, M. Haug, W. de Jong and M. Albornoz (2007). Supporting Forest Communities in Times of Tenure Uncertainty: Participatory Mapping Experiences from Bolivia and Indonesia. *Proceedings: International Conference on Poverty Reduction and Forests*, Bangkok, September, 2007

De Jong, W., S. Ruiz and M. Becker (2006). Conflicts and communal forest management in northern Bolivia. *Forest Policy and Economics*, 8: 447– 457

De Soto, H. (2000). The Mystery of Capital: Why Capitalism Triumphs in the West and Fails Everywhere Else. Basic Books, New York.

Environmental Leader. (2009). "Carbon Market Up 83% In 2008, Value Hits $125 Billion." http://www.environmentalleader.com/2009/01/14/carbon-market-up-83-in-2008-value-hits-125-billion/

FAO (2005). State of the World's Forests. Rome: Food and Agriculture Organization of the United Nations.

Forest Dialogue (2008). Beyond REDD: The Role of Forests in Climate Change - A Statement from The Forests Dialogue. 8p.

Goldstein, E. (1995). Economics and the Environment. Prentice Hall, New Jersey.

Griffiths, T. (2007). Seeing 'RED'? 'Avoided deforestation' and the rights of Indigenous Peoples and local communities. http://www.forestpeoples.org/documents/ifi_igo/avoided_deforestation_red_jun07_eng.pdf
Hardin, G. (1968). Tragedy of the Commons. *Science*, 162: 1243-1248
Houghton, R.A. (2007). "Balancing the global carbon budget," *Annual Review of Earth Planetary Sciences*, 35: 313-47.
IPCC (2001). Climate Change 2001: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change. (J.J. McCarthy, O.F. Canziani, N.A. Leary, D.J.Dokken and K.S.White, Eds.) Cambridge University Press, Cambridge, 1032 pp. http://www.ipcc.ch/
IPCC (2003). IPCC Workshop Report on the Detection and Attribution of the Effects of Climate Change. (C. Rosenzweig and P.G. Neofotis, Eds.) NASA/Goddard Institute for Space Studies, New York, 87 pp. http://www.ipcc.ch/
IPCC (2007). Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. (S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L.Miller, Eds.). Cambridge University Press, Cambridge, 996 pp. http://www.ipcc.ch/
Keeling, C.D. (1973). "Industrial production of carbon dioxide from fossil fuels and limestone." *Tellus*, 25: 174-98.
McCay, B.J. and J. Acheson, eds. (1987). The Question of the Commons: The Culture and Economy of Communal Resources. U of Arizona Press, Tucson
Miles, L. and V. Kapos (2008). Reducing Greenhouse Gas Emissions from Deforestation and Forest Degradation: Global Land-Use Implications. *Science*, 320:1454-1455
Millenium Ecosystem Assessment. (2005). Ecosystems and Human Wellbeing: Current State and Trends, Vol.1. IslandPress, Washington, Covelo, London..
Miller, M., M. Wilder and E. Knight (2008). Local Issues and Contractual Solutions for LULUCF Projects under the Clean Development Mechanism. In *Climate Change and Forests: Emerging Policy and Market Opportunities* (eds. C. Streck, R. O'Sullivan, T. Janson-Smith and R, Tarasofsky), Brookings Institution Press, Baltimore, MD.
OCC (2008). Eliasch Report – Climate Change: Financing Global Forests. Office of Climate Change, U.K.
Ostrom, E., J. Burger, C. Field, R. Norgaard and D. Policansky (1999). Revisiting the Commons: Local Lessons, Global Challenges. *Science*, 284(5412): 278-282
Ostrom, E. (2002). "Managing Resources in the Global Commons." *Journal of Business Administration and Policy Analysis*. On-line: http://www.allbusiness.com/sector-55-management-companies-enterprises/430275-1.html (accessed 3 March, 2009).
Pacheco, P. (2007). La economía política del desarrollo forestal en Bolivia: Políticas, actores e ideologías. *Revista Virtual REDESMA* (June), una publicación del Centro Boliviano de Estudios Multidisciplinarios, Bolivia: 30-52
Parker, C., A. Mitchell, M. Trivedi and N. Mardas (2008). The Little REDD Book: A guide to governmental and non-governmental proposals for reducing emissions from deforestation and degradation. Global Canopy Programme, Oxford, UK.
Pearson, Walker and Brown (2008). Sourcebook for Land-Use, Land-Use Change and Forestry Projects. BioCF Document Library, World Bank, Washington, D.C.
Phillips, G. and A. Razzouk. (2007). "A trillion dollar marketplace." *Environmental Finance*.
Porrua, M. and A. Garcia-Guerrero (2008). Case Study: The Noel Kempff Climate Action Project, Bolivia. In *Climate Change and Forests: Emerging Policy and Market Opportunities* (eds. C. Streck, R. O'Sullivan, T. Janson-Smith and R, Tarasofsky), Brookings Institution Press, Baltimore, MD.

Robiedo, C. and H. Ok Ma (2008). "Why are there so few forestry projects under CDM?" *ITTO Tropical Forests Update Online Newsletter*, 18(3). (http://www.itto.or.jp/live/PageDisplayHandler?padeld=243&id=4476).

Schwartzman, S. and Moutinho (2008). Compensated Reductions: Rewarding Developing Countries for Protecting Forest Carbon. In *Climate Change and Forests: Emerging Policy and Market Opportunities* (eds. C. Streck, R. O'Sullivan, T. Janson-Smith and R, Tarasofsky), Brookings Institution Press, Baltimore, MD.

Sedjo, R. (1993). "The Carbon Cycle and Global Forest Ecosystem," *Water, Air, and Soil Pollution* 70: 295-307

Singer, J. (2000). "Property and Social Relations: From Title to Entitlement." In *Property and Values: Alternatives to Public and Private Ownership* (eds. C. Geisler and G. Daneker), Island Press, Washington, D.C.

Stern, N. et al (2007) Stern Review on the Economics of Climate Change (Cambridge University Press, Cambridge, UK.

UNDP (n.d.) UN-REDD Program Fund. http://www.undp.org/mdtf/UN-REDD/overview.shtml

UNFCC (2008). CDM statistics (http://cdm.unfcc.int/Statistics/index.html).

von Benda-Beckmann, F. (2000). "Relative Publics and Property Rights." *Property and Values: Alternatives to Public and Private Ownership* (eds. C. Geisler and G. Daneker). Island Press, Washington, D.C.

White, A. and Martin A. (2002). Who Owns the World's Forests? Report published by Forest Trends, Washington, D.C.

Woods Hole Research Center (2008). An overview of Readiness for REDD: A compilation of readiness activities prepared on behalf of the Forum on Readiness for RED. (T. Johns and E. Johnson, eds.)

World Bank (2008). State and Trends of the Carbon Markets. World Bank Institute, Washington D.C. http://wbcarbonfinance.org/Router.cfm

Zellmer, S. and J. Harder (2008). "Unbundling Property in Water." *Alabama Law Review*, 59(3) http://works.bepress.com/sandi_zellmer/1