Where forest carbon meets its maker: Forestry-based offsetting as the subsumption of nature

Wim CARTON – Department of Human Geography, Lund University
wim.carton@keg.lu.se

Elina ANDERSSON – Lund University Center for Sustainability Studies
elina.andersson@lucsus.lu.se

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ABSTRACT

The 'subsumption of nature' framework focuses on productivity increases and extractive innovations in nature-based industries. In this article, we argue that it can also be employed beyond that context in order to capture the convoluted dynamics of market environmentalism. To substantiate our argument, we draw on recent fieldwork on 'Trees for Global Benefits', a forestry-based offsetting project in western Uganda. Like industrial tree plantations, this project relies on the subsumption of carbon sequestration to market imperatives in order to guarantee the quality of its carbon credits. The ecological and socioeconomic difficulties this process engenders give rise to unintended consequences and set in motion the disciplining of the carbon offset producers themselves. The application of the subsumption framework to non-industrial sectors in this way calls attention to the interlinked socioecological dynamics involved in the subsumption of nature, and highlights potential synergies with previous work on the subsumption of labour.

Key words: subsumption of nature, subsumption of labour, carbon offsetting, forestry, Uganda

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Introduction

In a 2001 article for this journal, Boyd et al. introduce the idea of the 'subsumption of nature' as a framework for analyzing the multiple and often contradictory ways in which nature enters into industrial production. Despite the resonance of their argument to ongoing debates on commodification, market environmentalism, and neoliberalizing natures (Arsel & Büscher 2012; Bakker 2010; Castree 2010; Heynen et al. 2007; Robertson 2012), few scholars have so far engaged with it in detail. This is surprising given that Boyd et al.'s main point revolves around the material obstacles and opportunities that nature poses to capital accumulation, an issue that is directly relevant to continued discussions on the role of materiality, non-human agency, and nature's 'unruliness' in commodification processes (Bakker & Bridge 2006; Fairhead et al. 2012).

This article revisits the subsumption thesis and argues that it can be fruitfully applied beyond the contexts focused on by Boyd et al., including for the analysis of market environmentalism. Based on 62 interviews and a document analysis of a carbon forestry project in western Uganda – 'Trees for Global Benefits' (TFGB) – we connect the subsumption thesis to recent debates on carbon offsetting and the multiple abstractions that are needed to 'force' biophysical processes into a market framework demanding predictability and calculability (Bumpus 2011; Lohmann 2011; MacKenzie 2009; Osborne 2015). Doing so, we propose, sheds light on the ways in which the materiality of carbon forestry shapes and impedes the creation of offsets, as well as the kind of strategies that market actors adopt to overcome the resulting challenges. It demonstrates how the production of carbon offsets is fundamentally underpinned by the subsumption of carbon sequestration to capital, a contentious and problem-riddled process that is always both social and ecological. As such, we suggest that the application of the subsumption framework beyond the boundaries of capitalist industry helps highlight the relationship between the subsumption of nature and the subsumption of labour. Our overall intention is thereby to constructively broaden Boyd et al.'s arguments in order to build a bridge between the subsumption thesis and ongoing debates on the neoliberalization of nature.

The next section gives a concise literature review of the subsumption of nature thesis and clarifies our interpretation of it. We then briefly elaborate on the relevance of the subsumption framework for understanding (forestry-based) carbon offsetting in general before introducing the TFGB project as the focus of our analysis. In the discussion we present the project's attempts to subsume the sequestration of tree carbon to the demands of the carbon market as well as the obstacles encountered in doing this. The conclusion summarizes the argument and underlines the importance of recognizing the intertwined relationship between the disciplining of labour and the subsumption of nature.

On the subsumption of nature

By analogy with Marx's (1977) arguments on the subsumption of labour, Boyd et al. (2001) propose that the evolving relationship between capital and nature can be conceptualized as a dual process involving the formal and real subsumption of nature. The former, they argue, is characterized by a fundamentally extractive relationship that "confront[s] the biophysical world as an exogenous set of stocks or flows, biophysical processes, and material characteristics" (p. 562), that is, a process by which nature-based industries enlist resources and ecosystem services as factors in the production process without any attempt to "control, intensify, manipulate or otherwise "improve"" (p. 562) upon them. The real subsumption of nature on the other hand directly attempts to "(re)make [nature] to work harder, faster, and better" (p. 564), for example by engineering the genetic code of species in order to increase yields or turnover times. Since the latter revolves around increases in the biological productivity of natural systems, the authors argue, it exclusively applies to biologically based industries. The formal subsumption of nature by contrast can be found in both biologically based and extractive industries.

In many ways, Boyd et al. continue, the real subsumption of nature allows biologically-based industries to overcome the obstacles posed by a nature that is subsumed only formally, including the spatiality and scarcity of resources, natural reproduction rates, perishability, etc. As much as the subsumption process introduces solutions to existing biophysical obstacles however, it also raises new ones. Alterations in species' genetic code for example pose risks in terms of "the potential escape and proliferation of novel life forms, the creation of super weeds or new virulent strains of virus and pathogenic bacteria, and the disruption of larger ecological processes" (p. 566), all of which may manifest themselves as new barriers to capital accumulation. In other words, the subsumption of nature here appears as a necessarily incomplete process, marking a continuous attempt by capital to control or 'discipline' nature for the purpose of accumulation, and a concomitant 'response' by nature that fundamentally escapes human intentionality (Smith 2006).

Smith (2006) puts forward an alternative interpretation of the subsumption thesis. Problematizing Boyd et al.'s "external conception of nature" (p. 30), he argues that the analytical distinction between extractive and biologically-based industries is altogether too simple. "Even the formal subsumption of nature," he notes, "always deployed biological systems as forces of production, as with industrial agriculture, and today's real subsumption of nature, while crucially biological, is not entirely so" (p. 31). Instead, Smith elaborates on his own 'production of nature' thesis (2008) to suggest that the transition from formal to real subsumption can also be thought of as the move from an extensive production of nature, characterized primarily by the geographical spread of extractivism, to an intensive one, that is, a "vertical integration of nature into capital". "Capital", Smith puts it, "is no longer content simply to plunder an available nature but rather increasingly moves to produce an inherently social nature as the basis of new sectors of production and accumulation" (Smith 2006, p. 33).

Smith furthermore draws attention to the seeming absence in Boyd et al.'s (2001) argument of the relationship between the subsumption of nature and human labour. Marx, he argues, insisted on the cooperative character of labour, organized by technological and organizational innovations, as the driving force behind the production of relative surplus value hence the transition towards the real subsumption of labour. If, as Smith (1996, 2008) argues, we recognize that the production of nature is ultimately the result of human labour, hence that the intensified search for relative surplus value changes the way in which labour produces nature, then full recognition of the relationship between the increased technological and social organization of labour on the one hand, and the deepening integration of nature into capital seems in order. Ultimately this opens up for a theory that considers the subsumption of labour and the subsumption of nature as dialectically related, rather than merely parallel developments.

For the purpose of this paper, we here broadly follow Smith's (2006) broadening of the subsumption thesis. Smith's reinterpretation of subsumption as the extensive/intensive production of nature usefully captures ongoing developments with carbon trading and offsetting, in which the circulation of capital has become associated with the intensive commodification of nature in the name of climate change mitigation (Lohmann 2011). This process involves not just the appropriation or 'grabbing' of an 'already-existing' nature (Fairhead et al. 2012), but also the discursive and material reworking of nature so as to make it more amenable to carbon market imperatives, for example by reshaping historical landscapes, applying particular offsetting technologies or prioritizing certain species over others (Bumpus 2011; Leach & Scoones 2015; Osborne 2011, 2015). A similar trend can be discerned in other examples of market environmentalism, including for biodiversity and wetland conservation (Robertson 2006; Sullivan 2013). Smith's (2006) broadening of the concept in this way allows subsumption to be recast as one particular moment in the commodification and neoliberalisation of nature. It goes beyond a mere focus on industry and industrial production as the space where nature is subsumed and thus mirrors evidence from the 'neoliberal natures' literature that the nature-capital relationship is increasingly negotiated outside the sphere of traditional industrial production (Arsel & Büscher 2012; Castree 2010; McCarthy & Prudham 2004). To the extent that "the fictitious capital of ecological credits and environmental derivative markets [has become] integral to socializing the real subsumption of nature" (Smith 2006, p. 31), it indeed makes little sense to try and fence off particular industries as the sole locus of subsumption. At the same time however, there is something very valuable in Boyd et al.'s (2001) attention to the obstacles and opportunities provided by biophysical nature. This recognition of nature's materiality as a socio-ecological force to reckon with, indeed of some form of natural agency independent of human labour, is largely lost in Smith's (2006) argument (and indeed in the 'production of nature' concept more generally) yet seems a crucial part of understanding the limits to the production and commodification of nature (Bakker & Bridge 2006). A number of scholars have engaged with this question in recent years, with Bakker (2005) for example examining the 'uncooperativeness' of water as a commodity, and we believe this perspective needs to be at the forefront of any discussion on the subsumption of nature. The challenge, then, and the line that we try to tread in this paper, is to take serious Smith's (2006) point on the socialization of the real subsumption of nature, while recognizing the fundamental materiality of biophysical processes as key obstacles that capital seeks to overcome.

Carbon forestry as subsumption of nature

Carbon offsetting – or the 'compensation' of greenhouse gas emissions by funding carbon reduction projects, primarily in developing countries – has emerged as one of the most fiercely contested issues in climate policy debates. While a full review of this literature is beyond the scope of this paper, it is useful to highlight some of the main controversies that have surfaced, bearing in mind that particular outcomes will always be contingent on the socio-economic contexts within which projects unfold (Bakker 2009). Amongst others, offset projects have been linked to land grabbing; the violent displacement of rural communities; the unequal distribution of, and access to resources; a particular propensity for corruption; and a range of deleterious environmental side-effects (Böhm & Dabhi 2009; Leach & Scoones 2015; Nel & Hill 2014). Offsetting practices have also been criticized for displacing the burden of mitigation to some of the world's poorest communities while giving the richest countries - and those most responsible for climate change - the opportunity to avoid taking action themselves (Bumpus & Liverman 2008).

Their alleged climate change mitigation effects, meanwhile, are often difficult to determine (Sedjo & Macauley 2012; Spash 2010). Forestry-based projects are particularly controversial in this respect. In order to make a reliable calculation of the amount of offsets that a forestry project can claim, developers need to provide detailed information about the project's sequestration activities that is hard if not impossible to come by. Proving that offset claims are genuine for example fundamentally demands that projects develop a baseline of how much carbon would have been sequestered without the project's activities, in order to prove that these are 'additional' to what would have happened otherwise. Because of the counterfactual nature of this exercise, its accuracy is impossible to ascertain (Lohmann 2011). Similarly, establishing accurate carbon sequestration rates requires reliable data on the biomass production in forests, which tends to be highly variable depending on tree species, climate, geography, tree density, etc. and needs to take into account hard-to-measure factors such as carbon deposits in the soil (Nair 2011). This is a degree of detail that is challenging for even the richest countries to provide, let alone those generally lacking the financial and technical capacity to carry out consistent monitoring of remote areas. Guaranteeing the permanence of sequestered carbon, meanwhile, comes with its own challenges, given the long timescales involved in growing trees and the often precarious ecological, socio-economic and political conditions at project locations (Galik & Jackson 2009). Because of the importance of forest resources to rural livelihoods in much of the global South, forest projects seem perpetually at risk of being challenged and contested (Leach & Scoones 2015).

Many of these problems relate to the variability and socio-ecological complexity of forests and therefore reflect challenges in the forestry sector more widely. As Prudham's work (2003, 2004) illustrates, forestry companies have long been confronting nature as a particularly uncooperative partner, providing obstacles to the economic rationalization of industrial tree growth in the form of decades-long growth rates and species and age diversity in natural forests. As companies sought to overcome these obstacles, they increasingly embarked upon the real subsumption of nature, i.e. the control of biological time and space through intensified plant breeding, the selection of faster-growing species, and a general tendency towards standardization and monoculture plantation in order to facilitate management and harvesting (Boyd et al. 2001; see also Scott 1999). The same concerns apply to forestry-based offsetting in that many afforestation/reforestation projects take the form of large-scale monoculture plantations of fast-growing species where tree densities and growth rates are carefully controlled to maximize carbon sequestration. In such projects, fast-growing species such as pine and eucalyptus are popular choices because they can typically be harvested on a shorter rotation than most other trees. Since biomass accumulation and the sequestration of carbon in trees largely go hand in hand, improvements in biological productivity and plantation management benefit the production of both carbon offsets and timber. This effectively aligns the subsumption of tree growth to capital with what could be called be called the subsumption of carbon sequestration, or attempts to increase the biosphere's carbon sequestration rate through interventions in land use and the species composition of forests.

The above, 'intensive' carbon forestry model has been extensively criticized for creating new environmental problems (biodiversity loss, soil moisture depletion by eucalyptus plantations, …) and neglecting the social and economic impacts of projects on rural communities (Cavanagh & Benjaminsen 2014; Lyons & Westoby 2014; Nel & Hill 2014). Partly in response to this, there has been a recent surge in interest for more small-scale, participatory offset projects that promote an active concern with the ecological aspects of forestry and its environmental justice implications, and therewith promise a sustainable alternative to large-scale monoculture plantations. In what follows we argue that the subsumption framework can in fact be extended to these non-industrial projects as well, and that doing so helps elucidate the contentious relationship between the subsumption of nature and human labour.

The subsumption in 'Trees for Global Benefits'

As one of the oldest offsetting projects in Uganda, Trees for Global Benefits (TFGB) has been producing carbon offsets for the voluntary carbon market since 2003. The project engages smallholder farmers to plant trees on their land and then provides the resulting carbon credits to buyers, mostly companies in Europe seeking to 'green' their products (Ecotrust 2009a). Participants thereby enter into a carbon contract through a Ugandan NGO called Ecotrust, which manages the project. In doing so, they agree to plant a given number of trees on a specified area (mostly 400/ha) and in return receive 5 payments spread out over a 10-year period. After this, farmers are expected to keep the trees for another 10 to 25 years (dependent on tree species) before they can harvest, sell the timber and use the proceeds as desired. Tree growth is evaluated by field monitoring, which is important to ensure the project's environmental integrity and in theory happens ahead of each of the five milestones outlined in participants' contracts. Project officials visit the farms and, depending on what stage in the project farmers have reached, count the number of trees or tree diameters. If the result matches the objective stated in their contracts, farmers are then qualified to receive the corresponding payment.

TFGB aims to go beyond mere carbon sequestration and envisages tree cultivation to create a number of environmental and community co-benefits, including biodiversity conservation, the provision of fuelwood and construction materials, and income diversification (Ecotrust 2009a; Plan Vivo 2016). A self-proclaimed 'community-based project', TFGB is thereby commonly framed as a best-practice example and a role model for other projects in the country to follow. In recognition of this, the project in 2013 won the SEED Low Carbon award for its role in "supporting entrepreneurs for sustainable development" (SEED 2013). TFGB has grown significantly over the years and now spans multiple districts in the east and west of the country. To date, it has issued nearly one million carbon credits and has approximately 5000 ha under management, involving over 4600 participants (Plan Vivo 2016). For this study, we have focused on one of the project areas, Mitooma (formerly part of Bushenyi) district, in western Uganda, where TFGB's original pilot study took place and participants have the longest experience with the project.

On the face of it, TFGB moves away from the subsumption of nature (and the attendant prioritization of economic efficiency) witnessed at industrial tree plantations. The project prides itself on the use of native species and fruit trees, which are meant to offer biodiversity benefits and alternative income opportunities to participating 'carbon farmers' (Ecotrust 2009a), but which also entail a comparatively lower yield and a lower rate of carbon sequestration than fast-growing eucalyptus and pine stands. Strong emphasis was put on the development of agroforestry-style forest gardens, in which different species are planted together and intercropping with common food and cash crops such as plantain (*matooke*), tea and coffee is practiced. In the areas that we visited nearly all participating farmers had what Ecotrust describes as a 'mixed native woodlot', containing a mixture of different indigenous trees and fruit trees. Initially also, the project envisioned a fairly individualized approach to offsetting that would increase both farmer involvement and the reliability of calculated offsets. TFGB's first annual report, published in 2004, describes how carbon sequestration rates would be estimated based on available data for the different tree species and then "adjusted based on the specific species combinations that each farmer has planted" (Ecotrust 2004).

Closer scrutiny of the project, however, reveals interesting parallels with the kind of 'nature production' that occurs at large-scale forest plantations. For example, the choice for indigenous trees hence for a slower rate of carbon sequestration makes perfect sense on the voluntary carbon market, where carbon credits that promise biodiversity conservation and community benefits command a higher price than offsets from the cultivation of exotic tree species (Bumpus 2011). As Ecotrust acknowledged in response to questions from farmers on why they could not grow pine and eucalyptus, "carbon from trees such as eucalyptus is not attractive to buyers" (Ecotrust 2007, p. 21). Rather than accumulating capital by way of the mere expansion of material production and concomitant increases in biological productivity, TFGB here taps into a growing market for what Paterson and Stripple (2012) call 'boutique' carbon credits, which more than 'ordinary' carbon credits rely on the production of attractive narratives about the added ecological and developmental virtue of offset projects. The cultivation of native tree species in this sense should be interpreted not as a step back from the intensive production of nature witnessed in tree plantations, but rather as a subtle change in the type of accumulation that nature is enlisted in. As such, TFGB serves to illustrate how the subsumption of carbon sequestration occurs not just through the appropriation/reworking of nature's material qualities but also through its discursive construction.

Within the boundaries of this 'boutique' market meanwhile, biological productivity has emerged as an important factor shaping project design as well as the composition of farmers' gardens. The project's initial intention was to help protect native trees by diversifying the species grown by farmers, whereby "special attention will be given to those species, whose populations and genetic variety has been greatly reduced by the overexploitation of forest resources in this area" (Ecotrust 2009a, p. 24). In practice however, and from the very beginning, particularly the fastest growing indigenous trees have been promoted by TFGB. During the project's pilot phase in Bushenyi for example, just four species accounted for nearly 80% of all trees planted during the first year of the project, namely *Maesopsis eminii, Funtumia elastica, Terminalia spp.* and a tree known only by the local name Omuyuvu (Ecotrust 2004). *Maesopsis eminii* and *Terminalia spp.* are both short rotation trees that can be harvested after 15-18 years, while *Funtumia elastica* is a medium rotation (25-30 years) species that can also be harvested after 10-15 years for use as construction poles.[1] Long rotation trees, including such high-value and ecologically vulnerable hardwoods as *Khaya spp.* (African mahogany), are clearly underrepresented in Ecotrust gardens.

This choice for fast-growing species is driven by farmers themselves as well as by the project design. On the one hand, Ecotrust states that "most farmers seem to prefer fast growing tree species" (Ecotrust 2004, p. 15), a conclusion that was confirmed by our field visits. In fact, the vast majority of farmers we interviewed stated that they would prefer to grow eucalyptus instead of indigenous trees. This can be seen as a reflection of the fact that farmers are given a direct financial stake in the production of nature, since they are the ones that stand to benefit from the harvested timber, while the benefits of biodiversity conservation are far more elusive. Eucalyptus cultivation, in addition to tea, coffee, and *matooke*, is a common land use in the area and participants are therefore well aware of the commercial benefits of fast-growing trees. On the other hand, Ecotrust has itself moved away from

[1] The rotation period and growing characteristics of Omuyuvu could not be determined.

its initial focus on agroforestry to rely more heavily on the cultivation of *Maesopsis eminii*. To estimate carbon sequestration rates and monitor progress, TFGB makes use of so-called 'technical specifications' that outline the species to be used, rotation periods, required tree densities, spacing, thinning and pruning practices, etc. and that serve to standardize cultivation practices and make them legible to the requirements of the carbon market (cf. Osborne 2015). While farmers in the pilot phase seem to have had a high degree of freedom with respect to tree choices and plantation systems, Ecotrust subsequently converged on two possible technical specifications, namely a 'mixed native species woodlot' composed of 80% fast/medium-growing species (<25 years) and 20% slow-growing species (>40 years) (Ecotrust 2016), and a 'sole species woodlot' existing of 80-100% *Maesopsis eminii*. The choice for this species was motivated by "its popularity in terms of fast growth, germplasm availability, ease of propagation, compatibility with most agricultural crops, and superior timber products" (Ecotrust n.d.). In other documents, the organization also mentions *Maesopsis*' benefits as a self-pruning (hence lower-maintenance) species and the fact that it is one of the few indigenous trees for which some data with respect to growth characteristics and biomass accumulation is available. Until recently, most farmers appear to have been recruited on the basis of the *Maesopsis* system.

Obstacles to the subsumption of forest carbon

In order to ensure the credibility, hence the marketability of its offsets, TFGB needs to guarantee a certain degree of carbon sequestration to its buyers. Apart from choosing fast-growing trees and standardizing the composition of gardens across its participants, it does this by demanding a specific tree management regime that is enforced by monitoring and the conditionality of payments. According to the technical specifications, farmers are expected to plant trees at 5x5m, 7x7m, or 8x8m depending on the system that is used (Ecotrust n.d., 2016). They are required to thin their trees when they reach 5 and 10 years to respectively 300 and 200 trees/ha, to properly weed their plantations at least twice a year, to keep the trees pruned and to postpone harvesting for at least 15 years. All this is to ensure optimal tree growth so that the carbon sequestration profile of the trees matches that described in the technical specification.

Our fieldwork shows that implementing this management regime has been anything but straightforward, and TFGB has had to contend with a wide range of obstacles over the years. The choice for *Maesopsis* as the main species, for example, has posed recurring problems, including sudden dieback of shoots, stunted tree growth and high pest pressure. Participants therefore commonly complain that

> [t]hey do not have many benefits, these carbon trees. They are not easily grown and they take time. I had to replace so many of them because they dried out. They started to dry from the top and then they refused to grow (Interview, 150131).

These problems are acknowledged by Ecotrust and are attributed to *Maesopsis*' maladaptation to the variety of growing conditions and soil types found across the project area, as well as to inadequate tree management practices (Ecotrust 2007, 2009b). In Kasese district, in the east of Uganda, the scale of the problem spurred the organization to start using fast-growing *Grevalia spp.* as a replacement (Ecotrust 2012a, p. 8), even though this is not an indigenous species and there was no technical specification to support this. Other common reasons for tree stunting and dieback include droughts, fires, a variety of pests including termites, and damage by livestock. Trees that die at any stage of their growth need to be replaced by the farmers themselves if they are to meet their targets, which given the sometimes high rate of replacements has led to discontent amongst participants:

> A farmer plants 300 trees, and 100 die. So when he is monitored, he is not paid. So you find people opting out. For me, now, I think I would do eucalyptus (Interview, 150122).

What is abundantly clear from the TFGB case, however, is that the project's efforts to produce a viable commodity not only run into nature's biophysical 'uncooperativeness' (cf. Bakker 2005), but fundamentally also involved a struggle to discipline the labour of the participating 'carbon farmers'. While in the project's early years nearly all participants reached their planting objectives, these numbers have declined considerably in recent times. Both in 2013 and 2014 for example, nearly one third of all monitored farmers did not reach their targets (Ecotrust 2013, 2014). In some districts, as much as half of all participating farmers currently fail to achieve the planting objective for which they are monitored. This evolution is explained primarily by the fact that Ecotrust has over the years moved towards a more rigorous implementation of the technical specification(s) and the carbon contract, reflecting an increasing orientation towards the requirements of the voluntary carbon market (cf. Osborne 2015). The organization's decision to seek verification from the Rainforest Alliance (2013), which raised TFGB's prestige but also required that a certain standard be upheld, likely provided additional incentives in this direction.

This in turn has brought to light a mismatch between Ecotrust's ambitions and how the project is understood and experienced by farmers on the ground. One of the major complaints by the organization, for example, is that farmers do not follow spacing and thinning requirements and therefore "end up with the required number of trees but not the required acreage to meet the conditions within their respective contract" (Ecotrust 2014, p. 13), implying that trees are crowded in and lack the space they need to achieve optimal growth rates. Ecotrust reports as well as our interviews suggest that this is a significant problem, explaining the majority of cases where farmers do not qualify for payments. Farmers on the other hand repeatedly highlight that the project's spacing guidelines were unclear from the beginning, that they have changed over time, and that the Ecotrust officials who monitor the trees do not communicate the reasons for disqualifying participants from payments, making corrective action all but impossible:

> In the beginning they could tell people to plant trees without telling the distance, the spacing. But today you must plant a tree with spacing of 10 meters. That consumes a lot of land! When monitors could come… it has been giving people headache. If someone had planted 500 trees they could calculate that they can keep only 200 because they are too dense. The rest must be eliminated. [...] I don't know… maybe because they changed the monitors. In the beginning they didn't care that much about spacing (Interview, 150202).

This is confirmed by the project's 2013 verification report, which raises concerns over unclear spacing guidelines and the failure of Ecotrust officials to consistently monitor spacing during field visits (Rainforest Alliance 2013). When farmers after a number of years are then finally requested to thin their gardens and plant additional land to make up for the missing trees, they have already invested significant amounts of time and money in their plantations. Often, they then also don't have the required extra land to plant new trees and continue meeting their contract obligations.

Problems with spacing are compounded by the fact that, as Ecotrust puts it, "[f]armers cannot correctly estimate the size of their land" (Ecotrust 2012a, p. 14), which they attribute to low literacy rates and a "lack of appropriate tools to measure their land" (Ecotrust 2012a, p. 14). Our fieldwork however shows that many farmers are not fully aware about the contents of the contracts they signed in the first place. Contracts are written in English, which hardly any of the project participants speak, and often farmers indicated that they did not have a copy in their possession. Land sizes in the contract are indicated in hectares even though this is not a common land measurement in Uganda, where farmers commonly talk about land in terms of acres instead:

> When we were planting we were told acres. Acres! They knew we are measuring our land in acres. But when we had already planted and they brought the GPS, they started the business of hectares (…) All of us are getting confused (Interview, 150205).

Some of our interviewees had actually planted the requested number of trees on 1 acre instead of the prescribed hectare and when prompted confirmed that they were not aware of the difference between the two. If nothing else, this can be seen as a major disparity between the specific relationship to land and tree management that the production of forestry offsets requires, and the lived geographies of participating farmers.

Our interviews revealed ample other examples of how farmers' actions conflict with how Ecotrust believes the project should be managed. Some interviewees for example expressed their intention to harvest trees whenever they were mature, irrespective of the rotation periods specified in their contracts, or told of how they had felled existing trees (usually eucalyptus) on their land in order to make space for the TFGB trees. In response to this, and in order to guarantee the production of reliable offsets, Ecotrust continuously attempts to 'correct' the behavior of its project participants. This takes its most benign form in the organization of training workshops, where farmers are educated about appropriate disease, pest and tree management, or in the drafting of a planting guide to clarify, amongst others, that "felling existing trees in order to plant trees for carbon payments is not encouraged" (Ecotrust 2006, p. 6). Similarly, the 2011 annual report describes how the organization began telling farmers to be more thorough with weeding and planting trees in rows, after it had become frustrated with the difficulties that badly weeded and haphazardly planted trees posed to its monitoring visits (Ecotrust 2012b). More coercive actions are hinted at in the 2014 monitoring report, which lists various "cases of indiscipline" (p. 16) and recommends working "with the farmers to develop penalties for unacceptable behavior" and cooperating "with local leaders to penalize errant farmers" (Ecotrust 2014, p. 16).

In all of this, the objective is to discipline project participants into adopting the kind of tree management practices that carbon markets prescribe. Ecotrust's interaction with farmers aims to implement a mode of behavior that is conducive to TFGB's offsetting activities, the viability of which depends on reliable and predictable rates of carbon sequestration. Given its position within the offsetting value chain, it is of course entirely logical for the organization to do this. As the project's history demonstrates however, this process has not been without problems and conflicts. Participants simply don't always follow the instructions they are given at training workshops, as one the local coordinators pointed out:

> We leave the workshop as if we understand, but just after two days you see that everyone has their own way (Interview, 150122).

Making project participants into compliant 'carbon farmers' has therefore proven difficult, in part because they are not tied into the kind of labour relationship that typifies fully industrialized economic sectors. As with most farmers (cf. Henderson 2003), their labour is not (yet) subsumed to capital in the way discussed by Marx, where the labourer confronts the means of production and the means of subsistence "as capital, as the monopoly of the buyer of his *[sic]* labour-power" (1977, p. 1026). This makes communication about, and implementation of appropriate project methods difficult. Even if participants are generally motivated to join the project for economic reasons, their land use and management decisions take form on the basis of considerations that are not easily reduced to the carbon stewardship logics that offsetting prescribes. This mismatch becomes apparent particularly when farmers feel that incentive payments no longer meet their expectations, as is increasingly the case in Mitooma district. Nearly all farmers that we interviewed had concerns about payments, noting that these were commonly delayed for months, were inexplicably lower than expected, or simply that they were left in the dark about why payments did not come at all. Mounting frustrations have driven some participants to leave the project, while some others have *de facto* done so by removing their trees in order to make other use of the land. This in turn raises questions about Ecotrust's ability to enforce its management regime for 5-25 more years after farmers have received all their initial incentive payments, as is envisaged by the project. When farmers leave the project they take their trees with them, thereby undermining TFGB's efforts to produce a stable commodity out of forest carbon.

Conclusion

This article has extended the subsumption of nature thesis beyond the industry-oriented framework that Boyd et al. (2001) originally proposed in order to help understand emerging forms of capital-nature interactions in offsetting markets. Inspired by Smith (2006), we thereby interpreted the real subsumption of nature as an increasingly prevalent strategy for the circulation and accumulation of capital in all kinds of economic spheres. As our case study illustrates, this includes the many ways in which the cultivation of indigenous trees is being mobilized in the production of 'boutique' carbon credits that relies not only on the material production of trees but also on discursive constructions of how, where, why, and by whom trees are cultivated (Paterson & Stripple 2012).

As part of this intensive production of nature, many of the processes that Boyd et al. (2001) describe can be identified. For the TFGB case this includes attempts to attain a high, reliable carbon sequestration rate by designing standardized technical specifications, giving preferential treatment to short rotation species like *Maesopsis eminii*, and enforcing a spacing and tree management regime aimed at optimizing tree growth and reducing monitoring costs. As Osborne (2015) has argued for the Scolel Té project in Mexico, which makes use of the same Plan Vivo methodology as TFGB, the ultimate result is a simplification of forestry practices that serves to reduce transaction costs and creates a form of carbon sequestration 'that capital can see' (cf. Robertson 2006). Much as in Robertson's classic study of wetland banking however, this subsumption of tree carbon to the requirements of the voluntary carbon market does not come about easily. Nature, as various scholars have noted, does not lend itself willingly to the constraining power of capital (Bakker 2005; Boyd et al. 2001; Castree 2003, 2008). Attempts to produce reliable, tradeable forest carbon run into difficulties when preferred tree species turn out to be maladapted to the range of soils and growing conditions prevalent in the project, making the trees vulnerable to pests, diseases and droughts and therefore negatively affecting carbon sequestration rates. The performative abstractions put forward in the technical specifications thereby stands in direct conflict with the complex and environmentally variable conditions under which actual tree growth occurs.

More than merely natural though, obstacles to the subsumption of nature are in the case of TFGB also profoundly socio-economic. Under the community-based framework that Ecotrust relies on, the subsumption of nature is effectively outsourced to participating communities and farmers, who assume a stake (and the corresponding risks) in the project by benefitting from installment payments and the value of the timber. To ensure that tree carbon is sequestered in a way that enables the production of tradeable offsets, farmers are thereby expected to live up to a specific planting, thinning and pruning regime, to keep track of exact land sizes and tree numbers, to combat pests and diseases and to base their involvement in the project on a cost-benefit estimation of tree cultivation compared to a range of alternative land uses. They are, in other words, submitted to a disciplining exercise that enforces the same logic employed in the subsumption of tree carbon, a logic that prescribes utility maximization and the rationalization of tree management for sequestration purposes. To all intents and purposes therefore, they are enlisted as 'green custodians' (Fairhead et al. 2012), as labourers in the new carbon economy. This is not to say that the project does not bring potential benefits to participants, that it does not contribute to afforestation, or that Ecotrust is to blame for all of the projects' shortcomings. Indeed, a detailed assessment of the positive and negative outcomes of TFGB project would need to attend to the multiple and contingent social and ecological dimensions of the project, which falls outside of the scope of this article. The point we here want to make, rather, is that the management practices of carbon forestry are fundamentally shaped by the requirements of the carbon market, which for all sorts of socio-economic reasons (not least widespread poverty) are often far from the reality on the ground. TFGB participants have their own priorities, time constraints and livelihood concerns that partly conflict with Ecotrust's ideas about 'boutique' offset production. To the extent that this puts them into conflict with the organisation's objectives, this has led to substantial misunderstandings and frustrations, causing large numbers of farmers to fall short of their contract requirements, with some even removing trees and leaving the project.

Apart from the implications this has for carbon offset claims, these dynamics raise an important point with respect to the subsumption of nature framework. As Smith (2006) notes, any analysis of the subsumption of nature ultimately requires recognition of the pivotal role of "labour as the fulcrum of the production of nature" (pp. 30-31). The characteristics of the labour process thereby become fundamental to understanding the dynamics of, and obstacles to, the reworking of nature through capitalist social relations. Ultimately this underlines the need for an analysis that considers the subsumption of nature *and* labour as dialectically related and closely entwined processes that prove hard to disentangle. As such, the subsumption framework actually provides a potentially constructive framework for structuring recent debates on the combined 'unruliness' of nature and labour in commodification process (Bakker 2005; Bumpus 2011; Fairhead et al. 2012; Leach & Scoones 2015). With respect to carbon offsetting, such concerns seem particularly relevant for community-based projects. The disciplining of labour in these contexts arguably presents a greater challenge than in industrial sectors, where labourers are more easily 'persuaded' of the prerogatives of specific production processes and therefore a more cooperative actor in the making and remaking of capitalist natures. One could perhaps expect forms of 'resistance' or 'unruliness' to take a more subtle or less pronounced form, the more the labour process itself has been subsumed to capital. Ultimately, this merely underlines the value of extending the subsumption framework beyond the spaces of industrial production, demonstrating as it does the fundamentally co-constituted character of the subsumption of nature and labour.

References

Arsel, M., & Büscher, B. (2012). Nature Inc: Changes and Continuities in Neoliberal Conservation and Market-based Environmental Policy. *Development and Change*, *43*(1), 53–78.

Bakker, K. (2005). Neoliberalizing nature? Market environmentalism in water supply in England and Wales. *Annals of the association of American Geographers*, *95*(3), 542–565.

Bakker, K. (2009). Neoliberal nature, ecological fixes, and the pitfalls of comparative research. *Environment and Planning A*, *41*(8), 1781–1787.

Bakker, K. (2010). The limits of "neoliberal natures": Debating green neoliberalism. *Progress in Human Geography*, *34*(6), 715–735.

Bakker, K., & Bridge, G. (2006). Material worlds? Resource geographies and the "matter of nature." *Progress in Human Geography*, *30*(1), 5–27.

Böhm, S., & Dabhi, S. (Eds.). (2009). *Upsetting the Offset: The Political Economy of Carbon Markets*. London: Mayfly.

Boyd, W., Prudham, W. S., & Schurman, R. a. (2001). Industrial Dynamics and the Problem of Nature. *Society & Natural Resources*, *14*(7), 555–570.

Bumpus, A. G. (2011). The Matter of Carbon: Understanding the Materiality of tCO2e in Carbon Offsets. *Antipode*, *43*(3), 612–638.

Bumpus, A. G., & Liverman, D. (2008). Accumulation by decarbonization and the governance of carbon offsets. *Economic Geography*, *84*(2), 127–155.

Castree, N. (2003). Commodifying what nature? *Progress in Human Geography*, *27*(3), 273–297.

Castree, N. (2008). Neoliberalising nature: Processes, effects, and evaluations. *Environment and Planning A*, *40*(1), 153–173.

Castree, N. (2010). Neoliberalism and the Biophysical Environment: A Synthesis and Evaluation of the Research. *Environment and Society: Advances in Research*, *1*(1), 5–45.

Cavanagh, C., & Benjaminsen, T. A. (2014). Virtual nature, violent accumulation: The "spectacular failure" of carbon offsetting at a Ugandan National Park. *Geoforum*, *56*, 55–65.

Ecotrust. (n.d.). *Technical specification for smallholder carbon management project, Bushenyi Uganda*. http://planvivo.org/docs/Single-Species-Native-Woodlot-Maesopsis.pdf (accessed 23 November 2016).

Ecotrust. (2004). *Annual Progress Report 2003 / 2004*. http://planvivo.org/docs/TGB-Annual-Report-2004.pdf (accessed 23 November 2016).

Ecotrust. (2006). *Trees for Global Benefits Annual Report 2006*. http://planvivo.org/docs/TFGB_annual-report_2006_public.pdf (accessed 23 November 2016).

Ecotrust. (2007). *Annual Report 2007*. http://planvivo.org/docs/Annual-Report-TFGB_2007_publicversion.pdf (accessed 23 November 2016).

Ecotrust. (2009a). *Plan Vivo Project Design Document: Trees for Global Benefits*. http://www.planvivo.org/wp-content/uploads/PDD_Trees_for_Global_Benefits-PlanVivo-Uganda1.pdf (accessed 23 November 2016).

Ecotrust. (2009b). *Trees for Global Benefits Annual report 2009*. http://planvivo.org/docs/2009_AnnualReport_TFGB_approved.pdf (accessed 23 November 2016).

Ecotrust. (2012a). *Trees for Global Benefits 2012 Plan Vivo Annual Report*. http://planvivo.org/docs/TGB-annual-report-2012a_published.pdf (accessed 23 November 2016).

Ecotrust. (2012b). *Trees for Global Benefits Annual Report 2011*. http://planvivo.org/docs/TGB-2011-annual-report_published.pdf (accessed 23 November 2016).

Ecotrust. (2013). *Trees for Global Benefits 2013 Plan Vivo Annual Report*. http://planvivo.org/docs/TGB-2013-AR_published-.pdf (accessed 23 November 2016).

Ecotrust. (2014). *Trees for Global Benefits 2014 Plan Vivo Annual Report*. http://planvivo.org/docs/TGB-Annual-Report-2014_Public.pdf (accessed 23 November 2016).

Ecotrust. (2016). *Trees for Global Benefit Programme: Technical specification - Agroforestry Farming*

System - Mixed Native and Naturalized Tree Species. http://www.planvivo.org/docs/ECOTRUST-Mixed-native-agroforestry-V1.0.pdf (accessed 23 November 2016).
Fairhead, J., Leach, M., & Scoones, I. (2012). Green Grabbing: a new appropriation of nature? *The Journal of Peasant Studies*, *39*(2), 237–261.
Galik, C. S., & Jackson, R. B. (2009). Risks to forest carbon offset projects in a changing climate. *Forest Ecology and Management*, *257*(11), 2209–2216.
Henderson, G. L. (2003). *California and the fictions of capital.* Philadelphia: Temple University Press.
Heynen, N., McCarthy, J., Prudham, S., & Robbins, P. (2007). *Neoliberal Environments: False Promises and Unnatural Consequences*. New York: Routledge.
Leach, M., & Scoones, I. (2015). *Carbon Conflicts and Forest Landscapes in Africa*. New York: Routledge.
Lohmann, L. (2011). The Endless Algebra of Climate Markets. *Capitalism Nature Socialism*, *22*(4), 93–116.
Lyons, K., & Westoby, P. (2014). Carbon colonialism and the new land grab: Plantation forestry in Uganda and its livelihood impacts. *Journal of Rural Studies*, *36(October)*, 13–21.
MacKenzie, D. (2009). Making things the same: Gases, emission rights and the politics of carbon markets. *Accounting, Organizations and Society*, *34*(3-4), 440–455.
Marx, K. (1977). *Capital: A Critique of Political Economy; Volume One*. New York: Vintage.
McCarthy, J., & Prudham, S. (2004). Neoliberal nature and the nature of neoliberalism. *Geoforum*, *35*(3), 275–283.
Nair, P. (2011). Methodological Challenges in Estimating Carbon Sequestration Potential of Agroforestry Systems. In B. M. Kumar & P. Nair (Eds.), *Carbon Sequestration Potential of Agroforestry Systems: Opportunities and Challenges* (pp. 3–16). Springer.
Nel, A., & Hill, D. (2014). Beyond “ Win – Win ” Narratives: The Varieties of Eastern and Southern African Carbon Forestry and Scope for Critique. *Capitalism Nature Socialism*, *25*(4), 19–35.
Osborne, T. (2011). Carbon forestry and agrarian change: access and land control in a Mexican rainforest. *The Journal of Peasant Studies*, *38*(4), 859–883.
Osborne, T. (2015). Tradeoffs in carbon commodification: A political ecology of common property forest governance. *Geoforum*, *67*, 64–77.
Paterson, M., & Stripple, J. (2012). Virtuous carbon. *Environmental Politics*, *21*(4), 563–582.
Plan Vivo. (2016). Trees for Global Benefits - Uganda. http://www.planvivo.org/project-network/trees-for-global-benefits-uganda/ (accessed 18 March 2016).
Prudham, S. (2003). Taming Trees: Capital, Science, and Nature in Pacific Slope Tree Improvement. *Annals of the Association of American Geographers*, *93*(3), 636–656.
Prudham, S. (2004). *Knock on Wood: Nature as Commodity in Douglas-Fir Country*. New York: Routledge.
Rainforest Alliance. (2013). *Verification Assessment Report for: Trees for Global Benefits, ECOTRUST in Uganda*. http://planvivo.org/docs/Verification-report_2013_TGB.pdf (accessed 23 November 2016).
Robertson, M. (2006). The nature that capital can see: science, state, and market in the commodification of ecosystem services. *Environment and Planning D: Society and Space*, *24*(3), 367–387.
Robertson, M. (2012). Measurement and alienation: Making a world of ecosystem services. *Transactions of the Institute of British Geographers*, *37*(3), 386–401.
Scott, J. C. (1999). *Seeing like a State: How Certain Schemes to Improve the Human Condition Have Failed*. New Haven and London: Yale University Press.
Sedjo, R., & Macauley, M. (2012). Forest Carbon Offsets: Challenges in Measuring, Monitoring, and Verifying. *Environment*, *54*(4), 37–41.
SEED. (2013). *Trees for Global Benefits, Uganda - Low-carbon winner 2013*. https://www.seed.uno/images/documents/725/849_Flyer_Trees_screen.pdf (accessed 14 September 2016).
Smith, N. (1996). The Production of Nature. In G. Robertson, L. Tickner, M. Mash, J. Bird, B. Curtis, &

T. Putnam (Eds.), *Futurenatural: Nature, Science, Culture* (pp. pp. 35–54). Routledge, Chapman & Hall.
Smith, N. (2006). Nature as accumulation strategy. In L. Panitch & C. Leys (Eds.), *Socialist Register 2007: Coming to terms with nature* (pp. 16–36). London: Merlin Press.
Smith, N. (2008). *Uneven Development; Nature, Capital, and the Production of Space*. London: The University of Georgia Press.
Spash, C. L. (2010). The Brave New World of Carbon Trading. *New Political Economy*, *15*(2), 169–195.
Sullivan, S. (2013). After the green rush? Biodiversity offsets, uranium power and the "calculus of casualties" in greening growth. *Human Geography*, *6*(1), 80–101.